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Political economy and market economy under Aztec rule: A regional perspective based on decorated ceramic production and distribution systems in the Valley of Mexico. (Volumes I and II)

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POLITICAL ECONOMY AND MARKET ECONOMY UNDER AZTEC RULE: A REGIONAL PERSPECTIVE BASED ON DECORATED CERAMIC PRODUCTION AND DISTRIBUTION SYSTEMS IN THE VALLEY OF MEXICO

by

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A dissertation submitted in partial fulfillment
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Doctoral Committee:

Professor Joyce Marcus, Chair
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Professor Jeffrey Parsons
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"You haven't told me yet," said Lady Nuttal, "what it is your fiancé does for a living."

"He's a statistician," replied Lamia, with an annoying sense of being on the defensive.

Lady Nuttal was obviously taken aback. It had not occurred to her that statisticians entered into normal social relationships. The species, she would have surmised, was perpetuated in some collateral manner, like mules.

"But Aunt Sara, it's a very interesting profession," said Lamia warmly.

"I don't doubt it," said her aunt, who obviously doubted it very much. "To express anything important in mere figures is so plainly impossible that there must be endless scope for well-paid advice on how to do it. But don't you think that life with a statistician would be rather, shall we say, humdrum?"

Lamia was silent. She felt reluctant to discuss the surprising depth of emotional possibility which she had discovered below Edward's numerical veneer.

"It's not the figures themselves," she said finally, "it's what you do with them that matters."

K. A. C. Manderville, *The Undoing of Lamia Gurdleneck.*

(Quoted in D. G. Kendall and A. Stuart (1961), *The Advanced Theory of Statistics, Vol. II: Inference and Relationship.*)

For my parents with gratitude,
and for my children with apologies.

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Several other people have been very closely involved in this study. First and foremost, of course, is Mary Hodge. Over the almost ten years that this project has been in the works, Mary has been both friend and colleague, and a much appreciated guide through the thickets of Aztec ethnohistory. Without her introduction to Aztec archaeology, this study would not have been. Hector Neff gave generously of his time and expertise in matters relating to INA analyses. Prior to his 1992 edited volume, no clear procedural guidelines (much less standards) existed for the quantitative analysis of compositional data sets, and I am indebted to his clear and patient advice on how to proceed. Liz Brumfiel, Mike Smith, and Fred Hicks read and commented on portions of the analyses and I appreciate their insights. Mary Parsons generously shared with me her unpublished data on the spatial distribution of Aztec spindle whorls. My debt to the theoretical perspectives of all these scholars runs deep.

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At a more personal level, this dissertation would not have been completed without the moral support of family and friends. My parents set an early example of work in progress (the stacks of books and piles of papers on the dining room table, pushed to one side to make room for dinner!) that I have followed faithfully throughout. Their interest in and appreciation of academic work has been a major source of support.

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PREFACE

The analyses summarized here are the result of a joint research project, initiated by Dr. Mary Hodge and myself in 1985, to determine the suitability of the regional ceramic collections generated by the Valley of Mexico surveys for addressing questions of economic interest. A feasibility study, based on the counts of ceramic wares as tabulated by regional survey crews along the eastern side of the Valley, demonstrated that the surface collections consistently responded to a number of analytical methods and revealed patterns that could be confidently interpreted as evidence of regional ceramic distribution systems (Hodge and Minc 1990). However, these results were considered to be somewhat coarse-grained.

Encouraged by our preliminary results and supported by grants from the National Science Foundation and the National Geographic Society, we then re-examined the regional survey ceramic collections to conduct more detailed analyses of ceramic production and exchange within the Valley (Hodge and Minc 1990, 1991). These reanalyses involved refining the existing ceramic typology with an eye to monitoring regional stylistic variability within the Valley, and extending our study area throughout the southern lakebed zone. Concurrently, we took sherd samples from selected variants of Orange and Red wares in collections at the University of Michigan Museum of Anthropology, so that INA analysis of trace elements could be performed (Minc et al. 1989, 1994; Hodge et al. 1992, 1993).

In order to complete the ceramic analyses in a timely fashion, we decided (somewhat arbitrarily) to divide the responsibilities for analysis along temporal and ware divisions within the ceramic data set (see Appendices in Hodge and Minc 1991). The emphasis on Aztec Red wares in this dissertation reflects that division of labor. Although the current work synthesizes my contribution and my views, it should be kept in mind that this is but a portion of the larger project.

TABLE OF CONTENTS

LIST OF TABLES

Table

LIST OF FIGURES

Figure

LIST OF APPENDICES

Appendix

CHAPTER 1

INTRODUCTION

General Problems and Questions

The Aztec empire, which controlled much of Mexico between A.D. 1430 and 1521, was initially forged through military supremacy. Emerging in 1428 as a coalition of three city-states -- the so-called Triple Alliance of Tenochtitlan, Texcoco, and Tlacopan -- the Aztec quickly established their hold over other polities within the Valley of Mexico (Fig. 1.1). Aided by their new dependencies, the Triple Alliance capitals then conducted a series of wide-ranging military campaigns outside the Valley of Mexico, eventually extending their control over much of central Mexico. When the Spaniards arrived in 1519, the Triple Alliance capitals were receiving tribute from provinces as far-flung as the Gulf Coast of Mexico and the Pacific coast of Guatemala.

Following their spectacular military expansion, however, the Aztec turned to a broad range of non-military tactics to consolidate and maintain their control. Like other established empires, the Aztec were concerned with the political and economic integration of previously autonomous polities into a regional system administered by the imperial capital. In this effort, the Aztec appreciated that strictly military or coercive controls were expensive to maintain and that successful imperial control often rested on a balance of coercion and persuasion. Thus, although military supremacy was critical in establishing control, political and economic approaches were recognized as the most efficient means for manipulating dependents to imperial ends.

Our understanding of the political integrative strategies employed by the Aztec to consolidate their empire comes from a series of contemporary Spanish and Nahuatl

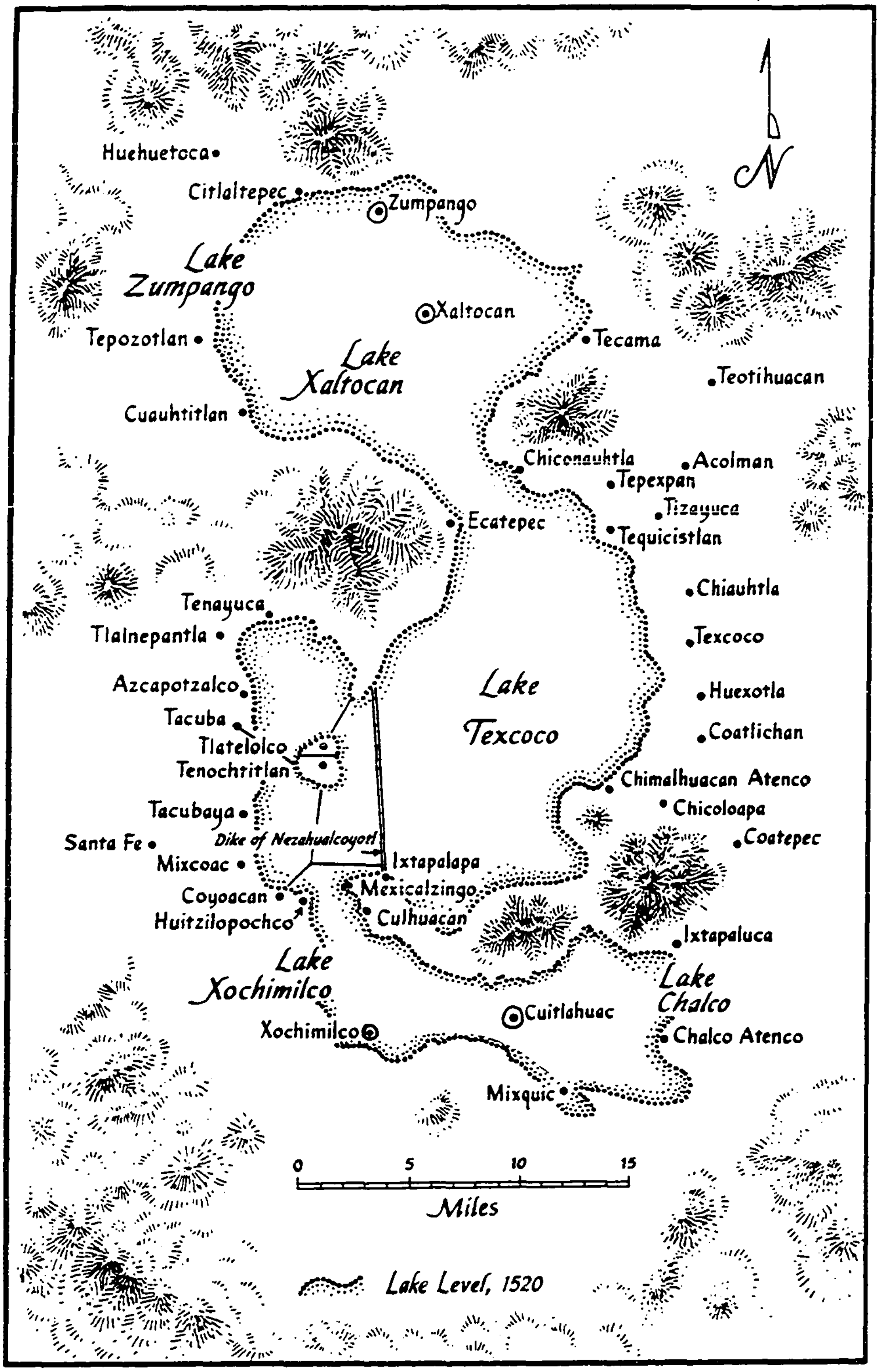


Figure 1.1. Principal towns in the Valley of Mexico under Aztec rule (after Gibson 1964:xii).

(Aztec) documents. These accounts outline a range of tactics designed by the imperial center to override traditional loyalties and institutions and to increase the dependence of local administrators on the emerging imperial elite. Within the Aztec heartland, these political strategies included the replacement of traditional rulers by more loyal members of the imperial family, intermarriage with members of the imperial dynasty, imperial largesse, the reassignment of agricultural lands and tribute to deprive traditional administrators of any landed or popular base from which to mount opposition to the center, and if all else failed, threats of military reprisal (Adams 1979; Berdan 1975; Brumfiel 1983, 1987b; Carrasco 1984; Hicks 1992; Hodge 1984; Kurtz 1978; Rounds 1979, 1982; M. Smith 1986). Taken together, these strategies represent a coherent and sophisticated imperial policy for political integration that is widely recognized by current researchers.

In contrast, there is little agreement concerning the extent of economic reorganization engendered by the rise of the empire, particularly within the arena of market economy. Although imperial tributary relations are known in some detail, the impact of imperial consolidation on the market system remains a topic of active debate. On the one hand, Aztec rule has been characterized as involving little more than the imposition of an additional level of tribute requirements that left systems of production and exchange relatively untouched, and on the other, as involving extensive governmental manipulation, leading to the regional centralization and direct control over many aspects of commodity production and exchange. In large part, this debate centers on whether or not the imperial elite actively manipulated the market system to create economic conditions that reinforced imperial rule. That is, do observed changes in economic organization reflect the imposition of an administered market economy designed to maintain the economic supremacy of the imperial elite, or the unimpeded operation of commercial market principles under the protective banner of the *pax azteca*?

The past 20 years of research within the Valley of Mexico have brought a diversity of methodological approaches to bear on the question of imperial consolidation and market economy (and have generated a considerable body of data), but have not dampened the debate. Although some scholars have argued strongly for either a commercial or an administered market economy, still others have concluded that the relationship between political process and market function is considerably more complex than can be accounted for within existing models.

This study enters into the debate at two levels. At a substantive level, I provide new data on the Aztec market system by examining changes in one sector of the market economy -- the production and exchange of Aztec Red ware ceramics. Decorated Red ware vessels were a widely available and widely exchanged commodity within the Valley of Mexico throughout Aztec times, and provide an appropriate medium for monitoring regional-scale changes in the market system through which these and other goods circulated. Although pottery was clearly not of central importance in the Aztec economy, the remnants of these vessels have survived and can reasonably stand proxy for the more perishable items of medium value that were produced and traded within the Valley.

Ceramic collections generated by regional archaeological surveys within the southern and eastern portions of the Valley are utilized to achieve two ends. First, the spatial distributions of distinct ceramic types are analyzed to reconstruct the organization of the exchange systems through which these vessels moved. Second, trace-element analyses of ceramic pastes are employed to examine the organization of ceramic production on a regional scale. Red ware types are examined for two archaeological periods: pre-imperial or Early Aztec (ca. A.D. 1150-1350), and Late Aztec period (ca. A.D. 1350-1520), during which the Aztec empire emerged and flourished. This diachronic perspective is utilized to reveal changes in the organization of decorated ceramic production and exchange systems through time that are indicative of the extent to which Aztec imperialism restructured the larger commodity marketing system.

The broader intent of this study, however, is to shift the current debate away from models that characterize the Aztec market system as *either* administered *or* commercial, and instead, focus on the interaction between political interests and market forces in the Aztec heartland. I begin by bringing together three distinct bodies of evidence -- studies of empires, analyses of market systems, and documentary information on the Aztec -- to develop a model delineating some key linkages between political economy and market economy under Aztec rule. Guided by an examination of political process under empires in general and the Aztec empire in particular, this model (1) focuses on those aspects of the economy most likely to be under direct imperial control, and (2) predicts how administrative controls over these key areas potentially altered the context of production and exchange through both direct and indirect channels.

To evaluate the explanatory power of the approach developed here, the study presents testable expectations for changes in the market economy that are then evaluated vis-a-vis changes in decorated ceramic production and exchange systems. The regional stylistic and geochemical analyses of ceramic data are employed to determine whether patterns of market system structure and market participation conform to those predicted for the study area, before and after consolidation into the Aztec empire.

Chapter Synopses

Because the theoretical basis of this study is wide-ranging, it may be helpful to provide the reader with an overview of the general approach and line of argument taken here.

Chapter 2 places this study in the context of current research on Aztec imperial economy and market organization. I begin with a critique of previous studies that have (with notable exceptions) tended to characterize the Aztec imperial economy as variants of either a *laissez faire* commercial system or an administered economy centralized under the imperial capital, Tenochtitlan. The data from these studies indicate that patterns of production and exchange within the imperial core are complex, and are not easily accounted for in terms of existing models. Equally important, these different data sets display patterns that must be explained by future models.

As an alternative to existing either/or approaches, this study seeks to determine specific points of articulation between political process and economic organization by examining specific strategies of Aztec political integration and the impact that these strategies had on the functioning of the domestic market economy of the imperial core. At the conceptual level, the inquiry focuses on the interaction between two different scales of activity: **macrolevel forces**, consisting of the political and economic actions of the dominant imperial elite that potentially affect society as a whole, and **microlevel** forces, comprising the rational responses of individual or corporate producers to the altered economic conditions under imperial rule.

The approach taken here attempts to integrate both macrolevel and microlevel processes, by assessing microlevel responses in production and exchange strategies to macrolevel changes initiated during empire formation. In subsequent chapters, macrolevel political processes (associated with the strategies and activities of the imperial elite) are identified through documentary sources. In contrast, microlevel economic responses (reflecting the productive decisions of the lower stratum of society) are examined through the archaeological record of material culture.

In **Chapter 3** I examine the characteristic political processes of empire formation and argue that these processes generate predictable features of imperial political economy (the macrolevel forces). Empires are political systems that expand through the conquest and incorporation of previously autonomous polities. Because empires are dependent on local, subjugated rulers for social and economic control over conquered territories, imperial rulers must simultaneously support these rulers as the apices of local administrative hierarchies and dominate these rulers as mere extensions of imperial rule. The imperial core accordingly relies on a mix of remunerative incentives and ideological sanctions, as well as the threat of military force, to promote their subjects' legitimacy and to ensure their compliance.

In this context, imperial control over resources emerges as a major strategy for establishing political supremacy and remunerating loyal dependents. Because administration can be costly, direct administrative controls are focused on a limited number of key or strategic resources perceived as vital to imperial interests, while much of the domestic economy falls outside the sphere of direct imperial interests. However, administrative meddling in key areas can have far-reaching consequences, and can directly and indirectly affect a broad range of economic activities. Thus, the challenge in analyzing a particular historic empire is to identify what these key or strategic resources were, and to monitor how imperial attempts to control those resources constrained or promoted other economic activities.

In **Chapter 4** I turn to the ethnohistoric record on the Aztec (1) to identify the resources of primary interest to the emerging imperial elite, and (2) to document the means by which these rulers attempted to control access and rights to these goods. This documentary analysis highlights two major administrative problems faced by the imperial elite within the imperial core: political consolidation and urban supply. Resolution of the former rested in part on imperial controls over exotic prestige items that served as the basis and symbols of political power and social status. Alleviation of the urban supply problem involved (in addition to tribute assessments and state-sponsored agriculture) the active manipulation of the market system to channel agricultural surpluses and other foodstuffs into the imperial capital.

I conclude that the problems of urban supply and controls over exotic prestige items were linked in a circuit involving both tribute and market systems. The predominant elite prestige items distributed by the state to cement political dependencies included cotton blankets and clothing (richly embroidered) and warrior costumes ornately covered with tropical bird feathers. The raw materials for these prestige items were imported into the imperial core under state auspices where they were introduced into the local market systems. The prestige items were then manufactured by subject populations and given in tribute to imperial tax stewards. The movements of the raw materials and finished prestige items appear to have been centrally controlled (at least in part), although the production of the goods was not.

The tribute-payers who produced these prestige items were dependent on the market system to obtain non-local raw materials to produce the manufactured goods required in tribute. Several authors have suggested that tribute requirements in finished prestige goods were a significant factor stimulating market participation (Berdan 1975; Hicks 1987; Brumfiel 1987b). My analysis suggests that the transformation of exotic raw materials into the prestige items demanded in tribute also helped to alleviate the problems of urban supply by generating flows of desired foodstuffs into urban markets. The need to procure exotic raw materials to meet tribute requirements stimulated rural agricultural production as a medium of exchange, while urban control over non-local goods provided the balance of payments. By directing the flows of exotic raw materials (through controls over both long-distance exchange and the introduction of these goods into local markets), imperial rulers were able to concentrate exchanges of agricultural produce for exotic raw materials in major centers where these foodstuffs became accessible to urban populations.

In **Chapter 5** I explore how administrative controls over exotic prestige goods and urban food supplies affected market structure and market participation within the Valley. The analysis suggests that the convergence of political interests and urban needs significantly distorted market structure, resulting in the development of strong vertical linkages between urban centers and dependent communities at the expense of horizontal market articulation. These market imperfections, in turn, affected strategies of market participation by the rural populace (the microlevel responses). Although the rural population was necessarily drawn into the market system to meet tribute assessments, their degree of market participation and market reliance depended on their ability to produce for the urban market. The model predicts that rural responses were largely constrained by the productivity of their agricultural resources, resulting in distinct patterns of market participation and commodity production within different parts of the Valley.

The second half of this study comprises an empirical evaluation of the new model through an examination of market system structure and market participation within the Valley of Mexico before and after consolidation in the Aztec empire. As I discuss in **Chapter 6**, this study focuses on decorated ceramics as a medium for monitoring changes in the organization of commodity production and exchange in the Valley of Mexico between ca. A.D. 1150 and 1520. In particular, this study concentrates on decorated Aztec Red wares, an important ceramic ware used for serving vessels throughout the late prehispanic period. This chapter presents a revised typology for Aztec Red wares, aimed at elucidating regional stylistic variability, as well as a series of quantitative seriations that clarify the chronological relationships among these stylistic variants.

The analyses of ceramic production and exchange systems are organized in two parts. In **Chapter 7** I employ regional analyses of ceramic distributions to reconstruct the organization of ceramic exchange systems. It is widely recognized that different market systems structure commodity flows in different ways and thus generate predictable patterns of artifact distribution. Accordingly, Red ware ceramic types and variants are mapped, and their distributions analyzed to characterize regional market system structure along the organizational dimensions of scale, network, and hierarchy, for the periods before and after imperial consolidation. While Aztec Red wares are clearly not representative of all commodities, their distributions are indicative of the basic structure of exchanges involving a broad range of utilitarian goods within the study area. These results are then used to evaluate models of market system organization commonly applied to the Aztec case and to test specific hypotheses derived from the model developed above.

In **Chapter 8** I utilize trace-element (Instrumental Neutron Activation or INA) analyses of ceramic pastes to examine changes in the regional organization of ceramic production under Aztec rule. As the economic geographer Carol Smith (1977:144) has noted, marketing systems are more than the organization of exchange, they also constrain and create opportunities for production. Thus, specific patterns of market relations can generate predictable patterns of commodity production as well. The characteristic geochemical signatures of Red ware ceramic clay sources are identified and utilized to indicate the number and probable locations of production centers for these vessels. In addition, the products of each source are examined to determine changes in production scale, intensity, and degree of specialization through time.

Finally, in **Chapter 9** I present a diachronic overview of observed changes in Red ware ceramic production and exchange, and return to the question presented at the beginning of this work -- What was the extent of market system reorganization engendered by the rise of the empire and to what degree did that reorganization serve to perpetuate imperial rule? I conclude that the market system was an active arena for controlling wealth and hence political power in Aztec society. Rather than direct manipulation, however, the efforts of the emerging imperial elite to control a few extremely valuable strategic resources (the macrolevel forces) indirectly generated imperfections in the regional market system structure that had significant and predictable consequences for commodity production and market participation (the microlevel responses) within the Valley. The resulting market structure served political interests and satisfied urban food needs, but severely constrained market reliance and hence economic integration within the imperial core.

At the substantive level, then, the regional patterns of ceramic production and exchange revealed in this study contradict long-standing views that characterize the Aztec market system as *either* an administered *or* a commercial system. By focusing instead on the *interaction* between imperial political concerns (the macrolevel forces) and market rationality (the microlevel responses), the explanatory framework developed here provides a new perspective on these regional developments and suggests an alternative direction for future thought and research on the Aztec market system.

CHAPTER 2

APPROACHES TO MARKET ECONOMY AND POLITICAL ECONOMY IN THE VALLEY OF MEXICO

To understand the role of economic development under empires, we must look at two issues of particular importance. These are (1) the **form** of dominance-dependence relationships found between conqueror and conquered, and (2) the **force(s)** giving rise to, supporting, and perpetuating that particular relationship (Cohen 1973:229). The current debate in Aztec studies indicates that both the structure of imperial economic organization, as well as the different administrative, social, historical, and commercial forces generating that structure, remain in doubt.

Market Economy vs. Political Economy: Current Views

Current views on Aztec imperial economy generally reflect one of three theoretical positions, each of which focuses on a different set of factors and driving forces responsible for economic development under the Aztec empire. As outlined by Brumfiel and Earle (1987), these positions are (1) the **commercial development models** that focus on specialization and exchange as factors integrating a regional market economy, (2) the **adaptationist models** centering on the role of political elites in creating and sustaining regional economic integration, and (3) the **political models** that concentrate on the role of imperial rulers in manipulating the economy to meet their own ends. Each of these perspectives has provided insights into, but only partial resolution of, the question of Aztec imperial economy and regional market system development. A brief overview of their significant contributions and weaknesses follows.

Commercial Development Models

Commercial development models focus on the role of microeconomic forces in creating a regional market economy from the bottom up. Increases in specialization and exchange are seen as an integral part of economic growth generated by the pursuit of individual advantage and the greater economic efficiency accrued by division of labor (Brumfiel and Earle 1987:1). Commercial systems have several definitive characteristics, including: (1) a series of full-time specialists of both utilitarian and elite goods, who do not produce their own food staples; (2) a corresponding body of producers who supply food staples and other necessities; (3) a market network to bring these complementary elements together effectively and continuously; and (4) a state power capable of maintaining order and stability for production and exchange, but with minimal interference in the actual functioning of either economic sphere (Brumfiel and Earle 1987; Hicks 1987). Because the market plays an essential role in integrating or bringing together different specialist producers within a commercial economy, the resulting configuration is often termed a "market-integrated economy."[1]

The documentary evidence suggests that within the Aztec capital of Tenochtitlan, the essential elements of a commercial economy (specialized producers, integrative markets, and a minimum of administrative controls) were in place at the time of European contact (Hicks 1987). A large number of skilled craftsmen, organized into wards (*calpulli*) composed of others of the same profession, lived within the capital where they worked at their professions full time (Hicks 1987:96). Although most of these craftsmen were skilled in the luxury trades, utilitarian craft specialists are also mentioned. Many of the Tenochtitlan specialist producers of luxury items worked primarily for royal or elite patrons (Brumfiel 1987b); however, some specialists produced for the market place as well (Sahagún 1959-1982, Book 9:80).

Complementing the presence of full-time specialists was the level of market activity within the capital. The Spaniards' awed descriptions of the great Tlatelolco market attest to the great volume and variety of items exchanged at this central market. An estimated 60,000 buyers and sellers congregated in the Tlatelolco market on a daily basis (Cortés 1928:87) to exchange goods covering the entire spectrum of subsistence goods, utilitarian commodities, and luxury items (Cortés 1963:72-73; Díaz 1956:215-17; Las Casas 1967, Vol. I:367; Sahagún 1950-1982, Book 8:67-69). This market activity was well-regulated and overseen by market judges commissioned with maintaining peace and fair trade, but the free flow of exchange does not appear to have suffered from strong governmental controls (Sahagún 1950-1982, Book 8:67, 69; Díaz 1956:216).[2]

The coexistence of these complementary elements (specialized producers and an integrative market) within the imperial capital has led Hicks (1987) to conclude that the imperial core was verging on a market-integrated economy. The extension of this model to the imperial hinterland, however, is more problematical. Documentary descriptions of markets outside of Tenochtitlan-Tlatelolco are scarce, but similar levels of exchange activity are sometimes assumed. M. Smith (1979:111), for example, quotes Torquemada (1969:555) to the effect that Tenochtitlan was typical of markets throughout central Mexico, and that documentary accounts are scarce because the Spaniards had little interest in describing them: "in order not to lengthen this chapter with innumerable matters, I will reduce all [the markets] to those of the city of Mexico [Tenochtitlan]: because you will see that through these it is possible to understand the markets of all the other parts of the land." Although it is probable that most cities and towns had regular periodic markets (Blanton 1994), the key question is whether the existence of these markets can be interpreted as evidence of a market-integrated economy.[3]

The Aztec market system on the eve of the Spanish conquest has been characterized as a complex interlocking system consisting of a hierarchy of periodic market centers serviced by both local producers and itinerant merchants that provided a high degree of economic integration for regional and community-level specialization in production (Gibson 1964; Berdan 1975, 1985; M. Smith 1979; Hicks 1987; cf. Evans 1980; Kaplan 1965; Kurtz 1974). One primary line of evidence to infer that markets formed an integrative network linking specialist producers is the use of central place theory (CPT) to infer that market principles were the dominant forces generating a hierarchy of settlements. Briefly, CPT holds that if the market principle is dominant then microeconomic forces will generate a predictable spatial patterning in the distribution and hierarchical arrangement of economic central places; conversely, if this predictable pattern is observed to be present, then the underlying market principle is assumed to have been operative.

Two separate central place analyses of the Valley of Mexico have concluded that Late Aztec settlement locations generally conformed to predicted central place models, and have argued on this basis for the operation of commercial factors and hence the foundations of a market-integrated economy under the Aztec empire. However, these analyses identify different structural patterns and hence different commercial principles to be operative. M. Smith (1979) found that Aztec settlements along the eastern side of the Valley most closely conformed to the K=3 or market principle pattern. In contrast, Blanton (1994) found the settlement hierarchies in this same area to conform to a solar system within the Texcocan domain (suggesting the suppression of competing market centers around the major market at Texcoco), but with the K=4 (or transport principle) pattern operative to the north and south (Blanton 1994 [ms.:49]).[4] However, Blanton identified only very partial hierarchies in those areas demonstrating either arrangement, suggesting that market network development was incomplete at best.

In spite of the recurrent use of this approach, the appropriateness of central place theory in a locational analysis of the Valley of Mexico has been strongly criticized (Evans

1980). The successful application of central place theory to infer that market principles were the dominant forces generating a hierarchy of settlements rests on several behavioral, geographical, and temporal assumptions.[5] Where these underlying assumptions cannot be verified, the results of the analysis may be questionable, at best. As Evans (1980:870) argues, "if the actual pattern resembles the ideal pattern in spite of such a violation to its theoretical assumptions, then the resemblance is quite possibly accidental, and other factors are responsible for the distribution of settlements."

In the Aztec case, the most questionable assumptions are (1) that market exchange was integrated and part of a single region-wide system and (2) that consumers had a choice as to which market they patronized such that there was competition for retailers (C. Smith 1974:168-169). Given this competition, markets would be situated to maximize access to consumers. In particular, both the K=3 and the alternative K=4 locations assume that rural market participants are free to choose market destinations.

Although these conditions may have been met following the rise of the Triple Alliance empire, most of the settlements that came to function as primary market centers under the Triple Alliance empire were established during the Early Aztec period, under very different political and economic conditions. At that time, almost continual conflict between polities severely restricted exchange between hostile territories (Minc et al. 1994) and may have been a significant factor in determining the maximal spacing of Early Aztec political centers. In the Late Aztec period, these local centers were incorporated into an expanding unitary structure, but were not in the process vastly restructured or eliminated (Blanton et al. 1981). As a result, the regular spacing of primary "market" centers may more accurately reflect historical attempts to maximize distance and minimize conflict between potentially hostile polities, than competition for free-ranging market-goers.

Settlement systems are determined by multiple factors, including ecological, economic, geographic, political, religious, and historical circumstances. Since the relative contribution of these different factors is precisely what we wish to determine, the conclusive use of central place theory may be premature in the Valley of Mexico, a factor underscored by the substantially different hierarchical patterns identified by independent central place analyses.[6] Seen in the light of these qualifications, the conclusions reached through central place analyses require further substantiation with more direct measures of exchange interactions.

Unfortunately, direct measures of market exchange activities remain limited. Some support is provided by archaeological studies that report the increased availability of non-local utilitarian goods, indicating the functioning of a regional exchange network (Brumfiel 1976:198, 1980), and the presence of exotic goods in both commoner and elite households, suggesting the widespread use of market networks (Hodge and Smith 1991). However, recent and on-going studies of utilitarian decorated ceramics suggest that commodity flows were not articulated into a single, regional system; rather, the spatial patterning of ceramic design elements indicate the operation of sub-regional market spheres and different levels of market integration within the Valley (Hodge 1989, 1990, 1992; Hodge and Minc 1990; Hodge et al. 1993).

The evidence for specialized production in the hinterlands similarly does not provide unqualified support for the commercial development model. Specialized commodity production clearly existed in the hinterlands, and much of this was apparently organization at the community level. Certain communities were famous for specific types of goods. Most of this community-level specialization appears to have been based on the spatial distribution of natural resources (Blanton 1994). Common specializations include wood products in communities situated in the lower piedmont, maguey and nopal production in the upper piedmont zone (J. Parsons 1971:221; Parsons and Parsons 1990), and the exploitation of lacustrine zone for food resources and salt production (J. Parsons 1971:226, 1994; Blanton 1972:176). Other community specialties, however, were not apparently linked to the distribution of resources. For example, six communities were famous for their ceramics at the time of European contact, although good ceramic clays were widely available along the lake margin (Hodge et al. 1993).

In contradiction of the expectations for full-time specialization, however, craft production in the hinterlands may well have been a part-time occupation. Brumfiel's (1987b) analysis of the *Matrícula de Huexotzingo* (Prem 1974), an early colonial census for the Huexotzingo province, argues strongly that much commodity production was carried out by part-time specialists. According to Brumfiel, the census reports that only 20% of the adult male population were engaged in specialized production or service occupations. Of these, 24% worked at their professions full-time and held no land, while an additional 24% were professional merchants. The remaining 52% of these specialists presumably combined their specialties with subsistence agriculture (Dyckerhoff and Prem 1976:165).

Although it is not clear to what extent the *Matrícula* represents continuity with prehispanic patterns, Brumfiel (1987b) argues that the early colonial period model is consistent with archaeological data for the Aztec period.[7] Systematic surface surveys of Huexotla (Brumfiel 1976, 1980) and Xico (Brumfiel 1985, 1986) revealed that tools and waste products associated with craft production were either ubiquitous (indicating non-specialized production) or they occurred in very light concentrations (indicative of part-time specialization) (Brumfiel 1987b). Such remains were never found in the large, dense concentrations that would suggest full-time specialization. A similar pattern is reported for obsidian production at Late Postclassic Teotihuacan (Spence 1985). Here, obsidian tool manufacture was apparently the work of part-time specialists, with the production unit consisting of one or a few closely related households. Under the Triple Alliance, the level of obsidian production increased, but this increase resulted not from a change in the scale of production, but from an increase in the number of part-time producers.

Recent work at Otumba, however, suggests a more complicated picture. An amazing variety of craft activities is reported for this site, all of it apparently taking place within households either as single units or organized into barrios (C. Charlton 1991, 1994; T. Charlton, Nichols, and C. Charlton 1991, 1993). Yet certain utilitarian goods (such as groundstone and ceramic figurines) appear to have been produced on a full-time basis, while others (including cotton, maguey, obsidian bifaces, ceramic censers, and spindle whorls) were a part-time industry (T. Charlton, Nichols, and C. Charlton 1991, 1993). C. Charlton (1991) suggests that the full-time industries represent high-demand commodities; every household, for example, was a consumer of ceramic figurines and groundstone *metates*. It is interesting to note, however, that the full-time industries are relatively few in number in contrast to the more general pattern of part-time specialization. Overall, the greater concentration of craft production found at Otumba relative to other provincial centers may well relate to its greater distance from Tenochtitlan and its position outside the market sphere of that imperial center (Nichols 1991, 1994; Nichols and Charlton 1988).

Two arguments have been advanced to account for the deviation from the expected commercial pattern of full-time specialization. Critics of the commercial development model would argue that full-time specialization of either agricultural produce or commodities cannot develop if the market does not function to bring these complementary elements together continuously and effectively (C. Smith 1974; Plattner 1989). In this case, part-time specialization is seen as a function of market imperfections that undermined the role of the market system as a reliable source of necessary goods. Other investigators, in contrast, conclude that an unreliable subsistence base in many parts of the Valley precluded complete reliance on agriculture (Brumfiel 1987b, following Hicks 1987). Thus, part-time craft production is seen as a strategy for buffering variable agricultural production. These two interpretations are strongly linked, since an integrative market network also serves to buffer local variability in agricultural output.

In sum, data marshalled in support of the commercial development model suggest that commercial development was uneven or incomplete at best. In place of the expectation of full-time specialized production, craft and commodity production appears to have been carried out in two different contexts (Brumfiel 1987b). Urban artisans producing luxury items for consumption by the elite (such as metal workers, lapidaries, and featherworkers) were full-time specialists who worked directly for elite patrons and were attached to their patrons' households, while producers of utilitarian items appear to have been part-time, independent specialists dispersed in rural areas. Overall, the evidence for market integration is greatest within the imperial capital. Within the surrounding Valley, the data generally suggest an increase in extra-local exchange, but relatively little is securely known about the organization and integration of the market networks. Thus, although aspects of the commercial development model are strongly supported, the argument is more appropriate for the capital than to the hinterlands. Major gaps still exist in our knowledge of commercial market development outside the capital.

Adaptationist Models

Adaptationist models assign an active role to political elite in creating and sustaining regional economic integration. In this view, political elites intervene to organize a more effective subsistence economy; as a result, powerful, centralized leadership develops in contexts where effective management is either necessary or beneficial to the larger society (Brumfiel and Earle 1987:2).

Two management problems have been identified as requiring political intervention within the Valley of Mexico. These are (1) high environmental diversity and (2) urban supply. Sanders (1956; Sanders and Price 1968:188-93) initially proposed that centralized leadership developed to facilitate market exchange in regions of high resource diversity by maintaining peace within the market region and adjudicating disputes. This model is supported by evidence of intensified regional exchange in the Valley of Mexico following its unification under the Aztec state, although factors other than resource diversity may have triggered this intensification (Brumfiel and Earle 1987:2; Brumfiel 1980).

More recent theories of Aztec imperial organization have focused on the problems of supplying the burgeoning urban population in Tenochtitlan as the driving force structuring the imperial economy. In general, these models focus on the development of an urban-rural or core-periphery symbiosis that stimulated both agricultural production and the development of a market system centered on the urban capital. Key attributes of this model are more intensive food production in rural areas and more intensive craft production in the urban sector, coupled with the exchange of complementary goods within a market setting.

The most popular argument reasons that the urban center created an artificial symbiosis by concentrating craft production in the imperial center as complementary to rural agricultural production (Calnek 1978a; Hassig 1985; Santley 1986, 1991). Hassig (1985), for example, has argued that due to advantages of central location and economies of scale, urban craft producers were able to out-compete rural producers. In turn, the lower prices for mass-produced craft goods stimulated greater rural production of foodstuffs that flowed into urban center in exchange for craft goods. The resulting market system is generally envisioned as a dendritic structure that channeled agricultural surpluses directly into the urban market of Tenochtitlan, and network analyses of the Aztec road system give some support to this view (Santley 1986, 1991).

In a somewhat related model, Hicks (1987) argues that the rulers of Tenochtitlan sought to strengthen the metropolitan market through the production and sale of luxury goods so important for display and competitive gift-giving. This strategy was actively supported by the concentration of artisans specializing in elite goods (lapidaries, feather-workers, et al.) as well as the centralization of *pochteca* trade in luxury raw materials within that city. The Tlatelolco market thus came to have the largest and best assortment of luxury goods, and its regular patronage by nobles and others seeking such goods would have created opportunities for the suppliers of more mundane goods as well (Hicks 1987:98). Since the nobility were also the largest land-owners, they commanded the flows of large volumes of tribute foodstuffs that could be used to underwrite expensive purchases in luxury goods.

Obviously craft specialization existed in Tenochtitlan as well as in other urban centers as noted above; there are, however, a number of problems with this model. First, the type of goods involved in generating the rural-urban symbiosis remains unclear; both elite and utilitarian goods are mentioned at various times (cf. Hassig 1985:137 vs. 1985:133; Hicks 1987). On the one hand, it is doubtful that elite goods would have the desired effect on the decision-making of local agriculturalists (Brumfiel 1980:475) since these goods circulated outside the sphere of commoner consumption. On the other, it is also doubtful that the urban center could adequately supply all utilitarian commodities for the entire Valley or even a substantial portion of them (Sanders 1980:474, reply to Brumfiel 1980) given the primitive technology and the energetics of certain crafts (Arnold 1985:203-210; Sanders and Santley 1983; Sanders and Webster 1988). Furthermore, it would be difficult to control or concentrate goods from multiple sources (such as most utilitarian goods); such concentration was likely not a cost-effective strategy of the part of the imperial elite.

In contrast, Brumfiel (1976, 1980; see also Blanton 1985) has argued that the influx of tribute goods depressed prices for commodities received in tribute and thus depressed rural production of these goods, leading to a rural-urban symbiosis in primary-secondary production:

> "The passage of non-perishable tribute goods into the market system seems to have had a noticeable impact on rural production. By lowering the value of most nonfood commodities in relation to foodstuffs, it induced a reallocation of effort in favor of the production of food; by improving the ability of the market to provide a steady supply of nonfood items to rural households at reasonable prices, it created conditions in which peasants would sacrifice their economic autonomy for greater dependence upon commercial activity" (Brumfiel 1980:466).

Brumfiel's model is supported by her work at two major sites, Huexotla and Xico, where an apparent decline in craft production was accompanied by evidence of more intensive agricultural production. However, as Brumfiel admits, there is no indication of where craft production was taken up. In addition, there are several causal links that remain unspecified in this model. First, what volume and what types of nonfood commodities were received as imperial tribute? The current data on tribute assessments do not indicate that utilitarian commodities were received as tribute in sufficient quantities to have had the proposed effect. Secondly, it is not clear how these tribute goods entered into the market to affect production strategies elsewhere.

In summary, the adaptationist models hold that highly integrated political units owe their existence to their ability to bring about and sustain complex, efficient economies (Brumfiel and Earle 1987:2) that resolve economic problems resulting from regional resource diversity or a concentrated urban population. Thus, the efficiency in the production and distribution of basic necessities is considered more consequential than efficiency in the production and distribution of sumptuary goods (Brumfiel 1987b:102). Overall, however, the evidence seems to indicate growth of elite goods production, not utilitarian crafts in the major cities (Monzón 1949; Brumfiel 1987b). Further, secondary production was not situated primarily in Tenochtitlan-Tlatelolco, nor was it an urban monopoly in any sense. Rather, ecologically based community specialization in utilitarian commodities was found throughout the Valley (Blanton 1994).

Political Models

Political models assign primary emphasis to the goals of political leaders, but in contrast to the adaptationist models, the political elite (rather than the general populace) are the beneficiaries of these economic activities. This view holds that political elites consciously and strategically manipulate aspects of the economy to create and maintain social inequality, to strengthen political coalitions, and to support new institutions of control (Brumfiel and Earle 1987:3). Mobilization, the transfer of goods from producers to political elites as either taxes or tribute, is fundamental to political development, supporting the elites and enabling them to fund new institutions and activities calculated to extend their power. However, control and manipulation of the flows of other goods and economic activities (including foreign commerce, certain food crops, weaponry, and wealth items) are also key factors in building political power.

A major proponent of the political economy approach for the Valley of Mexico is Pedro Carrasco (1978, 1980, 1983). By combining insights from both the Polanyi school of economists and Marxist models for the Asiatic mode of production, Carrasco argues that a free or commercial market economy cannot develop in a class structured society where the basic means of production (land and labor) are controlled by the elite stratum. Rather, utilizing documentary sources, he characterizes Aztec Mexico as having a command economy based on a system of production that relied on political control of land and labor, and on a tribute system and state-controlled long distance exchange in prestige goods for accumulating surpluses and perpetuating social relations (Carrasco 1980:79). In this view, the Aztec market system, although regulated by the state, is considered of little interest to the imperial elite and basically disarticulated from other, politically more important sectors of the command economy (i.e. the tribute system and long-distance exchange).

Other proponents of political models have focused on the role of prestige items in structuring regional political interactions. Within Aztec society, elite craft products acquired importance as a type of "political capital" (Brumfiel 1987b), displayed and distributed by rulers to define their own social status and the statuses of others, with all the rights and obligations adhering thereto (Brumfiel and Earle 1987:4). Thus gifts of exotic prestige goods were used to reward clients, attract allies, and solicit favors.

Under Aztec imperial rule, royal largesse in the form of prestige goods served to restructure political relations in two important ways. First, royal patronage of local elites increasingly took the form of remuneration in valuable craft items rather than rewards in tribute-producing lands, a strategy that placed local rulers in a situation of dependency on Tenochtitlan as the basis of their wealth, prestige, and local authority. This elite incentive plan ensured compliance with Tenochtitlan, while generating competition for imperial favor among local elites and preventing the emergence of organized opposition to the state.

Secondly, luxury craft goods were instrumental in linking prestige to achievement in warfare and hence to the interests of the state. Success and valor on the battlefield were marked by the bestowal of elaborate warrior costumes and the right to wear specific types of dress, adornment, and precious goods. Since imperial conquest simultaneously increased the supply of precious raw materials and provided the opportunity for their attainment, individual interest coincided with state goals. As a result, both Aztec rulers and the traditional ruling elite subject to them were linked by common interests (Calnek 1978b; Rounds 1979).

Models focusing on the political manipulation of prestige goods in the Aztec economy point to the emergence of Tenochtitlan as a center of elite craft production and argue that this emergence is not a consequence of Aztec imperialism but structurally related to the process of political integration. The impact of this political restructuring on other aspects of the economy, such as subsistence agriculture or utilitarian craft production, are not generally explored. Many analysts conclude that the production and consumption of elite craft goods and tribute items represent a circuit relatively disarticulated from the more mundane aspects of domestic economy.

Brumfiel (1987b), however, identifies some key links between political process and the market system that deserve further exploration. She suggests that tribute flows were a potent stimulus in the development of regional exchange:

> "Some tribute goods collected by the Aztec ruler and distributed to members of his court were used by the elite to purchase subsistence goods in the market place (Calnek 1978a:101-2). This was particularly true of cloth and cacao which served as media of exchange. Hinterland commoners selling subsistence goods in the marketplace in exchange for cloth and cacao were able to acquire the quantities they needed for tribute payment. Cloth and cacao would be paid in to the capital as tribute and flow out again in payment for food" (Brumfiel 1987b:109).

Brumfiel suggests that although this flow led to an increased volume of regional exchange, it did not necessarily promote a regional division of labor and hence the efficiency of the regional exchange system.

Mixed or Compromise Models

Relatively few scholars have proposed bridging the approaches presented above. Some, however, argue for a compromise model in which specific aspects of the economy were strongly state-controlled while other aspects excited little administrative interest or intervention (Hicks 1982a; Berdan 1983; Davies 1987:150; Smith and Hodge 1994).

In general, these authors suggest that different types of commodities circulated through different systems, and were thus differentially affected by market and administrative forces. The primary distinction generally made is between utilitarian items and luxury items. Hicks (1982a), for example, suggests that trade in mundane subsistence goods fell outside the sphere of elite interests and thus operated with minimal administrative intervention, probably through an interlocking market network system. In contrast, the trade in luxury goods most likely moved along lines of political authority.

Theoretical Orientation of this Study

It is clear from the preceding presentation that these three perspectives (the commercial development, adaptationist, and political intervention) have contributed significantly to our understanding of Aztec economy; all three have elucidated the functioning of specific aspects of Aztec economic organization. It is also clear that none of these models provide a complete nor completely accepted picture of market system organization under Aztec rule. The problem lies in singling out any one factor as representing the primary or dominant economic force, in spite of the growing body of empirical and theoretical studies that strongly suggest that market systems respond to multiple factors (Claessen and van de Velde 1991:19; C. Smith 1977; Brumfiel 1987b; Evers and Schiel). The challenge, therefore, is to develop a model for the Aztec market system that elucidates the links between commercial, adaptive, and political forces within the context of imperial expansion and consolidation.

The present study attempts to develop that integrated stance. It seeks to move beyond the general models of market economy that characterize market systems as either wholly dominated by, or wholly outside, the sphere of imperial interests, and instead, to focus on the **interaction** between political interests and market forces under Aztec rule. Briefly, the goals here are to (1) identify key points of articulation between political actions and economic conditions within the Valley of Mexico, and (2) predict how those ramify through the larger market economy, comprising the interaction of systems of commodity production and exchange.

At the outset, the approach taken here follows the lead of Carol Smith in assuming that all economies reflect a mixture of political, ecological, and commercial factors. Reduced to its essentials, Smith's argument is that all economies are instituted, that is, all economic activities are embedded in a cultural-historical matrix (C. Smith 1977). She further argues (1977:119) that economies may be instituted in different ways and that the way in which the economy is instituted strongly affects the opportunities for production and exchange.

In essence, Smith's argument is that we cannot in reality dichotomize economies into purely commercial or purely political:

> "To say that the economy is instituted is not to deny that peasants are for the most part 'economic men'. It is only to observe that there are no pure economies -- there are only historical or political economies which provide institutional constraints on economic behavior. If we ignore the constraints, we may use the universal, invariant, market principle to analyze economic behavior. But if we

ignore the constraints, we can do little to explain the organization of any **real** economy, the actual response of any **real** economic men" (C. Smith 1977:144).

The central aim of this study, then, is to examine the ways in which the Aztec market system was instituted under imperial rule, by elucidating institutional constraints on economic behavior within the sphere of commodity production and market exchange. Further, this study attempts to assess the degree to which the institutional constraints resulted from the process of imperial conquest and consolidation, and conversely, the degree to which the resulting economic structure contributed to imperial integration. To this end, the study examines the ways in which imperial political processes affected production and exchange systems by identifying key facets of imperial political economy and assessing how these directly and indirectly affected the economic decisions of producers participating within the market system.

The assumptions underlying this approach are, at the most general level, that political and economic processes are driven by the actions of self-interested social groups within the context of environmental and societal constraints and possibilities. It is therefore necessary to identify the participants (imperial elite, local elite, and commoners), their respective goals, their strategies for meeting those goals, existing constraints on meeting those goals (due either to conflicting goals or external factors), and finally, implications for production, exchange, and control of goods, since material culture provides the means for monitoring these developments.

In stratified or state societies, the inherent uneven balance of power between elite and commoners places greater control in elite hands; this necessarily gives precedence or causal priority to the imperial elite as the dominant social stratum. In the aggregate, political decisions pursued by the imperial elite potentially affect society as a whole. As a starting point, then, the task is to determine how imperial goals, strategies, and policies affect goals and options of other participants. This is not, however, to deny the significant role of environmental factors, since responses to imperial dicta are worked out within the context of the social and natural environments.[8]

This study begins by examining the political problems endemic to empires as a model for understanding the political problems facing the Aztec imperial elite. The study then assesses how the central political concerns shaped the goals, strategies, and policies of imperial rulers and develops expectations for the ways in which these imperial goals in turn affect the control of goods, based on the ways in which different goods function or are used to achieve political and economic ends of both local and imperial rulers. It is suggested here that imperial concerns for political security and stability generated the over-arching structure of imperial economy, both **directly** through manipulation or control over the flows of material goods, and **indirectly**, by creating economic stresses and opportunities, by limiting certain economic responses and favoring others.

Methodological Approaches

The methodological approaches for investigating Aztec imperial economy and market economy are threefold. First, this study places economic development in a diachronic perspective. Much of the debate concerning Aztec imperial development stems from a very partial knowledge of pre-imperial systems. We therefore need to determine the baseline or starting configuration of market structure in order to examine changes due to imperial integration. However, to merely attribute observed economic changes to empire formation becomes an exercise in circular reasoning; it is necessary to specify ways in which political processes affected aspects of economic organization.

Accordingly, the second methodological tool utilized here parallels the regional analysis approach advocated by economic anthropologists (Barlett 1980:549-500; Roseberry 1989; Gladwin 1989) that structures the inquiry around the impact of macrolevel processes on microlevel behavior. In keeping with this perspective, I suggest that forces giving rise to specific forms of economic integration can be monitored through the interactions between two levels of activity: the **macrolevel** forces, consisting of the political and economic goals, strategies, and policies of the dominant imperial elite that affect society as a whole, and **microlevel** forces, consisting of the responses of individual or corporate producers to the economic stresses and opportunities engendered by imperial rule.

In brief, this approach holds that macrolevel changes in political organization (in this case brought on through the processes of imperial expansion and consolidation), directly and indirectly altered the context of production and exchange within the imperial core. These macrolevel changes in turn affected the individual, decision-making producer, who was not just a passive bystander, but a reactive actor. By making plans and decisions in response to these macrolevel forces, microlevel producers in the aggregate generated structural changes in economic organization, observable again at the macrolevel (Barlett 1980:549-550; Gladwin 1989:415). In this study, I attempt to integrate both macrolevel and microlevel processes, by assessing microlevel responses in production and exchange strategies to macrolevel changes engendered by empire formation.

Third, the methodology employed here utilizes and balances both historic and archaeological sources of information. Macrolevel forces, reflecting the actions of the imperial and upper level elite, are best recorded in documentary sources. Microlevel forces, corresponding to the reactions of individual commoner producers, are generally visible only through archaeological investigations.

The result is a melding of macroeconomic and microeconomic theory. That is, following the lead of Brumfiel (1980:475), I assume that "once the institutional context of an economy is defined and once the goals of participants are understood we can probably expect to find participants pursuing their goals according to some sort of least-cost/maximum-return principle." It is hoped that this approach will prove complementary to existing studies of Aztec market organization and provide additional insights into the complex problem of imperial economic integration.

Notes to Chapter 2

[1]Although active market exchange may also take place in societies with poor commercial development, the market is not a reliable source of everyday necessities in these situations. Rather, the markets are patronized by producers who trade in the market when they happen to have a surplus to exchange or need some item they do not produce. Such market activity is seen as "peripheral" to the economy, rather than serving as a primary integrative force (Bohannon and Dalton 1965).

[2]For the famous Tlatelolco market, the presence of market judges and supervisors to regulate prices and adjudicate disputes (Berdan 1975:205-206), the imposition of market taxes (Berdan 1975:208-209; Cortés 1928:93; Durán 1967, Vol. I:180), and regulations prohibiting exchange outside the marketplace (Berdan 1975:206; Durán 1971:276) all represent administrative controls over market exchange. What is not clear is the degree to which this intervention inhibited the functioning of a market-integrated economy within the capital.

[3]Although most researchers assume that all major cities and most towns were serviced by a marketplace, in only a few cases can the presence of a market be clearly documented (see Blanton 1994:Appendix).

[4]The K=3 pattern is the most efficient system for predominantly rural landscapes and is especially effective in facilitating rural-urban exchange (C. Smith 1976a:20), while the K=4 or transport principle minimizes transport costs and is the most efficient for servicing agglomerated settlements with bulked goods (C. Smith 1974:174-175).

[5]The behavioral, geographic, and temporal assumptions underlying the successful application of central place theory are as follows:

1. **behavioral assumptions**

   a. consumers have a choice as to which market they will patronize such that markets compete to attract consumers;

   b. market exchange is integrated and part of a single region-wide system;

   c. market centers exist for the express purpose of facilitating market exchange and are located so as to minimize the frictional effects of distance;

   d. market suppliers are knowledgeable and rational in seeking to maximize profits while market consumers are equally knowledgeable and rational in seeking to minimize costs (C. Smith 1974:168-169).

2. **geographic assumptions**

   a. the landscape is featureless and has equal transport facility in all directions;

   b. population and purchasing power are evenly distributed in the marketing region (C. Smith 1974:168-169).

3. **temporal assumptions**

a. the forces that generated the settlement patterns are those that are still operational in economic interactions (CPT has no time depth, thus the model fails to account for historical inertia, i.e. those cases in which it might be more economical to travel further to carry out economic transactions than to move or re-establish a central place with a long-standing history and investment in public places);

b. market locations represent a steady-state or static situation.

[6]Both central place analyses acknowledge that discrepancies from the predicted pattern indicate that economic factors alone cannot fully explain the size and location of market centers in the Valley; political and other factors must also be taken into account (M. Smith 1979:120). In fact, Blanton's (1994) detailed analysis of spatial discrepancies argues that imperial rulers were actively manipulating market location and market access to achieve political goals.

[7]The *Matrícula de Huexotzingo* (Prem 1974), written in 1560, postdates the first major epidemics that decimated indigenous populations. A factor that must be considered in applying these data to the prehispanic period is whether the drastic decline in population necessitated a return to part-time craft production supplemented by part-time agricultural work as a response to decreased availability of foodstuffs, declining demand for craft goods, and strong pressure from the Spaniards to increase agricultural production.

[8]My perspective follows that of Rounds (1979:74), in that I treat political economy as "a social process of interaction between the human and the material in which the humans involved have complex individual motivations and complex relationships with one another. Within the limitations imposed by their material environments, these interpersonal relations are seen as the primary driving forces of social history." Thus, I do not disagree with the ecological perspective concerning the importance of environmental constraints on the operation of social and economic systems. The difference is that where ecologists are primarily concerned with elucidating the nature of those environmental constraints, my concern is more with the "analysis of how humans deal with those constraints and manipulate them in the service of goals that are only partially (or not at all) economic" (Rounds 1979:74).

CHAPTER 3

IMPERIAL POLITICAL ECONOMY AND MARKET FUNCTION

Definition of Empire

Empires are political systems characterized by the expansion and incorporation of other polities and the imposition of imperial political and economic systems on those conquered territories (D'Altroy 1987; Sinopoli 1994).[1] The extension of control over other societies results in a two-tiered administrative system: the imperial core or metropole (comprising the strong centralized state that fostered imperial expansion) and the periphery (the politically decentralized and/or relatively weak polities incorporated by the imperialized metropole) (Doyle 1986).

The task of integrating the formerly autonomous polities of the periphery into a single functioning system that supports the continuance of empire defines the political and economic problems and processes characteristic of imperial development. This chapter explores how these characteristic political processes in turn generate predictable features of imperial political economy within ancient or archaic empires.[2]

Forms of Imperial Control

The establishment of imperial rule entails both (1) **political controls**, involving the extension of sovereignty over subject polities by the imperial core and appropriation of decision-making in the subject polities, and (2) **economic controls**, comprising the reorganization of the economy within both the subject population and the imperial core to support the imperial infrastructure (D'Altroy 1987:5-6). Historically, empires exhibit a considerable range of variability along both political and economic dimensions.

The extension of political control can be either **formal**, established through territorial annexation, or **informal**, as influence exercised over a legally independent peripheral regime (Doyle 1986:135). In contrast, the mode of imperial rule can be characterized as either **direct**, consisting of colonial bureaucratic control by natives of the imperial core, or **indirect**, in which local administration is left to the peripheral, collaborating elite. These two primary dimensions of empire are interrelated to a degree. Informal empires necessarily rely on indirect rule; however, formal empires may rule by either direct or indirect means.

Economic control of subject territories similarly can be classified as direct or indirect (D'Altroy 1987:7). Indirect strategies of exaction leave the form of intensification in the hands of the subject polities and are typically associated with indirect political rule in the form of patron-client political relations. In contrast, direct economic manipulation places exaction and the form of intensification more directly in the hands of a central hierarchy and is necessarily associated with direct political rule.

Types of Empire: Hegemonic and Territorial Control

The interrelationship between the form of political control and mode of rule provides the basis for distinguishing two distinct types of empire: hegemonic and territorial (Luttwak 1976; Hassig 1985:90-103; D'Altroy 1987:5-8).[3] Hegemonic empires rely on informal rule and indirect political control. In a hegemonic system, the empire is characterized by the extension of political control over semi-autonomous "client states" rather than direct occupation of annexed territories (Luttwak 1976:192). Local elite retain power and domestic policy decisions are made at the level of the subordinate polity[4], while imperial controls are focused on the exaction of tribute and/or resources. To this end, imperial influence and imperial revenues are used to coopt local leaders and absorb their traditional avenues of social control into a centralized administration; military power is held in abeyance as a latent threat (Luttwak 1976:192).

Territorial empires, in contrast, are characterized by formal rule and direct political and economic controls. The establishment of territorial imperial control entails the direct occupation and governing of subject territories, with the imperial core exerting control over both the foreign and domestic policies of subordinate polities through the establishment of a more complete civil service and imperial infrastructure (Doyle 1986:44). With formal annexation of territory, however, a military presence is required throughout the empire to maintain peace within its expanded borders. While this military investment increases the security of the periphery and reduces the threat of rebellion, it is much more expensive for the core: military force is now used directly to maintain control, and not as a latent threat, as is the case in a hegemonic system (D'Altroy 1987:6, after Luttwak 1976:192).[5]

Although often contrasted as distinct types of empire, the hegemonic and territorial empires represent the endpoints of imperial control as measured simultaneously along several important dimensions of variability. It is therefore important to remember that hegemonic and territorial empires grade into each other, and that the implementation of these strategies can vary in time and space within empires. On a temporal or development scale, hegemonic and territorial strategies may represent phases of imperial consolidation, with hegemonic representing early or expanding empires, while a territorial strategy may reflect the existence of a "mature" empire that has developed an exportable administrative bureaucracy (Luttwak 1976:191-194; Sinopoli 1994). Similarly, strategies may vary over space according to the relative strength and organization of the periphery, the nature and quantity of resources available, and specific imperial goals (D'Altroy 1987:6; Murra 1980; Smith and Berdan 1992).[6]

The Dynamics of Empire

The Endemic Problem of Empire

Although empires exhibit a broad range of formal and functional variability, they share the same underlying dynamic, that of expansion and incorporation of foreign territories and polities with pre-existing and formerly autonomous political institutions (Wright 1977:385). Imperial expansion results in the coexistence of two levels of authority and political power: (1) the **traditional** local ruling elite, whose power was embedded in traditional bases of support and legitimation, and whose territories were incorporated by the expanding empire; and (2) the emergent autonomous **imperial** bureaucracy whose legitimation did not derive from any traditional roles, but was imposed from the outside.

The coexistence of these two forms of power was the central problem of the empire's political system. Although militarily dominant, the empire was dependent on traditional or local rulers to provide a direct and crucial link to their subject populations for both implementation of imperial policy and taxation (Service 1975:301-302; Rounds 1979). Vested with traditional authority, local rulers supplied a well-established system for controlling primary producers and resources. These traditional linkages, however, could also be tapped by local rulers to mobilize resistance against imperial control, generating breaches in internal security and loss of revenue (Webster 1976:820).

This uneasy distribution of power between central and local foci left the early imperial elite in a political quandary. Without a pre-existing bureaucratic structure that could be expanded to incorporate local populations, no alternative mechanism existed for administrative control of conquered masses (Rounds 1979:79). Thus, the outright destruction of local leadership was generally not an option. However, the dependency on local power as a conduit for imperial control created another dilemma for the early imperial elite: in order to exploit the subject population and its resources, the empire needed to support the very administrative structures that it attempted to dominate. As a result, the imperial rulers' activities were paradoxically oriented to maintaining traditional bases of legitimation and power, while at the same time manipulating those bases to support non-traditional (i.e. imperial) dominion (Eisenstadt 1963:25; Wolf 1965:175).

It is this pattern of dominance and dependence that constitutes the endemic problem of empires, and it represents the primary determinant of political process in developing empires (Eisenstadt 1963:24-25). At the core of this process were the conflicting power relations of imperial and traditional elite: the conquering imperial elite attempted to dominate the local, traditional elite, yet the conquerors remained dependent on the conquered for administrative control and to ensure the upward flow of tribute. Imperial attempts to resolve this conflict and invert initial dependency relations generated the concrete political actions through which imperial rule was consolidated.

Seen in this light, territorial and hegemonic empires represent two basic strategies for resolving dependencies, reflecting different balances in the use of force vs. persuasion. Territorial empires generally rely on military supremacy to coerce local rulership into compliance. In contrast, hegemonic empires rely on more persuasive tactics to convert local rulers to imperial goals. Neither strategy, however, can be successfully employed in isolation; thus both types of empire are faced with resolving dependencies on traditional rulers through some mix of political and economic incentives and deterrents.

Political Process under Empires: Imperial Goals, Strategies, and Policies

Based on his detailed analysis of historic bureaucratic empires, Eisenstadt (1963) argued that the emerging empire's dependence on traditional, local rulers shaped the general goals, specific strategies, and concrete policies of the imperial rulers in consistent and predictable ways. He suggests that, in general, imperial rulers had "a vision of a unified polity, of an empire or realm in which the rulers would be free from the fetters of traditional groups in setting and implementing political aims" (Eisenstadt 1963:29). They wanted to wrest the monopoly of political and administration positions from the representatives of hereditary elite groups and to establish new patterns of centralized administration. However, the rulers of the expanding empire could realize their political objectives only in so far as they could control economic resources and revenues that were also independent of traditional avenues of extraction and control (Eisenstadt 1963:118).

The primary imperial goals were thus twofold: the political autonomy to set their own political objectives, and the economic autonomy to support those endeavors (Eisenstadt 1963:117-119; Adams 1979; D'Altroy 1992:9). The realization of both goals centered on the rulers' ability to invert the imperial dependency on the local rulers. i.e. to resolve the endemic problem of empire.[7]

Political Goals. Traditional elite clearly were a key focus of imperial energies, since control over these rulers brought control over productive subject masses and their resources. Accordingly, the aim was not to destroy the power of local leaders, but to subvert these traditional rulers to the goals and interests of empire (Kurtz 1981). To this end, the imperial core developed wide-ranging strategies aimed at separating traditional rulers from their local, traditional bases of power and in turn making these rulers dependent on imperial elite as their sole source of political authority, economic power, and social prestige. In short, the central goal was to ensure that local elite were dependent on (and therefore faithful to) the imperial ruler, thereby inverting the empire's dependency on local rulers and resolving the endemic problem of empire.

Eisenstadt's analyses have identified several strategies consistently employed by the emergent imperial elite to ensure the cooperation of traditional rulers. As a political incentive to compliance, imperial rulers attempted to limit the traditional hereditary transmission of titles and positions and to make the holding or transmitting of positions contingent on the imperial rulers' will (Eisenstadt 1963:132), thereby changing the basis of local rulership from power allocated from below by their followers to power delegated from above by the imperial core (Rounds 1979:77). This policy had a dual function: it encouraged political loyalty to the imperial rulers, while advancing the rulers' own legitimation as the chief dispenser of political power and authority.

This political strategy was closely connected with the rulers' endeavors to formalize (and monopolize) the status system by generating a social hierarchy based on service to the empire. As Eisenstadt has noted, "The rulers constantly tried both to establish the degree of proximity and access to political power and position as the primary criterion of stratification, and, at the same time, to acquire or retain control over as many avenues to this access as possible" (1963:132). By linking status and prestige to imperial service and loyalty, potentially disruptive competition between elites was channeled into avenues that supported continuance of empire. The new criteria for attaining status thus created a body of elite with common interests in perpetuating empire and simultaneously served to distance elite from their commoners and traditional bases of power and legitimation. As a whole, these social tactics fostered vertical linkages, while discouraging horizontal alliances among local elite that could lead to rebellion.

A political strategy complementing the subversion of traditional elite involved the development of alternative sources of administrative personnel through creating systems of acquired status and avenues of social and political mobility that by-passed or cross-cut traditional bases of inherited power (Eisenstadt 1963:144). By opening these channels of mobility to persons traditionally excluded from office, the empire created a body of loyal bureaucrats and imperial personnel with no traditional loyalties to conflict with the goals of empire. This newly promoted group diminished the imperial rulers' dependence on traditional rulers for administrative tasks and provided essential checks and balances on the power of traditional elite, as well as a body of armed support if necessary. However, this strategy could only be safely pursued within limits at the risk of fostering potential competitors; thus the rulers were especially interested in establishing and controlling the avenues of social and political mobility within society (Eisenstadt 1963:132).

Eisenstadt (1963:19) argues that the realization of political goals was limited by several important factors, including the legitimation and accountability of the rulers:

"The legitimation of the rulers in historical bureaucratic societies was mainly religio-traditional; and the criteria governing their appraisal usually combined political and religious values and orientations. The designated rulers of these societies were either members of hereditary traditional groups, or charismatic persons embodying the society's 'sacred' values and symbols and expected to establish new hereditary dynasties."

Thus, imperial rulers of a necessity claimed religious and traditional legitimation for their positions (Conrad and Demarest 1984; Demarest and Conrad 1983). Methods of imperial control were formulated within the framework of traditional legitimation and involved manipulation of traditional bases and symbols of power and authority.

Economic Goals. In the economic arena, imperial elite needed a constant supply of resources to maintain their administrative machinery and as basis of strength for executing their policies. Thus, the primary economic goal was to generate and control continuous flows of resources from various strata of society, independent of traditional claims and rights of these strata and of the wishes of their members (Eisenstadt 1963:117).

Three general strategies were implemented as foundations for economic autonomy. These included attempts to (1) gain direct or centralized control of strategic resources (as through monopoly of production or distribution); (2) disembed traditional resources, i.e. to free-up or remove resources from the strict control of traditional ascriptive groups (as through mobilization, conscription, and the redirection of tribute flows); and (3) support the development of new resource bases outside the domain of traditional controls (primarily in the form of commerce) that could be tapped through taxation (Eisenstadt 1963:121; H. Wright, personal communication [cited in Hodge 1984:2]). Concomitantly, the imperial rulers attempted to prevent others from gaining access to these resources as a basis of political or economic power (Eisenstadt 1963:118).

These economic strategies were all aimed at creating and gaining control of 'free-floating' resources, i.e., material and labor resources not embedded within or committed beforehand to any traditional power group. These resources could then be utilized by imperial rulers to establish autonomous political institutions and to pursue autonomous political goals and activities (Eisenstadt 1963:27-28).

In the political arena, then, imperial rulers wanted to weaken the strength of traditional leaders, while encouraging competing strata of potential administrators and loyal followers. They wanted to foster the dependence of both traditional and newly promoted elite, through limiting access to traditional bases of power and by elevating themselves as the sole source of power and prestige. Economically, imperial rulers attempted to disembed resources from their traditional bases of control, so that these resources could be used to support imperial structures and implement imperial strategies free from the constraints of traditional rulers. Imperial goals thus became closely interwoven: political autonomy rested on control of resources and control of resources depended on political autonomy.

Imperial Controls over Resources

For the emerging imperial elite, the realization of political and economic autonomy depended in large part on their ability to control key or strategic resources, as the bases of power and authority within society. Control over strategic resources both supported and legitimized their dominant position. And control of strategic resources enabled imperial elite to manipulate political relations among traditional rulers and restructure economic ones, thereby creating conditions of political and economic dependency on the imperial core.

Definition of Strategic Goods

The strategic value of goods or resources rests on their political role or function in the process of imperial consolidation and depends on how essential a commodity is perceived to be for the foundation or maintenance of imperial power. From the perspective of imperial power relations, several different classes of goods may have strategic value. In general, resources may be critical in their role as bases of power, sources of legitimation, or as symbols of authority.

One obvious category of strategic resources includes goods that constitute bases of power due to their material worth. Such strategic valuables include precious raw materials and monetary wealth. In general, these goods are general purpose, durable, and have an exchange value that is widely recognized within the society. The desire to control these valuables is often cited as the factor driving imperial expansion and they were equally important in consolidating control. Resources that generate such wealth, including land and labor and their products, may also function as strategic valuables.

Other material resources may be the focus of imperial attention, however, because of their strategic function in legitimating control, as in establishing military superiority and/or maintaining the security and well-being of the governed populace. Material goods in this category include mundane commodities that are perceived by the imperial hub as necessary to the continuance of imperial rule. For example, Athens in the 5th century B.C. severely restricted the circulation of wood for oars and ship-building as part of a strategy for maintaining the supremacy of the Athenian navy (Finley 1973:169). Similarly, Rome came to directly control much of the wheat trade with Egypt, since grain and bread to feed the urban poor were essential to the maintenance of domestic peace in the imperial core (Finley 1973:160).

An equally important class of strategic goods, however, includes goods that function as symbols of authority; in this case, it is their symbolic role that has strategic value. In the absence of fully institutionalized power, the display of power symbols becomes an important form of propaganda to impress subjects and competitors alike (Marcus 1974:83). Included in this class of power symbols are the prestige or luxury goods that serve to mark relative position within the social hierarchy as well as the emblems and insignia of office and administrative positions within the political hierarchy.

Such symbols are value-laden with information. Their value rests on their role in society (the uses to which they are put), their relative worth within structured sets of meanings and valuations, and how institutionalized or recognized is their role and significance. In general, such symbols tend to be rare or 'precious' materials, since a generalized availability undermines ability to signal limited status. They also tend to be 'value-added' objects, with modifications of raw materials that further limit the general availability of these goods (Peregrine 1991).

Within the social arena, prestige or luxury items are one class of goods that frequently function as important markers of social status: to display these goods is to communicate and validate the relative status of the bearer (Douglas and Isherwood 1979; Brumfiel and Early 1987:4). Control over the distribution and display of prestige goods are thus primary means of manipulating the configuration of sociopolitical relationships in society (Brumfiel 1987a, 1987b:112; Hicks 1991; Peregrine 1991; M. Smith 1986).

Within the political realm, Eisenstadt (1963:132-134) also notes that much of imperial control was effected through the control of the titles and insignia of office as the foundation of rank and authority. Since the wearing of these symbols conferred power on the wearer, control over the symbols of office translates into control over office, both symbolically and in political process. Where these insignia of rank and office are also wealth items, their display can serve to control the society both economically and symbolically (Earle 1987:75).

Symbols whose relative value is established in the pre-imperial setting will often carry the weight of tradition into the imperial value system and thus display a more institutionalized and widely recognized system of meanings. It can be anticipated, then, that the manipulation and control of traditional symbols of power and prestige was a key target of imperial energies. Further, this process can be expected to involve attempts to control the circulation of pre-imperial symbols of power, and the conversion of these from symbols of inherited power to the rewards offered as incentive for cooperating with the emerging imperial elite.

Levels of Imperial Concern and Control

The political economy of empires consists of the ways in which imperial goals, strategies, and policies affect the control of goods, based on the ways in which different goods function or are used to achieve political and economic ends desired by imperial rulers. As a general rule, we can expect that the more strategic the resource is perceived to be, the more direct will be imperial attempts to control the production, distribution, and consumption of that resource. The form that imperial controls take, however, can range from legislative regulation to direct operation, reflecting concerns about the costs of administrative controls both in terms of expenditure of resources and public relations (Morrison and Sinopoli 1992).

Conversely, products that are not considered critical or strategic axiomatically fall outside the sphere of direct imperial concern. Goods in this latter category may, however, be indirectly affected by attempts to control strategic goods. Indirect effects of imperial control may result in a wide range of factors affecting the larger economic sphere, including land-labor relationships (Alcock 1989, 1993), trade and exchange (Hopkins 1978, 1980, 1983; Edens 1992), transportation routes and efficiency (Santley 1986; Fulford 1992), and technological development (Kohl 1987; Costin et al. 1989). Accordingly, to assess the full impact of imperial political economy, we must be concerned with both the direct effects as well as indirect impact of imperial actions.

Summary: Overview of Imperial Political Economy

Up to this point I have argued that control over traditional ruling elites was a critical aspect of imperial integration underpinning both the effective administrative and efficient exploitation of conquered populations. In this context, imperial controls over resources -- particularly the strategic resources representing the bases of power in society --

emerges as a key factor in manipulating traditional rulers to imperial ends and thus as central to the process of imperial consolidation. Administration can be costly, however; as a result, imperial decisions to control a given resource are based on the strategic importance of that good (how vital it is to imperial interests), with more strategic goods generating higher levels of imperial concern and more direct imperial involvement.[8] The political economy of empires thus consists of multiple strategies to control specific goods in order to achieve the dual goals of political and economic autonomy. The effects of those strategies are evident both as direct controls over the production, exchange, and/or consumption of resources, and as the indirect impacts or ramifications of these actions within the wider economic sphere.

Markets Under Empire

What role then does the market system play in imperial attempts to control strategic goods? Does market development contribute to or impede imperial goals of political and economic autonomy?

Several authors have argued that a strong, centralized state power is hostile to market system development, because the market potentially competes with the ruler for control over strategic resources (e.g., Blanton et al. 1981:234-236). If merchants traffic in goods that are vital for maintaining political control, the development of a market system could serve to undermine the political and economic power of the imperial ruler. Accordingly, the centralized political authority in strong states plays a prominent role in the production and distribution of goods, while attempting to limit the access of competing elites to these sources of political and economic power by dampening independent, commercial development.

Alternatively, the development of market enterprise is viewed as supportive of imperial rule. Market exchange can be an effective way for a ruler to mobilize resources outside the framework of traditional patrimonial domains, thus reducing the power of local lords or rulers and strengthening his own (Hicks 1987:96). As Eisenstadt (1963:27-28) points out, market commerce provides a free-floating, taxable resource base independent of local rulers that can be utilized to meet imperial goals. Economic growth and general prosperity also make administration and taxation an easier task, since commercial development is a particularly easy form of wealth to tax (Doyle 1986:96-97). In addition, the development of a transprovincial economy dependent on the maintenance of empire can serve to support imperial administration, by aligning imperial and personal interests. Empires may therefore encourage pre-existing market systems to develop, while attempting to regulate market exchange to their own advantage.

The variable role of the market in imperial economy can be interpreted as reflecting a diversity of political goals that affected economic activities. Eisenstadt (1963:126), for example, suggests that in most archaic empires, "economic development was not very articulate as a fully conscious goal of policy." Economic development per se was subordinated to political goals and considerations: economic activities were encouraged only if they advanced the political interests of the state.[9]

According to this view, rather than trying to discern an overarching policy of economic controls, we need to view imperial activities in the economic field as representing specific actions taken to meet specific administrative and political needs. The role of market exchange in developing empires can consequently be clarified by examining how the pursuit of political goals potentially conflicted with or coincided with the development of market systems. As Finley (1973:156) phrases it, "To appreciate how the ancient state made its mark on the economy (and vice versa, the economy on the state), it is necessary not only to differentiate aims and consequences but also to...pinpoint the interests [of the state] as precisely as possible."

Administrative controls over strategic goods constitute part of how the economy was instituted. It should be emphasized, however, that imperial efforts to control strategic resources represent but one component (albeit a major one) of the political economy and the political economy but one factor affecting the organization of the larger economic sphere. Other factors (historical, economic, and ecological) constrained or favored specific aspects of exchange as well.

Further, it is important to remember that imperial goals affected market economy both directly through manipulating the flows of desired goods, and indirectly, by altering the context of production and exchange. Since we have argued that the interests of the empire are largely concerned with controls over goods strategic to the maintenance of imperial political control, we need first to focus on specific strategic goods and monitor imperial attempts to directly control their flows in society. Secondly, we must attempt to delineate how these flows articulate with other sectors of the economy such that the indirect impact of imperial controls can be determined.

Variability in Market Structure: Causal Factors and Imperial Controls

A principal way that imperial actions can affect the larger economic sphere is through their impact on market system structure and hence on market system function. The primary dimensions of market system organization are **scale** of inclusiveness (spatial extent), **hierarchy** (the development of vertical linkages) and **network** (the development of horizontal linkages) (C. Smith 1976d:314-315). Historically, the growth of empire is associated with an expanding scale of international market economy (Eisenstadt 1963:46; Finley 1978). However, even a brief survey of archaic empires demonstrates significant variability in the resulting structure of exchange interactions along the dimensions of hierarchy and network. Two main patterns can be contrasted.

Integrated Market Networks and Transprovincial Exchange. Market systems characterized by both well developed hierarchy and network represent integrated market systems. Goods flow laterally between market centers of the same order of the hierarchy, as well as vertically between levels of the hierarchy, as between dominant centers and their dependencies. The unrestricted flows of goods and market commerce enable the operation of microeconomic forces and market competition; economic interactions are conditioned by supply and demand, balancing the self-interests of producers and consumers. Within empires, the development of an integrated market network is associated with conditions of political stability and transprovincial security, governmental support for the development of commercial infrastructure (including an investment in transportation and communication) and the absence of administrative intervention and controls affecting the flows of goods.

The expanding Roman empire (200 B.C. - A.D. 200) provides a case in point. Under Roman rule, administrators attempted to ensure the security of trade avenues involved in the flow of vital materials (primarily grain), invested in transportation infrastructure to facilitate that flow, policed market and currency exchange regulations to deter theft and fraud, and collected market and harbor taxes as means of underwriting the above costs (Finley 1973:158-161). As a result of these imperial activities and the increasing monetization of the Roman economy (Hopkins 1978, 1980), commerce expanded rapidly throughout the Mediterranean world (Fulford 1992; Woolf 1992). Wine, oil, pottery, and bronze produced in Italy were exchanged for African grain and eastern spices. Large, specialized productive enterprises emerged throughout what was otherwise an overwhelmingly agricultural world.[10] Doyle (1986:98) argues that "Rome revolutionized the commerce of the ancient world on a most extensive scale, and in commerce lay much of the free-floating, imperially mobilizable resources that fed and armed the legions and paid the administrators." In this case, imperial and commercial interests converged, resulting in a well-developed transprovincial economy that provided a major integrative force within the expanding empire (Doyle 1986:97-98).[11]

This pattern of a well-developed transprovincial economy was later broken, however, when administrative interests dictated the need for intervention. The continued growth of empire, particularly the expansion of the military and the city of Rome, elevated the strategic importance of grain as essential to the maintenance of imperial power and domestic peace (Finley 1973:160). This in turn stimulated administrative efforts to more directly control the flow of wheat, observable in two trends: first, the payment of tribute in kind, rather than coin; and second, the gradual withdrawal of grain and other military (as well as urban) requirements from the play of the market, a trend culminated in late Roman times under Diocletian (r. A.D. 284-305). An unanticipated by-product of centralized controls was the reduction of economic potential for industrial producers, by lowering the total volume of market trade (Finley 1973:160-161; Hopkins 1980). Thus, the indirect impact of administrative controls was the weakening of the larger market economy.

Vertically Structured Market Systems and Core-Periphery Exchange. At the opposite extreme are imperial market systems in which vertical flows of goods predominate. In this case, the flow of commerce is primarily if not exclusively between core and periphery, while transprovincial exchange is inhibited. The result is often termed a dendritic structure, in which lower-order centers are linked to a single higher-order center, creating a chain (as opposed to a network) of economic contacts that is predominately vertical or hierarchical in organization (C. Smith 1974:177). Vertically organized exchange systems often appear to exploit rather than to integrate peripheral economies, since commodity flows are centralized to the obvious benefit of the metropole.

The origins of vertically oriented market systems are generally linked to monopolistic controls over key aspects of wholesale trade that create conditions of imperfect competition through either spatial monopoly or commodity oligopoly. C. Smith (1974:178), for example, associates dendritic systems with the conditions of spatial monopoly characterizing a primate center. Under conditions of primacy, centers do not have competitors, and thus reap the economic advantages of monopoly. Economies of scale develop in these primate centers, undercutting less efficient competitors and suppressing secondary productivity (and hence exchange) within the periphery while generating conditions of core-periphery symbiosis. Such primate-dendritic systems seem to occur mainly in imperial or colonial contexts where marketing is imposed by an outside group following conquest. Alternatively, vertically structured market systems can result from conditions of commodity oligopoly, as through state controls over long-distance or foreign exchange (C. Smith 1977:131-132).

Such extractive market systems are most closely associated with colonial (territorial) empires forged through strong imbalances in military force and technology (including those established by European conquest of Latin American, Africa, and Asia), and motivated by an imperial policy of mercantilism. Within the Spanish-American empire, for example, the state manipulated trade with its New World colonies to create a "complementarity" in exchange relations that functioned to bind the peripheries to the metropole. Doyle (1986:111-112) suggests that this power was realized by two mercantilist means: "First, regulating the foreign trade of the colony, by requiring exclusive trade relations with the metropole or the use of only metropolitan shipping; second, by regulating the internal production of the colony to ensure complementarity with the metropole, usually making the colony a producer of raw materials for the metropole and a consumer of the metropole's finished products." This artificial complementarity led to the one-sided accumulation of wealth in the imperial core, where it served to underwrite the costs of enforcing the unequal relationship between core and periphery.

Parallels can be found in ancient imperial systems characterized by informal and indirect rule, as well. For example, the Athenian empire of the 5th century B.C. instituted an indirect, but no less effective means of generating centripetal flows of desired goods under a system of hegemonic rule, through monopolistic controls over the production of currency. In this case, it appears that a transprovincial trading pattern initially developed without direct government interference. For the first half of the 5th century, there is no evidence that the government intervened to influence the course of trade, except to safeguard the inward flow of vital materials. With suppression of piracy by the Athenian navy, widespread trade in the Mediterranean flourished; *pax imperica* encouraged commercial development and the latter in turn underwrote a portion of imperial expenses in the form of harbor taxes, etc. It was only when the trading network was well established that the Athenian leaders realized that "trade itself was a weapon that could be turned to political ends" (French 1964:122). Athens then set policies that effectively subverted the earlier trading pattern, resulting in the centralized flow of desired goods at the expense of transprovincial interactions (French 1964:120-121).

To accomplish this end, Athens exerted two types of control. The most obvious governmental controls were direct restrictions on trade concerning strategic materials. Certain goods could only be sold to Athens, including grain and the wood for oars and ships that were the basis of Athens' naval supremacy. However, Athens employed an equally compelling indirect measure of control as well. At the core of this control was the Athenian regulation enforcing the use of her own coinage throughout her empire by requiring "allies" to pay their tribute to Athens each year in Athenian coined silver (French 1964:121).[12] To obtain this coinage, her allies obviously had to buy it directly or indirectly from Athens; they were thus forced to sell their surplus products either to Athens or to states that sold to her. This strategy placed the allies in competition with each other to sell to Athens, drove down the cost of their wares on the Athenian market, and placed Athenian consumers in an enviable position. The overall effect of the Athenian coinage monopoly was to direct flows of goods, both strategic and non-strategic, into Athens, while dampening the transprovincial market.[13]

Indirect Impact: Market Structure and Opportunities for Production and Exchange

The actions of imperial elite that directly affected the regional market system structure also indirectly affected opportunities for production and exchange for the laboring population at a more local level. As discussed by Plattner (1989), the relative predominance of horizontal vs. vertical linkages in the market system leads either to the integration or the underdevelopment of the hinterland into the regional system. To understand how these differing market structures effect different outcomes in regional economic organization, Plattner focuses on the impact that market structure has on individual producers and market participants.

For example, Plattner (1989:203) argues that:

> "An integrating market system stimulates economic development by allowing different parts of the region to exchange horizontally as well as vertically.... For example, an Indian farming community in Latin American could specialize in its most productive product (such as peppers) since subsistence food (corn, beans, and other staples) will be available at a reasonable price from other similar farming communities in horizontal exchange. Manufactured urban goods may be available in vertical exchange (from towns to villages) for agricultural products, or goods from a craft-producing village may be available in horizonal (village-to-village) exchange. This process of regional economic integration stimulates economic development."

The result is a true market-integrated economy, in which a large proportion of the population are dependent on the market for daily subsistence goods.

In contrast, the predominance of vertical linkages leads to "underdevelopmental" market systems: "When the system of exchange is controlled by and for an urban elite population, then the horizontal links are minimized in order to stress the vertical ties" (Plattner 1989:203). The elite class is interested in supplying itself with rurally produced goods and in obtaining agricultural foodstuffs for urban support or export, in exchange for the downward distribution of imported and urban-produced manufactured goods. In such a case, there is "no horizontal flow of farm produce to integrate the different agricultural districts of the region. Farmers in such a system cannot specialize fully lest they gamble their welfare on a market system that is not structured to deliver the food they need" (Plattner 1989:203). Similarly, without a reliable food supply entering the market system, rural artisans cannot expand their trade to become manufacturers. Even part-time specialization may be impaired as local outlets for craft goods are undercut by urban economies of scale that can produce goods that are likely to be both cheaper and better made than local products (Berdan 1989:93; Marcus 1983). In this case, peasants may be fully drawn into a market economy, but without obtaining the economic and other benefits supposedly following from market integration (C. Smith 1977:144).

The impact of market structure on the regional organization of production and market participation can be seen in historical empires, as well as in modern peasant societies. In the case of Rome (200 B.C.- A.D. 200), characterized by horizontal as well as vertical links and flows of goods, imperial consolidation led to economic stimulation and regional development. In contrast, within the Spanish American colonial empire, the links were predominantly vertical, with the flow of goods benefitting the core at the expense of the periphery, leading to underdevelopment and isolation of the periphery.

The Interaction of Imperial Political and Market Economies: Programmatic Statement for Analysis

The historical examples cited illustrate the structural and functional variability in international market economies that develop under empire as well as the diversity of ways in which imperial actions affected market structure. Equally important, the preceding examples also suggest that the type of imperial rule and the type of market structure do not necessarily covary in a predictable manner. The formal, direct rule of territorial empires may lead to either an elaboration of transprovincial, horizontal links (as under Rome), or primarily vertical links between core and periphery (as in the Spanish American colonies). Conversely, informal, indirect rule under hegemonic empires may indirectly foster economic development throughout the peripheries under the stable conditions of *pax imperica* or may manipulate the economy to channel exchange goods in a primarily vertical flow (as under Athens in the 5th century B.C.).

This lack of congruence suggests that in order to understand the interaction of imperial political and market economies, we need to step back from simplistic categorizations that associate general types of empire with general types of market systems. Instead, we must attempt to monitor specific links between the political processes of imperial formation and the resultant economic conditions that directly and indirectly affect market participation and development.

As one strategy for monitoring the interaction of imperial political and market economies, this analysis focuses on both macrolevel political forces, consisting of the political and economic goals, strategies, and policies of the dominant imperial elite, and microlevel economic forces, consisting of the responses of individual or corporate producers to the economic stresses and opportunities engendered by imperial rule. This analysis consists of three main steps:

1. Definition of Macrolevel Political Forces. The analysis of imperial political economy necessarily begins with the identification of strategic resources, beginning with the primary sources of wealth and symbols of power in imperial society. The analysis then monitors imperial efforts to control those resources directly through legislation and administrative policies, and attempts to identify indirect controls over these resources by (1) monitoring their production, acquisition, and redistribution; (2) identifying the personnel involved in this circuit; and (3) examining how avenues of access and control are regulated.

2. Impact on Microlevel Economic Responses. Second, the analysis identifies the economic stresses and opportunities created by the imperial political economy, by examining how controls over strategic goods affect other economic activities. Imperial political activities may affect a broad range of economic conditions through their impact on market structure, but also through alteration of the physical environment, labor reallocation, market regulations, technological advance, or developments in the areas of transportation and communication -- all of which potentially alter patterns of production and market exchange.

3. Microlevel Economic Responses. Finally, this analysis attempts to predict and then measure the responses of producers to the altered economic circumstances in terms of commodity production strategies and market participation. In the aggregate, these responses form the basis for predicting macrolevel economic changes and their corresponding on-the-ground patterns of market behavior.

The following analysis of Aztec imperial economy attempts to implement this strategy by identifying and monitoring the flow of strategic goods through the Aztec empire. Chapter 4 focuses on the circuit of specific luxury goods and exotic raw materials that formed the primary symbols of Aztec political power and prestige, and identifies the administrative controls over this circuit that represent the macrolevel forces of interest. Chapter 5 then explores the impact that these controls potentially had for systems of commodity production and market participation within the Valley and predicts specific microlevel responses.

Notes to Chapter 3

[1]Within anthropology, empires to date have not received the same level of scrutiny and definitional precision as other levels of sociopolitical complexity (e.g. Flannery 1972; Service 1975; Wright 1977, 1978). Rather, empires are frequently considered to be a special class of state level societies, that differ primarily in their size and internal complexity (see Sinopoli 1994 for a review). For example, Adams (1979:59) defines empires as:

> "...territorially extensive, at least moderately durable, state systems, that were substantially preoccupied with channelling resources from diverse subject polities and peoples to an ethnically defined ruling stratum whose authority ultimately derived from the repeated exercise of its military power."

Within the field of political history, greater emphasis is placed on the establishment of unequal political relations:

> "Empires are relationships of political control imposed by some political societies over the effective sovereignty of other political societies. They include more than just formally annexed territories, but they encompass less than the sum of all forms of international inequality. Imperialism is the process of establishing and maintaining an empire" (Doyle 1986:19).

> "Imperialism refers to those particular relationships between inherently unequal nations which involve effective subjugation, the actual exercise of influence over behavior. The concept is basically operational. Inequality is the necessary condition; active affirmation of superiority and inferiority is the logical condition of sufficiency" (Cohen 1973:15).

> "Properly defined for analytical purposes such as ours, imperialism allows for all these potential forms and forces. It simply refers to any relationship of effective domination or control, political or economic, direct or indirect, of one nation over another. This is not meant to suggest that the alternative variations of forms and forces are unimportant. In fact, they are the very meat of analysis" (Cohen 1973:15-16).

[2]This discussion is explicitly limited to the more archaic forms of empire, and avoids discussion of imperial formation within the modern "world system" (Wallerstein 1974).

[3]The difference between hegemonic and territorial empires roughly parallels Eisenstadt's distinction between weakly integrated "patrimonial empires" and more highly integrated "bureaucratic empires". See also Mann (1986) on empires of domination vs. territorial empires.

[4]According to this criterion, Doyle's (1986) definition of empire excludes hegemonic systems of imperial rule, since he defines empire as control over both the internal and external (international and domestic) affairs of the periphery.

[5]Hegemonic and territorial empires also differ in the administrative costs involved in overseeing the dominated region and the degree of imperial exploitation enabled by imperial domination. Hegemonic control is one of low investment in administration and

defense, with a concomitantly limited ability to extract resources (Hassig 1985:101). In contrast, territorial control is a high-control, and potentially high-exaction strategy of imperial integration (Hassig 1985:101).

[6]In large measure, the form of imperial control depends on the level of political organization of the periphery prior to metropolitan contact (Doyle 1986:135-36; D'Altroy 1987:7; Hodge 1984:2). Two attributes are seen as being of particular importance: the degree of political centralization of the periphery (which determines the degree to which collaboration is feasible), and the level of economic differentiation (which determines the extent to which collaboration is advantageous or desirable). In general, imperial domination of pre-state societies is seen as requiring formal incorporation and direct rule, because these incompletely differentiated societies lack the stable infrastructure to collaborate with the metropole. In contrast, stratified, state-level societies offer the potential for informal control; if formally annexed, they tend toward indirect rule. Thus, extant political and economic structures affect imperial policies and contribute to organizational solutions.

[7]The realization of the goals of political and economic autonomy leads to what Doyle (1986:93-96) has termed the **threshold of persistent empire**, characterized by the institutionalization of a distinct imperial bureaucracy and the economic infrastructure to support it. These dual developments historically created the conditions for steady imperial rule. A strictly imperial administrative structure distinct from domestic politics meant that the periphery could be ruled efficiently, with concerns of the empire taking precedence over and remaining unencumbered by local domestic affairs. Similarly, strong central rule created the stability on which economic growth could flourish, creating economic bonds between core and periphery that supported the continuance of imperial rule.

[8]This argument parallels Costin's concern (1991:12) that: "In dealing with the issue of control, we must be careful to state explicitly the rationale for controlling the industry." For example, Costin criticizes Feinman (1980) for not addressing the issue of why an administration would want to control production of ceramic wares in particular.

[9]Similarly, Finley (1973:158-161) argues that the primary factors driving the economic actions of ancient states was the "satisfaction of material wants" of the central administration. In this view, imperial activities represented specific actions taken to meet specific administrative and political needs, rather than a general policy of economic development.

The absence of a national economic policy in ancient empires can be contrasted with the modern policy of mercantilism, in which "the economic interests of the nation as a whole are more important than that of individuals or parts of the nation, with a balance of exports over imports (with a consequent accumulation of bullion) as desirable, and that industry, agriculture, and commerce should be directed toward this objective" (Webster's New 20th Century Unabridged Dictionary). Mercantilism is associated with the decline of feudalism and the rise of commercialism in Europe.

This contrast between ancient empires and those of the modern era is consistent with Wallerstein's (1974) distinction between world empires (based on political controls and relative primitive means of economic domination) and world economies (based on the greater economic efficiencies of capitalism). However, for an application of world-systems analysis to ancient empires, see Ekholm and Friedman (1982), Frank (1990) and Wallerstein (1990).

[10]Hopkins (1978) points out that Roman workshops were actually quite small by modern standards, rarely employing more than 20 people (Moeller 1976), although the aggregate volume produced could be quite large (e.g. Stanfield and Simpson 1958). As a basis of comparison, however, most manufacturing units in a pre-industrial economy are small: 95% of all manufacturing and mining units in Germany, and 98% in France employed less than 10 persons in 1906-7 (Gerschenkron 1962:64, cited in Hopkins 1978:53).

A more telling characteristic of Roman manufacturing was the sophisticated division of labor and dependence on the market system to bring these specialists together (Hopkins 1983:xvi). For example, 85 different occupations have been documented for Pompeii, while 264 occupations are known for the city of Rome (Hopkins 1983:xvi). At least five different specialized occupations were recorded just within the textile industry: fuller, spinner, weaver, dyer, and garment maker (Hopkins 1978:71).

[11]The high degree of regional (i.e. transprovincial) integration within the Roman market system is illustrated by parallel fluctuations in provincial money supplies (Hopkins 1980).

[12]The motivation for this decree is debated. Finley (1973:166-169) argues that the political insistence on the employment of Athenian coinage represents a reaction to the chronic shortage of coins -- a strategy to ensure cash on hand for supporting imperial activities, primarily the payment of the navy. Alternatively, it may represent a political statement of dominance, by denying the subject-states the traditional symbol of autonomy, their own coins. Whatever the motivation, the impact on the flows of goods was the same.

[13]Allen (1992) discusses a similar case for Mesopotamia, in which Assyrian controls over currency and credit led to economic underdevelopment of the Anatolian periphery.

CHAPTER 4

AZTEC IMPERIAL POLITICAL ECONOMY

Formation and Organization of the Aztec Empire

Pre-Imperial Political Organization

Prior to imperial consolidation, the Valley of Mexico was divided among a number of independent, competing, and often conflicting polities that can best be described as city-states (Bray 1972; Hodge 1984; Marcus 1989). Each city-state (Nahuatl: *altepetl*) consisted of an urban center (the locus of political administration and elite residence) and a discrete territory containing dependent villages and hamlets. In late prehispanic times, the Valley contained ca. 50 such polities, with territories of about 100-200 km^2 (Gibson 1964:34; Sanders and Price 1968:151-152). Each city-state was traditionally ruled by one or more *tlatoque* (sing. *tlatoani*; lit. "he who speaks") who were entitled to the position through inheritance and membership in the elite stratum, and who governed by divine right. These city-state rulers were assisted by a hierarchy of officials filled by members of the nobility (*pipiltin*).

Historical chronicles report that groups of city-states formed alliances or regional confederations for purposes of mutual defense or military campaigns (*Anales de Cuauhtitlan* 1938, 1945; Chimalpahin 1965; Durán 1967; Alva Ixtlilxochitl 1975-77). These confederation territories may also have facilitated exchange over a larger region -- exchange that would have been essential when basic resources could not be found within the narrowly circumscribed territories of individual polities (Calnek 1982:45; Blanton 1994). Confederations were often chartered on shared origin myths and thus have been called "tribes", although they were not ethnic groups per se (Hodge 1984:139).

In the late preconquest period, eight "tribes" or confederations co-existed in the Valley: the Acolhua, Tepaneca, Mexica, Chalca, Mixquica, Cuitlahuaca, Xochimilca, and the Culhua (Hodge 1984; Gibson 1964:14, Map 2). Of these, the Acolhua and Tepaneca were the largest and most durable. Both of these confederations had evolved an internal political hierarchy in pre-imperial times, in which one city-state served as capital and the ruler of the capital directed the rulers of the other, dependent polities (Hodge 1984:139). Other confederations, such as the Chalca and Xochimilca, formed alliances of separate but equal polities.

Processes of Empire Formation

The Aztec empire has its origins in the environment of conflict between city-states and confederations that had developed in the Valley by the late 1300s. By the end of the 14th century, two dominant confederations had emerged in the Valley: the Tepaneca, headed by Azcapotzalco, along the western side of the Valley and the Acolhua on the eastern side (Brumfiel 1983:Fig. 1). Beginning in 1371, the city-state of Azcapotzalco, ruled by Tezozomoc, and aided by its client-state, the Tenochca of Tenochtitlan, began an aggressive campaign of expansion, at the expense of the Acolhua. By the early 1400s the Azcapotzalcans had incorporated the major Acolhua cities into their realm. With the defeat of Texcoco in 1418, Azcapotzalco came to control almost the entire Valley (Gibson 1964:16-17; Brumfiel 1983).

Their dominance was short-lived, however, and when a crisis in dynastic succession following the death of Tezozomoc in 1426 or 1427 temporarily weakened Azcapotzalco, several polities seized the opportunity to rebel. In 1428, a military force assembled by the ruler of Tenochtitlan and the deposed heir of Texcoco defeated Azcapotzalco and a new coalition of three city-states -- the so-called Triple Alliance of Tenochtitlan, Texcoco, and Tlacopan (the latter representing the more "accommodating" nobility of Azcapotzalco) -- was forged (Brumfiel 1983). This Triple Alliance quickly consolidated their control within the Valley of Mexico, conquering polities in the northern, central, and southwestern portions of the Valley to form an imperial core. The Triple Alliance attempted to defeat the still-independent Chalca in the SE part of the Valley, but the polities in this area successfully resisted, and the entire Chalco region was not brought into the empire until A.D. 1465 (Chimalpahin 1965:199-207). Meanwhile, aided by their dependencies, the Triple Alliance capitals conducted a series of wide-ranging military campaigns outside the Valley of Mexico, eventually extending their control to the Gulf Coast of Mexico and the Pacific coast of Guatemala.

The internal organization of the Triple Alliance empire initially followed a threefold division based on pre-existing confederation boundaries. Tlacopan nominally controlled much of the Tepanec realm along the western side of the Valley, Texcoco continued as head of the Acolhua domain along the eastern side of the Valley, and Tenochtitlan administered territories acquired in the south. Each division was considered politically autonomous, and each ruler was considered king and head of his domain (Alva Ixtlilxochitl 1965, Vol. II:154; Berdan 1975:71; Carrasco 1991) (Table 4.1).

Table 4.1
Rulers of Tenochtitlan and Texcoco Under the Triple Alliance

Tenochtitlan (Mexica)		Texcoco (Acolhua)	
Ruler	**Reign (A.D.)**	**Ruler**	**Reign (A.D.)**
Itzcoatl	ca. 1427-1440	Nezahualcoyotl	ca. 1428-1472
Motecuhzoma I	ca. 1440-1468		
Axayacatl	ca. 1469-1481	Nezahualpilli	ca. 1472-1515
Tizoc	ca. 1481-1486		
Ahuitzotl	ca. 1486-1502		
Motecuhzoma II	ca. 1502-1520	Cacama	1515-1520

Although theoretically equal powers, Tenochtitlan continually encroached on the administrative powers of its confederates, particularly Tlacopan. Tenochtitlan assumed the right to appoint the highest level rulers in Tlacopan's territory, and the lords of city-states subject to Tlacopan were confirmed at Tenochtitlan. In contrast, Texcoco remained a powerful member state in the Triple Alliance (Gibson 1956, 1964; Hicks 1982b; Offner 1983; Carrasco 1991). Texcoco continued to appoint rulers to Acolhua city-states (Hodge 1984:141) and remained independent enough to strongly resist the meddling of Tenochtitlan in its internal dynastic affairs (Gibson 1964:18-19 on role of Texcoco in rebellion of A.D. 1515).

External affairs of the empire were more directly centralized. By the late 1440s, Tenochtitlan emerged as the capital of the Triple Alliance empire, with the collection of imperial tribute and military affairs directed by its ruler (Gibson 1971:388; Davies 1987).

Hegemonic Control

The pattern of Aztec imperial expansion conforms closely to the hegemonic imperial model (Hassig 1985:92-103, 1988:17-22; Hicks 1992). In contrast with territorial empires, seizure and control of territory was not an Aztec goal except within the immediate core zone. Rather, Aztec expansion appears to have been directed at the economic exploitation of territories by tapping into local tribute flows. Outside of the imperial core, Aztec conquests focused on areas of high economic potential (Adams 1979:69), and within these areas on the main centers representing the apices of local tribute hierarchies. The result was a widespread, but territorially discontinuous empire (Barlow 1949; Berdan 1975, 1994; Smith and Berdan 1992, 1994).

In subsequent imperial rule, the Aztec exercised very little direct administrative control, relying on indirect rule and indirect strategies of exaction for purposes of administration and taxation (Berdan 1975:75-76, 242-243; Hassig 1985, 1988:21; Hicks 1992; Hodge 1984, 1991, 1994b). On conquering a territory, the indigenous political structure was generally left intact, and local, traditional rulers were frequently retained. These rulers were required to pay tribute and to supply warriors for imperial military campaigns, but as long as they cooperated, they were supported in office by the imperial core (Hicks 1987:95; 1992:1). Although hostile local rulers were removed, they were usually replaced by Aztec nobles who married into the local ruling families (Carrasco 1976, 1984). This intermarriage with local dynasties served a dual function: it gained traditional legitimation and support for Aztec rule, and it provided continuity, enabling local relations of dependency (and hence tribute flows) to continue.

The Aztec empire also relied heavily on local means of exacting tribute for the empire, a system that was both efficient and cost-effective (Adams 1979:65; Gibson 1971:390; M. Smith 1986:81; Zorita 1963:190-191). Once a political center was dominated, so too were its dependencies, and tribute, flowing from dependency to city-state center to provincial capital, could be drained from an entire region simply by dominating the center (Hassig 1985:104). The cost of this indirect system of exaction was correspondingly low. By relying on pre-existing tribute systems, the Aztec needed to control only the highest level of the local tribute hierarchy, a tactic that greatly reduced the number of imperial tribute stewards required to collect the imperial assessment (Hassig 1985:147). Further, since tribute demands were moderate, they could be backed by the threat of Aztec reprisal, rather than by actual military presence. Thus, the costs of maintaining a standing army throughout the provinces to enforce compliance was eliminated.

The hegemonic system was characteristic of both the imperial core and the periphery (Hicks 1992:1), although the degree of direct control and manipulation was obviously greater closer to the imperial capitals. Within the Valley, imperial rulers admittedly intervened in both the structure and personnel of local administrative hierarchies to varying degrees (Hodge 1984, 1991), but pre-existing city-state territories remained largely intact, and the city-state, under the direction of the traditional local elite, remained the basic unit of administration within the Valley until well after the Spanish conquest (Calnek 1982:44).

In essence, the Aztec imperial system sacrificed depth of control for breadth of extraction. In order to facilitate the efficient exaction of tribute, the Aztec empire not only permitted, but relied on, the existence of largely autonomous governments (Hassig 1985:99). As a result, formerly independent polities both near and far were conquered, but only partially integrated, into the empire (Calnek 1982:56). The corollary of this incomplete integration, of course, was that internal rebellions were rife (Berdan 1975:243). Tenochtitlan's chronicles report planned and actual rebellions frequently enough to suggest almost continual attempts by dependent rulers and elites to regain independence, wealth, and power (Kelly and Palerm 1952; Gibson 1971; Hodge 1991; M. Smith 1986:82). Hassig (1985:94; after Holt 1976), for example, records 28 revolts against Aztec rule involving 17 different provinces, many of which were located near the center of the empire.

For the most part, these rebellions were not armed uprisings, but the cessation of tribute payments to the Triple Alliance capitals (M. Smith 1986:82). They should therefore be interpreted not as a nationalistic response to foreign imperial domination, but as attempts to keep a larger share of local tribute revenues to themselves. M. Smith (1986, following Broda n.d.) suggests that the Triple Alliance policy of local autonomy in tribute arrangements coupled with economic benefits and political support from the imperial core was the root cause of these rebellions: by increasing the local authority and prestige of the provincial nobility, these rulers gained sufficient power to attempt withdrawal from the empire. Thus, by strengthening local elites to their own fiscal ends, the imperial elite also produced the conditions for political instability.

The Aztec were clearly facing the endemic problem of empires: the need to simultaneously dominate and support the traditional rulers upon which the empire was dependent for tributary flows. Although rebellions suggest that political control was incompletely consolidated, the dramatic expansion of the empire just as clearly indicates that imperial rulers had sufficiently wrested political and economic control from local rulers to finance imperial policies.

Strategic Goods as a Means of Imperial Political Control

The strategies and mechanisms of political integration (above and beyond the threat of military force) that supported the continuance and expansion of the Aztec empire have generated considerable academic interest, and studies have identified a broad spectrum of strategies for realigning social and political connections (Rounds 1979; Carrasco 1984; Brumfiel 1983, 1987a, 1987b; Hicks 1992; Hodge 1984, 1991, 1994b; M. Smith 1986). Without denying the importance of these often mutually supportive tactics, this section explores how political integration was achieved through the control and manipulation of two major classes of strategic resources.

Strategic Goods in Imperial Economy

The primary bases of wealth and power in Aztec society were (1) land and the labor of commoners to work the land, and (2) luxury goods as the outward displays of status and prestige (Berdan 1975:145; Davies 1973:79; Hicks 1986:48-49). Because position within society depended on access to and control over these strategic resources, the emerging imperial elite actively manipulated both resources to achieve political compliance.

Land and Labor. Land and labor represent the more fundamental basis of power, in that the income from this land could be converted into the other major form of wealth, that of exotic luxury goods, thereby allowing elites to maintain and enhance their positions through giving gifts and sponsoring feasts. The size of land-holdings was therefore a key to the political and social order. Land and labor were also bases of power that were comparatively easy to manipulate, since the administrative structures and relationships of dependency between elite and subject commoners were well established in pre-imperial times.

From the formation of the Triple Alliance, each successive conquest within the Valley of Mexico was marked by the taking and redistributing of lands and the tribute labor of commoners. The Triple Alliance rulers retained the largest share of the newly conquered lands, thereby assuring themselves a firm basis of economic power, independent of the claims of traditional rulers (Durán 1964:59, 71-72; Davies 1973:79; Hicks 1987:95).

The redistribution of land-holdings or the rights to produce from expropriated lands was the primary means of rewarding loyal allies and dependent nobles for participation in imperial conquests. These war prizes generally consisted of fields of a specific size within a dependent community, that were worked by commoners who otherwise continued to serve their local ruler in matters of war and corvée labor. Frequently the tribute fields allotted to a meritorious noble were widely scattered and distant from his traditional administrative jurisdiction. By rewarding loyal nobles not with whole domains, but with the receipts of individual fields, nobles were prevented from accumulating an independent basis of power from which to oppose the empire. As Hicks (1987:95) noted, these nobles could live handsomely, but they remained dependent on the stability of the empire to ensure continued access to their possessions. These nobles thus came to share an interest in the perpetuation and expansion of the empire as the power defending their rights to tribute fields and supporting their standard of living (Adams 1979:65; Berdan 1975:281; Brumfiel 1983:273-274).

Exotic Prestige Goods. The second category of strategic goods -- exotic luxury items -- represented a more fluid system, although this category also had a long tradition in pre-imperial times as well (Hicks 1981; Brumfiel 1987a, 1987b, 1989). Items in this category include exotic, and hence precious, raw materials (such as cotton, tropical bird feathers, gold, amber, jade, turquoise, and other semi-precious stones), as well as specific items of dress and adornment fashioned from these goods.

As symbols, these classes of exotic luxury goods both represented and constituted relative status within Aztec society. Outward symbols of status were prevalent and rigidly defined under imperial rule; each rank in the society, whether inherited or achieved, carried with it certain exclusive items of dress and ornamentation (Berdan 1975:144-45; Anawalt 1980). The display of prestige items therefore provided the means by which rulers defined their own social statuses as well as the statuses of others, with all the rights and obligations attending to those positions (Brumfiel and Earle 1987:4). By controlling the distribution and rights to display elite goods, the Aztec state established and imposed on the larger society "its own evaluations of people and events and its own interpretation of the universe" (Brumfiel 1987a:679).

Prestige goods were also essential in constituting relative statuses. In this context, luxury items functioned as a form of political capital, whose value was actuated through gift-giving (Brumfiel 1987b:112; Hicks 1981, 1982a; M. Smith 1986:75-76). Brumfiel's (1987b) analyses of exchanges of prestige goods both before and after the emergence of the Triple Alliance indicates that gift-giving was an essential component in affirming and manipulating the configuration of sociopolitical relationships in ancient central Mexico. Political transactions such as rewarding clients, attracting allies, and soliciting favors from superiors all involved the exchange of precious goods. Following the foundation of the Triple Alliance, Brumfiel (1987b:112) notes a tremendous increase in the level of gift-giving as Aztec rulers instituted a system of centralized patronage to consolidate their power. The lavish distribution of prestige goods by Aztec rulers both established the pre-eminent position of the givers, and forced the recipient into a position of submissive reciprocity. In sum: "The distribution of elite goods by Aztec rulers was clearly an important means of enhancing political integration and centralization immediately prior to Spanish conquest" (Brumfiel 1987a:676).

Brumfiel (1987b:114) also suggests that through time, a shift occurred in the patronage system from rewards in tribute lands to prestige goods. Initially, the emphasis appears to have been on the distribution of tribute lands; distinguished warriors were rewarded with tribute lands and noble titles (Durán 1964:70). Later, prestige goods began to overshadow tribute lands as the reward most frequently distributed. This trend may partially reflect a greater availability of these goods relative to tribute lands, as discussed below. But Brumfiel argues that the shift may represent a conscious and politically astute move as well: "The Aztec ruler Itzcoatl is said to have argued against the restoration of local rulers on the grounds that it would be better to have them dependent upon the gifts and honors that the state would bestow only when their acts and good service merited it" (Brumfiel 1987b:114).

Imperial Incentive Plan and Patronage System

The distribution of these primary classes of strategic goods (i.e. land and labor, and exotic prestige items) through royal patronage was simultaneously directed to two ends: (1) to control the traditional ruling elite, and (2) to create an alternative hierarchy of status positions and potential administrators to serve as a check and balance on traditional bases of power.

Control of Traditional Rulers. The traditional hereditary elite (or "nobility of lineage") constituted the established administrative authorities (*tlatoque*) in the Valley of Mexico. Aztec political economy accordingly focused on control of this class of individuals as key to the control of subject populations. A number of direct controls over traditional rulers have been mentioned in passing: removal from office, intermarriage with the royal lineages (Carrasco 1976, 1984), forced attendance on the imperial court where they could be kept under direct observation (Durán 1967, Vol. II; M. Smith 1986:77-78), and the requirement that noble youths be educated in Tenochtitlan where they served as political hostages. Control of strategic resources that served as the bases for power and prestige in Aztec society provided an equally effective means of control.

The rulers of the expanding Triple Alliance empire created an elite 'incentive plan,' including both positive incentives (imperial support and patronage) and negative deterrents (loss of tribute lands or removal from office), to encourage cooperation with imperial interests. A large portion of this plan involved the control and manipulation of traditional bases of power and symbols of status. Through controlling access to sources of wealth (land and labor) as well as the outward symbols of status and authority (prestige items and insignia), the imperial elite were able to make the continued rule of traditional rulers contingent on their compliance with imperial goals. Thus patronage, through the distribution of these strategic resources, played a critical role in inverting the empire's dependency on traditional rulers by making them dependent in turn on the imperial rulers' will for status, prestige, and income.

The success of this elite incentive plan was assisted by the long period of internecine wars that directly preceded political consolidation under the Triple Alliance. These struggles had virtually depleted the pool of direct descendants to local *tlatoani* seats (Brumfiel 1983). As a result, appeals to the higher authority of Tenochtitlan or Texcoco were necessary to support local claims to rule by less direct descendants.

Imperial gift-giving and display led to a cycle of inflation in elite goods consumption. As Hicks has noted, "The lavishness with which the Triple Alliance rulers were able to dispense gifts must have raised the general standard of high-level gift giving throughout the region" (cited in Brumfiel 1987b:116). This inflation may also have increased the level of gift-giving among private citizens. Brumfiel (1987b:116), for example, comments that private feasting and competitive gift-giving as a means of marking life crises were integral parts of Aztec culture by the time of the Spanish conquest. These celebrations were competitive events in which the elite vied for pre-eminence through conspicuous consumption and/or conspicuous gift-giving. This increase in private gift-giving played into the imperial elites' hands in two ways (Brumfiel 1987b:116). First, competitive gift-giving undermined the establishment of horizontal alliances among nobles, thereby preventing the emergence of organized opposition to the empire. Secondly, it created a sustained demand for goods distributed by the empire through its patronage system, a demand that supported vertical alliances with the imperial center.

Creation of System of Achieved Statuses. The Aztec also created an alternative system of achieved statuses, open to both nobility and commoners, through military service in the expanding empire (Berdan 1975:66-69). This nobility of service provided a new sociopolitical hierarchy, whose ranks were defined on the basis of the number of captives taken on the field of battle. Distinguished military service was rewarded with rights to land (held on life tenure only) and the rights to wear specific luxury goods as symbols of attained status (Davies 1973:79; Zorita 1963:86).[1] Feathered warrior costumes and cotton mantles (*tilmatli*) of different designs were distributed in recognition of the number of enemy prisoners taken (Berdan 1975:127; Anawalt 1980). Warriors who successfully captured four or more prisoners were qualified to attend war councils and to serve in important military and civil offices (Berdan 1975:67).

For the nobility, participation in imperial conquests provided the opportunity to increase their landholdings and status (and not to increase was to stand to lose). For commoners, military service provided the primary means of social mobility. Although commoners could not attain full noble status through military success, they could attain high status, and access to goods and services otherwise reserved for the nobility (Berdan 1975:67). For the empire, the emphasis on achieved status pitted the nobles against one another to compete for honors and limited the number of noble claims to imperial liberality (Brumfiel 1983:274). More importantly, the new sociopolitical hierarchy provided an alternative source of military and civil administrators whose loyalty was tied to the continuance of empire and who served as a vital check on the independence of traditional elite.

There is some evidence that the elite stratum came to resent the encroachment of promoted commoners on the perquisites of elite status and feel competition with this class for important military and civil offices. Wolf (1959:138) suggests, for example, that during the last phase of Aztec rule, an aristocratic reaction may have prompted Motecuhzoma II to curtail the privileges of the service nobles in favor of a renewed monopoly of power in the hands of the nobility of descent (see also Berdan 1975:238-39; Davies 1973:214-216). At that time, Motecuhzoma II ordered that all officials of low descent, whether in the capital or in the provinces, be replaced by persons of noble blood (Alva Ixtlilxochitl 1952, II:310).

The system of acquired statuses through military success contributed to the unity of the empire in a number of ways. First, it directly tied status (and hence individual elite interests) to the expansion of the empire. It thus created a community of interest uniting imperial Aztec rulers and traditional rulers in a common goal (Calnek 1978b; Rounds 1979; Brumfiel 1987b:114). Second, it channeled competition between nobles into avenues that did not disrupt imperial integration. In the pre-imperial period, competition over succession to positions at the heads of noble houses had generated considerable strife, since there were many more qualified persons than positions to fill (Brumfiel 1987b:114). As long as the empire continued to expand, the hierarchy of achieved statuses could accommodate as many qualified individuals as existed. At the same time, the competition for military success created a division among the nobles, preventing them from acting as a unified class in opposition to the state (Brumfiel 1983:274).

Imperial Controls over Strategic Goods

Given the importance of land and luxury goods in achieving imperial political integration, it should come as no surprise that Aztec dominance was accompanied by attempts to consolidate control and limit access to these key resources. Of the two classes of goods discussed here, land and luxury items, the former proved less easy to manipulate. Traditional avenues of access and control over land and labor were already defined in pre-imperial times. Except as a direct consequence of conquest, the imperial rulers could not alienate elite control of lands without politically alienating the nobility as well; thus compliant traditional rulers retained a level of independent income from their patrimonial lands.[2] Elite rights to landholding were in fact strengthened against encroachment by meritorious commoners by the restrictions set on non-nobles that limited their holding to life tenure, prohibited the transfer of these holdings, and forbade the use of attached (*mayeque*) labor in their cultivation (Berdan 1975:68).

Where traditional landholding rights could be alienated, as through conquest, the imperial rulers consolidated their control over this resource by reserving large portions of conquered lands for their own support and retaining the rights to distribute the remainder at their own discretion (Berdan 1975:44). They also restricted competing traditional rulers from gaining access to this resource (1) by increasingly rewarding military and administrative service with the rights to produce only, rather than with land-ownership, (2) by disbursing widely scattered land parcels rather than contiguous domains, and (3) by attaching the rights to income to a particular administrative office, not as the personal property of the incumbent office-holder.

In contrast, exotic luxury goods constituted a more open system, and it is here that political maneuvering for control is most apparent. Although the value of these goods was established in pre-imperial times, control over the circulation of these goods was not. Imperial strategies to control these resources targeted three main areas, including rights to consumption, mechanisms of redistribution, and avenues of acquisition and circulation.

Control over Consumption

During the reign of Motecuhzoma I (A.D. 1440-1468), sumptuary rules were dictated decreeing who had rights to display certain types of luxury goods as status symbols. This decree established a clear hierarchy of statuses and their associated insignia. Durán (1964:131-132) records that Motecuhzoma's decree:

> (a) restricted use of gold diadem, gilded sandals, and fine embroidered cotton mantles to the king;
>
> (b) established that only kings and sovereigns of the provinces could wear gold armbands, anklets, rattles, garlands, headbands, chains of gold and jewelry of semi-precious stones;
>
> (c) limited to the great lords the rights to wear lip-plugs, ear-plugs, and nose-plugs of gold and semi-precious stones;
>
> (d) reserved for other valiant warriors the right to wear common garlands and eagle and macaw feathers as well as necklaces of bone, small snail or scallop shells, or of small cheap stones, while brave captains and soldiers were to wear ornaments of bone, wood, or other inferior materials;
>
> (e) restricted the wearing of cotton to the nobility, while commoners were to wear only maguey fibers, upon pain of death. Within the royalty and nobility, the king was entitled to wear fine mantles of embroidered cotton, lords could wear less fine cotton mantles, while warriors were entitled to only the simplest type of plain cotton mantles.

Motecuhzoma's regulations also dictated how goods were to be displayed and garments worn. For example, high ranking nobles and priests were permitted to tie their cloaks in front, under the chin, while the majority of the male population tied these cloaks over the right shoulder (Anawalt 1980). Similarly, only the highest ranking nobility could wear sandals. Only the nobility were allowed to wear a mantle that reached below the knee. Exception was made for warriors of commoner origin who had been wounded in the leg; these were allowed to wear longer mantles as a sign of respect for the valiant leg until the wound healed.

Anawalt (1980:43) had argued that these sumptuary laws were principally applied to the ritualistic and official side of Aztec life; everyday dress may not have been as strictly regulated: "the vaunted sumptuary laws did not dictate what people wore every day but rather provided a set of rules governing clothing used for ceremonial and ritual occasions." However, on important official occasions these sumptuary rules served to publicly affirm the political and social order in three ways. They reinforced the political status of elite goods and formalized these goods as visible markers of the underlying sociopolitical hierarchy. They limited the display of exotic prestige items to the nobility, whether of birth or of achievement. And they effectively raised the value of status achieved through military service to that of inherited positions at the heads of noble houses.

Control over Redistribution

Motecuhzoma I is also credited with formally linking the distribution of elite goods to achievement in warfare. Near the end of Motecuhzoma's reign, Tlacaelel reportedly ordered that great warriors were to fight in a "military market place" where honor and glory would be bought with their blood and their lives:

> "When you go to the market place and see a precious ear-plug or nose-pendant,
> Or when you see splendid and beautiful feathers
> Or a rich gilded shield, or weapons done in feather work,
> Do you not covet then, do you not pay the price that is asked?
> Know now that the king, who is present, has willed that lip-plugs,
> Golden garlands, many-colored feathers, ear-plugs, arm-bands,
> Shields, weapons, insignia, mantles, and loin cloths
> Are not to be bought in the market any longer by brave men.
> From now on the sovereign will deliver them as payment
> For memorable deeds. Each one of you, when he goes to war to fight,
> Must think that he has journeyed to a market place
> Where he will find precious stones" (Durán 1964:141-142).

Those not participating in imperial military campaigns were excluded from these honors; they were destined to wear the clothing of the common man, even if they were of high-ranking noble birth, as a symbol of their cowardice. They were forbidden to wear cotton garments and to adorn themselves with feathers and flowers.

Tlacaelel's decree had several important effects. First, it formalized the redistribution of elite goods as symbols of the political order and reinforced the political status of elite goods. Second, it explicitly tied the right to display such goods to achievement in warfare, not merely to the capacity to purchase such goods in the market place. Finally, and most importantly, the decree effectively institutionalized the imperial ruler as the sole distributor of these goods, and hence as the sole source of power and prestige within society. As Anawalt (1980:40) notes, Motecuhzoma's decree turned feathered warrior costumes and decorated cotton cloaks into the most highly visible and supremely sought after status symbols in Aztec society. Small wonder that the ruler reserved the right of dispensing these prestigious status symbols. Although this decree ostensibly affected only the military, achievement in warfare was the most important and the most fluid social arena, and Tlacaelel's decree indicates that this area was becoming an increasingly formalized system for gaining status.

Avenues of Acquisition and Circulation

With the institutionalization of their political value, exotic luxury goods became "necessary luxuries" for the Aztec state (Davies 1987:100, 135).[3] Imperials controls over acquisition and circulation of these goods were directed at two systems: the tribute system and long-distance exchange.

Tribute Flows. Imperial patronage and elite participation in the consumption and exchange of luxury goods was financed by the tribute system. Tribute flows were organized through two distinct systems: a provincial system focused on the individual Triple Alliance capitals and an imperial system (Hassig 1985:105). These distinct tribute systems led to multiple tribute obligations, as commoners gave tribute through different channels to different lords. The dual systems also led to overlapping and interdigitated tribute jurisdictions, with the result that city-states no longer functioned as politically isolable or cohesive units.

At the provincial level, each of the Triple Alliance members (Tenochtitlan, Texcoco, and Tlacopan) controlled a sizable area close to its capital. Torquemada (1969, Vol. I:175) describes the division of the Valley among the three members following the formation of the Triple Alliance. Roughly speaking, Texcoco gained control of the NE quarter, Tlacopan controlled the NW quarter, while the whole of the southern half of the Valley went to Tenochtitlan. Within their respective territories, the Triple Alliance rulers received tribute in goods and services from subordinate rulers and from dependent towns in the capital's rural hinterland, and rents in produce from commoners who cultivated parcels of land for the lord (Hicks 1984; Carrasco 1991).[4] The rulers also received income from their own patrimonial lands (worked by attached serfs), as well as from lands set aside for the support of their office (*tlatocatlalli*) and for the palace (*tecpantlalli*).

In addition to their individual tribute revenues, an imperial-level tribute system developed in which Triple Alliance capitals shared the revenues from conquered regions, according to a variety of arrangements (Gibson 1971:391; Carrasco 1991). The most frequently cited division was a 2:2:1 split going to Tenochtitlan, Texcoco, and Tlacopan, respectively (Zorita 1963:89). This tribute was delivered first to Tenochtitlan and there divided among the Triple Alliance rulers (Berdan 1975:119; Alva Ixtlilxochitl 1952, Vol. II:198). Thirty-eight provinces that were geographically distinct from traditional native political units and bases of power were established for the collection of this imperial tribute (Barlow 1949). The Codex Mendoza and associated *Matrícula de Tributos* have traditionally been interpreted as recording the imperial tribute shared among Triple Alliance members (Berdan 1975:82; cf. Carrasco 1991, who suggests that this represents only Tenochtitlan's share). By the mid-fifteenth century, this imperial tribute system was overseen by a well-defined hierarchy of tribute stewards and officials (Brumfiel 1983).[5]

Tributary receipts at both the provincial and imperial levels included both subsistence items (foodstuffs and utilitarian craft items) and prestige goods. Cotton mantas (plain and decorated) and warrior costumes and regalia were major tribute items, along with jewelry of gold and semi-precious stones. It is noteworthy that most prestige items were received as finished goods (Berdan 1975:112); only limited amounts of exotic raw materials for the manufacture of these items are listed on tribute rolls.

Long-Distance Exchange. Exotic raw materials for the manufacture of elite prestige goods were largely supplied through long-distance exchange conducted by a class of professional merchants (*pochteca*) who trafficked between the Valley of Mexico and the tropical lowlands. The merchants involved in this foreign trade were exclusively members of specific merchant guilds which received the "foreign trade monopoly" by virtue of their relationship with the state (Berdan 1975:188; van Zantwijk 1985:134). The professional merchants dealt in relatively large lots (wholesale) and specialized in luxury goods, conducting trade both within and outside of the empire (Berdan 1987b).

Outside of the Valley, the merchants are best known for their role in state-sponsored trading activities. In one famous case reported by Sahagún, merchants of Tenochtitlan and Tlatelolco were given 1600 cotton mantas by the Aztec ruler Ahuitzotl, with which they purchased luxury goods in the Tlatelolco market (including embroidered mantas, breech cloths, and skirts) for foreign exchange (Sahagún 1950-1982, Book 9:7-8; Davies 1973:136-137; Berdan 1975:175).[6] The property of the Aztec ruler was then traded abroad for brightly colored tropical feathers, jade, turquoise, and shells of many kinds. Upon their return home, the merchants were rewarded by the ruler for facilitating this transaction. It is clear that in this context, the goods remained state property and the merchants acted as emissaries for the state in carrying state goods to extra-empire trading centers (Berdan 1975:178; Carrasco 1978:59).

The *pochteca* also actively participated in entrepreneurial exchange (Carrasco 1978:58-59). In addition to state-owned goods, the merchants carried their own goods (including jewelry of gold, rock crystal, copper and obsidian) for trade in distant (extra-imperial) markets, returning with cacao and other goods. Within the empire, the professional merchants circulated exotic goods among major markets in the provinces as well as within the Valley (Berdan 1975:167-8). Durán (1971:138) comments that these merchants traveled to "...all the markets of the land, bartering cloth for jewels, jewels for feathers, feathers for stones, and stones for slaves, always dealing in things of importance, of renown, and of high value." Similarly, other ethnohistoric accounts record that the merchants circulated from market to market throughout all the imperial provinces (Clavijero 1945, Vol. II:280-281, trans. Berdan 1975:168; Motolinía 1971:375). This entrepreneurial trade appears to have been the basis of the merchants' famed wealth, since rewards given by the ruler appear small in comparison to the great distances traveled.[7]

Goods carried by the *pochteca* on their outbound trips were almost exclusively manufactured luxury items. This included both state and private merchant goods. These goods were exchanged almost entirely for exotic and precious raw materials. The direction of this exchange was apparently essential, since relatively small amounts of exotic raw materials were received through tribute (Berdan 1975:188, 269-70, 1987b). The merchants undoubtedly maintained close relations with craftsmen within the Valley; craftsmen would have had to depend on the merchants to obtain non-local raw materials, such as feathers, precious stones, and metals (Berdan 1975:270; Calnek 1978a).

Twelve Valley of Mexico cities had professional merchant guild organizations: Tenochtitlan, Tlatelolco, Cuauhtitlan, Azcapotzalco, Huitzilopochco, Mixcoac, Texcoco, Huexotla, Coatlinchan, Otumba, Xochimilco, and Chalco. Berdan (1986:284) suggests that these merchant guilds were responsible to the Triple Alliance capital in whose provincial territory they resided, and that the imperial capitals operated rather independently in their economic deployment of these merchants. For example, only the merchants from Tenochtitlan and Tlatelolco were entrusted with the Tenochca ruler's goods on state-sponsored trading ventures outside the empire, while the merchants from three other cities (Cuauhtitlan, Azcapotzalco, and Huitzilopochco) travelled as their companions (Sahagún 1950-1982, Book 9:17). These latter cities were under Tepanec control and, although not stated, their merchants may have carried the property of the ruler of Tlacopan in these ventures (Berdan 1986:284). Similarly, those guilds located in Acolhua territory, while restricted from the lucrative Gulf Coast trade (Sahagún 1950-1982, Book 9:48-49), may well have served elsewhere as extra-empire emissaries for the ruler of Texcoco (Berdan 1986:284).

Increasing Controls over Acquisition and Circulation of Luxury Goods

Centralization of Tribute Flows. Centralized control over the imperial tribute system was apparently achieved during the reign of Motecuhzoma I (Brumfiel 1983:276). Initially, the tribute collectors were selected by and were responsible to the local rulers (Berdan 1975:113). By 1458, Motecuhzoma had assumed personal responsibility for naming imperial tribute officials. In addition, he instituted the system of 2 *calpixque* per imperial tributary province: one stationed at the site of the tribute collection, the other in Tenochtitlan, the site of tribute receipt. By 1462, the office of *petlacalcatl* or chief steward had been instituted to supervise the tribute assessments and collections, serving as a middle-level administrative post between Motecuhzoma and provincial tribute stewards. These actions removed tribute collection from local authorities and placed it in the hands of a well-defined hierarchy of tribute officials directly responsible to the ruler of Tenochtitlan.

Control over Acquisition of Exotic Raw Materials. With growth of the empire came an increase in both direct control and indirect influences exerted by the state on acquisition of exotic luxury goods (Berdan 1975:265). These controls took two forms: (1) increasing intervention in foreign trade, and (2) the replacement of long-distance trade with tribute.

During the earliest phase of the Triple Alliance empire (1428-1450), the merchant guilds apparently operated independently of state interests (Berdan 1975:291). The growing importance of the merchants, however, is underscored by the conquest of the merchant center and main market at Tlatelolco in 1473 (Davies 1973:132; Carrasco 1978:63; Berdan 1985:345). Following this conquest, the merchant guild increasingly came under direct state control; thereafter they were employed as spies and trading agents of the state (Berdan 1975:291; Davies 1987:134). The documents further report that these merchants were greatly esteemed by the ruler, presumably both for their commercial activities and for the role they played in spying out enemy territory.

The merchants gained from this new relationship, as well. Only merchants sanctioned by the imperial ruler were allowed to trade in certain provinces outside the empire. Entrance to the profession was also restricted. Membership was by birth or by permission of the ruler only (Berdan 1975:149; Zorita 1963b:181). By the time of the Spanish conquest, the professional merchants appear to have enjoyed a virtual monopoly in trading of status-linked luxury goods (Berdan 1975:159, 1978:82; Calnek 1978a:105).

The imperial government benefitted from this relationship in several ways. Through state-sponsored trade, the imperial rulers could receive a considerable flow of essential exotic goods. The state could amass and direct significant capital into foreign trading enterprises and it had the ability to conduct such expeditions on a grand scale (Berdan 1975:271). In addition to gains through state-sponsored trade, the state received exotic and precious goods through taxes paid in kind by the merchant guilds, and from gifts to ruler as part of special guild celebrations.

Through time and with imperial expansion, however, the means of state control shifted from state-sponsored trade to tribute from conquered provinces (Berdan 1975:265-73; Carrasco 1978:58-59). As Berdan (1975:273) notes, long-distance trade was apparently not the most stable nor profitable strategy for obtaining exotic luxury goods for the Aztec state. The merchants could be attacked and supplies cut off; trade in distant provinces could be redirected so that sufficient amounts of desired goods were not available to Valley of Mexico merchants. At home, inflation in imperial patronage would have been increasingly dependent on the availability of exotic goods, and in increasingly large quantities. Although this increased demand might have been met by an expanded volume of trade, such an increase would jeopardize the ruler's position as chief dispenser of power and prestige.[8] If these goods increasingly circulated through the market system, control over their production and distribution would have been diffused (Berdan 1975:253).

These strategic considerations dictated that the Aztec rulers follow a dual policy that jointly limited foreign trade and attempted to centralize direct control of goods through tribute. Thus, time after time, long-distance exchange was followed by conquest and the imposition of tribute in goods previously obtained through trading (Berdan 1975:273, 1985:357; Davies 1987:152). In fact, much later imperial expansion appears to have been motivated by the desire to directly control the flows of exotic luxury goods and to obtain a more direct and reliable supply of these strategic items (Berdan 1978:87-91; Hassig 1985:87; Davies 1987:133).

In summary, the strategic value of exotic prestige goods in achieving political integration is underscored by imperial attempts to consolidate control over and limit access to these key resources. These controls included monopoly rights on foreign exchange and increasingly centralized imperial tribute flows.

The Inversion of Political Dependency

The foregoing suggests that an important component of Aztec political economy was the manipulation of two classes of strategic goods (land and labor on one hand, and exotic prestige goods, on the other) to engage the cooperation of conquered elite and absorb them into the political and economic fabric of the empire. Of these, land and labor constituted the more traditional basis of wealth, and imperial elite were politically constrained by established systems of land-ownership. Only following an outright conquest were imperial elite able to redistribute land-holding and tribute rights, and it is in this context that imperial attempts to redirect land resources to meet political ends are most apparent.

The wealth system of exotic prestige goods, in contrast, seems to have been more open to manipulation, and the documents report an increasingly formalized system of control over these luxury items. Rights to acquisition and display of status goods were regulated by sumptuary laws that formalized the valuation of prestige goods and tied this system of relative statuses to the political hierarchy. Imperial legislation also explicitly limited promotion within the political hierarchy to individuals demonstrating achievement in imperial warfare and service to the state. Rights to redistribution established the state as the source of status and prestige and legitimized the apical role of the imperial ruler as the chief dispenser of prestigious status symbols. The empire thus achieved centralized and direct controls over critical flows of exotic prestige goods.

In essence, then, controls over strategic goods created an elite incentive plan that (when backed up by the threat of military reprisal) strengthened vertical ties with the imperial core while simultaneously undermining the formation of horizontal alliances among nobles that might foment rebellion. Political and economic interests tied elite loyalty to the continuance of the state, and made their own position and status dependent on participation in the expansion of empire. In short, the traditional elite generally stood to gain more through compliance than resistance.

Through controlling access to strategic goods, the elite incentive plan effectively inverted relations of political and economic dependency between traditional and imperial elite, thereby contributing to political consolidation and to the resolution of the endemic problem of early empire. The result was a loosely organized, hegemonic empire. Yet the degree of political and economic integration was sufficient to generate a rapid expansion of empire and to capture temporary control of resources over a vast area.

The New Dependency

Urbanization in the Imperial Core

The successful consolidation of imperial control generated a new, if more mundane problem: the rapid demographic growth of the imperial core. During the 14th and 15th centuries, cities in the Valley of Mexico experienced an enormous urban growth. With an estimated population of 150,000-200,000, Tenochtitlan was arguably the largest city in the western hemisphere at the time of the Spanish conquest (Gibson 1964:377; Calnek 1972). Texcoco, the empire's second city, had a nucleated urban population estimated at 20,000-30,000 (Parsons 1971:120), while its suburban area may have encompassed up to 100,000 (Hicks 1982b). Below these primary cities were large city-state centers with urban populations of 10-15,000. Overall, the Valley's population appears to have doubled from pre-imperial times (Parsons 1974).

In addition to the explosive increase in population, the proportion of the urban population engaged in non-agricultural pursuits also increased, reflecting the expansion of the imperial bureaucracy (Calnek 1972; Sanders 1956:121; Sanders and Price 1968:151). As Berdan (1975:251) has noted, "The Triple Alliance capitals experienced a proliferation of political and religious positions, filled primarily by members of the expanding nobility class...The rapidly increasing nobility class required greater amounts of prestige goods; the urban population as a whole required additional subsistence goods."

The major spurt in urban growth appears to correspond temporally with the consolidation and expansion of Aztec imperial control. Increasing social differentiation and rapid growth of the administrative sector were initially both supported and stimulated by conquest and the incorporation of tribute networks that funneled elite goods, utilitarian commodities, and foodstuffs into the imperial core (Calnek 1972, 1976; Brumfiel 1980:466). Thus, the growth of empire emerges as a major causal factor driving the transition from an essentially rural to a highly urbanized economy.

Cities as Food-Deficient Sites

Several social historians have pointed out the vulnerability of such urban development to problems of food scarcity and supply (Tilly 1975; Hassig 1985:5; Parsons 1991). They argue that no population aggregate of any size can exist as an independent entity. Urban centers are food deficient points in a rural landscape where food production is in excess of local consumption, thus cities are dependent on rural food producers for their basic sustenance. However, this urban-rural relationship is essentially asymmetrical: while urban areas are always dependent upon rural areas, rural areas are not necessarily dependent upon urban centers. Thus, there may be relatively little economic incentive for rural agriculturalists to produce food surpluses for urban consumers. To ensure the flow of necessary foodstuffs, cities seek to redress this imbalance, forcing the rural hinterland into a position of dependency on the urban center through economic and political measures (Hassig 1985:5).

For the Aztec, the successful resolution of the endemic problem of empire generated a new dependency -- that of the urban core on the agricultural products of the rural hinterland. Supported initially by the influx of imperial tribute, the growth of Tenochtitlan and other cities soon exceeded the support capacities of those tribute revenues (Berdan 1975:264; Calnek 1978a). As a result, imperial economic goals were reformulated away from initial and more narrow support needs of imperial infrastructure to consider the urban supply problems of the expanding imperial core.

Imperial Responses to Problems of Urban Supply

The Aztec developed both coercive and remunerative solutions to the problem of urban supply. Tenochtitlan (and other major urban centers) received foodstuffs through tribute from conquered areas and rents from expropriated lands, through the creation of new agricultural lands (in the form of *chinampas* and terraces), and through trade in the regional market system. As Price (1979:300) comments, this mixed strategy balanced political costs against anticipated returns: "For the elite the question is essentially one of strategy: Which combination of force and benefits (both of which, of course, cost something) will have the highest payoff and under what circumstances?"

Tribute and Rents in Foodstuffs

As discussed above, the Triple Alliance capitals received tribute in foodstuffs through both imperial and provincial systems. Imperial tribute assessments were made following conquest (based on degree of resistance), but were doubled if that tributary later attempted to rebel (Berdan 1975:246). There is also some evidence that tribute levies increased generally through time to meet the growing demand for both subsistence and prestige goods. However, this rise in tribute receipts may reflect the growth of the tribute-paying population, rather than a per capita increase (Berdan 1975:247).

Berdan's analysis (1975:120-30) of the distribution of imperial tribute indicates that imperial interests and causes (including royal palaces and personnel, administrative and military activities, and gifts and rewards distributed through royal patronage) were the primary recipients of income from imperial tribute stores. But there is some evidence that tribute from conquered provinces contributed to the subsistence support of urban populations residing in the Triple Alliance capitals as well.

In addition, imperial and local administrators received foodstuffs produced on their own patrimonial lands through agricultural labor service and as rent from parcels of land attached to the administrative office and worked by rural tenants. The office of *tlatoani*, for example, was supported by fields called *tlatocatlalli* or *tlatocamilli* (ruler's land or ruler's fields), that were reportedly a standard size (400 *brazas* per side, approximately 2,500 m^2) and were rented to commoners for the maintenance of the ruler (Gibson 1964:259; Hodge 1991:129). Lesser officials received rents from smaller plots of land (Gibson 1964:260). These plots were attached to a specific administrative office, and were distinct from the personal landed property of the incumbent office holder.

State-Sponsored Land Reclamation and Agriculture

The state also directed and/or sponsored large-scale projects that generated extensive areas of highly productive *chinampas* (raised fields) in Lakes Chalco-Xochimilco, the agricultural produce from which could be funneled into Tenochtitlan (Sanders, Parsons, and Santley 1979:176-77). Ethnohistoric and archaeological data indicate that the principal period of swamp drainage and *chinampa* construction in the southern lakebed dates to ca. A.D. 1426-1467, that is, within the reigns of Itzcoatl and Motecuhzuma I (Armillas 1971; Calnek 1975; Parsons 1976:236, 1991). The earliness of these projects suggests that the stress of urban food needs was felt or anticipated early-on during the period of initial imperial consolidation. At its maximum extent, approximately 9500 ha of *chinampa* land were cultivated, with an estimated maximum annual surplus capacity of ca. 20,000 metric tons of maize (Armillas 1971; Parsons 1976:246, Table 12.4).

In addition to the *chinampas*, stone-walled terraces were constructed on the piedmont slopes of the Tenango subvalley and within the Texcocan piedmont to increase the productivity of these areas under Aztec rule (Parsons et al. 1982:356-58; Parsons 1971:221). Although it is not clear that these represent state-directed or state-sponsored activities, their construction coincides with the period of rapid urban growth in the Valley and may reflect attempts by the Triple Alliance capitals to increase productivity within their hinterlands. Foodstuffs from these areas of intensive agriculture could have been obtained by the capital centers through tribute, rents, and sales of surpluses.

A related category may include the establishment of new communities to increase the food supply of urban centers. Hicks (1984:159), for example, names several communities that were settled, at least in part, by colonists from Texcoco sent there originally by Nezahualcoyotl to raise food for that city (Alva Ixtlilxochitl 1952, II:199). In the archeological record, dispersed rural settlements in the Texcocan piedmont and elsewhere may represent communities of renters directed by the state (Sanders, Parsons, and Santley 1979:178-179; cf. Williams 1991:206).

Markets

The market system in the Valley of Mexico consisted of a series of primary and secondary markets. Markets in the major cities such as Tenochtitlan-Tlatelolco and Texcoco met daily, while markets in secondary urban centers generally met on a 5-day cycle (Berdan 1975:197; Motolinía 1971:375; M. Smith 1979). The occurrence and periodicity of markets in smaller communities remains in question.[9]

Early descriptions of the great market at Tlatelolco report a broad range of foodstuffs organized by type of commodity. Raw foods included grains, beans, vegetables, fruits, and herbs; meat (including turkeys, cottontail rabbits, hares, deer, mallards, young dogs, fish, and lake products); honey, maguey syrup, and other dainties like nut paste; and salt. In addition, women sold a variety of cooked foods (including tortillas and tamales) and prepared maize dough. Most food vendors were apparently small-scale producer-sellers or retailers (*tlanecuilo*) specializing in a specific commodity.[10] Sahagún (1950-1982, Book 10:65), for example, notes that the seller of maize is "a worker of the fields, a worker of the land, or a retailer." Similarly, the meat seller is characterized as "an owner, a possessor of meat -- a meat owner, an animal owner. He hunts; he pursues game. Or he is a meat dealer. He keeps [animals] -- raises them" (Sahagún 1950-1982, Book 10:80).

Once in the urban center, market produce circulated through two levels to meet urban supply needs. First, market vendors were taxed in kind at a rate up to 20%, with the revenues going to the local *tlatoani* (Cortés 1928:93; Torquemada 1969, Vol. II:560). Berdan (1975:209) suggests that market taxes may have been a significant factor contributing to the support of royal and noble households and their attached clientele. More generally, produce was available for purchase by the urban populace.

Relative Contribution of These Sources

A quantitative assessment of the relative contribution from these sources to the total subsistence requirements of Tenochtitlan has been presented by Parsons (1976). This analysis argues that with a maximum population of 150,000-200,000, Tenochtitlan required 30,000-40,000 metric tons of foodstuffs per year to support its urban population. Assuming that Tenochtitlan had very limited local agricultural capacity, nearly all this produce must have come from outside the capital itself (Calnek 1972). According to the Codex Mendoza, Tenochtitlan's received 86 *trojes* (16,000 metric tons) of grain annually as tribute. Rents are more difficult to estimate, but Parsons suggests that the population of tenant farmers of the Lake Chalco-Xochimilco *chinampas* was capable of producing the equivalent of about 2535 metric tons of surplus maize annually in rent; the volume of foodstuffs appropriated in rents from other areas is not estimated. The balance of Tenochtitlan's total subsistence requirements, some 10,000-20,000 metric tons (40-50% of the total) is assumed to have been obtained through mechanisms other than rent or tribute -- that is, through the market system.

Within Parsons' (1976) model, then, the market institution assumes an especially critical role, for it provided at least 40% of Tenochtitlan's total food supply. Although the actual statistics reported are tentative[11], they are consonant with ethnohistoric statements that virtually all the basic foodstuffs consumed in the city were imported, and that of these, more were obtained through the market system than were received as tribute or rent (Durán 1951, I:61,64,66, cited in Calnek 1978a:100).

There are theoretical reasons to assume that the market played a critical role in the procurement of foodstuffs, as well. An increase in tribute assessments does not necessarily increase available quantities of foodstuffs; in times of food stress, peasant households feed themselves first. Attempts at heavy exaction increase the potential for revolt and hence increase administrative and military costs. As Brumfiel (1980:475) has commented in response to the query as to why Triple Alliance rulers didn't simply force local peoples to give them food as tribute: "Perhaps the potential costs of a tax revolt in the Triple Alliance heartland led by disaffected local elites but manned by oppressed commoners were great enough to discourage implementation of this rather straightforward option." Similar considerations of cost-effectiveness may have limited the contribution of land reclamation and intensive agriculture. *Chinampas* were very costly and labor intensive to build and maintain, and were spatially restricted to areas of shallow, fresh lakes within the Valley. In contrast, market participation that relied on economic incentives and self-interest was a relatively inexpensive means of promoting increased agricultural production.

Urban Market Dependency and the Balance of Payments

The apparent significance of market institutions in supplying urban populations in the Valley, and the dependency of urban systems on those markets, is at the core of a long-standing question: If the emerging urban populations and imperial interests were dependent on market exchange to tap rural agricultural production, with what did the urban populations balance the incoming trade in foodstuffs? How did urban consumers motivate rural production and market system participation? As discussed in Chapter 2, the magnitude of this problem had led a number of studies to focus exclusively on the role of urban supply problems in structuring Aztec imperial economy.

To recapitulate briefly, several researchers (Sanders 1956; Calnek 1972; Hassig 1985; Santley 1986) have proposed that Aztec urbanism represents an urban-rural symbiosis consisting of more intensive food production in rural areas and more intensive craft production in the urban sector, coupled with the exchange of complementary goods within a market setting. In contrast, Brumfiel's (1980, 1983) early analyses concluded that urban food needs were met not by the sale of urban craft products, but by the urban-based market resale of craft goods (both utilitarian and elite) received in tribute. In either case, the centralized availability of craft goods in urban markets is seen as a primary stimulus directing the flow of agricultural produce into the centers and as a major factor undercutting rural craft production.

Both of these mechanisms operated to some extent in balancing urban accounts. Obviously some level of core-periphery symbiosis exists in the production of higher-level goods in all urban situations, and tributary influxes may well have dampened rural production of some classes of goods as well. With respect to the first model, however, growing evidence seems to indicate that secondary production was not situated primarily in Tenochtitlan-Tlatelolco, nor was it an urban monopoly in any sense (Blanton 1994). Craft production apparently remained dispersed throughout the hinterland, even as evidence for agricultural intensification increased.

Given the emerging picture of dispersed craft production, it seems unlikely that the political elite were able to sufficiently control tribute flows of utilitarian craft goods or to corner the market in those goods, as a means of promoting rural agricultural production and market participation. The political elite were, however, consolidating their control over a more strategic class of goods, that of exotic raw materials and prestige items, through processes described earlier in this chapter. This control suggests an alternative solution, in which urban supply problems were bound up with problems of imperial political control.

The Transformation of Prestige Goods

Two frequently cited characteristics of Aztec tribute assessments are the predominance of finished goods over raw materials, and the necessity to procure non-local raw materials to produce the manufactured goods required in tribute. Several authors have suggested that tribute requirements in manufactured goods were a significant factor stimulating market participation since tribute-payers were dependent on the market to obtain materials from non-local sources (Berdan 1975:215-54, 1985; Brumfiel 1987b; Hicks

1987:99). In fact, the growing tribute demand for items manufactured from non-local goods would be feasible only in areas with an extensive market system.

Following their lead, it is suggested here that the transformation of exotic raw materials into the prestige items demanded in tribute also helped to alleviate the problems of urban supply by generating flows of desired foodstuffs into urban markets. Briefly, the structure of imperial tribute payments meant that non-local goods had to be procured through the market system by tributaries to rework into the manufactured goods necessary to meet tribute requirements (Hicks 1987:99; Berdan 1975:27). The need to procure exotic raw materials stimulated rural agricultural production as a medium of exchange, while urban control over non-local goods provided the balance of payments. By directing flows of exotic raw materials, imperial rulers were able to concentrate exchanges of agricultural produce in major urban centers where these foodstuffs could be tapped by urban populations. Thus, imperial tribute requirements, consciously or unconsciously, were critical for resolving domestic problems of urban supply.

Imperial Tribute Requirements

For tributaries in the Central Highlands, two major classes of tribute goods typify the pattern in which the acquisition of exotic raw materials was required to meet tribute assessments. These were cotton cloth and feathered warrior costumes, both of which depended on obtaining lowland tropical raw materials.

Loads of cotton cloth were demanded in tribute by both local rulers and imperial tribute stewards on a regular schedule of once, twice, or four times per year (Berdan 1975:105-108). Cotton cloth was given as mantas (both plain and decorated, large and small), as well as tunics, skirts, and loincloths. Garments received as tribute were worn by nobles or circulated as gifts, while plain cotton mantas (*quachtli*) served as a medium of exchange. According to the Codex Mendoza and *Matrícula de Tributos*, imperial tribute in cotton cloth delivered to Tenochtitlan totaled over 280,000 garments annually (Berdan 1975, Appendix C).

A second major category of prestige items required in imperial tribute was the feathered warrior suits awarded for meritorious conduct in battle. These suits were made of tropical bird feathers sewn to a fabric backing, and were worn over quilted cotton armor (Hassig 1988:85-90). The *Matrícula de Tributos* records that a total of 683 feathered warrior costumes and shields were delivered annually to Tenochtitlan (Barlow 1949).

Communities in the Valley of Mexico supplied both classes of tribute items, although their contribution to the total assessment of these goods differed. All but four of the 38 imperial tribute provinces gave some amount of cotton cloth in tribute (Barlow 1949). With the exception of the Huaxtepec province (contributing 14% of garments received), tribute assessments were relatively evenly distributed, with each province paying from 1-5% of the total assessment (Table 4.2). Imperial tribute provinces encompassing the Valley of Mexico (Acolhuacan, Tlatelolco, and Petlacalco) contributed only 12% of the cotton garments delivered in tribute to Tenochtitlan (Table 4.3).

In contrast, although most provinces also paid tribute in warrior costumes, the majority of these suits were produced in the central highlands (Berdan 1987b:172). The three tribute provinces encompassing the Valley of Mexico contributed nearly 40% of all warrior suits, while the nine provinces closest to the imperial core contributed 85% of the costumes received in tribute (Table 4.3). Most other provinces contributed only 1 or 2 warrior suits per year.

Organization of Production for Tribute

Cotton cloth was produced as part of the domestic mode of production. In native documents, the production of cloth is portrayed as an integral part of female labor and a symbol of femininity (Sahagún 1950-1982, Book 8:49; Berdan 1987a; Hicks 1994). Cloth-making for women was perceived as the counterpart of agriculture and food

Table 4.2
Imperial Tribute Assessment in Cotton Garments by Province

Tribute Province[a]	Cotton Garments per Assessment Period[b]					
	Plain		Decorated		Total	
	#	%	#	%	#	%
1 Çihuatlan	2400	8.8	1600	4.8	4000	5.6
2 Tepequacuilco	2400	8.8	400	1.2	3200	4.5
3 Tlachco	0	.0	400	1.2	800	1.1
4 Ocuilan	400	1.5	400	1.2	800	1.1
5 Tuluca	0	.0	400	1.2	400	.6
6 Malinalco	0	.0	0	.0	0	.0
7 Quahuacan	0	.0	800	2.4	800	1.1
8 Xocotitlan	0	.0	0	.0	0	.0
9 Atotonilco	800	2.9	800	2.4	1600	2.2
10 Quauhtitlan	400	1.5	800	2.4	1200	1.7
11 Xilotepec	400	1.5	1600	4.8	2800	3.9
12 Axocopan	800	2.9	1200	3.6	2400	3.4
13 Hueypuchtla	0	.0	400	1.2	400	.6
14 Oxitipan	2000	7.3	800	2.4	2800	3.9
15 Ctzicoac	800	2.9	400	1.2	2000	2.8
16 Tuchpa	1600	5.8	3040	9.0	5440	7.7
17 Atlan	400	1.5	800	2.4	2000	2.8
18 Tlapacoyan	800	2.9	400	1.2	1200	1.7
19 Atotonilco Grande	0	.0	800	2.4	800	1.1
20 Acolhuacan	2000	7.3	1200	3.6	4000	5.6
21 Chalco	800	2.9	0	.0	800	1.1
22 Quauhnahuac	2000	7.3	1200	3.6	4000	5.6
23 Huaxtepec	1400	5.1	8000	23.8	10200	14.4
24 Tlalcoçauhtitlan	400	1.5	0	.0	400	.6
25 Quiauhteopan	400	1.5	0	.0	400	.6
26 Tlatlauhquitepec	0	.0	1600	4.8	1600	2.2
27 Quauhtochco	400	1.5	0	.0	400	.6
28 Cuetlaxtlan	1200	4.4	1360	4.0	3360	4.7
29 Tochtepec	0	.0	2400	7.1	2800	3.9
30 Xoconochco	0	.0	0	.0	0	.0
31 Tepeacac	0	.0	0	.0	0	.0
32 Yoaltepec	400	1.5	0	.0	400	.6
33 Tlapan	800	2.9	400	1.2	1600	2.2
34 Tlachquiauco	400	1.5	0	.0	400	.6
35 Coayxtlahuacan	0	.0	1200	3.6	2000	2.8
36 Coyolapan	800	2.9	400	1.2	1200	1.7
37 Tlatelolco	800	2.9	0	.0	800	1.1
38 Petlacalco	2400	8.8	800	2.4	4000	5.6

[a]Data from Barlow (1949).

[b]Number and % of total mantas (of the specified type) received by Tenochtitlan.

Table 4.3
Annual Tribute Assessment in Feathered Warrior Suits by Province

Tribute Province[a]		#	%[b]	Cum. %
20	Acolhuacan	121	17.7	17.7
37	Tlatelolco	80	11.7	29.4
38	Petlacalco	65	9.5	38.9
19	Atotonilco Grande	62	9.1	48.0
10	Quauhtitlan	62	9.1	57.1
13	Hueypuchtla	62	9.1	66.2
23	Huaxtepec	46	6.7	72.9
12	Axocopan	42	6.2	79.1
7	Quahuacan	41	6.0	85.1
2	Tepequacuilco	22	3.2	88.3
5	Tuluca	22	3.2	91.5
4	Ocuilan	21	3.1	94.6
22	Quauhnahuac	8	1.2	95.8
9	Atotonilco	4	.6	96.4
16	Tuchpa	2	.3	96.7
33	Tlapan	2	.3	97.0
35	Coayxtlahuacan	2	.3	97.3
21	Chalco	2	.3	97.6
11	Xilotepec	2	.3	97.9
18	Tlapacoyan	2	.3	98.2
3	Tlachco	2	.3	98.5
26	Tlatlauhquitepec	2	.3	98.8
28	Cuetlaxtlan	2	.3	99.1
15	Ctzicoac	2	.3	99.4
32	Yoaltepec	1	.1	99.5
25	Quiauhteopan	1	.1	99.6
34	Tlachquiauco	1	.1	99.7
24	Tlacoçauhtitlan	1	.1	99.8
29	Tochtepec	1	.1	99.9
36	Coyolapan	0	.0	100.0
14	Oxitipan	0	.0	100.0
6	Malinalco	0	.0	100.0
30	Xoconochco	0	.0	100.0
8	Xocotitlan	0	.0	100.0
1	Çihuatlan	0	.0	100.0
31	Tepeacac	0	.0	100.0
17	Atlan	0	.0	100.0

[a]Data from Barlow (1949) and Berdan (1975:Appendix A).

[b]Percent and cumulative percent of total warrior costumesreceived by Tenochtitlan. Tribute provinces are arranged in descending order, with provinces contributing the most warrior suits listed first.

production for men (Durán 1971:232-33). The implication is that all women were involved in the production of cloth; thus cloth production affected the economy of every household.[12] Hicks (1994) argues that the dispersed, household production of cotton cloth was the most economically efficient way to organize the production of large numbers of tribute textiles given the nature of the technology and labor requirements.

In contrast, the production of feathered warrior suits and shields was clearly the work of specialists. Sahagún (1950-1982, Book 9:91-92) describes in detail the specialized skills required for featherworkers (*amanteca*); in addition, this specialty required a knowledge of designated designs or types of warrior costumes specified by the tribute rolls. The more concentrated production of warrior suits in the central highlands may correspond to the distribution of knowledgeable specialists near the imperial core.

Featherworking specialists attached to the palace of Motecuhzoma II were responsible for crafting that ruler's "array" and precious mantles; to that end, the royal storehouse was open to them (Sahagún 1950-1982, Book 9:91-92; Díaz del Castillo 1964:157; 213-14). There were also independent featherworkers, organized in wards, similar to other specialized craftsmen. Featherworkers are reported for the major urban centers, including Tenochtitlan, Texcoco, and Xochimilco (Díaz del Castillo 1964:318-319; Hodge 1984:81; Sahagún 1950-1982, Book 9:91). To meet tribute assessments, it is probable that a tribute-paying community would have had to purchase the materials and commission one of these independent specialists to produce the required suits.

Acquisition of Raw Materials by Tributaries

The raw materials for these tribute goods entered the Valley of Mexico through one of three channels (Berdan 1975, 1985). These are (1) state-sponsored long-distance trade utilizing the professional merchants (*pochteca*) as executors; (2) tribute from tropical provinces or provinces having contacts with tropical areas; and (3) non-state commercial exchanges, through the entrepreneurial activities of *pochteca* as well as through pre-existing exchange networks, the latter probably on a very small scale.

The acquisition of these raw materials by the tribute-paying commoners for the production of tribute goods remains an area in which we have very limited information. The division of control over these resources between the state (through tribute or state-sponsored exchange) and commercial enterprises (via the *pochteca*) suggests two major mechanisms: through the recycling of tribute raw materials and through market exchange. In the former case, the production of items for tribute involved only the labor of the tributaries; in the second case, the tribute assessments also required the output of resources to purchase the raw materials for the production of tribute goods.

Recycling of Tribute. Davies (1987) has argued that the manufacture of tribute goods from non-local materials depended on the recycling of non-local materials received in tribute; that is, raw materials received in tribute were handed out to tributaries for the manufacture of other tribute goods. We do know that rulers sometimes provided their subjects with the raw cotton to meet their tribute requirements (Alva Ixtlilxochitl 1952, Vol I:146-147; 1975-7, Vol. I:327; Zorita 1963:187), but it is unclear whether this was commonplace.[13] For example, Zorita (1963:187) claims that:

> "The Indians had fields planted to cotton for tribute in those areas where cotton was grown. Some towns, which did not grow it themselves, gave cotton as tribute because they had subject to them places where it was cultivated. The ruler in turn handed this cotton over to other towns which did not grow cotton but worked it into a very good cloth. This excellent cloth was made by the people of the *tierra fría*, who are better workers than those of the *tierra caliente*. Thus some towns gave cotton, and other turned in into cloth."

It is unlikely, however, that this was the predominant pattern, since an insufficient amount of raw material was received in imperial tribute to account for the volume of manufactured goods paid back in tribute. Only four provinces gave raw cotton, for a total of 4000 bales (Berdan 1975:313). Similarly, only five provinces gave tropical bird feathers, for a total of roughly 30,000 feathers (Berdan 1975:315). It is more probable that most of the exotic raw materials received in tribute were reserved for the use of attached specialists (including both weavers and featherworkers) who served the royal palaces.

Market Purchase of Raw Materials. Alternatively, the purchase of non-local raw materials was the responsibility of the tribute-paying unit (i.e. the community, the *calpulli*, or the individual household). In this more likely case, raw materials had to be procured through the market system by tributaries to rework into goods to meet tribute requirements (Berdan 1975:27, 114-16; Broda 1978; Hicks 1987:99).

Although a considerable gap existed between professional long-distance trade in exotic goods and local market exchange, a full complement of merchants served to articulate trade between the elite *pochteca* and the local producer-seller (Calnek 1978a:106; Hassig 1985:117-118). An important component of this system were the professional merchants that did traffic primarily in cotton and other extralocal goods, who apparently served as middle-men by circulating among the major markets and carrying goods from one area to another (Motolinía 1971:375; Durán 1971:138; Berdan 1975:167, 1985). For instance, Sahagún (1950-1982, Book 10:75) records that the seller of cotton is "a planter of cotton, or an importer, or a retailer." While it is unlikely that the growers themselves traveled the great distances to sell at the Tlatelolco market, professional merchants could expect to make significant profits from transporting and retailing these goods (Berdan 1976:205).

As a result of merchant activities, exotic raw materials were common in the markets of major cities. Raw and spun cotton were available for sale in the great market of Tlatelolco in such profusion that this section of the market reportedly rivalled the silk markets of Spain (Zorita 1963:158, quoting Cortés). Early reports of the Tlatelolco market also consistently mention tropical feathers for the manufacture of devices and shields (Berdan 1975:199; Sahagún 1950-1982, Book 8:67; Anonymous Conqueror 1858:392-393). Major city-state centers and provincial markets also carried non-local goods. The consistent availability of cotton in the city-state center markets is indicated by the fact that this commodity was classed as a necessity in markets of this type (including Ecatepec, Xochimilco, and Acolman) at a time when the Spaniards permitted only the sale of articles necessary for Indian sustenance in town markets (Gibson 1964:355-56).

Exotic goods were not necessarily widely available in markets outside the major urban centers. Berdan (1975:202, 1985:350) reports that statements abound concerning the great distances required to obtain cotton. Berdan's (1975, Appendix D) analysis of early colonial tax records for the Coyoacan market (a city-state center less than ten miles from Tlatelolco) reveals no vendors specializing in cotton products. However, the presence of professional merchants in the smaller markets may have made exotics more generally available, if only on a periodic basis (Berdan 1975:201).

Purchase of Finished Goods. The purchase of finished mantas or other cotton cloth from the market has been proposed as an alternative means of meeting tribute requirements. Brumfiel (1987b:109), for example, suggests that "Hinterland commoners selling subsistence goods in the marketplace in exchange for cloth and cacao were able to acquire the quantities they needed for tribute payment." Although cotton mantas and cloth of all forms were obviously available in the market for purchase, it seems unlikely that the purchase of mantas to meet tribute requirements was an affordable alternative for individual households. For the *calpulli* or town, the collective purchase of tribute mantas may well have been an option if expendable resources were more available than labor.[14]

Alternatively, cloth producers may have been balancing demands on their labor and resources through the purchase of spun cotton fiber rather than raw cotton for the production of tribute cloth. Both raw cotton and spun cotton fibers were available for purchase in the market (Sahagún 1950-1982, Book 10:75; Zorita 1963:158). The dramatic increase in the cotton spinning industry reported for Morelos (Smith and Hirth 1988; M. Smith 1994; Smith and Berdan 1992) may have made spun cotton fibers more generally available in the Valley. Importers of cotton into the Valley would have had an incentive to import cotton in a partially processed form, since they could increase their profits relative to their transportation costs per unit of weight by transporting the value-added spun cotton rather than raw cotton. For women in the Valley, pressure to produce cotton cloth to meet rising tribute requirements may have placed considerable stress on their time, creating a demand for products that shortened the production process. By purchasing spun cotton, women could produce substantially more cotton cloth per unit of available time.[15]

In contrast to cotton cloth, completed feathered warrior costumes are not among the luxury goods listed in the great market of Tlatelolco, although many accounts cite the brightly colored feathers from which they were made. For example, Sahagún (1950-1982, Book 8:67) lists "quetzal feathers, and those of the blue cotinga, and the red spoonbill, and all the various precious feathers of birds, which were needed for devices and shields", but makes no mention of completed warrior costumes and devices. Similarly, the Anonymous Conqueror (1971:392-393) records the presence of "*plumas y penachos de todos colores para adornar las ropas que usan en la guerra y en sus fiestas*" [feathers and plumes of all colors for adorning the clothing that they use in war and in their celebrations].

Although warrior suits were apparently not available for purchase through market exchange, price equivalencies are given in terms of mantas. Berdan (1975:211-214, after Scholes and Adams [1957] *Información of 1554*) lists one warrior costume as equal to 25, 30, 40, 60, 100, 200, or 240 mantas, depending on the type, and one shield as equal to 10, 15, 25, or 80 mantas, again depending on the type. These figures probably represent the price of commissioning a specialist to complete a warrior suit of the specified design.

In summary, both the raw materials for manufacturing elite tribute items and sometimes the finished goods themselves were available for purchase in the market. In both cases, however, their availability seems to have been limited to the larger urban markets, where their occurrence was due to the presence of the professional merchants who circulated among these markets. Smaller, provincial markets may have only occasionally carried exotic wares and luxury goods (Berdan 1985:356).

Market Transactions Involving Foodstuffs for Exotic Raw Materials

To obtain exotic raw materials, it is suggested that commoners intensified production in areas available to them and for which there was a steady market: agricultural produce and subsistence goods. Exchanges involving foodstuffs for exotic raw materials appear to have occurred through two main avenues: by pulling in marketable surpluses from primary producers and through the sale of excess tribute in foodstuffs in exchange for other tribute goods needed.

The most prevalent type of exchange presumably involved the individual tributary or *calpulli* utilizing surplus foodstuffs to purchase the raw materials necessary to meet tribute quotas. Given the limited purchasing power of commoners, it is likely that these exchanges primarily involved raw or spun cotton to produce the cotton cloth required of most (if not all) households. At a higher level, raw materials and finished goods required for tribute were purchased collectively by the *calpulli tequitlato* or by imperial *calpixque* out of the stores of other goods received in tribute. For example, the *Relación Geográfico de Texcoco* reports that "*los mayordomos que en cada pueblo había... [éstos] tenían cuidado de buscar y comprar, de las rentas que entraban en su poder, de las piedras ricas que podían haber...[y] enviábanlas a su rey por la cosa más principal que le podían enviar*" [the stewards of each city ... were in charge of seeking out and buying (from the rents that came into their control) the most precious stones ... and conveying these to their king as the most valued thing they could send] (Pomar 1941:53). The reference to "rents" indicates that agricultural produce was involved in these exchanges. Similarly, Alva Ixtlilxochitl records that in Texcoco, the *calpixque* conferred with the leading merchants about the distribution of royal tribute as a means of procuring other desired goods: "*El cuarto [Consejo] era de*

Hacienda, en donde se juntaban todos los Mayordomos del Rey y algunos mercaderes de los más principales de la ciudad á tratar de las cosas de la hacienda del Rey y tributos reales" [The fourth Council was that of the estate, in which all the stewards of the king and some of the principal merchants of the city met to discuss matters of the king's property and royal tributes] (Alva Ixtlilxochitl 1952, Vol. I:326).

A related type of exchange may have involved the sale of excess tribute in the market place, a practice that was common in early colonial times (Gibson 1964:199-200). Gibson (1964:94) reports that recipients of Indian tribute payments had a distinct commercial advantage in that they were able to speculate in certain commodities and control markets -- hinting at the degree to which the controls of tribute flows may have affected market participation in the preconquest situation as well. Gibson's analysis (1964:199-200) also highlights the role that tribute potentially played in the market system. Following the Spanish conquest, excess tribute goods initially were marketed to consumers through sale or auction. Since a variety of goods were received in tribute, a broad range of goods were introduced into the market in this way. When tribute assessments were later regularized to payments in maize or money, the shift to a single commodity operated as a deterrent to the production and exchange of goods.

Administrative Mechanisms to Increase Market Participation

The concentration of non-local raw materials that were needed to meet tribute requirements was a major factor pulling foodstuffs into urban markets. The centripetal force of this circuit was further strengthened, however, by political and economic measures that increased market participation.

One such measure was the regulation that prohibited the sale of goods outside the markets. This regulation was enforced with penalties and supernatural sanctions (Durán 1971:276-277 [Ch. 20]; Berdan 1975:206-207). Although Motolinía (1971:368) claims that exchange transactions were restricted to the marketplace to reduce theft, the regulation may have equally attempted to reduce problems of forestalling (that would have prevented produce from reaching the urban center) or attempts at market tax evasion, since "the planting of this awe and nonsense in these people brought a certain income from all that which was sold in the markets [in the form of taxes], which was divided between the lord and the community" (Durán 1971:277).

A related supernatural sanction enforced regular market attendance. Durán (1971:273-274), for example, states that the gods of the market place "threatened terrible ills and made evil omens and auguries" to the people of neighboring villages who did not attend their market. This sanction was buttressed by a law requiring people to attend the market, not only out of respect for the market place gods, but also "so that provisions would be on hand for the villages" (Durán 1971:274).[16]

A second strategy involved attempts to increase the attractiveness of markets in terms of the quality and variety of goods offered. Markets were a source of pride to local rulers, who attempted to attract artisans of higher class goods (Carrasco 1978:56, 1983:75) -- a concentration that in turn served to attract long-distance merchants to these market centers as well. Hicks (1982b, 1987:96-97) notes, for example, that the rulers of Tenochtitlan and Texcoco brought many skilled makers of luxury goods to their capitals, for the purpose of increasing the renown of those cities. These artisans produced both for tribute and for the market, but only for the ruler's own market (Alva Ixtlilxochitl 1975-77, I:444, II:101; Sahagún 1950-1982, Book 9:Ch. 18). The variety of luxury goods served a dual economic function, by generating market taxes (vendors were taxed in kind) and by promoting critical flows of foodstuffs into the city.

A more extreme measure was the creation of specialty markets through administrative decree (Durán 1971:277-78). The most famous of these included the slave markets at Azcapotzalco and Itzocan, the dog market at Acolman, and the turkey markets at Otumba, Tepepulco, and other sites (Hicks 1987:102; Motolinía 1971:375-376, 378).

Although these markets specialized in one commodity, they offered a wide range of other goods as well. Hicks (1982a, 1987) argues that specialty markets were devices to artificially concentrate both the supply of and demand for particular goods at selected points, as a means of increasing general market traffic: "A market known for a particular specialty would...attract long-distance merchants seeking that product, and they would bring goods not available everywhere. The resulting heavier market traffic would provide a clientele for food and other mundane items, and the market would grow" (Hicks 1987:102). The overall effect of such a decree would have been to increase the volume of all types of goods, including foodstuffs, moving into a specific market where they could be tapped for the use of urban populations.

Some administrative controls, however, extended over other major markets as well, not just those noted for specialty attractions (Carrasco 1978:55-56, 1983:75; Hassig 1985:112-113; Hicks 1981). According to Carrasco (1983:75), "The creation of the market was one of various ways to strengthen the political power of the city that established it", and there are numerous historical examples in which the right to hold a market depended on the balance of power relations between rival states. For example, when Azcapotzalco conquered Cuauhtitlan in the early fifteenth century, the conqueror sowed the marketplace of the defeated town with maguey, and removed its market trade to his own city (*Anales de Cuauhtitlan* 1945:43-44; Hassig 1985:111). Conversely, following the conquest of Tepeaca, a regional "gateway" market was established in that city by administrative decree in order to promote interregional trade: "The king...wishes that a great market place be built in Tepeaca so that all the merchants of the land may trade there on an appointed day. In this market there will be sold rich cloth, stones, jewels, featherwork of different colors, gold, silver and other metals..." (Durán 1964:102-105; Berdan 1985:352).

Hassig (1985:112-113) contends that what was controlled was not the existence of a market, but the right (overseen by the Aztec) to traffic in certain types of commodities. As noted in the case of Tepeaca, above, these commodities were not the more mundane goods of the ordinary markets but the elite goods produced within that region and those brought in from elsewhere by professional merchants. Since the state and the *pochteca* achieved near monopolistic control over the influxes of foreign goods into the Valley of Mexico, control over their entry into the market system could have been readily maintained through granting or removing the rights to sponsor market trade in luxury goods. In this view, then, the major urban markets were sites that had the social and political right to traffic in elite goods, with all the attendant benefits such commerce entailed (Hicks 1981).

Impact on Markets

What then was the impact of these measures on the functioning of urban markets? One obvious effect was to concentrate the availability of higher status goods at politically sanctioned points in the landscape. As such these markets not only served as suppliers and consumers of elite products, but also as bulking points that facilitated the dissemination of exotic goods circulating via the *pochteca*-controlled interregional trade (Hassig 1985:113).

An equally essential benefit, however, was the powerful impact that concentrated luxury trade had on flows of subsistence goods. As noted above, commoners were dependent on the market place to meet their tribute obligations. To obtain exotic raw materials, commoners intensified production in areas available to them and for which there was a steady market: i.e. agricultural and subsistence goods (Berdan 1985:351). The result was the stimulation of agricultural produce and increased flows of these goods into the urban centers via the market system in exchange for goods only available in urban centers.

The centripetal pull of a major market on foodstuffs was recognized by native rulers. Following the conquest of the Chalcan League in 1465, for example, the Tlalcochcalca were required to provide the army of Motecuhzoma I with rations, including tamales and enchiladas. Apparently anticipating the volume of foodstuffs required to meet that tribute, the people of Tlalmanalco requested that the regional market be moved to their city, supporting their request with the claim that historically their ancestors had had the right to hold such a market (Chimalpahin 1965:205).[17] The perceived benefit of a regional market for the task of feeding an advancing army may reflect, in part, the role that the market vendors played in the preparations of marching rations. Sahagún (1950-1982, Book 9:69) records, for example, that it was the duty of the "market place folk" of the Tlatelolco market to make the war provisions.[18] Alternatively, the Tlalcochcalca's request represents an explicit recognition of the efficiency of a regional market for drawing large volumes of foodstuffs into a central place.

In summary, then, the market system appears to have played a critical role in alleviating the problem of urban supply, in part through coordinating the exchange of rurally produced agricultural surpluses for exotic raw materials needed to produce prestige items demanded in tribute. Oligopolistic controls over supplies of exotic goods coupled with administrative controls over rights to traffic in these goods enabled imperial elite to manipulate commodity availability in order to increase, direct, or concentrate the flows of foodstuffs to market locales where they could be utilized by urban populations. Because this exchange was central to both imperial and urban interests, the market system experienced regional growth and expansion under Aztec rule. But this role also potentially structured the nature of market commerce. As Brumfiel (1987b:116) has commented, "much of the expansion in regional exchange seems to have consisted of rural producers marketing food to acquire products needed for tribute assessments. This did not involve the exchange of goods between specialist producers, simply the flow of tribute wealth into the center as payment of taxes and out from the center in exchange for food."

The New Dilemma

Blanton's (1994) insightful analyses have suggested that the resolution of the urban supply problem within the domestic economy may well have given rise to a new political problem: the unintentional fostering in the market system of an alternative source of power and wealth outside the established political channels for the acquisition of prestige goods. On the one hand, emergent urban and imperial interests depended on the market system to motivate rural production to fund urban growth and political centralization. Yet market traffic and vendor taxes in luxury goods were an important source of wealth and prestige for local rulers (Hicks 1981, 1982a; Alvarado Tezozómoc 1975:396) and thus a potential threat to imperial attempts to distribute those goods according to their own political ends. Imperial efforts to stimulate market participation and spur food production potentially exacerbated this situation, inadvertently generating alternative sources of wealth for the local elite that decreased their reliance on imperial mechanisms of wealth distribution. Thus, the empire was faced with the challenge of encouraging market system growth while "disconnecting" this growth from the power bases of rival elites (Blanton 1994).

Imperial attempts to control and regulate access to market revenues as a source of politically important wealth are evident in a number of regulations regarding the type and location of market traffic. These administrative controls, however, reflect a balance of economic and political considerations. On the economic side, market locations reflect the need for a decentralized system that could efficiently disseminate non-local raw materials to tributaries while simultaneously tapping rural agricultural and subsistence production. Hicks (1987:102) suggests that an important component of such a system would have been rural bulking centers, where rurally produced goods could be obtained in large quantities for movement to Tenochtitlan (Hicks 1987:102). Yet political considerations dictated that these rural commercial centers by-pass traditional bases of power.

Hicks (1987) and Blanton (1994) suggest that two types of market centers were established to meet these dual needs: specialty markets and markets in *calpixque* centers. As discussed above, specialty markets served to spatially concentrate both the demand for and supply of specific commodities -- a tactic that greatly increased the volume, reliability, and efficiency of bulk transactions in these goods. The establishment of "monopoly" slave markets at Azcapotzalco and Itzocan may reflect more of a concern for centralizing this lucrative traffic for purposes of taxation. However, it is interesting to note that the other famous specialty markets (including the dog market at Acolman, and the turkey markets at Otumba, Tepeaca, and Tepepulco) involved Mexico's only domestic animals, perhaps reflecting a concern on the part of Tenochtitlan for securing reliable supplies of meat for the city.

Motolinía (1971:378) confirms the role of these specialty markets as rural bulking centers from which goods were transshipped to Tenochtitlan. With reference to the bird markets at Otumba, Tepeaca, and Tepepulco he comments that "*de todos éstos [mercados] llevan muchas aves a vender a la ciudad grande de México que allí se gastan y van más caras, según por los otros mercados valen muy barato, ganan los mercaderes algo en México*" [from all these markets they carry many birds to sell in the great city of Mexico where they go for a good price, and as the birds are very cheap to buy in the other markets, the merchants make a profit in Mexico City]. Markets located in *calpixque* centers may have functioned somewhat differently. The juxtaposition of tribute and market structures facilitated the bulk exchange of rurally produced goods for items required in tribute or the conversion of excess tribute by the *calpixque* into other tribute goods needed to fulfill the tribute assessment.

There were few of these markets, however. While they may have served important economic functions, their political role in separating traditional elite from economic bases of power would appear to have been limited. The administration accordingly developed more overt political controls over market revenues, by converting the rights to market taxes into a mechanism to ensure compliance.

Markets could be removed or granted through administrative decree, as discussed above. Throughout the late prehispanic period, such an action was taken to achieve two political ends: either to undermine the powerbase of competing rulers or to reward meritorious military service. In the former case, the loss of a market or market revenues resulted from political subjugation, as symbolized by the planting of maguey in the marketplace following the conquest of Cuauhtitlan (*Anales de Cuauhtitlan* 1945:43-44). In the latter, rights to market revenues were granted as war prizes. In the dispute mentioned above between Tlalmanalco and Amecameca, Tlalmanalco's request to relocate the regional market was denied, because the people of Amecameca had earned the rights to the revenues of that market through their valor in the war against Tollantzingo (Chimalpahin 1965:205). Similarly, when Tenochtitlan's ruler conquered Tlatelolco in 1473, the revenues of the Tlatelolco market were divided among his nobles, a prize said to have been worth a hundred towns (Alvarado Tezozómoc 1975:396; Berdan 1985:344-345; Hicks 1987:96). Under the Triple Alliance, markets were clearly recognized as sources of political power and imperial controls over market locations potentially provided one more component of an incentive plan designed to ensure the cooperation of dependent rulers.[19]

Summary

The foregoing synthesis delineates the salient features of Aztec political economy as these are known from current research on the Aztec empire and illustrates the complex interactions between the political and market spheres of the imperial economy. It focuses on two major kinds of dependency experienced by the expanding empire: first, the dependency of Aztec imperial elite on local rulers for control over and tribute flows from their subject populations, and second, the dependency of the imperial core's urban sector on the rural hinterland for agricultural produce. Attempts on the part of imperial elite to invert these dual dependencies are visible in the imperial strategies and policies that structured major aspects of the political economy.

It is argued here that the problems of imperial integration and urban supply were directly linked through the movement of certain classes of goods: the transformation of exotic raw materials into elite prestige goods. Exotic prestige items and cotton clothing were displayed and consumed by the elite to establish and symbolize their political power. The state institutionalized the rights to display such goods and established the military framework through which such rights could be achieved, while concurrently consolidating state controls over the avenues through which these prestige goods circulated. The effect was the inversion of dependency relationships between traditional elite and empire, and the channeling elite energies into the imperial goals of military expansion and resource control.

But imperial consolidation set in motion a positive feedback loop driven by military expansion (Davies 1973:202-204; Demarest and Conrad 1983). As Hassig (1988:20) has noted, "War was the empire." Military achievement as the primary means of increasing status and power may have generated incentive to participate in imperial campaigns, but it also created an inflationary cycle in the consumption of prestige goods. The need for more reliable controls over luxury prestige goods led to further expansion as tribute replaced long-distance trade in exotic raw materials. Imperial expansion thus increased both the demand for and supply of exotic prestige items, while simultaneously increasing the size of the non-producing population and the problems of urban-rural dependency.

The increasing demand on the part of the growing elite class for cotton cloth and feathered warrior costumes was passed on to the commoners in the form of tribute requirements and this sector of the population came under increasing stress to obtain the exotic raw materials in order to produce the finished goods required as tribute payments. The primary source for these raw materials was through the urban market system, and the need to exchange for these raw materials provided a major incentive to increase local production as a medium of exchange. Although both primary and secondary production may have been affected, the problems of urban supply created a high and constant demand for foodstuffs and therefore favored the market in consumable subsistence goods.

The interactions between Aztec political economy and market economy thus hinged on the articulation of two flows of goods: (1) the transformation of exotic raw materials into prestige items via tribute assessments, and (2) the market exchange of foodstuffs for the raw materials needed to meet tribute demands in manufactured goods. The former alleviated the endemic problem of empire, while the latter addressed the problem of urban supply in the imperial core. Because of the central role that market exchange played in areas of vital political and economic concern to the empire, the market system experienced regional growth and expansion during the period of Aztec rule. This growth was in part, however, structured by the administrative strategies for political consolidation and economic integration of which it was a key component. As a result, it may be more appropriate to regard the expansion of the market system as "evidence of a reorganized system of elite extraction or finance" (Brumfiel 1987b:116), rather than as the reflection of increased economic specialization and efficiency marking the rise of a market integrated economy.

The preceding synthesis has outlined some key components of Aztec imperial economy and presented the general theoretical orientation that will be followed here. The following chapter explores the implications of the imperial economy as delineated above for the market system structure and hence for the production and exchange of utilitarian craft goods or commodities.

Notes to Chapter 4

[1]Davies (1987:122) argues that the distribution of land grants for military service was based both on merit and elite status; only meritorious warriors of noble birth (the *tetecuhtin*) were rewarded with grants of land. In contrast, chief warriors of commoner status (the *tequihuas*) were generally not landowners. Berdan (1975:67-68) suggests that only the most distinguished commoners, recognized by the title *cuauhpilli*, were supported on lands granted to them by the *tlatoani*.

Davies (1987:163-165, following Sahagún 1950-1982, Book 8: Ch. 20-21) mentions other ways in which noble and commoner warriors were distinguished by the ruler and by society, including the right to use red ochre and quetzal feathers by the former, in contrast with yellow ochre and eagle feathers by the latter.

[2]The nobility held inalienable rights to land (Davies 1987:124). The political incorrectness of alienating elite landholdings except through conquest is reflected in a transfer commented on by Hicks (1982a), who notes that:

> "According to the Crónica X histories, the Mexica ruler Moteuczoma I (r. 1440-1469) asked Nezahualcoyotl of Texcoco for some of his lands. Nezahualcoyotl agreed, but to legitimate the transfer, the Mexica insisted on a ritual war between Tenochtitlan and Texcoco, which the latter was to lose (Durán 1967, II: Ch. 15; Alvarado Tezozómoc 1975: Ch. 19-20)."

Following this ritual war, the Mexica received from Texcoco not whole towns, but individual parcels of land from several communities within Texcoco's domain. Although other sources give different versions of what transpired between Motecuhzoma I and Nezahualcoyotl, the important point here is that even the dominant power in the Valley was expected to respect the inalienable rights of noble landholdings.

Hodge (1991:128-129) reports a rather different situation for Cuauhtitlan, in which the local ruler was capable of appropriating lands from his dependents for his own support following that polity's conquest by Tenochtitlan. Hodge (1991:129) comments, "Perhaps this tlatoani had gained support from Tenochtitlan's rulers that allowed him to do this without local repercussions."

[3]For a similar case of "category shifts", see Edens (1992).

[4]Carrasco (1991) reports that the tribute roles of Tlacopan and Texcoco distinguish three distinct classes of tributaries; data are less complete for Tenochtitlan, but tributaries appear to have been organized similarly under this capital as well. The classes of tributaries responsible to an individual capital were:

First, a series of subordinate towns with their own kings who were subject to the great king of their capital city. These subordinate rulers were often related by marriage to the *huey tlatoani* and they served as advisors on that ruler's council and gave military service. In addition, they had limited tributary obligations, primarily in labor to repair or build the temples and palaces, or in supplying firewood to the palace. Each of these dependent towns had their own rural districts that supported the local rulers and elite.

The second class of tributaries consisted of the immediate rural area surrounding each capital. This area had a steward in charge of collecting the revenue of foodstuffs and craft goods sufficient to support the palace for a portion of the year, and collected at varying intervals: daily, weekly, every 15 days, and three or four times per year. Daily and weekly tribute most often consisted of food or other perishable goods, while the collection of manufactured goods occurred at less frequent intervals (Hodge 1991:125).

A third category comprised villages of renters, without rulers of their own, that were administered by stewards. These villages cultivated lands for the lord, while also supplying some goods (such as firewood) in tribute; the products of their labor were collected on an annual or semi-annual basis (Hodge 1991). Villages of renters were generally relatively close to the capital, but beyond its immediate rural area (Carrasco 1991). There was, however, considerable interdigitation of these subject communities (Gibson 1964:45-47; Hicks 1982a; Hodge 1991:129) and by 1519 both Tenochtitlan and Texcoco received tributes from lands in each other's administrative territories (Borah and Cook 1963:75-76; Gibson 1971; Hodge 1984:29). Carrasco (1991:111) notes that these parcels were also spread across a variety of environments, giving the capitals "access to the resources of different areas and facilitating the organization of a supply system based on direct prestations in kind and labor basically separate from the commercial sector of the economy."

Hicks (1984:156), however, argues that although places are listed as towns, the rosters "probably do not mean that the whole town, and all of its inhabitants, was obligated in the way specified" since the same town often appears on different lists as having different obligations. Rather, the lists refer to certain landholdings within the boundaries of these towns, and/or certain barrios of macehualtin, that were set aside for the purposes dictated; the amount of land and/or macehualtin in each place may have been relatively small.

[5]The highest imperial tribute official was the chief steward or *petlacalcatl*, who was responsible directly to the ruler at Tenochtitlan and who supervised the provincial tributary stewards or *calpixque*. Within each tributary province, one community was designated as the head town or collection point for the entire province and there tribute was collected for transhipment to Tenochtitlan or stored in imperial warehouses until it was requested (Zorita 1963:192-3; Alva Ixtlilxochitl 1952, Vol. II:416; Durán 1967, Vol. II:242, 333). At the local community level within each province, tribute assessment and collection was organized at the level of the *calpulli* or *tlaxilacalli* and supervised by the fiscal officer of that group (the *tequitlato*), who was directly in charge of the tribute paying commoners (Zorita 1963; Berdan 1975:117-118; Hicks 1982b:239). Thus, the upward flow of imperial tribute was from individual commoner to the *tequitlato* who delivered the goods to the imperial tax stewards at the provincial collection center, who in turn transferred the goods to the control of the chief steward in Tenochtitlan.

[6]Several authors (including Calnek [1978a:107-108] and Isaac [1986:331-333] warn against over generalizing from this one account to assume that all or even most *pochteca* trade was state-sponsored.

[7]The professional long-distance traders were intermediate in status between commoners and nobility, but capable of accumulating considerable wealth (Berdan 1975:145). These merchants were allowed to attend the *calmecac* (traditionally the prerogative of the nobility), allowed to sacrifice slaves, and to wear certain symbols of noble status at special

annual festivals, but paid tribute as well as gave gifts to the ruler. They participated in a guild organization characterized by exclusive residence, control over membership, specific laws and codes, and a system of internal ranking (Acosta Saignes 1945; Berdan 1975:148; van Zantwijk 1985).

[8]Davies (1987:100, 152-57) argues that Tenochtitlan suffered from an imbalance of payments owing to its poor performance as an exporter. Other than skilled artisanry, central Mexico had little to offer in exchange for exotic goods. Since imports could not be paid for with exports, the Aztecs resorted to obtaining the desired goods by force, through conquest and the imposition of tribute. Davies cites Tehuantepec as a case in point. When the merchants of that province complained about the poor value of goods offered by the Valley of Mexico merchants in exchange for cacao, gold, feathers, and precious stones, their lack of compliance served as a pretext for Aztec conquest (Durán 1967, Vol. II:357).

[9]For example, Hassig (1982) suggests that markets occurring at longer periodicities (following a 9-, 13-, or 20-day sequence) were not functional markets serving smaller communities, but rather were ritual markets. As such they were held of the first day of their respective ritual cycle only in those towns with whose market day they coincided, making its regular market slightly more important than it would ordinarily be.

[10]Berdan (1985:345) interprets the *tlanecuilo* as "regional merchants" who specialized primarily in non-luxury goods, including maize, amaranth seeds, chili, tortillas, wheat, sandals, palm fiber cloaks, gourd bowls, cane baskets, turkey, and salt. However, they are also mentioned in connection with two exotics: cotton and cacao. Berdan (1985:345-346, 361) seems to suggest that the cacao and cotton were imported by guild merchants and then retailed by *tlanecuilo*, since numerous references indicate that the purchasers of these products traveled to the sources of production rather than the producer marketing his goods in highland towns.

[11]As J. Parsons admits, modifications of the parameters of this model could drastically alter its predictions. On the one hand, the model underestimates food supplies available to Tenochtitlan by not including rents from parcels of land attached to administrative offices. Conversely, the model may overestimate tribute flows by assuming that the Codex Mendoza represents Tenochtitlan's share alone of annual grain tribute.

[12]Brumfiel (1991d), however, has questioned whether this picture represents a cultural ideal instead of the actual organization of labor. She cites evidence of a significant decline in spinning (and presumably weaving) of both cotton and maguey during the Late Aztec period at three major sites, and suggests that cloth production played a less central role in the allocation of women's time and energy.

There also appears to have been regional variability in the relative effort invested in the spinning of cotton vs. maguey, based on the distribution of small and large spindle whorls within the Valley (M. Parsons 1972, 1975). A reexamination of the spatial distribution of cotton and maguey whorls within the Chalco-Xochimilco survey regions shows that 86% of maguey whorls were found in upland areas, with only 15% of this type occurring within the lakebed. In contrast, 64% of cotton whorls were found in the lakebed, primarily associated with Late Aztec *chinampa* settlements, while only 34% of cotton whorls were found on upland sites. The differential distribution of maguey whorls represents an environmentally based specialization in maguey fibers. The higher number of cotton whorls in the lakebed, in contrast, may reflect a higher standard of living and/or the greater purchasing power of settlements in the *chinampa* zone.

Ethnohistoric evidence similarly suggests that not every region nor every household was involved in the production of cotton cloth. For example, Zorita (1963:241) comments that: "To ask the Indians for tribute in *reales* is also a great injury to them. Unless an Indian lives in a town not far from a Spanish town, or on a main traveled road, or raises cacao or cotton, or makes cotton cloth, or raises fruit, he does not receive money." Also, "there is always cloth available in those areas where the Indians are accustomed to make cloth; they make it for themselves and also take it to sell in places where it is not made. There are many cloth merchants, both Indians and Spaniards" (Zorita 1963:252-3). The implication is that not everyone made cotton cloth.

[13]The situation recorded by Alva Ixtlilxochitl is clearly one of political manipulation and may therefore not be typical. Twice Tezozomoc sends cotton to Ixtlilxochitl and asks (out of friendship) that Ixtlilxochitl request his subjects to make the cotton into fine mantas, "*como se sabían hacer en aquel tiempo en esta ciudad*" [such as they knew how to make at that time in this city]. Ixtlilxochitl complies, calling for aid on his subject lords from Huexotla, Coatlinchan, Coatepec, and Ixtapaluca, to distribute the work among their subjects. The third time Tezozomoc tries this ploy, Ixtlilxochitl rebels and orders his subjects to make the cotton into warrior costumes instead, much to the consternation of Tezozomoc. Zorita apparently records a more generalized situation.

[14]The cost or affordability of a tribute manta has been difficult to estimate. But assuming, as Berdan has argued (1975:217), that the relative value of goods did not change drastically in spite of the general price inflation following the Spanish conquest, price equivalencies from the early colonial period provide some insight here. For example, according to the *Información of 1554*, 1 manta was equivalent in price to 8 *fanegas* of maize (valued at 4 *pesos* per manta and 1/2 *peso* [4 *reales*] per *fanega* of maize) (Scholes and Adams 1957; Keen 1963:77). Yet Zorita (1963:240) reports that the 1/2 *fanega* of maize taken in tribute per household per harvest was considered a hardship; at the price equivalent quoted above, a single manta would represent 16 times that hardship. This is consistent with Zorita's (1963:252) claim that "each piece of [tribute] cloth is worth much more than the tribute ordinarily required of Indians."

[15]Because cotton cloth could be traded for virtually anything offered on the market, a woman would have a strong incentive to maximize her production of cloth (Hicks 1994) above and beyond meeting her tribute assessment. The use of spun cotton may have represented a more cost-effective strategy both for meeting tribute requirements and producing cloth for exchange. If this were the case, we might well expect a decline in the evidence of spinning within the Valley such as has been recorded for Huexotla (Brumfiel 1976, 1980, 1991c), as women concentrated their energies on the weaving of cotton cloth. Thus, Zorita's (1963:187) statement to the effect that people of the *tierra caliente* produced the cotton while the people of the *tierra fría* turned it into cloth may reflect a regional specialization within the industry based not on primary vs. secondary production, but on different steps of the production process.

[16]Durán's (1971:274) claim here may partially reflect postconquest concerns with the provisioning of Mexico City. For example, Gibson (1964:354-355) reports that the Spanish state became actively concerned in matters of native marketing after the plague of 1545-48, which created the first crisis in Mexico City's food supply. In 1551, a viceregal order

sharply restricted all Indian markets in the Valley except in Mexico City and Texcoco in order to concentrate foodstuffs in these centers. Later, the Audencia ruled that all towns within a 20 league radius of the Mexico City were to bring to that city's markets every Saturday, 100 turkeys, 400 chickens, 2,800 eggs, and all available firewood and fodder.

[17]The relevant passage in full states that:

> After the arrows, bows, and shields had been put aside, it fell to the Tlacochcalcas [formerly of Chalco Atenco, latterly of Tlalmanalco] to follow in the footsteps of the great Motecuhzoma Ilhuicamina to provide his sustenance, his cooked tamales wrapped in a dry maize leaf and his enchiladas. Because of this it happened that the people of Tlalmanalco gathered before him to ask that the regional market that is held take place in Tlalmanalco, because as they said, our ancestors had arranged that the right to establish a market day fell upon the Totolimpas, and to the settlers at the edges of the Sierras [Nevadas, next to Tlalmanalco]. But even though the Tlalmanalca supported this [claim], the truth is that the people of Amecameca, as is well known, had the option by which a market is celebrated in the city of Amecameca, since this right was the source of revenues of the Nonohualcas, Poyauhtecas, Panohuayas, the same populations that had earned it in the war against the city of Tollantzingo, whose inhabitants they had robbed of the right to celebrate a market, because these people of Panohuayan were people very strong and valiant in ancient times (Chimalpahin 1965:205; translation: LDM).

[18]"It was the duty of the market place folk to make the war provisions -- biscuits, and finely ground, dried maize and chia seeds, and dried maize dough, and dried, lime-treated maize dough. With these was the market place charged, and the market place directors, the men and women thus appointed, were charged with assigning the tribute" (Sahagún 1950-1982, Book 9:69).

[19]Examples of the recognized role of markets in augmenting political power can be found in a broad range of other societies, as well. For example, among the Tiv, Bohannon and Bohannon (1968:242) claim that "the political aspects of market places were of immeasurable importance .... **Markets were -- and to some extent still are -- political plums**" (emphasis added). Thus Tiv markets were founded and controlled by Tiv chiefs who used the centralizing and economic power of a market to underwrite their own local control of people (C. Smith 1976a:41). Similarly, in late 19th century Zinder province, the local ruler invited a number of immigrant artisans to set up their households and workshops near the palace, and to exercise their crafts under his patronage as a means of increasing trade to the ruler's market; these crafts added to the ruler's revenues and to the economic importance of Zinder (Arnould 1982:168).

CHAPTER 5

MACROLEVEL STRESSES AND MICROLEVEL RESPONSES: LINKING AZTEC IMPERIAL ECONOMY AND MARKET PARTICIPATION

Introduction

Imperial attempts to control strategic resources and to resolve the problems of urban supply in the imperial core altered the context of production and exchange in the Aztec heartland both directly and indirectly, by creating economic stresses and opportunities within the market system that favored certain economic developments and discouraged others. To understand the specific ways in which the imperial political economy affected production and exchange, this chapter attempts to define causal links between specific political processes and changes in the context of market participation.

In doing so, this analysis first focuses on decision-making processes of peasant producers as a means for modelling economic decisions among the vast majority of the commoner population engaged in agricultural production and/or craft production in Aztec times. It assumes that these producers were not merely passive by-standers, but rational reactors to economic problems, whose solutions to those problems were largely guided by concerns for income security and stability.[1] The analysis begins with a general discussion of market system characteristics that would encourage or discourage market participation under a strategy of economic risk minimization.

The analysis then turns to an examination of how Aztec imperial political activities (or macrolevel forces) potentially altered those characteristics. It brings together the many-stranded argument presented in Chapter 4 to propose key points of articulation between Aztec political economy and market structure and to predict changes in market system organization resulting from that articulation. Finally, predictions are set out concerning specific microlevel responses to those changes -- reflecting the decisions of individual producers -- that would affect the organization and energetics of craft production, and thus be visible in the archaeological record.

An overview of the argument followed is presented in schematic form in Table 5.1. As suggested in this diagram, macrolevel political forces associated with imperial consolidation, in conjunction with urban growth and ecological diversity, established the context of craft production. These factors combined to structure peasant production decisions through their impact on market system organization, market demand, and the distribution of agricultural resources, respectively. Microlevel responses to these factors involved decisions concerning what to produce, as well as how that production should be organized.

Table 5.1
Factors Affecting the Regional Organization of Craft Production

MACROLEVEL FORCES	LINKAGES	MICROLEVEL PROCESSES
political consolidation -->	market system organization	**Organization of Craft Production:** - distribution - scale/composition - intensity
urban growth -->	market demand	
ecological diversity -->	agricultural resources	**Strategy of Craft Production:** intensification vs. diversification

The argument assumes, based on ethnohistoric data, that craft specialists in Aztec society were predominantly male, the major exception being that spinning and cloth-making were conducted by women (Hicks 1994). To date, the evidence suggests that the majority of these craft producers worked at their specialties on a part-time basis, and relied on their subsistence plots for their day-to-day livelihood (Cortés 1865:541-542; Hicks 1982b:241-242, 1987:93, 1994; Sanders and Webster 1988). Only a minority of specialists were full-time producers; these full-time specialists, however, appear to have engaged primarily in the production of elite prestige items (Carrasco 1978; Brumfiel 1987; Hicks 1987; Charlton, Nichols, and Charlton 1991).

The production of most utilitarian commodities, then, was constrained by a more primary concern, that of the cultivation of household plots for the maintenance of the household unit. This constraint governed both the total amount of time available for other production activities as well as the scheduling of available free-time according to the changing work load of the agricultural cycle. Further, it suggests that most producers were balancing opportunities to engage in craft production against the advantages of subsistence agriculture, as alternative ways of making a living in a variable physical and social environment.

Production for Agrarian Market Systems

Preconditions for Market Participation

In agrarian systems, peasant farmers aim at economic self-sufficiency by producing all or most of their subsistence needs. Although they may participate in market exchange as "target marketers" when they happen to have a surplus to exchange or need some item they do not produce, the market is not the source of everyday necessities (Bohannon and Dalton 1965; Kurtz 1974; Hicks 1987). In contrast, production for a market as a major component of subsistence activities usually involves a degree of specialization -- a channeling of productive energies into some aspect of either primary or secondary production that is perceived as likely to reward that investment, but that reduces the time available for producing staple goods.[2]

Specialization is generally held to be more productive than subsistence production since it implies the more efficient employment of the resources available; subsistence farming on the other hand implies an attempt to wrest from the soil products which it is not necessarily best suited to produce. The greater efficiency and productivity of specialized production promises increased income and hence improved welfare for the producer's family. However, such specialization entails the loss of self-sufficiency. If a subsistence farm family is to become more specialized in either primary or secondary production, it must give up some independence and control over its well-being (Plattner 1989:180). In an agrarian society where self-sufficiency is highly prized, the move from subsistence agriculture to a market economy is not an obvious step. Decisions concerning market participation (what to produce and how much) involve weighing the merits of self-sufficiency and security associated with subsistence farming against the increased efficiency and income accruing from specialized production.

Plattner (1989:181) suggests that in order for producers to commit themselves to a market economy, three preconditions for market trade must be met -- (1) regularity, (2) adequacy, and (3) security. First, the market must be regularly and predictably available and the demand or outlet for goods must be steady and sufficiently predictable for producers to schedule their production to meet that demand. In addition, the supply and assortment of goods desired or needed in exchange must be appropriate and sufficient to satisfy the needs of agrarian producers. Finally, market activity must be protected by authorities so that people can trade without fearing for their safety. Only when these three preconditions are met are people willing to entrust their future to it.

Factors Affecting Market Participation

Although imperial consolidation may guarantee the security of market interactions, a number of interrelated factors can affect the regularity and adequacy of agrarian market systems under imperial rule. Primary among these are market structure, consumer demand, and agricultural productivity.[3]

Market Structure. One critical factor affecting market system participation is the existence of a reliable market network to bring primary and secondary components together on a consistent basis. As discussed in Chapter 3, economic geographers (Plattner 1989:203-204; C. Smith 1977) make a fundamental distinction between integrative and underdevelopmental market systems, resulting from differences in market structure and direction of commodity flow. In integrative market systems (characterized by both well-developed network and hierarchy), goods move both vertically and horizontally between communities. In contrast, underdevelopmental market systems (typified by predominantly hierarchical linkages), goods move vertically between core and periphery or between center and subordinate communities, with minimal lateral movement between centers at the same level of the hierarchy.

The integrative and underdevelopmental market systems offer very different opportunities for market participation and hence production strategies, primarily to the extent to which they offer regular and adequate sources of subsistence goods. In an integrative market system, the free flow of goods through the marketing system means that any producer can specialize in the production of a single commodity, secure in the knowledge that the staples the local community does not produce will be forthcoming from the market (Plattner 1989:203). In contrast, the absence of horizontal linkages between communities in the underdevelopmental market system means that communities do not have access to subsistence goods to buffer local fluctuations in supply or to exchange for specialized produce. Thus, the rural population is more likely to retain its self-sufficiency by engaging in subsistence agriculture and petty commodity production.

Consumer Demand. Incentives to participate in a market economy also depend on the kinds of goods desired in the market and in what volume, and the individual's or household's ability to produce for that market. In an integrated market system, every producer can potentially specialize in a marketable product, knowing that the basic necessities not locally produced will be obtainable through the market (C. Smith 1977). Producers can thus concentrate on whatever product their resources and skills render most profitable. In contrast, when the market is structured by and for an urban elite, consumer demand will be greatest for agricultural produce and other foodstuffs (see for example Appleby 1976). Obviously, the rural producer's ability to meet that demand depends on the productivity of his agricultural lands or his access to other food-producing resources.

The volume of consumer demand also affects decisions concerning market participation. Specialized producers of either primary or secondary goods need to be able to supply a sufficiently large number of consumers that are willing and able to purchase a sufficiently large quantity of their goods, such that the volume of exchange meets or exceeds the subsistence needs for their own households. With sufficient consumer demand, specialized suppliers are supported; below that point, part-time or mixed production strategies are called for (C. Smith 1974).[4]

Consumer demand for a subsistence or utilitarian good is largely a function of population density. An overall increase in population size and density potentially contributes to the regularity of a market system by increasing total consumer demand. But consumer demand, and hence opportunities to engage in specialized production, also vary spatially according to settlement size and market access. Dense urban centers create a large and stable consumer demand for foodstuffs, and may select for the greater efficiency and productivity of specialty farming in adjacent agricultural regions (von Thünen 1966; French 1964:128-132; Hassig 1985:21-28). Similarly, these population centers would be more likely to support specialized craft production than would less densely settled areas. But in either case, full-time specialty production to meet urban demand depends on whether the market system was structured to deliver subsistence goods required in exchange. Even under conditions of a large consumer demand, part-time specialization will persist if specialists need to be buffered against fluctuations in supply and demand, or if exchange is not sufficiently stable to provide reliable quantities of subsistence goods or raw materials (Brumfiel 1986; Brumfiel and Earle 1987:5).

Agricultural Productivity. At the general level, market participation depends on a reliable supply of staple food surpluses entering the market system to receive in exchange for specialty foods or manufactured goods, as noted above. Again, this availability is a function of both overall productivity and of market structure: a region may be capable of producing surpluses, but if the market system is poorly articulated, those surpluses will not reach consumers.

Agricultural potential also clearly affects decisions concerning production strategies at the level of the individual rural producer. Several agricultural factors combine here to create different opportunities and incentives for production and hence market participation. These are: (1) the overall productivity of agricultural lands, (2) the reliability of agricultural productivity; (3) the intensity and scheduling of agricultural activities, and (4) the demand for agricultural supplies. Agricultural productivity determines what and how much agricultural surplus can be produced for market exchange, while agricultural reliability and scheduling affect whether surplus production for exchange is feasible and desirable.

An obvious contrast in the level of agricultural productivity, reliability, and intensity of effort is between extensive and intensive forms of agricultural production. Extensive forms of cultivation may be characterized as requiring lower labor inputs, but may also be less productive and less predictable in yield. In contrast, more intensive forms of cultivation aim not only at increasing productivity but also at evening out productivity through greater investments in labor and resources. These different agricultural regimes provide different incentives and opportunities for market participation, reflecting two different strategies for alleviating economic uncertainty: diversification and intensification.

In areas of extensive agriculture, natural interannual variability in agricultural output may call for the development of alternative resources (both agricultural and non-agricultural) to supplement shortfalls and to alleviate agricultural uncertainties (Arnold 1980, 1985:168; Feinman and Nicholas 1990; Netting 1974:40). In addition, the naturally busy and slow times in the agricultural cycle can accommodate the incorporation of other types of production, on a part-time or seasonal basis (Waddell 1972:218). Thus, there is both more incentive and more opportunity to develop alternative sources of income, i.e. to diversify. Efforts to diversify production may involve the addition of back-up (specialty) crops, alternative food resources (such as hunting, fishing, salt-making), or part-time production of utilitarian commodities that can be utilized by the family or for exchange.

Intensive agriculture, in contrast, provides a relatively more productive and more reliable agricultural base. In addition, the pace of agricultural activity is more continuous, with less time for other types of production. In this case, there is less incentive as well as less opportunity to diversify subsistence pursuits or to engage in craft production as a supplemental form of income. As a result, under a strategy of intensification, regions focusing on intensive agriculture increase their agricultural production for market exchange and hence their reliance on the market to deliver desired commodities in exchange for surplus foodstuffs (Blanton et al. 1982:22-23; Blanton 1985).

In summary, in agrarian market systems, decisions concerning market participation (what to produce and how much) are conditioned by three primary considerations: consumer demand, sufficient and reliable primary production, and a reliable market network to bring primary and secondary components together. To the extent that any of these factors are variable in space, market system participation can be expected to vary spatially as well. Thus, we cannot expect to see a uniform response in regions of diverse economic potential. Finally, these responses affect both the organization of production (in terms of the distribution, scale, and intensity of productive activities), as well as the type and quality of good produced -- factors that allow us to monitor economic responses along several dimensions.

Microlevel Responses: Predicting Regional Patterns in the Organization of Craft Production

The impact of market structure, urban demand, and agricultural productivity on the regional organization of craft production can be examined in modern peasant marketing systems. For example, the organization of rural productive strategies (in both agricultural and non-agricultural goods) in relation to regional variations in exchange systems and consumer demand has been demonstrated by Carol Smith (1977, 1989) for Western Guatemala. Western Guatemala contains a variety of market system structures, three of which have relevance here (Table 5.2).[5]

Table 5.2
Market System Characteristics of Western Guatemala

Characteristic	Market Zone		
	Core	Central	Periphery
market structure	top-heavy	interlocking	dendritic
distance to major market	0-15 km	15-30 km	75 km
local vehicles per # families	1:85	1:142	1:2320
farm size (*cuedras*)	35.3	89.0	176.8
annual farm income ($)	313	195	167

Note: data drawn from C. Smith (1989:793-798).

The **core zone** is representative of urbanized areas and/or areas at the centers of regional systems adjacent to the highest order center. Most residents are located within easy walking distance of a major urban market (Table 5.2) where market attendance is regular and predictable and where consumer demand for rural produce is high.

The **central zone** has an interlocking hierarchy of markets, characteristic of regional market systems providing both vertical and horizontal integration among producers and consumers. Market demand is regular and predictable, but distance to urban markets (and to urban demand for rural produce) is significantly greater than in the core zone.

Finally, the **peripheral zone** of the regional system is dendritic in structure. Commodity flows are primarily vertical, with minimal articulation among market centers of the same order. The reliability and consumer demand in local markets is low, while distance to the major urban market is great.

In all market zones, the rural population engages primarily in agricultural production. In addition, virtually all rural households produce some non-agricultural goods, most of which are sold. For both these activities, however, the scale and intensity of production vary significantly across the different market zones.

Differences in agricultural production indicate a tendency toward intensification near the urban core and extensive land-use systems in the periphery, although land qualities are roughly equivalent. Core-zone farmers have smaller field sizes, but take in a much higher income from their land (Table 5.2). This is due to both land improvements such as terracing and fertilizing, as well as the fact that farmers put a larger percentage of their land under cash crops (nearly two-thirds) (C. Smith 1989:797-798). In contrast, farmers in the periphery produce less income on more land, partly as a function of extensive fallow field systems as well as a tendency to plant subsistence rather than cash crops.

In examining the organization of non-agricultural production, C. Smith (1989:798-799) distinguishes two types of production, handicrafts and artisanry, that also differ in scale and intensity. In handicraft production (e.g. baskets, mats, rope, some pottery, and certain other household goods), the individual is generally the unit of production. Inputs consist of materials produced by the household itself, such that investments (and associated risk factors) are low, but returns tend to be very low as well. Production is part-time, and Smith comments that it fits in especially well with non-intensive agriculture.

In contrast, artisanal production (e.g. clothing and shoes) is a larger-scale and more intensive enterprise. The production unit tends to be either the household or a small workshop (C. Smith 1977:139) and requires a greater investment in the purchase of raw materials and equipment (such as a sewing machine). Investments (and risk levels) are therefore higher, but so are the potential returns. To warrant this risk and to pay-off capital investments, more time is devoted to production efforts, such that production is more intensive.

By monitoring the distribution of handicraft vs. artisanal production across market zones, Smith demonstrates that the distribution, scale, and intensity of independent production vary significantly with regional variations in market system structure and access to urban markets. These trends are quite strong (Table 5.3).

In terms of the distribution of producers, artisanal production is concentrated in the core zone. Greater than 70% of full-time craft producers in the region live in or near the core zone, although this area supports only 38% of the population (C. Smith 1977:125). In terms of scale, a much greater percentage of producers are engaged in the larger-scale artisanal enterprises in the core zone (Table 5.3A), while artisanry is relatively rare in the peripheral zone. Finally, the intensity of production is affected: a much greater percentage of work-time is devoted to the more intensive artisanal production in the core, as compared with the central and peripheral zones (Table 5.3B).

Table 5.3
Differences in Craft Production Concentration and Intensity by Market Zone in Western Guatemala

A. Number of producers as a measure of concentration:
(% male heads of households in household survey [N=2525])[a]

Occupation	Market Zone		
	Core	Central	Periphery
Agriculture	22.7	46.2	45.0
Commerce	26.9	20.1	19.2
Handicraft	1.8	5.6	16.7
Artisanry	43.7	15.1	9.0
Commodity[b]	45.8	20.7	25.7

[a]Data from C. Smith (1989:Table 6).

[b]Handicraft plus artisanal production.

B. Allocation of time invested as a measure of intensity:
(% of total time worked by household members)[c]

Occupation	Market Zone			N
	Core	Central	Periphery	
Handicraft:				
Men	4.3	3.0	5.6	5132
Women	11.3	11.7	13.9	4422
Total	7.5	7.0	9.4	9554
Artisanry:				
Men	37.2	20.0	21.2	5132
Women	55.1	35.9	21.6	4422
Total	45.5	27.3	21.4	9554
Ratio (H:A):	1:6.0	1:3.9	1:2.2	
Commodity:[d]	53.0	34.3	30.4	

[c]Data from C. Smith (1989:Table 8).

[d]Handicraft plus artisanal production.

Thus, in the core zone, more producers are involved in larger scale and more intensive forms of craft production (artisanry vs. handicrafts), and these non-agricultural activities take up a significant proportion of their work time (mean = 53%). In the central zone, artisanal production still dominates over handicrafts, but the total amount of time devoted to non-agricultural production drops to 34%. Finally, in the periphery, the small scale, low intensity handicraft production is more common; total time invested in non-agricultural activities declines slightly to an average of 30%.[6]

The relative balance of agricultural and non-agricultural production reflects the strategies noted earlier: intensification vs. diversification. In the core zone, proximity to urban markets and high consumer demand means that agricultural systems reward additional inputs of effort that increase salable outputs. The result is both intensification of effort and increasing agricultural specialization in the form of cash crops. Proximity to urban markets, however, also supplies sufficient demand for craft production, leading to intensification of efforts in secondary production. In this context, scheduling conflicts will eventually arise that require the would-be artisan-farmer to choose between these two economic pursuits for more intensive exploitation; in these cases, some artisans will opt for yet more intensive (i.e., full-time) craft production (Costin 1991:17).

In the periphery, in contrast, local forms of agricultural production do not reward additional inputs of labor because local consumer demand is low. In addition, the dendritic market system is not structured to deliver a reliable supply of subsistence goods needed in exchange for more specialized production. Producers accordingly rely more heavily on subsistence agriculture, and diversify their income with primarily low investment/low risk handicraft production.

The central zone does not fit the neat dichotomy between intensification and diversification. Land productivity levels are slightly higher here than elsewhere in Western Guatemala (C. Smith 1989:793). Most rural households produce food for market sale, while relatively few adult males (20%) engage in either handicraft or artisanal production. Thus, there would appear to be no strong pressures on households to increase productivity through either intensification or diversification. Alternatively, had land productivity or land availability been poor in this region, we might expect to find more intensive craft production emerge as a response to agricultural insufficiency, as found elsewhere (Arnold 1985:192-193; Feinman et al. 1992; Finsten 1983). In this case, the degree of market integration noted in the central zone could be relied on to supply craft specialists with subsistence goods needed in exchange. Local specializations based on non-subsistence resources could be supported.

Carol Smith (1989:791) summarizes her findings in Western Guatemala with the statement that "it is the organization of marketing that explains variations in rural employment and income better than any other factor." Her regional data therefore support the observations of other economic geographers: (1) that peasant survival strategies are strongly conditioned by regional market system organization; and (2) that peasant responses to specific marketing patterns generate predictable regional patterns in the organization of agricultural and craft production.

Although her case study does not provide specific expectations for the full range of marketing systems, the three market zones investigated in her study are applicable to the Aztec case. In particular, differences between the core zone and the peripheral zone are directly relevant for developing expectations concerning the differential organization of craft production if the Aztec market system was dendritic in structure.

Macrolevel Forces: The Aztec Case

The macrolevel forces affecting marketing structure in the Aztec case were obviously complex. As we have seen in the preceding chapter, the rulers of the emerging Aztec empire faced two problems. The first resulted from the dependency of imperial rulers on traditional rulers for the administration and taxation of their subject populations.

The second problem was the dependency of the empire's urban core on the rural hinterland for agricultural produce. Further, imperial attempts to resolve the problems of imperial integration and urban supply were directly linked through two flows of goods: (1) the transformation of exotic raw materials into prestige items via tribute assessments, and (2) the market exchange of foodstuffs for the raw materials needed to meet tribute demands in manufactured goods.

Because the market system provided the point of articulation for these two flows, the market system was of vital concern to the empire both politically and economically. Let us turn now to an examination of how these political and economic concerns affected market participation, by assessing their impact on market structure, consumer demand, and agricultural productivity.

Market Structure

The Aztec market system was responding to political and economic forces that were potentially, but not necessarily, in conflict. On one hand, the urgent food needs of urban populations could be expected to select for the greater economic efficiency of specialization and a market-integrated economy. Urban food demand is frequently cited as a factor increasing rural production and stimulating regional trade (Appleby 1976; C. Smith 1974, 1976a; von Thünen 1966). Several conditions, including internal security resulting from the *pax mexica*, administrative investments in transportation routes such as roads and canals (Hassig 1985:31-32, 56-60), and ecological diversity, could have supported urbanization in leading to a rapid increase in the degree of interaction among communities along both horizontal and vertical dimensions. The result would be a market structure characterized by both well developed network and hierarchy, leading to the stimulation and development of the rural hinterland, apparent in the emergence of full-time craft specialization and economies of scale.

Such a pattern, however, is not consistent with much of what we now know about Aztec production in hinterland areas. As Brumfiel (1987b:110) comments, "Ecological diversity and population density ought to have made full-time specialization profitable; the apparent reluctance of hinterland peoples to engage in full-time specialization seems to violate the canons of economic rationality." Brumfiel further suggests that we account for this apparent irrationality by referring to structural imperfections in the market system.

The analyses of political process under Aztec rule as presented earlier identified two main factors that directly or indirectly affected market system structure.[7] Political concerns over the circulation of exotic raw materials, as well as the prestige items fashioned from those materials that served as the bases and symbols of power and status in Aztec society, could potentially distort market system structure along vertical lines. As C. Smith (1977:129) notes, when flows of essential goods are controlled by merchants external to the local system, who hold their goods in monopoly and distribute them directly, market competition cannot exist and distortion of the local market economy will occur.

Three attributes of the trade in exotics, taken together, could well lead to market imperfections that locally favored vertical commodity flows. These are (1) the conditions of near monopolistic control over wholesale trade in exotic raw materials; (2) tribute assessments that required the purchase of these goods by the rural populace; and (3) administrative controls over the rights to market traffic in prestige goods that restricted their availability to specific urban centers. Locally, under these conditions, the primary flow of goods would have been vertical between rural producer and urban center: rural agricultural produce flowed into the center in exchange for the exotic raw materials that flowed out again to meet tribute requirements in manufactured goods. As predicted by Brumfiel (1987b), this market structure would intensify market exchange within the region, but it would not lead to a corresponding regional division of labor characterized by specialization.

Although the primary concern may have been controlling the lucrative (and politically important) trade in exotics, the restricted availability of exotic raw materials also (perhaps incidentally) generated centripetal flows of foodstuffs into centers dealing in those goods. In this case, the exotics needed to complete tribute assessments functioned as a form of currency. By controlling the flow of that "currency," it was also possible to control and direct the flows of foodstuffs, in a manner not unlike that utilized by Athens in the 5th century B.C. to encourage centripetal flows of desired goods at the expense of transprovincial exchange. From the perspective of urban supply, these centripetal flows may have been less efficient than an interlocking market network for generating agricultural surpluses at the regional level. But at the local level, the alignment of political and economic interests could favor development of vertical rather than horizontal linkages -- an arrangement that satisfied urban needs but led to the underdevelopment of the rural hinterland.

It is unlikely, however, that monopolistic controls over exotics would have led to a dendritic market system focused solely on the capital at Tenochtitlan-Tlatelolco (cf. Hassig 1985). Rather, several important factors (including the size and richness of the market) that attracted merchant trade and thus commodity flows argue for at least a dual market hierarchy. Two cities in the Valley had daily markets -- Tenochtitlan and Texcoco -- reflecting their distinctive size and political status. Although historic accounts have focused our attention on the Tlatelolco market, Texcoco almost certainly had a daily market comparable in size and organizational complexity to that described at Tenochtitlan-Tlatelolco (J. Parsons 1971:228; Hicks 1982b).

Further, the imperial capitals operated independently in their sponsorship and deployment of *pochteca* trade (Berdan 1986:284). While state involvement in long-distance trading ventures is best demonstrated for the Tenochca, Texcoco also actively defended the interests of her merchants, and provinces conquered by Texcoco were obligated to permit merchant traffic within the confines of their territories (Alva Ixtlilxochitl 1965, Vol. II:190-191; Berdan 1975:167). If, as van Zantwijk (1985:134) and Berdan (1986:284) have suggested, the merchants maintained close ties with the Triple Alliance subdivision to which their guild belonged and to which they owed their livelihood, merchants may have been obligated to give preferential treatment to the dual political centers of empire. Thus, population size, economic potential, and political position could favor a regionally bifurcated market system structure within the Valley, focused on Tenochtitlan and Texcoco.

In sum, it is anticipated that at the local level, imperial efforts to control the traffic in exotic raw materials and elite prestige goods indirectly distorted market structure, stressing the development of vertical commodity flows between urban center and dependent communities, while undermining the development of a market network among settlements at the lower end of the hierarchy. At the regional level, however, the dual division of political power and economic status within the Valley would be expected to prevent the development of a unilineal dendritic market structure. Rather, economic subregions could develop centered on the major political and economic centers within the Valley.

Consumer Demand

Under Aztec rule, the consolidation of the empire was paralleled by a general increase in population size and density, as well as an increase in the non-productive administrative sector -- a trend that culminated in the emergence of sizable urban centers. This process of urbanization in turn generated a high consumer demand for rurally produced foodstuffs. While food stress was admittedly greatest for Tenochtitlan, Tenochtitlan was not the only city in the Valley. J. Parsons (1976) suggests that a high demand for food existed almost everywhere in the imperial core, placing pressures on the agricultural sector to produce. Demands of the state contributed to these pressures, through increased tribute assessments in agricultural supplies. As a result, consumer demand placed great emphasis on foodstuffs, and rural producers were stressed to meet the demands of market and tribute, in addition to their own subsistence needs.

As consumer demands for foodstuffs increased, the value of foodstuffs increased, and agricultural surpluses and other food resources became a major exchange commodity for the rural populace. But ability to produce to meet that demand varied according to two other interrelated factors: market structure and agricultural productivity. As we have seen, market structure was a major factor determining a producer's ability to specialize in a marketable commodity. Within the context of a competitive, interlocking market system, producers can profitably specialize in any commodity, either primary or secondary, while relying on the market system to deliver subsistence goods in exchange. Conversely, if the development of vertical commodity flows constrained producers' ability to specialize, then the extent to which they were drawn into the market system depended on their ability to produce for the urban market, that is, on their ability to produce agricultural surpluses.

Agricultural Productivity

Agricultural productivity and reliability in the Valley of Mexico result from the interaction of a number of factors, principally precipitation (or soil moisture) and frosts (J. Parsons 1971; Sanders 1957, 1976a; Sanders, Parsons, and Santley 1979). In general, precipitation increases from north to south and from lower to higher elevations, ranging from 500-600 mm per year in the drier northern third of the basin to 1500 mm per year on the southeastern basin slopes. Soils tend to be deeper and hence more moisture retentive at lower elevations; conversely, lower areas are more subject to frost damage than hill slopes.

Interannual variability in the timing and the adequacy of the rainy season, as well as the timing of spring and fall frosts, is high in the Valley -- with potentially disastrous results for agricultural activities (Sanders 1957, 1976a).[8] If a late rainy season delays planting, the crop may not mature before the first killing frosts of autumn. Given this critical relationship between rainfall and frost in determining agricultural productivity and dependability, it should come as no surprise that the Aztec developed a range of cultivation practices (varying in labor intensity and output) designed to deliver adequate moisture to cultivars during the critical planting stage.

Levels of Agricultural Intensity. Agricultural practices utilized in late prehispanic times in the Valley of Mexico have been presented in detail (J. Parsons 1971; Parsons et al. 1982; Sanders 1976b; Sanders, Parsons, and Santley 1979). Within our area of concern (corresponding to the Texcoco, Ixtapalapa, and Chalco-Xochimilco survey zones), three major types were of particular importance.

The least labor intensive agricultural practices included rainfall (*temporal*) and floodwater cultivation developed in alluvial and gently sloping lower piedmont areas. In areas of adequate precipitation, as in the south, most piedmont cultivation was apparently rainfall based during Aztec times (Parsons et al. 1982:377). In the drier north, in contrast, adequate moisture was obtained by utilizing rainy season run-off from adjacent slopes for floodwater irrigation. On sloping terrain without adequate floodwater irrigation sources, cultivation was more casual, with crop yields reflecting variability in annual rainfall. Cultivation on well-watered and irrigated slopes is presumed to have been annual (Williams 1989:719); in areas of inadequate moisture, cultivation was extensive following a short 1:1 fallow cycle (Sanders 1976b:143-144). Lands cultivated with this suite of agricultural techniques presumably represents traditional *calpulli* or *tlaxilacalli* lands (Williams 1991).

More intensive forms of agricultural production included terraces and *chinampas*.[9] *Chinampa* or raised field cultivation is a highly labor intensive method of converting poorly-drained soils into highly productive agricultural fields, by laboriously raising masses of soil and aquatic vegetation and consolidating them into planting surfaces at a level above the water table of the surrounding canals (Rojas Rabiela 1984; Parsons et al. 1982). Adequate moisture levels result from high water tables (controlled with dikes and sluice gates) or with irrigation from the canals, while long-term productivity is maintained through a complex pattern of crop rotation (in which soil nutrients depleted by one type of crop are replaced by another) and fertilization with lake muck and night soil (Sanders 1957; Parsons et al. 1982:20). Through the use of seed beds and nurseries, two crops of maize are possible per year. As a result, the intensity of *chinampa* agriculture is rewarded by extraordinary productivity: up to 3 metric tons or more per ha of maize annually (J. Parsons 1982:20).

The principal area of *chinampa* construction within the Valley of Mexico was the Chalco-Xochimilco lakebed; localized areas of *chinampas* are also known from Tenochtitlan, Chimalhuacan, and Xaltocan (Sanders, Parsons, and Santley 1979:280-281). Although some small-scale *chinampa* construction is recorded for the period preceding Aztec imperial consolidation, the main period of land reclamation and *chinampa* construction within the Chalco-Xochimilco lakebed has been dated to ca. A.D. 1426-1467 based on ethnohistoric and archaeological data (J. Parsons 1976:237, 1991; Parsons et al. 1982; Parsons et al. 1985). At its fullest extent, these *chinampas* provided an estimated 9500 ha of cultivable land. The large-scale alignment of these *chinampas* and the complex hydraulic controls (in the form of dikes and sluices) necessary to maintain proper water levels argue strongly that these *chinampas* were built under the sponsorship or the direct administration of the Aztec state (Armillas 1971; Sanders, Parsons, and Santley 1979:281; Parsons et al. 1982:23).[10]

Settlement remains within the Chalco-Xochimilco lakebed suggest that the organization of *chinampa* labor utilized two distinct social classes. The predominant settlement type within the lakebed consists of small, widely scattered clusters of housemounds, that are interpreted as the residences of landless persons of *mayeque* status, who were not organized on a corporate (*calpulli* or *tlaxilacalli*) basis, but who existed as dependent tenants on the landed estates of powerful nobles (J. Parsons 1976; Parsons et al. 1982:356; Brumfiel 1991a).[11] This class of landless commoners apparently resulted from the confiscation and break-up of corporate landholdings following Triple Alliance conquests within the Valley (Berdan 1975:60); later, these tenants were recruited as a labor force and resettled in key agricultural areas to work the nobles' estates.

By J. Parsons' (1976) own accounting, however, these tenants would have been insufficient in number (as estimated from settlement remains) to provide adequate labor for *chinampa* cultivation. Thus, it is likely that part of the population living in traditional aggregated settlements located in and near the lakebed was also engaged in *chinampa* cultivation (J. Parsons 1991). In either case, it is likely that these *chinampa* agriculturalists were full-time specialists, since productive *chinampa* cultivation demands a high level of experience, somewhat analogous to that possessed by skilled craftsmen, acquired through long apprenticeship (Parsons et al. 1982:23).

A second important (but less well known) form of agricultural intensification involved the construction of terraces on steeper piedmont slopes to reduce soil erosion and improve soil depth and moisture retention, thereby increasing both the total hectarage of soils in cultivation as well as the productivity of those soils. Terraced embankments of packed earth (*bancal*) frequently stabilized by maguey plantings are sufficient for gentle slopes, while stone-faced terraces provide greater structural support on steeper slopes. Stone-walled terraces were encountered during regional surveys in several areas, including upper piedmont settlements east and northeast of Texcoco (J. Parsons 1971:221), and in the Tenango subvalley (Parsons et al. 1982:357).[12] However, it is likely that virtually all piedmont areas within the northern and central portions of the Valley were covered with *bancal* or stone terraces in late prehispanic times (Sanders, Parsons, and Santley 1979:251). In the north, terrace productivity may have been associated with floodwater irrigation as has been documented for the Teotihuacan Valley (Sanders 1957; T. Charlton 1970; Williams 1989), although maguey and nopal are two important crops which would have flourished under conditions of terrace agriculture wholly dependent upon rainfall (J. Parsons 1971:221; Evans 1992). In the south, substantially higher rainfall amounts would have made irrigation of terraces unnecessary.

The construction history of these terraces is virtually unknown, but they appear to be primarily associated with Late Aztec sites, and may represent processes of agricultural intensification in response to urban food needs (J. Parsons 1971:221; Parsons et al. 1982:357; Sanders, Parsons, and Santley 1979:251). For example, Parsons et al. (1982:357) tentatively suggest that the terrace features encountered in the Tenango area "could represent state-directed efforts...to improve and expand productive agricultural land in little-used piedmont areas in order to expand the base for supporting a growing administrative bureaucracy."[13] There are several lines of evidence that support this interpretation of the Tenango terraces. First, the dispersed rural settlements found here could represent the residential quarters of landless tenants (Parsons et al. 1982:357), suggesting that the organization of labor in this region was similar to that employed in areas of state-sponsored *chinampa* agriculture.

In addition, the location of the Tenango terraces relative to major transportation route argues that they were established with a concern for supplying Tenochtitlan. The Tenango subvalley, although less productive than the seemingly far more fertile piedmont to the northeast, abuts directly on the southeastern corner of the *chinampa* district (J. Parsons 1982:358) and (according to the Santa Cruz map) was directly linked to metropolitan commerce via the trans-lake canal port at Ayotzinco (Blanton 1994).[14] Thus, it would have been relatively easy to channel flows of foodstuffs from this area directly into the Tenochtitlan-Tlatelolco market. To date, however, although the presence of these terraces is recorded for numerous sites, their total hectarage and hence their contribution to meeting rising food demands remains unknown.

Regional Variability in Agricultural Productivity. The overall configuration of cultivation practices, combined with the north-south trend in total precipitation, generated regional differences in agricultural productivity. Within the Texcocan heartland, comprising much of the east-central side of the Valley, several studies have concluded that agricultural carrying capacity had been reached or exceeded under Aztec rule. Regularly poor crop yields documented for early colonial times (Offner 1980) combined with a high incidence of disastrous years (Hicks 1987:100), suggests that many commoners may have been living at the margin of subsistence.

One of the more detailed studies to reach this conclusion is Williams' (1989) analysis of landholdings of a rural *tlaxilacalli* located on the lower-middle piedmont slopes, 8 km northeast of Texcoco. Based on maps and records of family size, landholdings, and soil type dating to ca. A.D. 1540, Williams found that carrying capacity under viable, long-term strategies (i.e. assuming some sort of fallow on poorer lands) had been exceeded for poor and average agricultural years in the Contact period. At the *tlaxilacalli* level, maize deficits of greater than -50% were projected for poor years even with the most intensive strategy, with a -28% deficit to +11% surplus in average years, and surpluses of 11-74% in good years (Williams 1989:715). Given the high incidence of bad years reported for the Valley of Mexico, these figures indicate a considerable imbalance between population and agricultural resources. Williams argues that such rural overpopulation may have been typical of many piedmont communities. Thus, the intensification of agricultural production in the marginal upper piedmont in the form of terraces may have resulted from local food stress, rather than from state-directed efforts to meet urban food needs. Williams (1989:730) concludes that it is difficult to see how Texcocan piedmont communities could have contributed significantly to the support of nonfood-producing urban populations in the Valley.[15]

Overall, the Texcocan heartland was experiencing some degree of population pressure, and may not have been entirely self-sufficient in maize cultivation (Offner 1983:18). It is noteworthy in this regard that Texcocan conquests outside the Valley incorporated a band of territory to the northeast that was more than self-sufficient agriculturally and that provided important tribute in maize. The fact that one of the tribute districts (Tepepolco) responsible for supplying the royal court at Texcoco with large amounts of food for seventy days each year (Alva Ixtlilxochitl 1952, Vol.II:168-169; Offner 1983:13) was located so far from the center suggests that maize resources closer to home were inadequate.

The apparent marginal productivity of the central and northern piedmont contrasts markedly with the south. The *chinampa* zone of Lakes Chalco-Xochimilco was clearly the tortilla basket of metropolitan Tenochtitlan. With 9500 ha under cultivation, this area was capable of producing an annual surplus of 20,000 metric tons (20 million kg) of maize, much of which apparently entered the market system (J. Parsons 1976:246). The agricultural terraces of the Tenango subvalley, although less productive, appear to have been an extension of the urban supply system, and were directly linked via canal to the urban market. The overall productivity of both areas was enhanced by the efficiency of canoe transport, which permitted the shipment of large volumes of foodstuffs at low cost in human labor and time (Hassig 1985:56-64).

In addition to these areas of intensive agriculture, favorable soil conditions and ample precipitation boosted the general productivity of rainfall and floodwater agriculture within the Chalco province. According to imperial tribute roles, the province of Chalco gave the richest food tribute of the whole empire (Barlow 1949:75). This high productivity continued into the colonial period, as the commercial maize hacienda reached its most highly developed form in Chalco province (Gibson 1964:328).

These regional comparisons of agricultural productivity indicate that the ability to produce surplus foodstuffs to meet household, tribute, and exchange needs varied greatly within the Valley, according to differences in precipitation, soils, and intensity of cultivation practices. Contrasts in agricultural productivity are particularly strong between the Texcocan heartland and more intensive and more productive areas of the south. These areas accordingly offered very different opportunities for market participation as well as their incentives to develop supplemental forms of income.

Under pressure to increase productivity, these areas of extensive and intensive agricultural regimes also enabled alternative strategies for buffering and/or supplementing agricultural output. Blanton (1994) suggests that where local forms of primary production did not permit substantial additional inputs of labor, attempts to increase productivity took the form of diversifying by adding specialty food production or craft production activities to rural subsistence production. In Europe, this strategy led to the distribution of secondary production in both cities and in the countryside, where it took the form of "cottage industry" (Thirsk 1961; Tilly 1975). This strategy of diversification of primary and secondary production may typify the more arid and less productive north and central portions of the Valley, including the Texcocan heartland.

An alternative strategy for rural producers was specialization. Where agricultural systems rewarded intensification of effort, the result was more complete rural specialization in primary production. In this case, rural families became more dependent on urban production for secondary goods they no longer produced within the household. Within the Valley of Mexico, areas of intensive *chinampa* cultivation may be characterized by this response.

Predicting Microlevel Responses: Regional Patterns in Aztec Craft Production

How did these factors of market structure, consumer demand, and agricultural productivity combine to affect strategies of market participation and commodity production under Aztec rule? It is suggested here that market structure and consumer demand affected the regional organization of production, while individual ability to produce for that market determined strategies of market participation and commodity production. Administrative controls over exotic raw materials and elite prestige goods indirectly distorted market structure, concentrating market traffic and commodity flows into the centers where these goods were available. At the same time, processes of population growth and urbanization generated a high consumer demand for rurally produced foodstuffs, increasing the value of foodstuffs and converting food resources into a major exchange commodity for the rural populace.

Rural commoners of the Valley of Mexico were drawn into the market system by the necessity to procure exotic raw materials to meet tribute requirements, but their ability to participate in a market economy was contingent on their ability to produce foodstuffs as a major commodity of exchange desired in urban settings. We can therefore expect to see two general patterns of production and market participation, that largely covary with agricultural productivity and intensity.

Inhabitants of areas with low agricultural productivity (such as those of the Texcocan heartland) have a limited ability to produce for urban food demands and hence a more limited ability to participate in the urban market system. The agriculturalist's low productivity translates into low purchasing power and limited ability to buy goods produced in or imported into urban centers. In the Aztec case, where market participation was required or enforced by the necessity to purchase raw materials for tribute assessments, the ability to purchase other goods in addition to those materials declined accordingly.

Under a strategy of diversification, rural producers may supplement their income through part-time production of specialty food items for exchange in the urban market. In this case, many small lots of foodstuffs are bulked for local resale or for shipment to larger urban markets to meet urban food needs (Appleby 1976). Alternatively, rural attempts to diversify productive activities to supplement low or variable agricultural income may include petty or part-time commodity production in the form of cottage industry. Such activities would be fitted around and strictly secondary to demands of the agricultural schedule. But because these part-time craft producers were not wholly dependent on income from the sale of craft goods (as would be the case for urban specialists) they can cope with the rural seasonality of purchasing power and demand for craft goods. Conversely, without steady rural demand for urban craft goods, specialist producers of utilitarian commodities are not well supported in the center, although the urban concentration of elite will support specialists producing higher class and better quality goods. In this case, then, we can expect a pattern of dispersed, part-time production of lower order goods and centralized, more intensive production of higher order goods.

In contrast, rural producers in areas of more intensive agricultural production (characterized by the *chinampa* district) that generate surplus foodstuffs are better suited to participate in urban market exchange and to utilize surpluses to purchase desired goods in addition to materials required to meet tribute assessments. Further, agriculturalists in areas of more intensive cultivation would have less time and less incentive to boost their income by engaging in supplementary production, so they become more dependent on external sources for those goods.

In this context, full-time specialists of a broad range of goods will be supported. Because of the concentration of commerce in secondary and urban centers, full-time specialists would be best supported in those central locations. With the concentration of specialist producers of both higher order (elite) craft goods as well as lower order (nonelite) craft goods in centers, a pattern of rural-urban symbiosis in primary-secondary production will develop.

Finally, these productive strategies may affect the energetics of craft production, as well. Where producers must compete to attract a portion of the market, producers can attempt to make their products more attractive and hence gain a competitive edge by increasing product value while holding cost steady, or by decreasing product cost (Arnold 1985; P. Rice 1981). The first strategy leads to elaboration and diversity, while the second leads to a reduction of energy investment resulting in a serviceable, but low cost, product. The choice of strategy may partially depend on the purchasing power of the targeted consumers. In areas of high market participation and rural market dependence we might expect to find producers manufacturing a full line of goods to meet the full range of consumer preferences in appearance and cost. In contrast, in areas where production is divided among the countryside and the center, we might expect to find a corresponding spatial division in competitive strategies between cost-minimization (simplification) and value-maximization (elaboration), respectively.

Predictions in Review

Based on the preceding model, the following expectations are advanced for systems of commodity production and exchange under imperial rule:

> (1) The operation of a dual market hierarchy in the Valley, centered on the two dominant political, economic, and urban centers, Tenochtitlan and Texcoco. These market hierarchies will be apparent as two distinct zones of exchange interaction whose boundaries are congruent with administrative divisions within the Valley.
>
> (2) Within each of these zones, market structure will be organized in a dendritic pattern, designed to channel agricultural produce and other foodstuffs up the hierarchy into the major urban centers.
>
> (3) Market participation and the organization of craft production will vary according to the regional distribution of agricultural systems within the study area.
>
> (4) Organizational differences in craft production will create observable differences in the number of producers, their scale of production, and their location in rural

vs. urban settings; production and marketing strategies will be reflected in the quality and diversity of goods produced.

(5) In areas of less productive and less reliable rain-fall agriculture, such as the Texcocan heartland, we can expect evidence of craft production in both urban and rural settings, but both the scale and intensity of production as well as the demand population targeted will differ.

(a) Craftsmen located in or near urban centers are expected to engage in more intensive production and to produce a greater volume of goods. Further, they are expected to produce higher class and better quality goods because they have access to consumers with higher socioeconomic statuses and purchasing powers.

(b) Rural producers are expected to engage in their craft only part-time. In addition, they are expected to produce serviceable but relatively inexpensive products to meet the needs of rural consumers with relatively lower purchasing power.

(6) In areas dominated by intensive agricultural systems, such as the highly productive *chinampa* zone of Lakes Chalco-Xochimilco, we can expect that both utilitarian and elite goods will be produced by full-time craft specialists located in urban centers. In this situation, craft production will be nucleated, potentially on a larger scale, and more intensive.

Summary

This chapter has attempted to delineate the complex ways in which imperial political economy altered market structure and function within the Valley of Mexico under Aztec rule. This analysis suggests that the dual problems of political control (effected in part through controls over strategic elite goods) and urban supply were articulated through the flows of two classes of goods: (1) the transformation of exotic raw materials into prestige items via tribute assessments, and (2) the market exchange of foodstuffs for the raw materials needed to meet tribute demands in manufactured goods. As the point of articulation for these two flows, the market system was of vital concern to the empire both politically and economically, and thus it was responding to both political and economic forces.

In the absence of political controls, rising urban demand for rurally produced foodstuffs is expected to select for the greater efficiency and productivity of an integrated market network. Such a horizontally articulated market structure would permit specialization in either primary or secondary production, and the development of large economies of scale in a full range of goods throughout the empire. This is a trend, however, that we do not see in the archaeological record.

The model developed here, in contrast, argues that the convergence of political interests and urban needs distorted market structure by strongly reinforcing vertical links between urban centers and dependent communities at the expense of horizontal market articulation. These market imperfections affected strategies of market participation by the rural populace. Although the rural population was drawn into the market system in order to meet tribute assessments, their degree of market participation and market reliance depended on their ability to produce for the urban market. Thus I argue that rural responses were largely constrained by the productivity of their agricultural resources, resulting in two distinct patterns of market participation and rural production.

This model generally conforms with aspects of production and exchange as they emerge in current research. Although commercial models and central place analyses have argued for the beginnings of a market integrated economy, the sites where we have the best data on production suggest a different picture of declining market participation and dispersed, part-time craft production (Brumfiel 1976, 1986, 1991c; C. Charlton 1994; Charlton et al. 1991, 1993; Spence 1985). Thus the model developed here fits some hitherto puzzling aspects of Aztec domestic economy, while generating testable hypotheses for larger patterns of commodity production and exchange that will be examined in the latter portion of this work.

Notes to Chapter 5

[1]A number of cross-cultural studies have indicated that peasant producers generally forego short-term profit maximization in the interests of long-term income security (Wolf 1966; Barlett 1980:556-557, 1982; Ellis 1988; Netting 1974:44; Roseberry 1989).

[2]P. Rice (1991:262-263) defines four types of specialization: (1) **site** specialization (referring to the specialized use of a site based on the non-uniform distribution of raw materials); (2) **resource** specialization (representing the selective use of particular resources); (3) **functional** or **product** specialization (where the producer specializes in producing a limited number of forms or types of a given commodity); and (4) **producer** specialization (where production of a commodity is limited to a few skilled producers).

She notes that most analysts of "specialization" are really concerned with the degree of intensification within producer specialization, including the distinction between part-time and full-time production, and between household industries and mass production or economies of scale. However:

> "Specialization does not necessarily imply intensification. What scholars really seek to distinguish in their studies of production organization is relative levels of intensification, in part because this differentiation occurs as part of evolving societal complexity. Specialization, in a more narrowly defined sense of skill or restrictedness, can occur on a number of different sociopolitical levels" (Rice 1991:265).

In this text, the terms "specialist" and "specialized producer" represent Rice's category of producer specialization. The term "specialty production" corresponds roughly with the concept of functional or product specialization, and is contrasted with generalized or subsistence production. Finally, "specialization" refers to either the move from subsistence to specialty production or to intensification with the category of producer specialization.

[3]These three factors are roughly equivalent to the factors identified by Blanton (1983; Blanton et al. 1982:22-23) as critical for the emergence of specialized production in Formative Oaxaca: access to markets, population growth (a measure of consumer demand), and agricultural intensification. The linkages between agricultural intensification and craft specialization have long been recognized in anthropology (e.g. Hole and Flannery 1967) and continues to be of theoretical interest (e.g. Dow 1985).

[4]The point at which consumer demand in a region becomes sufficient to support specialized producers is referred to as the "demand threshold." Above this threshold, specialized suppliers are supported; below this point, the specialized producer will not survive without a change of strategy (C. Smith 1974). In the case of low consumer demand, producers may survive through part-time production (thereby reducing dependency on specialty production for survival), generalized production (by carrying multiple goods, each with a different demand threshold, consumer demand can be multiplied), or itinerant marketing (by becoming mobile, a producer can tap a wider area of demand).

[5]The fourth system (a primate market structure designed to export cash crops to a world market) is not considered relevant for the precolonial case and is not discussed here.

[6]The difference in production strategies between core and periphery is captured admirably by Xenophon (4th century B.C.):

> "In small towns the same workman makes chairs and doors and ploughs and tables, and often this same artisan builds houses, and even so he is thankful if he can only find employment enough to support him....In large cities, on the other hand, one trade alone, and very often even less than a whole trade, is enough to support a man: one man, for instance, makes shoes for men, and another for women; and there are places even where one man earns a living by only stitching shoes, another by cutting them out, another by sewing the uppers together, while there is another who performs none of these operations but only assembles the parts" (cited in Starr 1977:86-87).

[7]Administrative meddling is frequently cited as a major cause of market imperfections in agrarian market systems (C. Smith 1976d:333-338), but direct meddling on the part of Aztec imperial rulers is generally seen as inadequate to have generated substantial market imperfections. Brumfiel (1987b:110-111), for example, argues that administrative intervention in the form of market taxes, fixed prices, and prohibitions against trading outside of the market would affect both part-time and full-time producers, and not necessarily favor the development of one over the other.

[8]For example, historic records show that from 1521 to 1600, droughts occurred on the average every six years (Williams 1989:728), while killing frosts that destroyed an entire crop overnight are reported throughout late preconquest and colonial times (Gibson 1964:316, Appendix V). Hicks (1987:100), based on an analysis of Gibson (1964), records 23 years in which adverse conditions seriously affected crop yields in the century between 1525 and 1625.

[9]Permanent (canal) irrigation was extremely important in restricted areas of the Valley, such as the Río Teotihuacan alluvium. However, the Teotihuacan Valley appears to have been unusual in its great potential for highly productive cultivation based on large-scale networks of irrigation canals. Other areas suitable for canal irrigation were, in contrast, on a fairly modest scale, such as along the alluvial plains of the Río Papalotla and Río Cuauhtitlan (J. Parsons 1971:220; Sanders, Parsons, and Santley 1979:253). Other major canal systems reported for the Texcoco region appear to have been utilized in prehispanic times primarily to support the pleasure gardens and rural retreats of the Texcocan rulers rather than agricultural fields (J. Parsons 1971:151; cf. Palerm and Wolf 1961a, 1961b).

[10]J. Parsons (1971; Sanders, Parsons, and Santley 1979:273-275) proposed another major type of intensive agriculture -- that of draining the lakeshore plain by means of large ditches -- and suggests that the canalized barrancas extending across the width of the Texcoco lakeshore plain may well have been constructed in Aztec times as a means of flood control and drainage of low-lying agricultural land. With adequate drainage, the productivity of this zone could potentially rival that of the *chinampas*. However, J. Parsons (1971:223-224) concludes that we lack any archaeological or documentary data to confirm the thesis of artificial drainage of the lakeshore plain during Aztec times (cf. Sanders, Parsons, and Santley 1979:275-276). For example, the pattern of dispersed rural settlement (so characteristic of agricultural intensification within the piedmont) is missing on large expanses of the alluvial zone; however, massive erosion in the postconquest era could have easily obliterated small sites here. Alternatively, labor could have been drawn from the

string of urban settlements (including Texcoco, Huexotla, and Coatlinchan) situated between the alluvium and the lower piedmont.

[11]This pattern of dispersed rural settlement, however, corresponds closely to settlement patterns within the traditional rural *tlaxilacalli*, as reported by Williams (1991). Williams argues that the ethnohistoric data suggest an alternative interpretation of archaeological remains of dispersed, rural settlements with largely domestic architecture: "Instead of communities of renters directed by the state (Sanders, Parsons, and Santley 1979:178-179), such sites could represent remains of rural tlaxilacalli subdivisions occupied by macehualtin who independently cultivated the land of their *común* but fell under the jurisdiction of larger entities" (Williams 1991:206).

[12]Relic stone-faced terraces are reported for TX-A-23, -28, -30, -31, -69, -76, -78, -79, -80, and -81 in the Texcoco piedmont (J. Parsons 1971), as well as CH-AZ-116, -119, -120, -121, -124, -129, -130, -144, -147, -148, -150, and -157 in the Tenango subvalley (Parsons et al. 1982:357).

[13]Due to differences in soil texture and drainage, the *chinampas* and piedmont terraces may well have supported different crops, and thus provided complementary niches for growing a broader range of foodstuffs.

[14]According to the Santa Cruz map (Linné 1948), a major canal runs west from Ayotzinco directly linking the Tenango area to Tenochtitlan-Tlatelolco, while by-passing the major settlements and markets within the lakebed (Blanton 1994). Blanton argues that this direct canal configuration was partly a strategy to prohibit competing markets from monopolizing (and hence gaining power from) the important flow of foodstuffs into the city.

[15]The focus on maize yields alone may substantially underestimate the productivity of this area by ignoring caloric contributions of xeric crops, such as maguey and nopal (Evans 1992; J. Parsons and Darling 1993). For example, J. Parsons and M. Parsons (1990:342-345;) argue that the common practice of inter-cropping maize and maguey may significantly increase the total productivity of lands at higher elevation, while adding an important reserve crop that is relatively impervious to the effects of drought, frost, and hail. While important, the contribution of maguey may not have been sufficient to relieve local food stress, since historic reports indicate that food was generally not available in great abundance. In general, Williams' assessment is more in agreement with statements concerning the overall poverty of Indians, such as that of Motolinía in the early postconquest period:

> "These Indians have almost no hinderance that might keep them from earning entrance to Heaven...for in life they are satisfied with very little, so little that they scarcely have the wherewithal to clothe and feed themselves. They eat most poorly indeed and clothe themselves in equal poverty" (cited in and translated by Cook and Borah 1979:162).

By this date, however, it is possible that pulque production for urban consumption had converted maguey from a locally consumed food resource to a cash crop (J. Parsons, personal communication). In either case, the role of maguey clearly merits further investigation.

CHAPTER 6

STUDY AREA AND ARCHAEOLOGICAL DATA BASES

The second half of this study comprises an empirical evaluation of market system organization in the Valley of Mexico before and after incorporation into the Aztec empire. This evaluation attempts to test the model for the interaction between political economy and market economy developed in preceding chapters, as well as evaluate other competing models commonly applied to pre-imperial and imperial market systems. It does so by examining regional patterns and diachronic change in the organization of production and exchange of one commodity, decorated Red ware ceramics.

Aztec Red wares were an important ceramic ware used throughout the late prehispanic period, whose patterns of distribution and variable paste composition permit an integrated analysis of production and exchange systems for this utilitarian commodity. This analysis includes two components. First, the spatial distribution of different Aztec Red wares are examined to monitor the structure of regional exchange systems through which these vessels were distributed before and after the consolidation of the Aztec empire. Second, Instrumental Neutron Activation (INA) analysis of trace elements is employed to examine the organization of Red ware production through time, as this was affected by market system organization.

Ceramic production and exchange systems are viewed from both regional geographic and diachronic perspectives in this study. At a regional level, assemblages of decorated ceramics collected by the Valley of Mexico Survey Projects within the eastern and southern portions of the Valley are used to examine regional patterns of ceramic distribution. The broad spatial coverage provided by the survey collections offers possibilities for determining the geographic scale of economic interaction and for assessing the impact of political geography on craft production and exchange.

Similarly, the collections' coverage of two archaeological periods permits a comparison of the scale and structure of exchange in two different political environments. Ceramic types and their distribution patterns are examined for two archaeological periods: the pre-imperial Early Aztec period (ca. A.D. 1150-1350), and the Late Aztec period (ca. A.D. 1350-1520), during which the Aztec empire emerged. Through this diachronic comparison the degree to which imperial integration altered pre-existing production and exchange systems can be assessed.

Definition of Study Area

The study area for this research encompasses the eastern and southern portions of the Valley of Mexico, corresponding to the area covered by the Texcoco, Ixtapalapa, and Chalco-Xochimilco Survey Regions (J. Parsons 1971; Blanton 1972; Sanders, Parsons, and Santley 1979; Parsons et al. 1982; see Fig. 6.1). This area represents a large (1450 km^2) contiguous block within the Valley, within which artifact assemblages were generated by a consistent field methodology, and for which site information has been published (J. Parsons 1971; Parsons et al. 1982; Parsons, Kintigh, and Gregg 1983; Blanton 1972).

The Valley of Mexico archaeological surveys provide comprehensive regional coverage of late prehistoric occupations within the study area. The purpose of these regional surveys was to locate, map, and describe settlements of all ceramic-producing societies in the Valley. Within the four survey regions, 563 Aztec-period sites were located and sampled for surface ceramics by the survey teams. Of these sites, 196 (35%) had significant occupations dating to the Early Aztec period; 541 sites (96%) were occupied during the Late Aztec period.

The surveys estimated populations and sizes of Aztec settlements from the density and concentration of sherds on the surface. These estimates were combined with

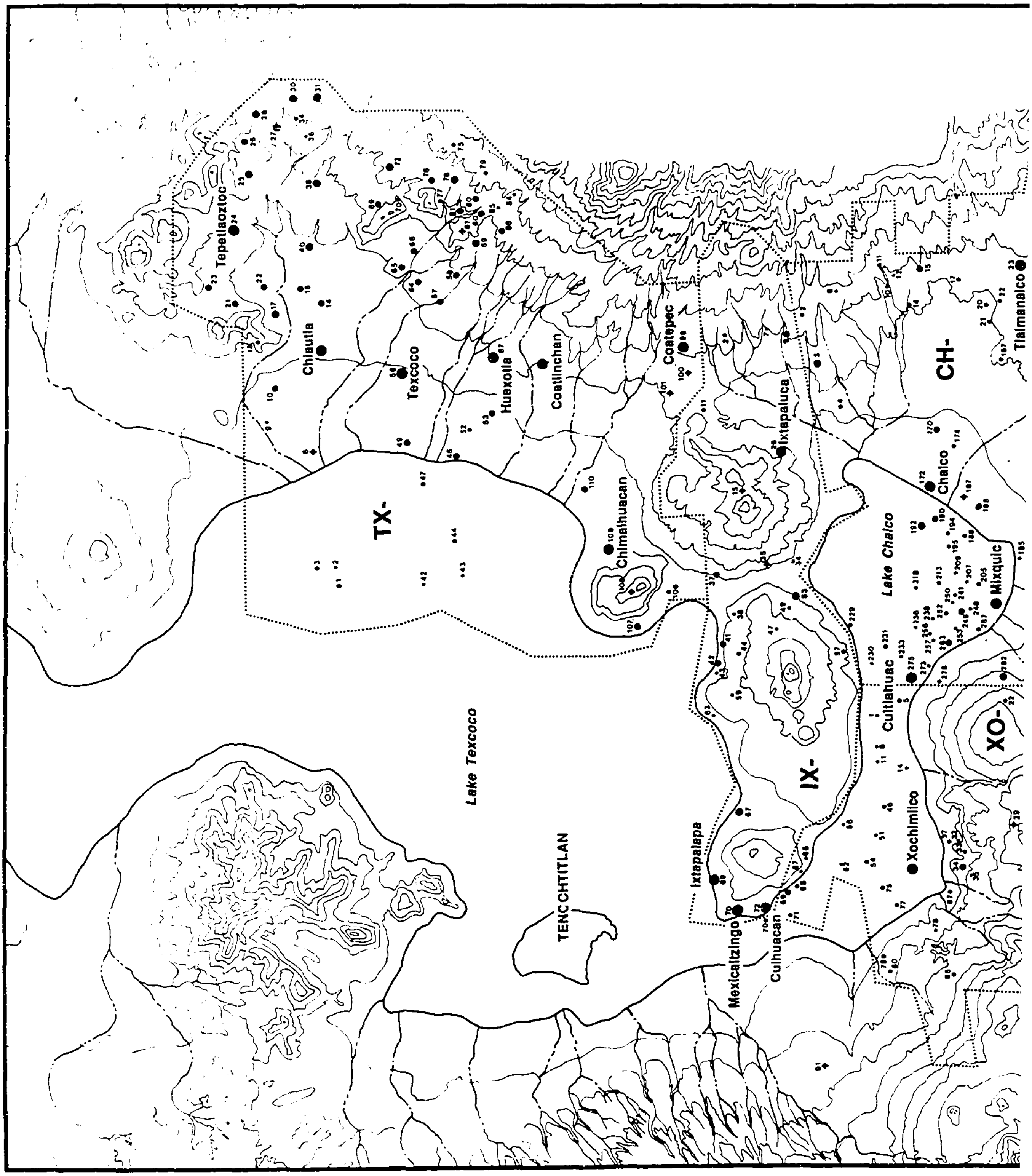
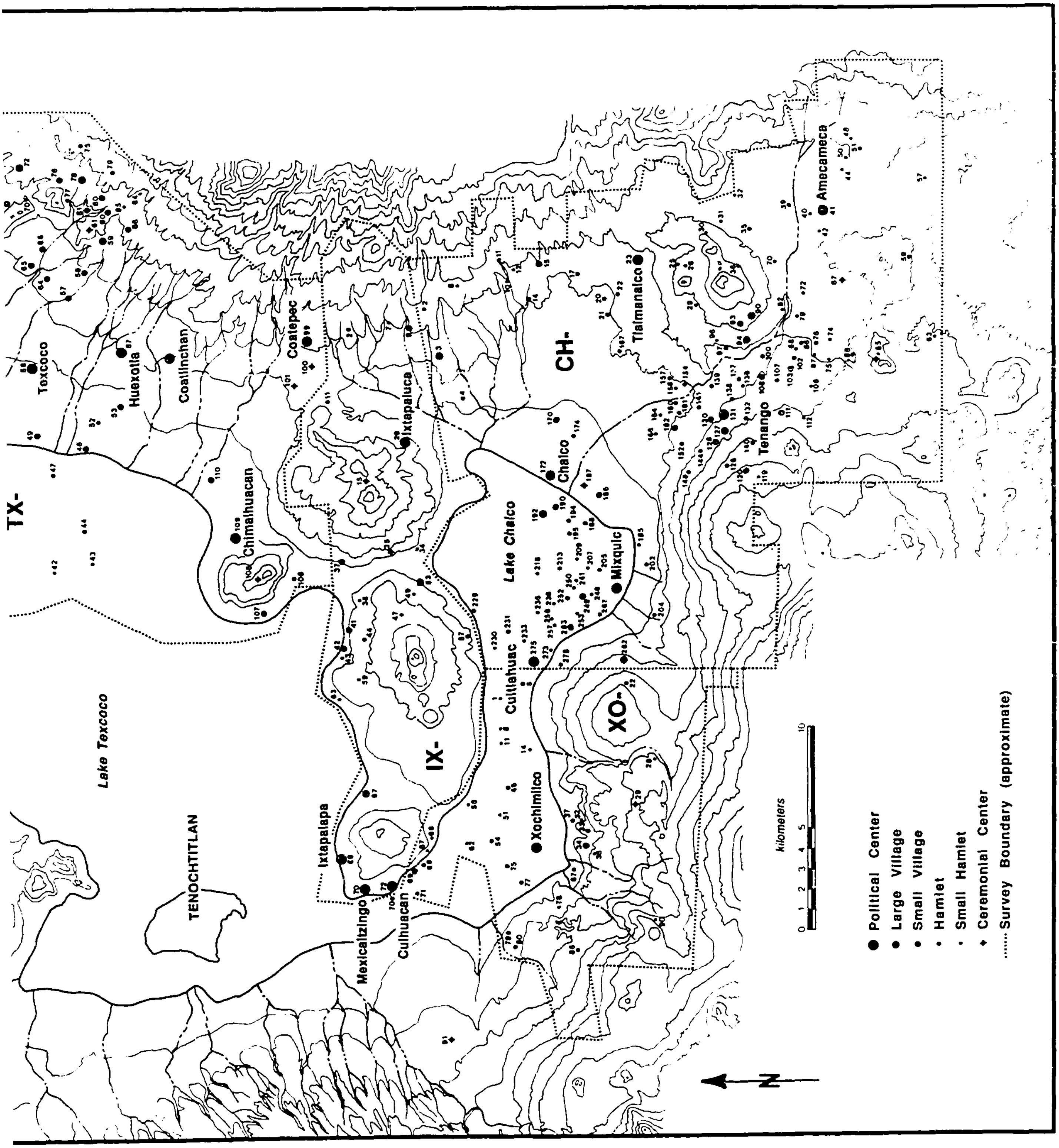


Figure 6.1. Map of study area showing survey zone divisions and sites included in this study.



g survey zone divisions and sites included in this study.

information on civic-ceremonial structures -- mounds or architectural remains -- and from these Aztec sites were divided into site class ranks. Site ranks included in this study are Supraregional Centers (i.e. the Triple Alliance capitals), Regional Centers, Large Villages, Small Villages, Hamlets, Small Hamlets, and Ceremonial Centers.[1]

Of the two Supraregional Centers, Texcoco is included in our archaeological data base, but Tenochtitlan is not, since it is located outside the boundaries of the survey regions included in this study. However, the study area includes portions of both Tenochtitlan's and Texcoco's hinterlands. In addition, 17 Regional Centers, known from documents to have been either city-state capitals or administrative centers, were within the study area. Villages and hamlets were political dependencies of the nearest center.[2]

Political Geography

The designated study area also represents an area for which specific information on political divisions and political history is now available. The major features of Aztec political geography as these relate to the study are summarized below.

Pre-Imperial Political Geography

During the Early Aztec period, the Valley of Mexico was divided among a number of independent (and often conflicting) city-state polities (Bray 1972; Hodge 1984). Groups of these polities formed alliances or confederations for purposes of mutual defense or military campaigns (*Anales de Cuauhtitlan* 1938, 1945; Chimalpahin 1965; Durán 1967; Alva Ixtlilxochitl 1975-77). The combined documentary accounts and the archaeological settlement data for the Early Aztec period suggest that city-state territories were relatively stable and discrete entities throughout this period, while confederation boundaries appear to have shifted more radically with the winds of political expansion or defeat.

The eastern and southern portions of the Valley that form our study area contained at least 14 city-states during the Early Aztec period (Fig. 6.2). The territorial boundaries for these city-states have been reconstructed utilizing the methodology

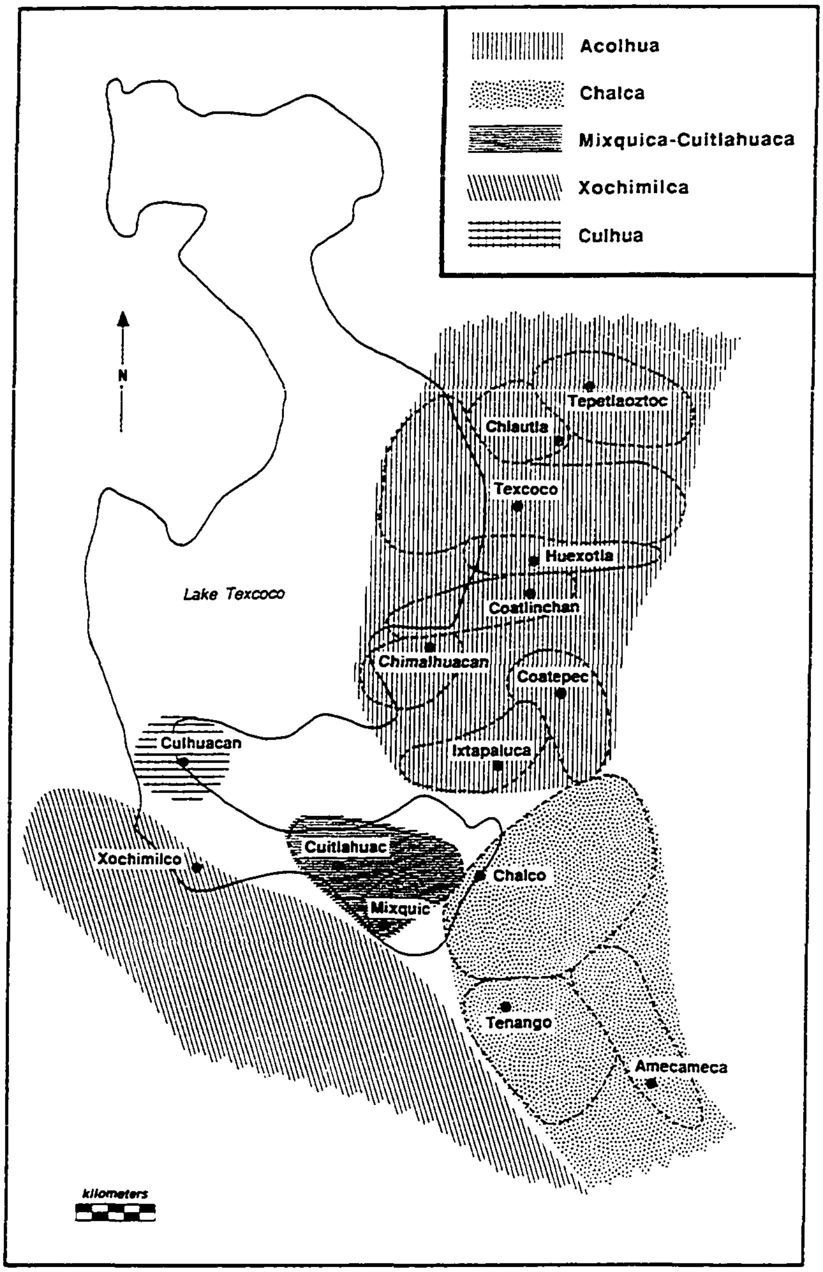


Figure 6.2. Early Aztec political divisions within the eastern and southern portions of the Valley of Mexico.

described by Hodge (Hodge and Minc 1990:422; Hodge 1994a). Briefly, city-state territories were approximated from the geographic spread of historically-identified dependencies clustered around each city-state's center (Hodge and Minc 1990:422). For the Early Aztec period, the territorial extent of each city-state was then reduced to conform with the distribution of archaeologically identified sites occupied during the Early Aztec period.

In the southwestern portion of the Valley, the major Early Aztec political centers were Culhuacan and Xochimilco. Reputedly among the original migrants into the Valley, the Culhua of Culhuacan claimed to have controlled a large territory encompassing much of the southern lakebed during the period of Toltec hegemony (Zimmermann 1960:29; Davies 1980:23).[3] Culhuacan continued to be an influential center in the Early Aztec period, but it is difficult to reconstruct Culhua political territory for this period. Gibson (1964:11) suggests that by the mid-1300s the principal Culhua communities included (in addition to Culhuacan) only the nearby centers of Ixtapalapa, Mexicaltzingo, and Huitzilopocho, indicating that Culhua territory had contracted considerably to a core area surrounding Culhuacan. Since both documentary and archaeological data on Culhuacan's territorial extent are limited for the Early Aztec period, Culhua territory is conservatively reconstructed for this study as a small territory on the western end of the Ixtapalapa Peninsula.

South of Culhuacan, Xochimilco and the Xochimilca confederation controlled a large territory throughout Early Aztec times, much of which extended south of our study area (Parsons et al. 1982:76-78). Xochimilco unfortunately remains a virtually unknown polity in our archaeological study, since very few Early Aztec ceramic collections exist from its territory.

The major Early Aztec political entities occupying the southeastern corner of the Valley were the city-states of the Chalco confederation. Of these, Chalco, Tenango, and

Amecameca fall within our study area (Chimalpahin 1965; Schroeder 1991). Two small buffer states, Mixquic and Cuitlahuac, were sandwiched between the stronger forces of the Chalca, Xochimilca, and Culhua polities. These small states often shared the same fate in the expansionist campaigns of their neighbors (*Anales de Cuauhtitlan* 1945:61-62; Gibson 1964:12), and are claimed in documentary accounts as dependencies of the larger political confederations (*Anales de Cuauhtitlan* 1945:23; Durán 1967:22; Alva Ixtlilxochitl 1975-77, I:310, 329; Parsons et al. 1982).

To the north, spread along the piedmont east of Lake Texcoco were the Acolhua polities. The principal Early Aztec Acolhua city-state centers within the study area include Huexotla, Coatlinchan, Texcoco, Chiautla, and Tepetlaoztoc (Alva Ixtlilxochitl 1975-77; J. Parsons 1971; Offner 1983). South of these, the Acolhua city-states of Chimalhuacan, Coatepec, and Ixtapaluca occupied a buffer zone with the Chalca confederation farther south. Although some sources report that this area fell under Chalca confederation control in the mid-14th century along with the entire Ixtapalapa Peninsula (*Anales de Cuauhtitlan* 1945:29; Parsons et al. 1982:81), Chalcan control of this area appears to have been brief. In imperial times, these border polities were clearly part of the Acolhua state. The sparse population and lack of extended suburban areas in this zone are archaeological confirmation of this area's role as a border zone (J. Parsons 1971:229-230; Alden 1979).

Imperial Consolidation and Political Geography

The Late Aztec period (A.D. 1350-1520) represents a period of increasing political centralization. First Azcapotzalco, a city-state of the Tepaneca confederation, conquered much of the Valley beginning in the 1370s (Gibson 1964:16-17; Brumfiel 1983; Marcus 1992). In A.D. 1428, city-state dependencies of Azcapotzalco joined together and overthrew the Tepaneca empire. The emergent political organization, known as the Triple Alliance of Tenochtitlan, Texcoco, and Tlacopan, soon controlled all politics in the Valley through political alliances or conquests.

Within the study area, Triple Alliance conquests represent three distinct phases of incorporation into the empire. City-states within the Acolhua federation, subdued and divided by Tepaneca, were quickly regrouped and consolidated under Texcoco, with assistance from Tenochtitlan.

Political control over the southwestern corner of the Valley was also consolidated early in Triple Alliance history, but under Mexica (Tenochca) control. The polities of Mixquic and Cuitlahuac were among the earliest tribute prizes of the Mexica (ca. 1403) while under Tepanec dominance, and these polities were conquered again (along with Culhuacan and Xochimilco) by Tenochtitlan in 1428.

In contrast, the Chalco region was not brought into the Triple Alliance empire until much later. During the late 14th and early 15th centuries, a state of formal war or *xochiyaotl* (lit. "flowery war") existed between the Chalca and the Mexica. Chalco was finally conquered by Motecuhzoma I and brought into the imperial fold in 1465; however, a history of its tributes to the Mexica indicate that it was not held firmly until the reign of Motecuhzoma II (ca. A.D. 1502-1520) (Gibson 1964:15).

By 1465, political control within the Valley was divided among the Triple Alliance capitals, with the NE under Texcocan (Acolhua) control, the NW under the remnants of the Tepaneca at Tlacopan, and the south under the Mexica of Tenochtitlan. According to that division, political control over the portion of the Valley under consideration in this study was divided between Tenochtitlan and Texcoco (Fig. 6.3). The northeastern portion, corresponding to the Texcoco Survey Region, remained under Texcocan control. In contrast, much of the Ixtapalapa, Chalco, and Xochimilco Survey Regions came under Tenochtitlan's control.

Although the exact boundary dividing areas of Acolhua and Mexica control is unclear, the general extent of their control can be reconstructed. Based on the distribution of communities paying tribute in goods, Texcocan control extended as far south as

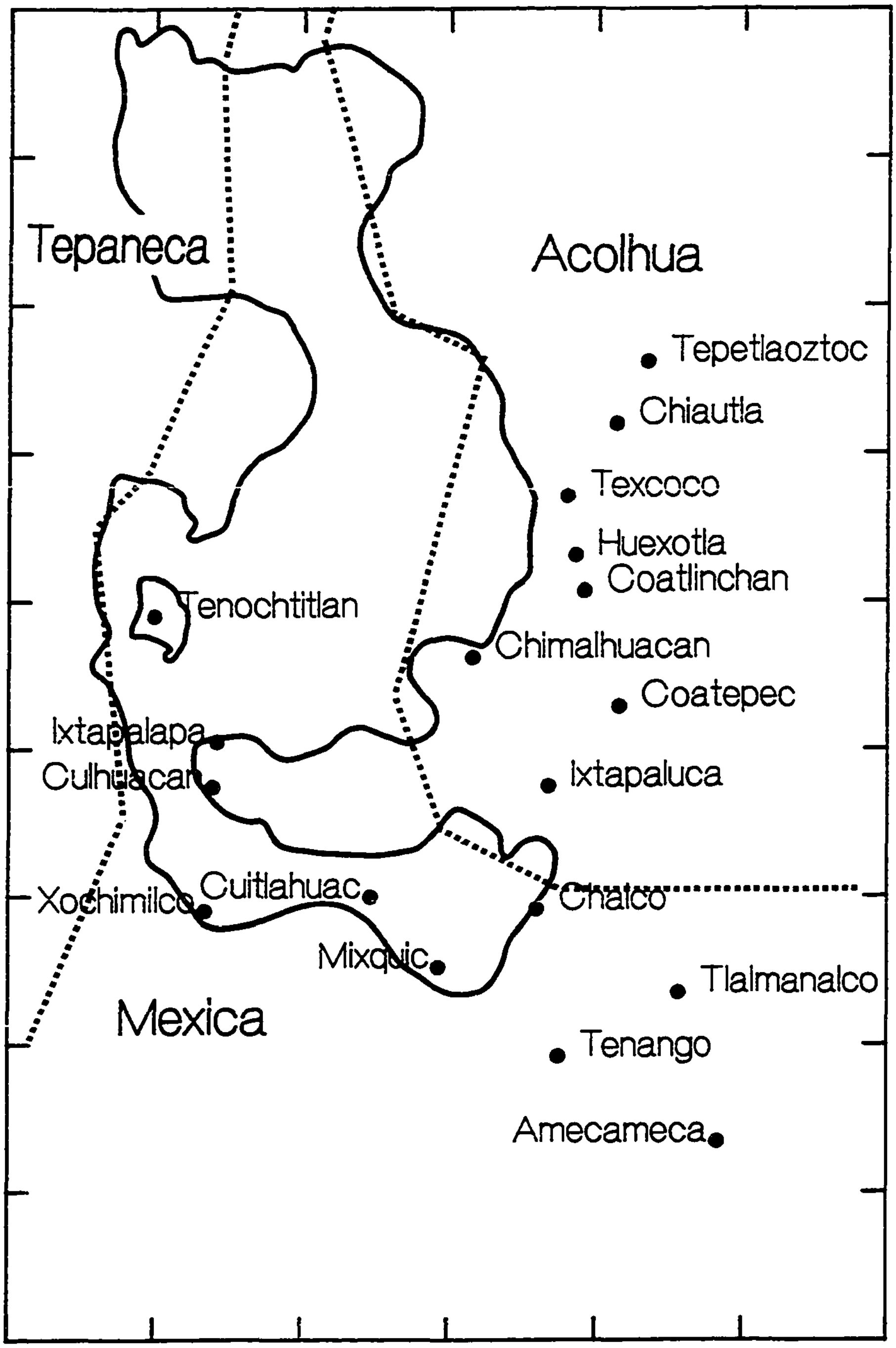


Figure 6.3. Late Aztec political divisions within the Valley of Mexico (after Gibson 1964:14, Map 2).

Coatepec and Ixtapaluca (Alva Ixtlilxochitl 1975-77, II:89-90). Texcoco received tribute payments from this area from the outset of Triple Alliance history and maintained control until the Spanish conquest (Gibson 1971:384). However, based on the distribution of towns owing labor service (*repartimiento*) to Texcoco, Texcocan control (in some form) also extended over Chalco as well (Gibson 1956). Cortés' comment (cited in Gibson 1964:15) that Tlalmanalco was the frontier between the Chalca and the Acolhua further indicates that Texcocan control may have extended somewhat farther south along the piedmont than indicated by tribute lists. Territories south and west of this line paid tribute to Tenochtitlan.

The Ceramic Data Base

The impact of imperial consolidation on production and exchange systems was examined from the perspective of Aztec decorated ceramics, particularly Aztec Red wares. Ceramics are an appropriate medium through which to monitor changes in the organization of commodity production and exchange for several reasons. Ceramics are comparatively well preserved and represent one of the most ubiquitous artifact classes encountered in archaeological studies (Feinman 1980:164; Blanton et al. 1982:182). Further, clays suitable for ceramic manufacture are widespread in the Valley, in both lacustrine and piedmont riverine locales (Branstetter-Hardesty 1978:19). Since ceramic production was not constrained by the differential distribution of clay resources, it is likely that the size and location of ceramic production loci reflect economic and political (rather than ecological) constraints on commodity production (Feinman 1980:164).

More importantly, however, ceramics are one of the few media permitting a realistic synthesis of chronological and economic information (Peacock 1982:1). That is, their stylistic and technical attributes reflect both temporal trends and socioeconomic factors. Ceramics can be dated directly from their stylistic attributes (within coarse limits) and thus the analyst is not always dependent on context to provide chronological information. But stylistic and technical attributes can also reflect variability in skill, standardization, and labor investment -- dimensions that can be brought to bear on questions concerning the organization and context of production. In addition, ceramics lend themselves to geochemical studies of provenience, enabling us to track their centers of production and patterns of dispersion with fair accuracy.

Aztec Decorated Ceramic Typology in the Valley of Mexico

Aztec decorated ceramics are currently classified according to three hierarchical categories: (1) wares, (2) types, and (3) decorative variants and subvariants.

Wares are distinguished on the basis of general uniformity of paste and modal surface color and finish (J. Parsons 1966). For the Aztec period, three major wares have been identified (Whalen and Parsons 1982:440-455): (1) Orange ware, characterized by a buff to natural paste and burnished but unslipped orange surface; (2) Red ware, identified by its red-slipped surfaces; and (3) Polychrome, distinguished by basal white or gray slip overlain with geometric designs executed in orange, red, brown, and black paint, and a buff or natural paste (Fig. 6.4).

Types are distinguished within each ware according to basic decorative traditions, including the presence and type of paint, incising, and specific motifs. The predominant decorated types of Orange ware are Black/Orange, all of which are decorated with black painted designs. Common Red ware types are Black/Red and Black-and-White/Red, in which the basal red slip is overlain with black or black-and-white painted motifs, respectively. Black/Red-Incised bears incised motifs in addition to those applied in black paint.

Aztec ceramic types are often combined with vessel forms to create single **type-shape** units. Within decorated Orange wares, the most common vessel forms are bowls, plates, dishes, *molcajetes* (grater bowls), and basins; the most prevalent Red ware

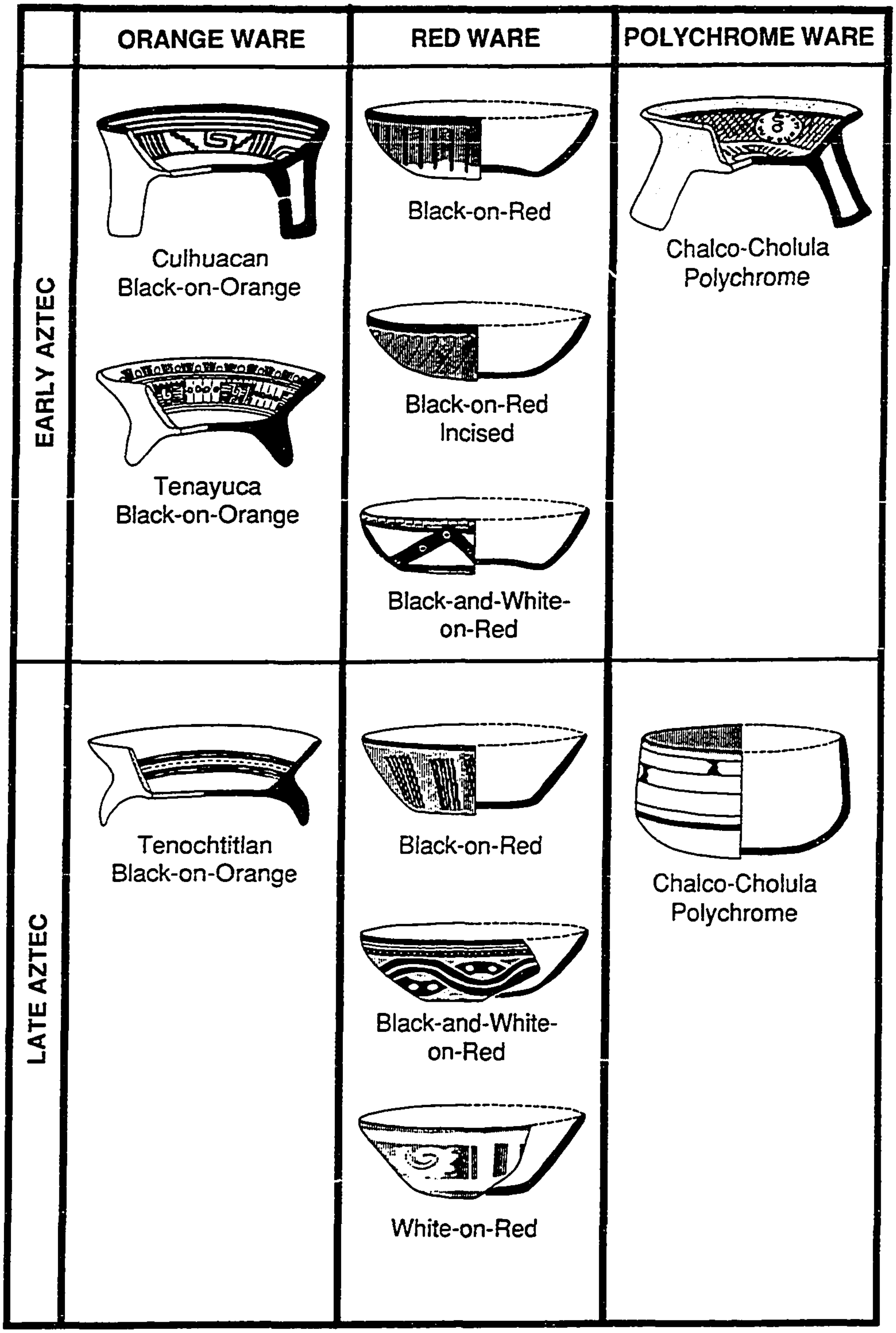


Figure 6.4. Examples of decorated Aztec ceramic wares and types, with typical vessel forms (from Hodge and Minc 1990:Fig. 3).

forms include bowls, *copas* (goblets), basins, and plates. Polychrome decoration is most frequently found on bowl, dish, and plate forms.

Decorative variants are yet a more detailed category within each type-shape class. Variants are defined on the basis of specific decorative patterns such as consistencies in the choice and execution of design motifs and in the spatial organization of the design (see Noguera 1930; Franco and Peterson 1957; J. Parsons 1966; Hodge and Minc 1991). **Subvariants** represent finer stylistic distinctions within a decorative variant.

Among the major decorated Aztec ceramic wares -- Orange, Red, and Polychrome -- types and stylistic variants have been defined by prior studies, based on data from both excavations and surveys (Noguera 1930, 1935; Brenner 1931; Vaillant 1938, 1941; Griffin and Espejo 1947, 1950; Franco 1945, 1947, 1957; Franco and Peterson 1957; Tolstoy 1958; O'Neill 1953-54, 1962; J. Parsons 1966, 1971; Sanders, Parsons, and Santley 1979; Whalen and Parsons 1982). These classifications were developed with a concern for establishing a regional chronology, and therefore often emphasized uniform characteristics of the ceramics in order to fit widely-distributed sites into comparable temporal units. The past emphasis on defining clear-cut chronological periods, however, has tended to lump a considerable range of stylistic variability into a single type. In contrast, this study concentrated on identifying meaningful stylistic and formal variability within Early and Late Aztec ceramics -- variability which is synchronic in nature and thus can be used to identify the spatial extent of exchange systems.

Existing Ceramic Chronologies

Existing Aztec ceramic chronologies rely heavily on the Black/Orange variants. The definition and relative order of these ceramics is based on a long history of detailed stratigraphic and stylistic analyses (Boas 1912; Gamio 1913; Brenner 1931; Noguera 1935; Vaillant 1939, 1941; Franco 1945, 1947; Griffin and Espejo 1947, 1950; Franco and Peterson 1957; J. Parsons 1966). Initially, Black/Orange ceramics were divided into four sequential phases (I, II, III, and IV) and assigned the phase names of Culhuacan, Tenayuca, Tenochtitlan, and Tlatelolco, respectively, after type sites of the same names.

More recent excavations and surveys have placed these ceramics in two broad temporal periods. Aztec I and II (Culhuacan and Tenayuca phase) Black/Orange ceramics are attributed to the Early Aztec period (ca. A.D. 1150-1350). These distinct styles are now recognized as roughly contemporaneous entities that have different spatial distributions during the Early Aztec period, with Aztec II prevalent in the northern part of the Valley and Aztec I occurring in the south (Whalen and Parsons 1982:438).[4] In contrast, Aztec III (Tenochtitlan phase) Black/Orange ceramics belong to the Late Aztec period (ca. A.D. 1350-1520), while Aztec IV (Tlatelolco phase) marks the end of the prehispanic ceramic tradition. Although some Aztec IV Black/Orange ceramics appear to predate the Spanish conquest, they also continued to be used for some time following European arrival (see Appendix IV, this volume, for discussion).

Absolute dates for the Black/Orange ceramic phases were initially derived from Vaillant's (1938, 1941) correlation of cyclical dumps of ceramics and temple rebuilding activities with ceremonies marking the end of the Aztec "century" of 52 years. Vaillant (1938) believed the dumps were created when dishes were broken in ceremonies honoring the end of each Aztec century, and thus he attempted to associate the Black/Orange ceramics of a specific dump with the calendric dates of a specific New Year ceremony. Subsequent research has suggested more chronological overlap of ceramic types (Sanders, Parsons, and Santley 1979; Parsons et al. 1982), so that archaeologists are most comfortable currently with the larger temporal units represented by the Early Aztec and Late Aztec periods, dating to ca. A.D. 1150-1350 and A.D. 1350-1520, respectively. The Early Aztec and Late Aztec phases parallel the Second Intermediate Phase III and Late Horizon periods, as defined by Sanders, Parsons, and Santley (1979) (Table 6.1).

Table 6.1
Archaeological Chronology for Postclassic Valley of Mexico

Absolute Chronology (A.D.)	Major Archaeological Periods and Phase Names			
	New System[a]		Old System[b]	Ceramic Phase
1500 1400	Late Horizon		Late Aztec/ Late Postclassic	Tlatelolco Tenochtitlan
1300 1200	Second Intermediate	Phase Three	Early Aztec/ Middle Postclassic	Culhuacan/ Tenayuca
1100 1000 900		Phase Two	Late Toltec/ Early Postclassic	Mazapan
800		Phase One	Early Toltec/ Epiclassic	Coyotlatelco

[a]Adapted from Sanders, Parsons, and Santley (1979).

[b]Phase names utilized in this study.

Aztec Red Wares

In contrast with the Black/Orange types, Aztec Red wares have been accorded relatively little importance, for the simple reason that Aztec Red ware chronology has been poorly understood. Although some Red ware variants were known to be early or late, many others remained less clearly assigned. Red ware distributions were also poorly understood. Existing Red ware typologies were developed within the northern and central portions of the Valley (J. Parsons 1966, 1971; Brumfiel 1976). Initial attempts to apply these typologies to the southern Valley immediately revealed strong regional differences.

This project accordingly began with a typological redefinition of Aztec Red wares with two main goals in mind. First, to document geographic variability in Aztec Red ware designs and decorative motifs, and secondly, to elucidate temporal variability in both decorative style and vessel form within this ceramic ware. These typological analyses were followed by quantitative seriations of Red ware types, variants, and subvariants based on surface collections, supplemented with an analysis of published and unpublished excavation data on the relative and absolute chronology of these ceramic units. The details of these typological analyses and seriations are presented in Appendices III and IV, respectively. However, since Red wares will be discussed at length in this study, the basic typological units and chronological distinctions are presented here briefly as well.

Red Ware Typology

Red Ware Types. As noted above, the most common Red ware types are Black/Red (B/R) and Black-and-White/Red (B&W/R), and Black/Red-Incised (B/R-I). Less common Red ware types include Yellow/Red (yellow paint over a red slip), White/Red (white paint over a red slip), Black-and-Yellow/Red (black and yellow paint over a red slip), Black-and-White-and-Yellow/Red (black, white, and yellow paint over a red slip), and Black-and-Red/Tan (black and red designs over a polished tan or buff exterior, with a red-slipped interior). All of these types, with the exception of Black-and-Red/Tan have been previously described in the literature (Tolstoy 1958; J. Parsons 1966, 1971; Brumfiel 1976; Branstetter-Hardesty 1978; Whalen and Parsons 1982).

Red Ware Variants and Subvariants. Stylistic variants and subvariants were defined within the three most common Red ware types (Black/Red, Black&White/Red, and Black/Red-Incised). In general, the definition of variants was based on the organization of design as established by black painted designs, with lesser attention paid to additional white painted or incised motifs. In developing the typological hierarchy, I attempted to follow a logical subdivision of overall design structure such that the variants generally represent distinct organizational frameworks or ways of dividing up the design field, while the subvariants represent modifications of that basic plan.

Much of the Red ware typology is a direct outgrowth of J. Parsons' (1966) earlier ceramic study. However, I have refined Parsons' basic categories where possible to recognize finer and more consistent distinctions in the organization of design. In addition, the need for new stylistic variants became evident as I attempted to apply typological units developed for the northern and central Valley (J. Parsons 1966; Brumfiel 1976) to collections from the southern lakebed region. Definition of a new variant or subvariant reflects consistencies in the organization and placement of decorative fields on the vessel not described in previous typologies. Brief descriptions of the major Red ware typological units are presented in Table 6.2.

Red Ware Vessel Morphology and Paste Characteristics. This study also focused on variability in vessel form and paste characteristics, particularly within the bowl shape-class. Red ware bowls have generally defied clear-cut chronological placement, in part because previous studies have focused exclusively on variability in decorative motifs. This study, in contrast, has found that vessel form and paste change over time, while decorative motifs show a disconcerting degree of continuity from Early Aztec into Late Aztec times. The predominant Early Aztec Red ware vessel form consists of simple rounded bowls with walls ranging from slightly incurving to outcurving, with a gentle basal angle, and flat or slightly dimpled base. Wall thickness is fairly even from lip to base. On these vessels with rounded profiles, the rim may take one of three forms: (1) simple with a rounded, direct lip (**direct**); (2) slightly thickened on the interior wall just below simple, rounded lip (**interior thickened**); or (3) slightly recurved (**recurved**). During Late Aztec times, in contrast, a distinct bowl form, termed "Late Profile", emerged. These vessels have thin, outsloping walls and **exterior thickened** rims that show a slight exterior bulge below the rim above which the lip is thinned. Bases are generally flat and basal angles are sharp.

These distinct early and late vessel forms also have characteristic differences in paste. In the simple rounded bowls, paste ranges from buff to red-brown in color, and frequently contains a gray-to-black medial core. Late Profile bowls have buff surface colors but a dark gray or black medial core that may comprise most of the thickness of the sherd, leaving only a thin veneer of buff paste at the surface. Thin-section analyses (see

Table 6.2
Aztec Red Ware Ceramic Units

Red Ware Bowl Variants

Unit	Brief Description
B/R A	widely spaced thick vertical black lines or solid circles
B/R B	evenly and continuously spaced vertical black lines
B/R C	sets of vertical or oblique black lines, spaced around vessel, equals J. Parsons' (1966) "comb motif"
B/R D	1-3 horizontal black lines above evenly spaced vertical lines
B/R E	grill of thick, vertical bars bounded by thick, horizontal lines
B/R F	characterized by the *xicalcoliuhqui* or "anchored scroll" motif
B/R G	characterized by the *ilhuitl* or lazy-S motif
B/R H	1-3 horizontal lines encircling upper vessel wall below the rim
B/R I	1-3 horizontal lines encircling upper vessel wall at rim
B/R Late A	thin vertical lines evenly spaced around the vessel wall
B/R Late B	groups of vertical or oblique lines spaced around the vessel wall
B/R Late E	curvilinear wing-like and scroll motifs with fine-line hatchure
B/R-I A	panel delimited by black-painted lines bearing incised and painted *xicalcoliuhqui* motif
B/R-I B	panel delimited by black-painted lines bearing incised motif consisting of vertical lines and opposed scrolls
B/R-I C	± black rim band above series of incised, vertical canes; interior black motifs present
B/R-I D	± black rim band above series of incised, vertical scrolls; interior black motifs present
B&W/R AW	large triangular areas delimited by wide diagonal lines
B&W/R AN	large triangular areas delimited by 2 narrow diagonal lines
B&W/R B	horizontal panel divided by vertical black and red spaces
B&W/R C	horizontal panel divided by oblique black and red spaces

Table 6.2
Aztec Red Ware Ceramic Units (continued)

Red Ware Bowl Variants, cont.

Unit	Brief Description
B&W/R D1	horizontal banding in black and red below red rim
B&W/R D2	horizontal panel delimited by black lines and containing complex geometric and curvilinear fine-line white motifs
B&W/R D3	horizontal panel delimited by thick black bands and containing free motifs in black overlain with white
B&W/R E1	horizontal panel delimited by two black bands at and below the rim containing fine black and white motifs
B&W/R E2	two close horizontal black bands at the rim overlain with white motifs
B&W/R E3	horizontal banding in black and red below a black rim
B&W/R F	horizontal panel containing wide-line curvilinear black motifs, including scrolls, spirals, and intertwining cables
B&W/R G	horizontal panel with complex curvilinear and floral motifs below a black rim-band overlain with fine-line white *zacate*

Red Ware Basin Variants

Unit	Brief Description
B/R A	2-4 horizontal lines at rim above sets of vertical lines
B/R B	horizontal panel containing lazy-S's above sets of vertical lines

Red Ware Copa Variants

Unit	Brief Description
B/R A	thick vertical lines extend from neck to rim
B/R B	sets of parallel horizontal lines encircle cup
B/R C	bears the "*espumoso*" or foamy motif, consisting of concentric inverted U's surrounded by a row of radiant tick marks
B/R D	bears a bounded grill similar to B/R Bowl Variant E
B&W/R	no variants defined; thick vertical black and white bars

Table 6.2
Aztec Red Ware Ceramic Units (continued)

Miscellaneous Red Ware Types

Unit	Brief Description
Yellow/Red	yellow-orange painted designs overlying a white underslip, on a deep red exterior slip
B&W&Y/Red	exterior curvilinear and geometric designs in black, white, and yellow over a red basal slip
White/Red	complex fine-line designs in chalky-white paint over a red slip
Black&Red/ Tan	large red and black circles painted on a polished buff exterior; red-slipped interior

Note: For more complete descriptions and illustrations see Appendix III.

Appendix V) show a pronounced decrease in the size and quantity of aplastic inclusions between Early Aztec and Late Aztec Red Wares, and confirm the characterization of Late Profile bowls as having a significantly finer paste. Because of these differences associated with vessel profile, I have cross-tabulated all Red ware sherds by both design variant and rim form.

The revised Aztec Red ware ceramic typology is described in detail and illustrated in Appendix III. The categories defined in the appendix are those which are examined geographically throughout the study region to determine regional patterns of exchange and through INA analyses to determine regional patterns in the organization of ceramic production.

Red Ware Chronology

Two distinct quantitative approaches were utilized to seriate Red wares based on surface collections from the Chalco, Xochimilco, and Ixtapaluca survey regions (for details on these analyses, see Appendix IV).[5] First, an indirect seriation attempted to assess the chronological placement of Red ware types and variants relative to the better-known and more widely distributed Black/Orange and polychrome components. In this seriation, individual collections were first dated according to their constituent Black/Orange and polychrome components and then grouped to represent four chronological periods. These were (1) an Aztec I/II or Early Aztec period; (2) a transitional Aztec I/II-III period; (3) an Aztec III or Late Aztec period; and (4) an Aztec III/IV or Contact period.

The chronological placement of Red ware types and variants relative to these dated collections was then assessed using a goodness-of-fit chi-square test to determine whether the ceramic type or variant had a significantly non-uniform distribution relative to the dated collections. It was anticipated that if a type or variant was not temporally sensitive, that is, if it was not associated with a specific chronological period, it would display a statistically uniform or near uniform distribution across the dated collections. Conversely, if a type or variant dated to a particular chronological period, significant departures from the expected uniform pattern could be expected. Positive and negative associations with a chronological period were summarized using standardized chi-square residuals for each type and/or variant across the dated collections. These residuals represent departures from the expected frequencies in standard deviations and reflect the strength of the positive or negative association of a type or variant with a particular chronological period.

A second seriation of Red ware types and variants was produced through direct comparison of these types against each other, based on their co-occurrence in surface collections. The assumption underlying this approach is that types or variants of the same date are more likely to co-occur than are those of different date. The degree of co-occurrence between any two types or variants was quantified using the Jaccard co-efficient, a similarity measure that counts only positive matches (co-presence) of types and/or variants. Temporal relationships among Red ware types and variants were then examined using non-metric multi-dimensional scaling (MDS). This methodology maps out the degree of co-occurrence among types and variants in terms of relative spatial proximity in a reduced dimensional space (Kendall 1971; Kruskal and Wish 1983; Marquardt 1978). In the resulting plot of the primary dimensions, types and variants of similar chronological placement are assumed to be located closer to each other than to ceramics of either an earlier or later date.

In general, these two seriations are in strong agreement and have provided clear indications of the temporal placement of Aztec Red ware types and variants, as well as vessel forms. Two major conclusions can be drawn from these analyses. First, the standardized residuals analysis for the Red ware types and rim forms (see Table IV.6) confirmed that vessel form provides a chronologically sensitive indicator. Recurved, interior thickened, and direct rim forms for all types show positive associations with the Aztec I/II and/or Aztec I/II-III collections. In sharp contrast, exterior thickened bowls show strong positive associations with the Aztec III and III/IV collections, thereby confirming the label of "Late Profile". Based on these results, it appears justifiable to make a typological distinction between an earlier bowl form (with either a recurved, interior thickened, or direct rim) and a late form characterized by an exteriorally thickened rim and "Late Profile". This does not, however, imply a strict correspondence between profile and date: although all exterior thickened rims are late, not all direct rims are early. In particular, Black/Red Variant C (the predominant late variant in the north) securely dates to the Late Aztec period, but consistently occurs on an early form.

A second major finding was the high degree of stylistic continuity through time. Many stylistic variants are found on the full range of early and late bowl forms, although some new design structures and motifs emerge and some drop out of the sequence. However, once the distinction in vessel form has been made, most stylistic variant-bowl form combinations can be ordered chronologically.

Relatively few variants could not be satisfactorily placed in the chronological sequence. For the most part, these are low frequency variants (such as Black/Red F, Black&White/Red C2 and F) or forms (e.g. Black/Red Basins). In the case of two well-represented bowl variants, however, Black/Red H and I, the poor placement may indicate that these variants experienced a longer-lived popularity or use-period.

The relative placement of all Red ware variants is presented in Table 6.3. This four-fold chronological division potentially permits a more fine-grained diachronic analysis of economic processes in the Valley of Mexico than has previously been possible. However, the limited sample sizes for some temporal units required that these finer ceramic phases be recombined for the purposes of this study into the traditional Early Aztec and Late Aztec periods. In this case, the Early Aztec and Transitional phases represent the Early Aztec period, while the Late Aztec and Contact phases represent the Late Aztec period.

Description of the Data Base

Sample of Aztec Sites

The Aztec Red ware ceramic collections analyzed in this study were generated by regional archaeological surveys within the Texcoco, Ixtapalapa, and Chalco-Xochimilco survey regions, comprising the eastern and southern portions of the Valley of Mexico (Fig. 6.1). Of the large number of Aztec sites located and mapped by survey teams, a sample of 243 Aztec period sites were included in this study. Sites were selected for this study if they yielded ceramic samples large enough to be useful in quantitative analyses. Choice of specific sites was also guided by the necessity of obtaining representative geographic coverage and a balanced sample of Early and Late Aztec period sites. The sites included in the study along with their location, site type, size, and population, are listed in Appendix I, Table I.1.

Table 6.3
Chronological Phasing of Aztec Red Ware Ceramics

Ceramic Unit	Aztec I/II Early Aztec	Aztec I/II-III Transitional	Aztec III Late Aztec	Aztec III/IV Contact
Black/Red-Incised	Variants B, C, & D Variant A ------------			
Black/Red	Variants A & B Plain Red Copas ------	Variants D, E, F, G, H, & I Basins -------------- Copa D --------	Variant C Late Profile Bowls A, B, & E ----------- Copa A & C -----	Copa B ------
Black&White/ Red	Variants AW, AN, D3, E1, E2, & E4	Variants B, C1, D1, D2, E3 Early Variant C2 ------? Early Variant F -------?	Variant G All Late Profile Bowls	Late Profile Bowls B, C, & F
Miscellaneous Red Types			Yellow/Red, White/Red, Black&White&Yellow/Red, Black&Red/Tan	

Note: Type and variant designations refer to bowls unless otherwise specified.

Overall, the sample of 243 sites represents 43% of all Aztec sites in the study region. However, site representation varies somewhat by survey region (Table 6.4). The lower percentage of Aztec sites represented in survey regions south of Texcoco is partially due to the lack of available collections from sites located in these areas. In the IX-, CH-, and XO- survey regions, many Late Aztec-period sites were not surface-collected by survey teams if the sites appeared to be purely of Late Aztec date. Also, site formation processes appear to have been different between these areas, resulting in fewer but more extensive sites in the Texcoco region, and a greater number of more aggregated sites farther south. The more extensive character of sites in the Texcoco region is reflected in the higher average number of collections per site there, since survey crews made a larger number of collections in sites spread over larger areas. For a concordance of sites and collections included in the study, see Appendix I, Table I.2.

Table 6.4.
Distribution by Survey Region of Total Sites and Sites Sampled

Region	Sites			Collections	
	Total	Sampled	% of Region	Total	Ave./Site
Texcoco	110	63	57%	248	3.9
Ixtapaluca	75	24	32%	44	1.8
Chalco	287	123	43%	205	1.7
Xochimilco	91	33	36%	38	1.2

The distribution of sampled sites by date and environmental zone is presented in Table 6.5. These figures indicate that coverage of settlements in all zones is adequate for the Early Aztec period, with percentages ranging from 63-86% of sites in a given zone. Coverage is less complete for the Late Aztec period, especially for the lakebed (*chinampa*) zone. Only 26% of Late Aztec sites in the Chalco-Xochimilco lakebed were included in this analysis, whereas 40% or more of Late Aztec sites in other zones are represented.

The distribution of sampled sites by date and site type (level of political hierarchy) reveals a similar problem (Table 6.6). Coverage of all site types is good for the Early Aztec period. For the Late Aztec period, coverage is good for the larger sites, but somewhat poor for the smallest settlement type, that of small hamlets. Again, the problem primarily affects coverage of the *chinampa* zone, where small, single phase sites were not as consistently surface-collected during field surveys.

Table 6.5
Aztec Sites Sampled by Region and Environmental Zone

A. Early Aztec

Environmental Zone[a]	Survey Region[b]			All Regions	
	TX	IX	CH-XO	#	%
Lakebed	0/0	1/1	19/30	20/31	64
Lakeshore Plain	12/12	3/3	10/14	25/29	86
Lower Piedmont	23/30	5/12	46/58	74/100	74
Upper Piedmont	9/13	0/3	8/11	17/27	63
High Valley (Amecameca)	--	--	7/9	7/9	78
Total	44/55	9/19	90/122	143/196	73

B. Late Aztec

Environmental Zone[a]	Survey Region[b]			All Regions	
	TX	IX	CH-XO	#	%
Lakebed	0/2	1/2	37/141	38/145	26
Lakeshore Plain	19/30	12/21	13/26	44/77	57
Lower Piedmont	30/50	10/42	65/130	104/222	47
Upper Piedmont	14/26	1/9	15/37	30/72	42
High Valley (Amecameca)	--	--	12/25	12/25	48
Total	63/108	24/74	142/359	229/541	42

[a]Data on site distribution relative to environmental zone from Parsons et al. (1983).

[b]Paired numbers indicate the number of sites included in this study out of the total number of sites recorded for that category.

Table 6.6
Aztec Sites Sampled by Region and Site Hierarchy

A. Early Aztec

Site Hierarchy	Survey Region			All Regions	
	TX	IX	CH-XO	#	%
Political Center	5/6	3/3	4/6	12/15	80
Large Village	10/11	0/0	3/4	13/15	87
Small Village	16/19	0/2	17/18	33/39	85
Hamlet	8/12	3/4	34/44	45/60	75
Small Hamlet	3/4	2/7	30/48	35/59	59
Ceremonial	2/3	1/3	2/2	5/8	62
Other (Temporary)	--	--	--	--	--
Total	44/55	9/19	90/122	143/196	73

B. Late Aztec

Site Hierarchy	Survey Region			All Regions	
	TX	IX	CH-XO	#	%
Political Center	5/6	4/4	5/7	14/17	82
Large Village	10/11	2/2	5/8	17/21	81
Small Village	24/29	2/8	15/17	41/54	76
Hamlet	12/35	8/13	53/91	73/139	52
Small Hamlet	7/13	6/39	59/226	72/278	26
Ceremonial	5/11	2/7	5/10	12/28	43
Other (Temporary)	0/3	0/1	0/0	0/4	0
Total	63/108	24/74	142/359	229/541	42

Note: Paired numbers indicate the number of sites included in this study out of the total number of sites recorded for that category.

The Ceramic Collections

The Valley of Mexico survey crews employed a relatively consistent and uniform method in gathering the surface collections utilized in this study (J. Parsons 1971:18-19; Parsons et al. 1982:67; Sanders, Parsons, and Santley 1979:27-29). After a site had been located and the extent of surface scatter mapped, the survey teams demarcated one or more collection areas within the site boundaries. Survey members then picked up 100% of the diagnostic sherds, including all rims and chronologically significant body sherds from this area.

The survey teams' purpose was to collect samples sufficient for determining the temporal placement of each site, thus collections tended to focus on areas with good visibility and higher artifact densities. Collection area sizes ranged from a 10 m. diameter circle to several thousand square meters if an architectural unit was used to designate collection area boundaries. At small sites, a single collection area was the rule; at larger sites, several collections areas were designated to ensure chronological control over the entire site. As a result, numbers of collections per site vary from 1 at small sites to 45 at large sites that had extensive areas of prehispanic settlement still exposed. The number of decorated sherds collected per site ranged from 10 to more than 3000.

The ceramic samples represent a standard collection procedure in all areas. The collection method employed nevertheless contains several possible sources of bias. First, the collection areas may not be representative of the ceramic assemblages of an entire site. Second, the size of samples varies depending upon the number of diagnostic sherds available and the density of ceramics at each site. For this analysis, several strategies were used to offset possible biases introduced by the collection procedures. These include (1) restricting the analysis to the best-represented and best-known types or variants; (2) focusing on regional patterns to minimize local sampling bias; and (3) where possible using relative measures (such as percentages or densities), as opposed to raw counts, as the basis of comparison.

Another factor affecting results of this study is the state of preservation of materials in these collections. Due to differences in ground water and soil chemistry and in modern land-use, the condition of sherds varies from area to area. In many cases, the paint is well-preserved and decorative motifs can be seen clearly. In other cases where sherds are more eroded (the case in many upper piedmont sites) or salt-encrusted (as at some sites on the lakebed), sherds could be identified only as to ceramic type and sometimes only by ware. While the percentage of sherds that could be identified is very low in a few areas, the surface collections are quite well preserved overall compared to collections recovered in other parts of central Mexico (Michael Smith, personal communication). Most of the collections provided identifiable sherds in quantities sufficient for qualitative and quantitative analyses.

In the intervening time since the surface surveys, the collections from sites in the Chalco, Xochimilco, Ixtapalapa, and Texcoco survey regions have been preserved in a warehouse in Mexico by Jeffrey R. Parsons of the University of Michigan, with permission from the Instituto Nacional de Antropología e Historia. These collections are of continuing importance to archaeological research because of the survey's comprehensive, regional coverage and because they constitute our sole source of information on many sites now lost to urban growth. Thus, although the Valley of Mexico survey data may present challenges for quantitative analyses, these data are currently, and are likely to remain, our best source of information for studies on a regional scale in the Valley.

Organization of Analyses

The regional survey surface collections yielded two distinct ceramic data sets for this study. First, the regional surveys provided data on the spatial distributions of different stylistic types and variants that were used to map exchange interactions and to reconstruct the organization of the regional market system through which these ceramics were distributed.

Second, sherds from the survey collections were sampled for INA analyses of the trace element composition of ceramic pastes, and these data were used to characterize changes in the regional organization of Red ware ceramic production through time. A total of 252 Red ware bowls and basins selected from the regional survey collections were analyzed for trace-element concentrations.

Because these data sets are directed at answering different questions, require different methodologies, and provide distinctive challenges for quantitative approaches, the analyses are presented in separate chapters. The spatial analyses are presented in Chapter 7, while analyses of the INA data are summarized in Chapter 8 (see also Appendix V). More detailed information on the nature, quality, and appropriateness of the data sets for those analyses is reserved for those chapters.

Notes to Chapter 6

[1]Another category, "Ethnohistoric Sites," are sites known from documents; they were not surveyed nor were collections made, because they are covered by modern towns.

[2]These analyses, like any based on the Valley of Mexico survey data, take into account the fact that much information about Aztec urban centers is not included. Nonetheless, some urban centers in our study yielded samples of decorated ceramics large enough to provide information representative of some urban settings.

[3]Chimalpahin (1958:3,5) reports that in the seventh and ninth centuries the Culhuaque controlled a large territory encompassing the centers of Xochimilco, Cuitlahuac, Mixquic, Coyoacan, Malinalco, and Ocuilan. Durán (1967: v. 1:22), however, indicates that the Xochimilca were the more powerful and included in their territory Culhuacan as well as Cuitlahuac and Mixquic. By the early 1200s, Culhuacan's power was definitely on the wane and other polities encroached on the Culhua realm. The Chalca laid claim to Cuitlahuac in ca. 1233 (*Anales de Cuauhtitlan* 1945:17-18), and in 1239-40 the Culhua had to fend off the threat of the Xochimilca (*Anales de Cuauhtitlan* 1945:22). In 1253, Culhuacan was conquered by the ruler of Coatlinchan and brought into the Acolhua confederation (Davies 1980:28).

[4]The relative temporal order of Aztec I and II Black/Orange ceramics, as well as their absolute chronology, continues to be debated, however. For example, several series of radiocarbon dates recently reported by Parsons et al. (1993) indicate that the beginning date for Aztec I Black/Orange may have varied within the Valley, and that in some areas its inception may significantly predate the traditional starting date for the Early Aztec period of A.D. 1150. For further discussion, see Appendix IV.

[5]Collections from the Texcoco region revealed a substantially higher degree of chronological mixture, and thus were unsuitable for seriation purposes.

CHAPTER 7

RECONSTRUCTING MARKET SYSTEM ORGANIZATION FROM PATTERNS OF DECORATED CERAMIC EXCHANGE

Goals of Analysis

This chapter examines regional patterns of ceramic distribution as a basis for reconstructing the major organizational features of the market system (through which these and other commodities circulated) before and after consolidation of the Aztec empire. Based on the distributions of Early Aztec and Late Aztec Red ware ceramics, this analysis attempts to (1) empirically delineate market zone boundaries; (2) evaluate the intensity and nature of exchange relationships among those zones; (3) examine factors influencing their spatial configuration and boundaries; and (4) monitor diachronic change in market system organization.[1]

This approach explicitly assumes that artifact distributions reflect the nature of the system through which they were distributed from their source. The analysis accordingly begins with a discussion of the major types of regional exchange systems, their organizational features, and their associated patterns of commodity distribution. The methods for evaluating features of market system organization from patterns of commodity distribution are then discussed.

The analysis then turns to the task of characterizing market system organization before and after imperial consolidation. For both the Early Aztec and Late Aztec periods, a brief review of relevant market system models and their spatial correlates is provided, followed by a detailed examination of the organization of commodity exchange based on ceramic distributions. Key questions guiding the examination of each chronological period include: Is there evidence for a single or for multiple exchange systems? What was the spatial organization and degree of articulation among market zones within the exchange system? Was the nature of commodity flows between zones primarily horizontal or vertical or both? And what was the relationship of market zones and exchange interactions to features of political geography?

Finally, this chapter evaluates specific expectations concerning organizational changes in the regional market system resulting from imperial rule. Aspects of change and continuity between Early Aztec and Late Aztec exchange systems are identified, and their relationships to processes of imperial consolidation are explored.

Models of Market System Organization

The primary dimensions of variability along which regional market systems can be characterized are (1) **scale of inclusiveness** (areal extent of exchange interactions or system integration), (2) **network** (the amount of horizontal commodity flows between communities of the same size), and (3) **hierarchy** (the amount of vertical commodity flows between communities at different levels of the site hierarchy) (C. Smith 1976d:314-315). This section begins by defining the major types of regional exchange systems in terms of these primary dimensions, drawing from the insights of previous studies (Renfrew 1975, 1977a; Fry and Cox 1974; Fry 1979, 1980; Feinman 1980). Second, by examining how these dimensions affect commodity flows, distinct patterns of commodity distribution associated with each market system type are predicted.

The primary dimensions of scale, network, and hierarchy can be integrated to characterize the distinct organizational features of four different market system models (Fig. 7.1). All these models have been applied to the Aztec case to explain features of regional economic organization in either preimperial or imperial times. The first two models discussed, the solar market system and the non-centralized overlapping market system, are models frequently discussed in conjunction with the Early Aztec period. In

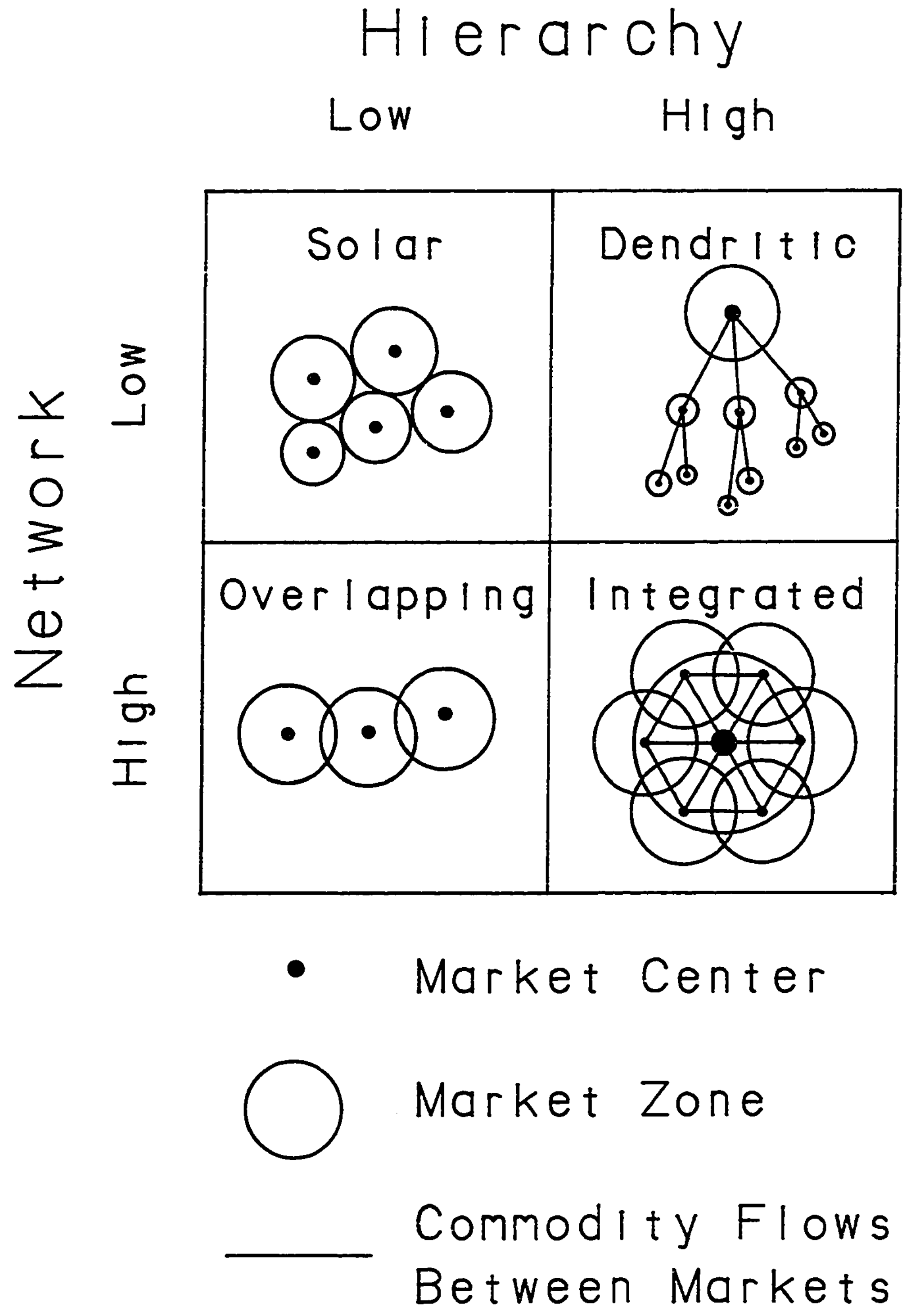


Figure 7.1. Regional organization of market systems along the dimensions of network and hierarchy.

contrast, the dendritic and integrated market network models provide alternative characterizations of economic organization during the Late Aztec period.

Solar market systems, also known as simple centralized market exchange systems, are characterized by both poorly developed hierarchy and network, and relatively small scale. As a system of central places, a solar market system consists of a localized, low-level market hierarchy (usually involving an administrative center serviced by several small rural market places) that is poorly articulated with other low-level hierarchies in the same region (C. Smith 1974:176). A key feature of solar systems is that the center provides both political and economic functions for dependent communities within its hinterland. As a result, the extent of political control is spatially congruent with the sphere of economic influence.

Under a system of enforced dependence on the primary center for both economic goods and administrative services, rural market participants (as either producers or consumers) are unable to exercise a choice in market destinations -- they must patronize the center to which they are politically dependent (C. Smith 1974:176-177). Goods move from production sources into the central marketplace where they are redistributed throughout the area served by the centralized market. If a number of producers contribute to this system, their products will have nearly identical, overlapping patterns of spatial distribution, resulting in a high degree of internal homogeneity within the area served by the central market.

At the regional level, restricted consumer and retailer movements result in poor articulation between solar market systems, marked by sharp discontinuities in commodity flows across system boundaries. The resulting pattern is one of discontinuous, bounded market territories. Linkages between these territories occur only as elite-controlled trade between administrative centers, indicated by the movement of foreign commodities only between primary central places.

Under a solar market system, then, the regional spatial patterns of commodity flow should be characterized by (1) bounded, discontinuous market territories that (2) are coterminous with political administrative units. If commodity exchange within the study area was centralized at the city-state level during the Early Aztec period, then the boundaries of market systems would be apparent as sharp discontinuities in type distribution, corresponding to polity borders. Ceramic assemblages of communities participating in the same market system will appear homogeneous in composition but distinct from those served by neighboring market systems.

Non-centralized or **overlapping market exchange systems** (also called **network exchange systems**) are also characterized by poorly developed hierarchy, but the higher degree of horizontal exchanges results in a higher degree of market network at the regional level than found under solar market systems (Bohannan and Bohannan 1968; Fry 1979). In non-centralized market exchange systems, political boundaries do not constrain the movements of goods or people, such that producers and consumers have access to several independent market centers. As a result, no sharp boundaries are visible between systems, when observed from the distribution of goods circulated through those centers. Rather, a gradient in similarity of assemblages extends along a line between exchange centers, as the frequency of each product declines with distance from its original source. Although there is free lateral movement of goods, a poorly developed market hierarchy leads to poor regional articulation, and economic interaction between communities declines rapidly with distance. Thus, neighboring communities will share a large number of commodities, while the assemblages of more distant communities will be more dissimilar.

These characteristics suggest several key aspects of regional spatial patterning generated by non-centralized or network market systems: (1) the structure is characterized by a series of fluid, overlapping market territories; and (2) the network is spatially unbounded by political or administrative boundaries. If the ceramics examined in this study were distributed through a non-centralized market system in which several independent exchange systems interacted, then individual ceramic types would likely form overlapping distributions and they would be represented in increasingly smaller proportions with distance from their source. Individual market zones would emerge as areas with similar ceramic assemblages, but the degree of similarity between adjacent market zones would be high and differences across these boundaries relatively weak.

Dendritic market systems, in contrast, are characterized by a well-developed market hierarchy, in conjunction with a poorly developed market network. Political and economic control emanates from a single primate center, and the rural hinterland is dominated by that primate center for the purposes of resource extraction and commodity production. Trade flows vertically up and down the hierarchy, but each dependent community has exchange interactions with only one higher level center. Horizontal connections among communities at the same level of the hierarchy are minimal.

Such a system facilitates the extraction of goods from the primate center's hinterland, but suppresses economic development in the hinterland. Peasant-produced goods flow directly from rural areas to urban centers and in the process leave the domestic economy or peasant economy poorly serviced and undersupplied (C. Smith 1976a:34-35). Because commodity flows are directed to only one higher-level center, rural goods do not flow with regularity across rural markets, and rural producers cannot depend on those markets for subsistence goods. Thus, the incomplete development of market network reduces hinterland dependence on the market system either as an outlet for products or as a source of desired goods.

Further, because such a system offers producers one and only one market for their goods, each level of the hierarchy is systematically disadvantaged in both sale and purchase of its goods (C. Smith 1974:177-178). As a result, "peasants at the peripheral ends of dendritic systems are little more commercialized than those in solar systems: They specialize in producing goods for a broad, often international market and consume other goods from that market; but at the same time they produce their own subsistence goods" (C. Smith 1976d:319-320).

A key characteristic of dendritic market systems, then, is the differential integration of communities into the regional system based on their distance from the primate center. If the regional economy of the Aztec imperial core was organized through a primate market system, the resultant geographic pattern would be that of distinct zones characterized by different levels of central market participation. At least two zones are expected: (1) a well-integrated core zone around the primate center displaying high market participation, and (2) a poorly integrated rural periphery with low market participation. If the Valley's economy was organized through a dual dendritic system, as suggested in this study, two distinct subregional systems would be apparent, with core zones centered on Tenochtitlan and Texcoco.

The degree of central market system participation will be reflected in the degree of access to higher-order goods produced in (or imported into) the primate center. As market participation declines with distance from the primate center, we can expect to see a decline in the abundance of centrally produced goods. Within the periphery, locally produced subsistence and utilitarian goods will predominate. These goods do not circulate through the regional market system and the lack of lateral commodity flows within the periphery will result in localized differences in style and assemblage composition.

Complex, interlocking market systems or **hierarchically integrated market networks** are characterized by both well-developed market hierarchy and network. In such a market system, goods are channeled through a series of local and regional centers, serving overlapping market regions of various spatial scales:

> "In interlocking systems each market center is linked to several higher-level centers as well as to several lower-level centers. This creates a network with several levels, several links between levels, and hierarchically organized service to all places in the

system. Goods flow to and from other systems and regions but are also exchanged within the local system at each level. Trade areas are overlapping and economic regions unbounded. Hence, supply and demand or price information is communicated across broad areas to ensure coordination of specialization. Under these circumstances the rural consumer can stay put and still enjoy product diversity in his marketplace; he can also depend on a broad market for the goods he produces. This allows specialization within the realm of food production, so that rural areas become as market dependent if not as diversified as urban centers" (C. Smith 1976d:320).

A primary feature of interlocking market systems is the high degree of regional integration. Because goods move both vertically and horizontally between centers, distribution patterns are geographically widespread and create a higher degree of similarity in artifact assemblages throughout the regional system. Local variations in the availability of goods from a given source may persist, however, generating minor differences in assemblage composition between local market systems. For example, the continued presence of local distribution systems would be evident from distinct clusters of types within the more homogeneous scatter.

If the Aztec regional economy was organized as a complex interlocking market system, then the distribution of ceramic types should reflect a pattern of widespread, relatively uniform distribution throughout the region served by the market system. Minimal intra-regional variation in type frequencies would occur, although pockets of locally-produced ceramics might appear. However, because trade areas are overlapping and unbounded, no sharp internal boundaries in ceramic distribution would be apparent. Similarly, because rural areas are well integrated into the market system, no core-periphery pattern in market participation is expected.[2]

Methods for Characterizing Aztec Market Systems

The four preceding models of regional market system organization present distinct expectations for commodity distribution patterns against which the Aztec case can be compared. The evaluation of Aztec commodity distributions in terms of these expectations entailed a number of steps. Fundamental to the analysis was the empirical identification of areas participating in the same market system, and the delineation of market zones, based on the degree of ceramic assemblage similarity among sites within the study area. Once market zones had been delineated within the study area, the organization of the regional market system was evaluated in terms of the size and number of distinct market zones, their spatial organization, the horizontal and vertical relationships among market zones, and their distribution relative to features of Aztec political geography. The specific methods employed in these analyses are discussed below.

The Data Base: Aztec Red Wares

The regional organization of exchange was evaluated based on the spatial distributions of Aztec Red ware ceramics. Red ware ceramics are an appropriate medium for monitoring exchange interactions because their distributions were not obviously constrained by other social, functional, or ecological factors. Decorated ceramics were nearly ubiquitous and occurred in communities of all sizes, statuses, and functional types. Ceramic clays are widely distributed throughout the Valley such that production and distribution of Red wares were presumably not constrained by resource availability (cf. obsidian).

Single commodity studies have been criticized, however, as a basis for reconstructing overall market system organization. After all, a market system carries a complex range of goods and services, and no one commodity need flow up and down through all levels of a hierarchy nor circulate laterally through an entire network (Jones 1976).

Several factors justify using the single commodity approach, if only as a point of departure. First, most economic geographers refer to a single market **system** for an area, but multiple market **paths**. That is, **different** goods flow through the **same** system in different ways, but they rarely form distinct systems (C. Smith 1976a:38).[3] This is because the market system functions within an established infrastructure consisting of recognized market places (either regular or periodic) and known transportation routes between those centers. If goods are exchanged within the market system, their movement utilizes this infrastructure, and hence their flows are restricted by that structure. Thus, even a single commodity is responding to and reflecting the constraints of the regional market system's organization.

Second, it is a well-known empirical fact that most consumers buy more than a single item in a marketing trip, so that the range of multiple items determines their willingness to travel and their ability to give custom to any particular supplier or location (C. Smith 1976a:24). Thus decorated ceramics are only one class of goods, but since most buyers deal in multiple items and make multi-purpose trips, the movement of pottery reflects the movement of other goods as well.

It is equally clear, however, that while a single commodity may provide information on the basic market system structure, it cannot represent the total complexity of market exchange interactions. Lower-order goods such as undecorated pottery may provide finer spatial resolution -- the smaller circuits of locally produced and exchanged utilitarian items, while exotic goods may indicate flows characterizing higher-order goods that circulated at the largest spatial scale.[4]

It is suggested here that Red ware ceramics represent a widely used and widely exchanged mid-range good, whose movement reflects the basic structure of exchange interactions within the Valley. However, to achieve a truly comprehensive understanding of the regional exchange system in Aztec times, similar studies must be carried out for a range of other commodities of both higher- and lower-order goods. This investigation should therefore be regarded as a pilot study based on a single commodity for which regional distribution data are most accessible.

Identification of Market Zones

Market zones are defined here as areas serviced by the same market center(s) that have access to the same array of ceramic goods and accordingly share similar ceramic assemblages. This approach explicitly assumes that sites interacting in the same exchange system have more similar ceramic assemblages, whereas those participating in completely different exchange networks have largely dissimilar assemblages. Greater and lesser degrees of similarity among ceramic assemblages can therefore serve as measures of the relative degree of economic interaction among different portions of the study area (Fry and Cox 1974; Pires-Ferreira 1976; Plog 1976, 1978; Fry 1979, 1980; Hodge and Minc 1990). Market zones are identifiable as areas of high economic interaction within which sites display compositionally similar ceramic assemblages. Boundaries between adjacent market zones are apparent as discontinuities in ceramic assemblage similarity reflecting a decline in exchange activities.

Two factors may distort the presumed relationship between assemblage similarity and economic interaction, however. First, differences in site function can obviously affect ceramic assemblage composition by altering the mix of vessels of different functional classes found at a site. A spatial concentration of functionally specific sites (such as lakeside salt-producing sites) might appear as a distinct "zone" based on ceramic assemblages dominated by functionally specific vessels (e.g. salt-water evaporation pans). In order to avoid variability in assemblage composition owing to functional differences, the delineation of market zones in this study focused on a single functional shape class -- that of decorated Red ware bowls used as serving vessels -- and was based on regional stylistic variability within that class of vessels.

Similarly, differences in social status potentially translate into differential purchasing power and consumption of ceramics of different degrees of elaboration and prestige. Sites at different levels of the sociopolitical hierarchy may therefore differ significantly in the types of Red ware bowls consumed if different types represent distinct statuses. It is anticipated, however, that differences in status will be largely averaged out across sites of different status levels within the region, unless, of course, areas are dominated by sites of a given level of the sociopolitical hierarchy. Thus, although differences in function and status certainly affect assemblage composition, it is assumed that the primary factor generating **regional** differences in Red ware bowl assemblage composition is the structure of the regional market system through which bowls were distributed.

The identification of market zones utilized the methodology entitled "unconstrained clustering for the analysis of spatial data" developed by Robert Whallon (1984). The goal of unconstrained cluster analysis is the identification of spatial clusters or areas with similar artifact assemblages that are not constrained as to their size, shape, density, composition, or patterns of artifact covariation by the very quantitative methods employed to identify them. This methodology was originally designed to assist intra-site analyses in the identification of activity areas within occupation floors. It is, however, a general approach rather than a specific technique (Whallon 1984:244), and as such is appropriate for the analysis of regional spatial data as well.

The approach requires, first, that we have data on the distributions of a number of different artifact types over a contiguous spatial area. Second, it requires that information on artifact type distributions within this area be sufficiently detailed to characterize the underlying distributional patterns. The Valley of Mexico survey data within the eastern and southern portions of the Valley satisfy both these requirements. As discussed in Chapter 6, the surveys provide relatively complete information on settlement distributions for the large contiguous area that is the focus of this study. The surface collections generated through these surveys (representing samples drawn from 73% of Early Aztec and 46% of Late Aztec sites located) provide a regional data base from which to characterize regional patterns of distribution. Theoretically, these surface collections represent samples drawn from the underlying "true" ceramic distribution patterns. Individual samples are, however, subject to considerable local "noise" or distortion of the regional pattern, due to differences in surface collecting conditions and factors affecting sherd preservation. One major goal of unconstrained cluster analysis, therefore, is to even out the local perturbations in artifact recovery in order to expose the larger underlying patterns of distribution.

Unconstrained cluster analysis proceeds through a number of steps; at each step specific decisions must be made to tailor the approach to the problem at hand. As implemented here, these steps involved: (1) creation of a regular data grid from irregularly spaced data points for each artifact type included in the analysis; (2) smoothing the data within each grid, using a moving template of surrounding grid cells; (3) calculation of grid point data values from the smoothed data as input for cluster analyses; (4) clustering of grid points based on density values for multiple artifact types; (5) cluster mapping; and (6) cluster interpretation.

The first step involves creating a regular data grid from irregularly spaced data points for each artifact type to be included in the cluster analysis. Within each grid, the value of a given grid point is estimated from neighboring data points, usually as a weighted average of the values of points within a certain distance of the grid point. Generally, the weights applied are the inverse squares of the distances from the central point.

For this study, the starting configuration consisted of local densities of Red ware ceramic types and variants at 243 sites within the study area (Fig. 7.2). Local densities are expressed as sherds/ha of a given ceramic type or variant, as determined from their densities in surface collections (e.g. Fig. 7.3).[5] A regular grid of 2.5 km squares was established over the study area; choice of grid size reflects a balance between the desire to retain local detail and the number of cases that cluster analyses can efficiently handle.

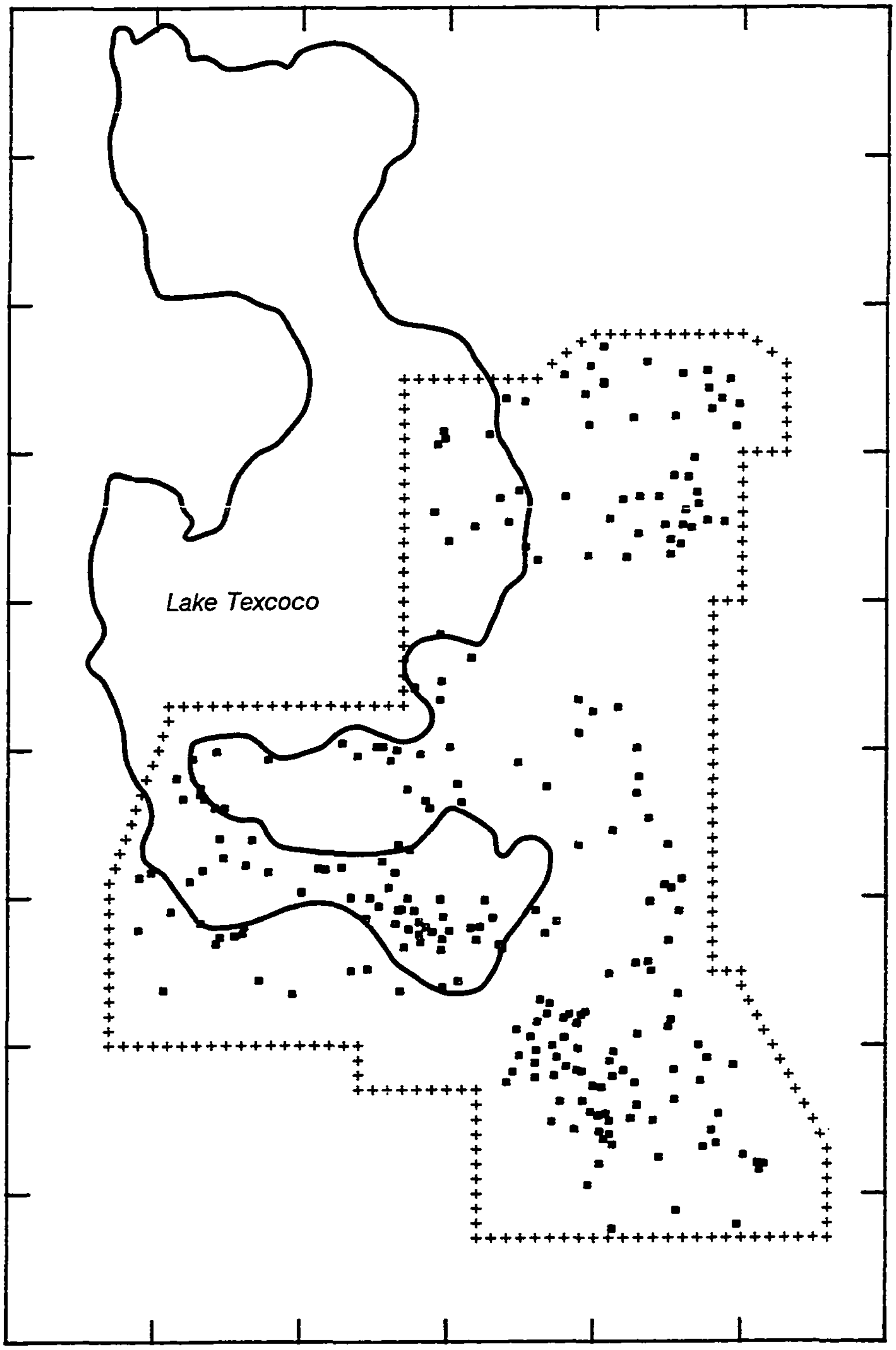


Figure 7.2. Location of sites within the study area providing ceramic data for this study.

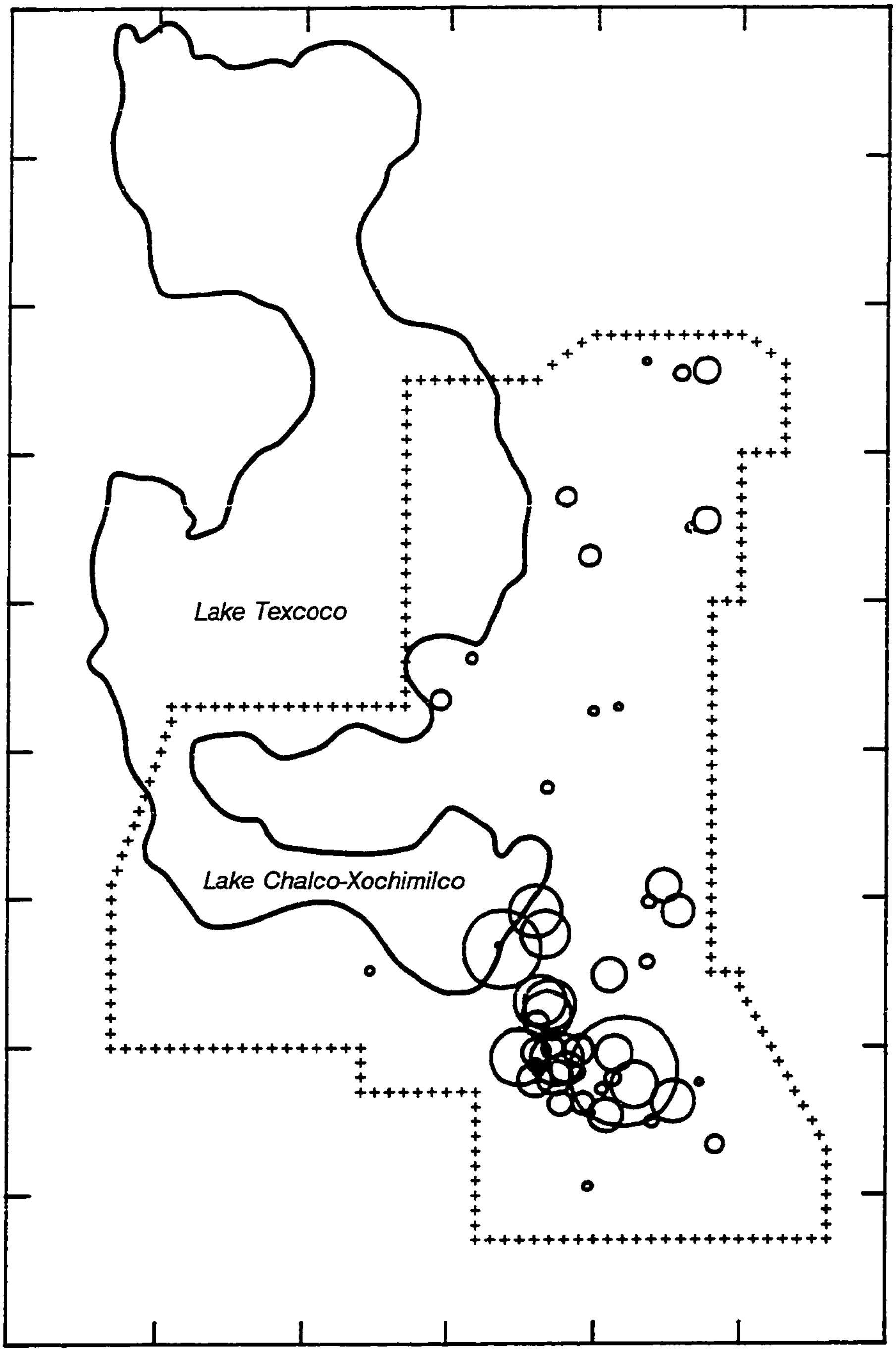


Figure 7.3. Example of density map for Black/Red Variant A. Symbol size indicates the density of this ceramic variant at sites within the study area, based on regional survey collections.

The estimated absolute densities of each ceramic type or variant were then calculated for each grid point. Grid point values represent the weighted average of ceramic type densities from the 10 nearest sites, using an unlimited search radius and an inverse distance ($1/D^2$) weighting factor. The inverse squares weighting factor was chosen to maintain the emphasis on local density fluctuations.

A second optional step involves smoothing the density grids using a moving template of surrounding grid points. In this procedure, each grid point is replaced with the average of itself plus its closest neighbors. Grid smoothing does involve some degree of generalizing from the data, but Whallon (1984:245) argues that this is necessary: "We are interested in distributional pattern, and pattern is a characteristic of the data as a whole rather than of the array of individual item locations. That is, pattern is a generalization from the data." In this context, grid smoothing is recommended in that it reduces noise and enhances the underlying pattern by averaging out random fluctuations (Whallon 1984:245).

For this study, the grid for each ceramic type was smoothed using a moving template of 3-by-3 grid squares, in which the central square had a weight of two, while the surrounding eight grid points were weighted using an inverse distance factor ($1/D^2$). The small template and the weighting factors were utilized to retain a fair degree of local detail within the grid while still attaining the advantages of smoothing out extremely local perturbations.

After the grid for each ceramic type had been smoothed, grid points beyond the limits of the irregularly shaped study area were discarded, leaving a total of 317 grid points within the study area from which to characterize ceramic distributions. Density contour maps were then generated for each ceramic type or variant (based on the smoothed grid) to visually characterize geographic patterns of ceramic distribution within the study area (Fig. 7.4).

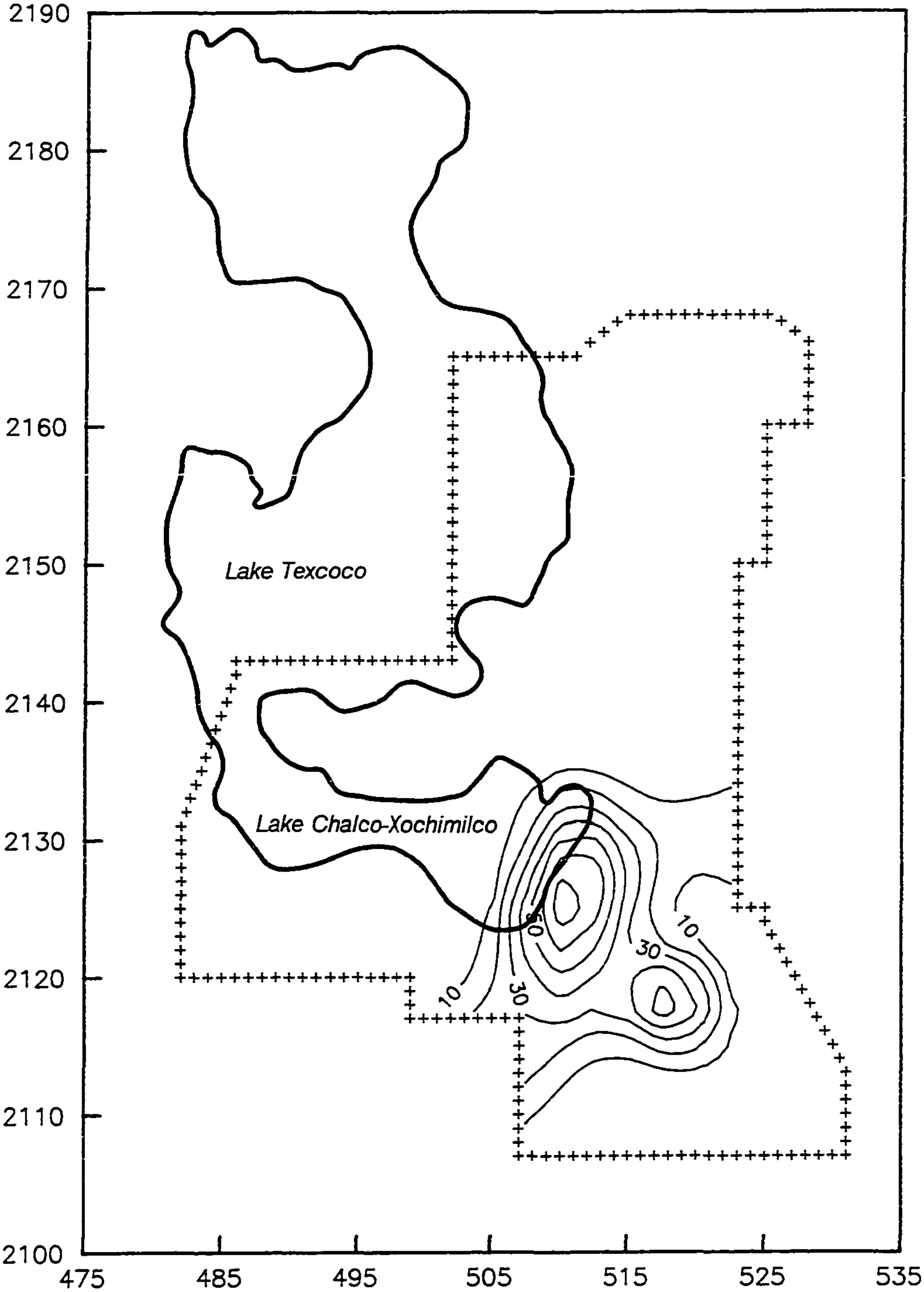


Figure 7.4. Example of contour density map for Black/Red Variant A, based on smoothed grid. Minimum contour = 10 sherds/ha; contour interval = 10 sherds/ha.

At this point in the analysis, cluster analysis is utilized to summarize the information contained in the multiple density contour maps and to reveal clearly the joint patterning of the different ceramic types and variants within the study area (Whallon 1984:245). Input data for the cluster analysis consists of the smoothed absolute densities and/or the relative (proportional) densities as calculated for each grid point. It should be emphasized here that what is being clustered are grid points, with clusters of grid points presumably representing areas with similar assemblage composition. As a result, the focus here is on identifying areas with similar ceramics, rather than on identifying groups of sites with similar ceramics.[6]

Spatial patterning in both absolute and relative densities of Red ware ceramics was examined in this study because these different density measures potentially provide complementary types of information. On one hand, relative densities (i.e. percentage data) reflect differences in assemblage composition that disregard differences in assemblage size. This is an advantage where assemblage size may well vary according to differences in settlement density or surface survey conditions. Through the use of relative densities, we gain information on what areas share types in similar proportions and thus can measure the degree of interaction among these areas. In this case, we assume that a greater similarity between areas reflects a relatively higher degree of interaction between those areas, while areas with lower similarity interact to a lesser degree.

On the other hand, absolute densities (i.e. differences in the total volume of sherds per unit area) also potentially reflect differences in access to ceramics or in the volume of consumption on a regional level. If we can associate source areas for a given ceramic type with high availability and high consumption (high absolute densities) and assume that declining accessibility with distance from a source translates into lower absolute densities, then more peripheral zones with lower consumption of that ceramic type will be evident as areas with low densities of that type. Absolute densities are also critical in identifying areas with low overall ceramic densities within which relative densities may be unreliable or misleading. Thus, through combining information gained from relative and absolute densities, we gain insights into both the relative degree of interaction as well as the volume of interaction between different areas. To the extent that the results of the two analyses agree, we can be assured that the patterning within the spatial data is relatively robust (Dunnell 1983:145-46).

The next step involves the cluster analysis proper. This study utilized the minimum variance or Ward's method clustering algorithm, a hierarchical agglomerative clustering algorithm than joins clusters by minimizing intra-cluster variance (Aldenderfer and Blashfield 1984). An explicitly hierarchical algorithm was selected in order to reveal the degree of relatedness among areas within the study area. The clustering was based on Euclidean distances between grid points as calculated from the densities of the different ceramic types or variants at those points. Two separate cluster analyses were carried out for both the Early Aztec and Late Aztec periods; these two analyses were based on the unstandardized absolute and relative densities of ceramic types dating to those periods.

The appropriate cluster solution(s) for each analysis were identified using the scree method, based on major changes in error sum of squares (SSE). According to this criterion, "clustering proceeds ... until a series of marked jumps in the error sum of squares are produced by the fusion of relatively dissimilar groups. These sudden jumps in the clustering criterion indicate significant increases in the heterogeneity of the groups being defined" (Whallon 1984:253). The strategy here is to examine cluster solutions just prior to major increases in the SSE, as these divisions represent relatively distinct groups.

Once grid points have been clustered, the next step involves cluster mapping. Grid points belonging to each cluster are plotted on a map of the study area, and these groups are examined for spatial integrity and geographic interpretability. It is expected that grid points belonging to the same cluster will also cluster spatially, and that as a group they represent an area with a distinctive ceramic assemblage.

If clusters pass these preliminary tests, the analysis proceeds to cluster interpretation. On the one hand this involves the calculation of descriptive statistics for each cluster to examine differences in assemblage composition between areas. For the present data set, these statistics could be calculated in one of three ways, based on: (1) type densities at grid squares assigned to each cluster, (2) type densities at sites assigned to each cluster, or (3) type counts at sites assigned to each cluster. Type densities were preferred, since density measures place assemblages of different sizes on an equal footing and prohibit sites with large assemblages from dominating the composition of an entire cluster. However, type densities and type counts were both calculated and compared; when expressed as percentage data, differences between the two were usually slight. Cluster interpretation in this study was also based on the spatial configuration of clusters, their size, and location relative to features of Aztec political geography, including political centers and polity boundaries.

The final step involved the integration of information from the dual analyses for each period, based on relative and absolute densities. Overlays of cluster maps were utilized to identify areas where the two different analyses were in agreement and to determine factors affecting areas of disagreement. The results were then synthesized to provide a map of economic interaction spheres and market zones within the study area for each of the two chronological periods.

Assessing Relationships among Market Zones

Once market zones had been delimited, the relationships within and among the zones were examined to characterize the regional market system structure. As discussed earlier, three organizational attributes are of key interest in characterizing regional market system organization: scale, network, and hierarchy.

Scale was simply evaluated from the number of market zones and their relative spatial extent. In this study, the number of grid points associated with a market zone was utilized to estimate areal extent. Of primary interest here is the characterization of the regional system as comprising one or a few large market zones as opposed to many, smaller market zones.

A second concern was whether these zones represented parts of one system or several. The presence of regional subdivisions was based in part on subgroupings suggested by the cluster dendrograms. In addition, the Brainerd-Robinson agreement coefficient (Robinson 1951; Cowgill 1990) was utilized to quantify the degree of interaction among market zones from the degree of similarity among their ceramic assemblages as a whole. The Brainerd-Robinson coefficient measures similarity according to the proportion of different ceramic types and variants shared by pairs of market zones. The coefficient can range from 0 (when pairs of market zones share no types in common) to 200 (when pairs of market zones share all types in common and in the same proportions). Using this measure, a high coefficient indicates a high degree of interaction among market zones, suggesting they belong to the same regional system. Conversely, a low coefficient suggests a lower degree of interaction; a sharp decrease in the agreement coefficient represents a boundary in economic interaction.

Brainerd-Robinson agreement coefficients were calculated between all pairs of market zones based on type counts and/or type densities summed across sites within each zone. The spatial configuration of similarity coefficients was then examined to determine areas of high economic interaction and to check for discontinuities in similarity coefficients indicative of boundaries that inhibited the exchange of goods.

The Brainerd-Robinson coefficient measures overall interaction among zones; it does not, however, indicate whether that interaction is lateral or hierarchical in nature.

Thus several other measures were employed to determine the degree of network and hierarchy among market zones.

A primary means of assessing relationships among market zones was through examining density contour plots of type distributions, in order to determine the degree and configuration of overlap of types relative to each other and to market zone boundaries. By determining the density contour line within which a certain high percentage (e.g. 75-95%) of a type was located, centers of distribution or areas of concentration could be identified for many types and variants.[7] By mapping these contour lines for multiple types, the extent to which type distributions overlapped each other and market zone boundaries could be assessed.

The degree of **network** or horizontal integration among market zones was then assessed according to how discrete or overlapping market zones appeared based on type distributions, that is, whether types appeared to conform to or cross over market zone boundaries. It was anticipated that a well developed network among market zones would be indicated by type distributions showing a high degree of overlap that crossed market zone boundaries. Conversely, a poorly developed network among adjacent zones would be indicated by a pattern of non-overlapping type distributions congruent with market zone boundaries.

The degree and spatial configuration of overlap of types relative to each other was also considered indicative of network development. Indicators of poor network development include multiple but relatively discrete type distributions, while a well developed network is recognizable from multiple, but overlapping areas of distribution.

The degree of **hierarchy** within the regional market system was evaluated from the dual perspective of differential access to more and to better goods. In a hierarchically organized system, higher-order markets offer higher-order goods, plus all lower-order goods (Appleby 1976; Mehretu 1982; King 1984:32; C. Smith 1985). As a result, higher-order markets are more diverse than lower-order markets, and carry a higher proportion of higher-order goods. Within a regional hierarchy, market zones surrounding the highest-order market centers are therefore expected to have a greater diversity and greater volume of high quality ceramics, whereas zones serviced by lower-order centers will appear less diverse and have reduced volumes of high quality ceramics. In the presence of a well-developed market hierarchy, we can therefore expect (1) significant regional variability in assemblage diversity, and (2) a spatial pattern in which access to higher quality ceramics declines with distance from the highest-order market center.

In contrast, in a non-hierarchically organized system, we can expect that all market zones will be more equally diverse and/or have roughly equal access to higher quality goods. Variability in assemblage diversity may arise, however, in the context of numerous small, interacting market zones, where some sites have access to more than one market-production zone. In this case, the greatest diversity will be found in the area of overlap between multiple distribution zones, i.e. at the margins of market zones, not at the center. In order to distinguish this pattern from that produced by market hierarchies, the distinction between hierarchical and non-hierarchical relationships among market zones must be based on both overall assemblage diversity as well as on the relative access to goods of different orders.

Assemblage diversity is a multidimensional concept encompassing both richness (the number of different artifact classes present) and evenness (the distribution of artifact counts across those classes). A large number of indices have been developed to measure richness and/or diversity (Pielou 1975; Ludwig and Reynolds 1988:85-95). Most of these, however, do not adequately account for the sample-size effect; that is, that the larger the assemblage is, the more artifact classes it should have, simply as a function of sample size (Rhode 1988).[8] In addition, many indices confound attributes of richness and evenness. Given the current debate over the applicability and interpretability of these various indices

(Bobrowsky and Ball 1989; Cowgill 1989; Kintigh 1989; Rhode 1988; McCartney and Glass 1990), I have not attempted to quantify assemblage diversity per se. Rather, following the lead of Jones et al. (1983; Grayson 1984), I have focused on the systematic relationship (generally linear or curvilinear) between assemblage richness and assemblage size using bivariate plots and examined deviations from that relationship.

In this so-called "regression approach", richness (the number of ceramic types or variants present) is plotted against assemblage size; data are frequently transformed using a log or semi-log scale to bring the data into compliance with the assumptions of linearity required by linear regression models (Diamond and Case 1986:560-561).[9] Because richness increases with total sample size, a strong linear relationship is generally found between these two variables after transformation. Small deviations from the linear association are interpreted as random variability, while larger deviations or outliers indicate cases that do not conform to the expected pattern. In general, it is the outliers that are of interest, in that they represent assemblages that are considerably less diverse or more diverse than expected based on sample size (Jones et al. 1983:69). However, even smaller deviations from the expected are of interest if they pattern spatially. As a spatial concentration or cluster, these deviations can indicate areas with greater richness than expected (potentially representing areas with greater access to higher-order markets) or lower richness (representing areas with lesser access to higher-order markets). By mapping the residuals (deviations from expected diversity), spatial patterns in market participation can be discerned.

A related strategy involves checking for the presence of distinct subgroups of assemblages and/or comparing the assemblages associated with different market zones to assess possible differences in richness. Presumably, if all market zones are equally diverse (as is expected in a non-hierarchical system), they will display nearly identical regression lines when richness is plotted against sample size. In contrast, if the assemblages of some market zones are considerably more diverse than others (as is expected in a hierarchically organized system), then the market zones will display significantly different regression lines.

In using the regression approach to compare the diversity of different groups of assemblages, two distinct cases arise that are of interest: (1) groups that display parallel or nearly parallel slopes but distinctly different intercepts (Fig. 7.5a), and (2) groups that display highly divergent slopes (Fig. 7.5b). (For this discussion, assemblage richness is plotted on the y axis, while assemblage size is plotted on the x axis.) In the first case, parallel slopes suggest that the same underlying relationship between richness and sample size holds for both groups, but that the two groups have different "base lines" in availability. When compared across samples of the same size, the group with the higher intercept is truly more diverse.

In contrast, differences in slope (representing the increase in richness per unit change in sample size) suggests a different rate of acquisition: the group with the steeper slope adds artifact classes at a faster rate. Differences in the rate of acquisition may reflect differential access to a broader array of goods; in this case, steeper slopes reflect market zones with greater assemblage diversity owing to their greater access to higher-order markets. Alternatively, the difference in rate may reflect underlying differences in assemblage structure, particularly in the dimension of artifact class evenness. Potentially, steepness of slope and artifact class evenness covary. This is because the probability of adding a different artifact class on subsequent trials is greater if artifact classes are evenly distributed than if they are highly skewed or uneven in distribution. In this case, the reasons underlying significant differences in artifact class evenness must be considered before differences in slope can be confidently linked to hierarchical levels of market participation.

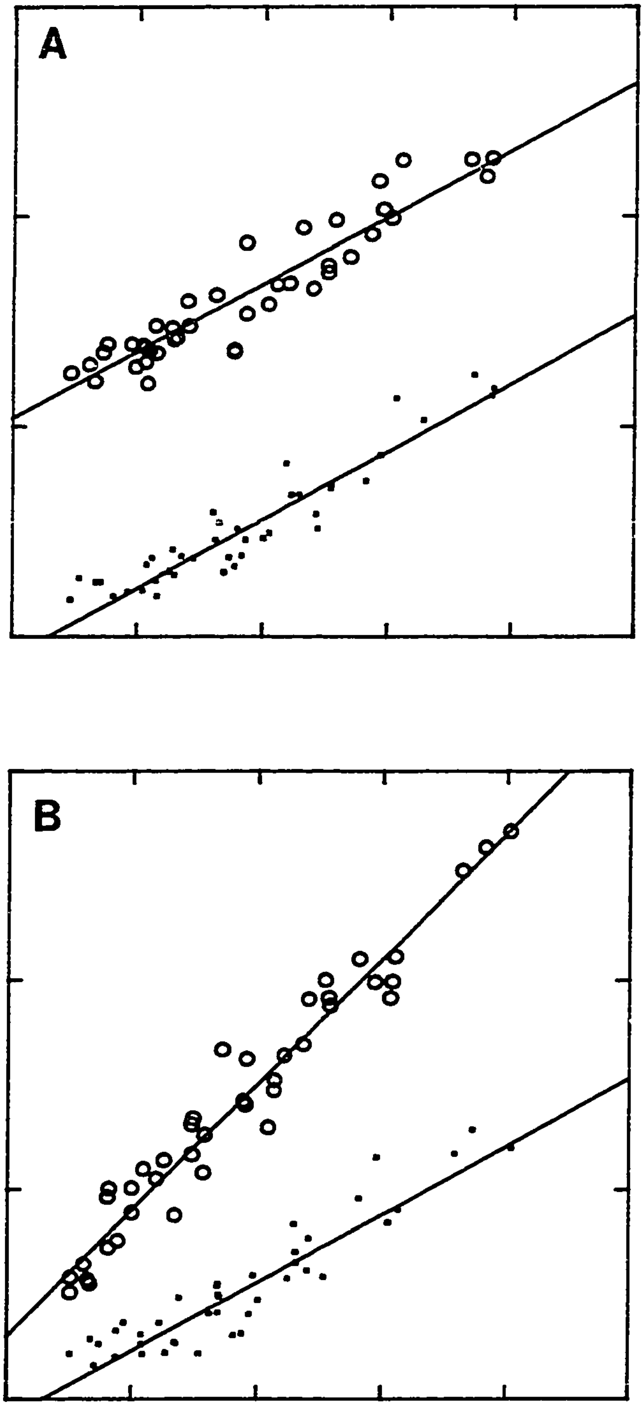


Figure 7.5. Regression lines for populations that have (**A**) parallel slopes but different intercepts and (**B**) different slopes.

The second measure utilized to examine the degree of hierarchy was the relative access to higher-order goods. Higher-order ceramics are defined as those requiring higher levels of labor input. By examining the various steps involved in the production of different ceramic types, it is possible to calculate a production-step index for each type that serves to rank the different types according to their level of labor input (Feinman 1980; Feinman et al. 1981). For this study, Red ware types and variants were classed into different levels of labor investment according to the number of colors employed in their decoration and the complexity of the design. Although decorated Red wares represent only a portion of the total labor input scale (ranging from undecorated utilitarian vessels to elaborate polychrome vessels), Red wares do vary from quite simple, monochrome decoration to elaborate, multicolor decoration, and thus represent differing levels of labor investment.

The distribution (relative to market zone boundaries) of ceramics belonging to different "labor input" classes was assessed using a chi-square test for homogeneity, based on type counts at sites assigned to market zones. Expected values are based on both the overall availability of a type (total type count), and the overall level of ceramic consumption (total assemblage size) for each zone. Deviations from the expected values are presented as standardized X^2 residuals that represent departures from the expected frequencies in standard deviations (Kendall and Stuart 1961; Haberman 1973; Reynolds 1977, 1984). In this case, significantly high positive residuals represent greater than expected access, and extreme negative residuals represent lower than expected access. By examining the sign and strength of the standardized X^2 residuals, market zones having greater access to higher-order ceramics can be identified.

Finally, the preceding diversity measures were supplemented by subjective evaluations of fall-off patterns in absolute densities of decorated ceramics, indicating declining access or differential market participation. As noted above, source areas of decorated ceramics theoretically can be identified as areas of higher availability and hence higher absolute densities of decorated ceramics relative to regional population. In hierarchically organized market systems, core vs. peripheral market zones accordingly can be identified from areas of high vs. low absolute decorated ceramic densities, respectively.

Combining the above measures of hierarchy, a non-hierarchical system is expected to contain market zones that are equally diverse and therefore display similar regression lines in bivariate plots of richness and assemblage size. At a regional level, sites with greater than and less than expected richness (positive and negative residuals) will be interspersed across market zones, although areas of high diversity may occur at the point of overlap between multiple market zones. Further, all zones will display similar levels of access to higher quality goods.

In contrast, in a hierarchical system, market zones are not equally diverse: zones surrounding higher-order market centers will display significantly higher intercepts or steeper slopes in bivariate plots of richness and assemblage size. Sites with greater than expected diversity (positive residuals) are expected to cluster spatially around the highest-order market center. These areas of greater diversity are also expected to have greater access to higher quality goods, and there will be a noticeable decline in both the diversity and the quality of goods with distance from that center.

The Regional Organization of Ceramic Exchange in the Early Aztec Period

Models for Early Aztec Market System Organization

The pre-imperial period in the Valley of Mexico is described in the ethnohistoric documents as a time of extreme political decentralization and instability, characterized by almost continual conflict between small, independent polities. The settlement patterns for the Early Aztec period support the documents on this point. The distribution of sites during the Early Aztec period consists of "a series of local centers, each dominating a small part of the Valley and each separated from its neighboring polities by a frontier of contested, not well-inhabited borderland" (Blanton et al. 1981:152).

In keeping with the political milieu of the Early Aztec period, several authors (M. Smith 1979:36-39; Hassig 1985:71-73; Hicks 1987) have suggested that prior to imperial consolidation market exchange was organized in a solar market system. Hicks (1987:93), for example, argues that: "The Early States [preceding the Triple Alliance] would appear to have had a 'solar' central place pattern with regard to both tribute and market activities... By this I mean that tribute in goods and services were brought to the royal palace in the city by commoners in the city's immediate hinterland, and the people patronized only the marketplace of their own city." According to this view, the political insularity of polities would have made it unlikely that the subject population was able to exercise a great deal of choice in which market they patronized or that they were able travel safely to the market center of a hostile polity. Thus, the degree of network development was low, and the regional market system is expected to have been organized through a series of small, discrete market zones coterminous with city-state polity boundaries.

A second model of market system organization that appears appropriate for the Early Aztec period is that of non-centralized, overlapping market zones. Proponents of this model argue that city-state polities, owing to their small size, were unlikely to have been economically self-sufficient. Thus, political confederations of such city-state polities -- ostensibly organized along ethnic lines for mutual defense -- may also have been critical economic alliances (Calnek 1982:45). By allowing trade to move unhindered across borders between allied territories, consumers would have had access to a broader range of necessary resources. Yet owing to the unstable and competing political structure of confederations, it is unlikely that an economic hierarchy of centers would develop. These characteristics are consistent with the development of a series of overlapping market zones, in which consumers had a choice -- within the limits of the political confederation -- as to which of several market centers to patronize.

In contrast, Blanton (1994) argues that the foundations of a hierarchically integrated market network were established in the pre-imperial or Early Aztec period, although the system was unevenly and incompletely developed at that time. Based on the number and spatial organization of primary and secondary centers or central places that serviced the local hinterland during that period, Blanton concludes that even at this early time a commercial principle was operating as a major determinant of central-place development in some portions of the Valley. For example, within the canons of Central Place Theory, the extremely regular spacing of the Early Aztec regional centers suggests that centrality to local hinterlands was a major factor in determining the locations and spacing of primary centers. Further, although the interstitial spaces of the settlement lattices were not completely filled in, the fact that a commercial principle appears to best predict the locations of the secondary centers that do exist implies that commerce was a major force structuring settlement system organization.[10] The operation of commercial forces implies the existence of a single, region-wide market system for the Early Aztec, with elements of both market system network and hierarchy.

Locating Early Aztec Market Zones from Patterns of Ceramic Distribution

The locations of Early Aztec market zones were determined from the density distributions of 18 different Red ware variants and subvariants using unconstrained cluster analysis of spatial data, as described above. The Early Aztec ceramic units included: Black/Red early profile variants A, B, D, E, H, I; Black/Red-Incised Variants A, B, and C-D; Black&White/Red early profile variants AW1, AW2, AN, B, C, D1, D2, D3, E1, E2, and E3. Two distinct cluster analyses were carried out, based on the absolute and relative densities of these ceramic units, and the results later integrated. In general, the spatial integrity of all cluster solutions was very high, and the clusters can be associated with distinct sub-areas of the study area.

Cluster Results based on Absolute Densities. The scree plot (Fig. 7.6a) for cluster solutions based on absolute densities indicates major jumps in the SSE following the 2- and 4-cluster solutions, and lesser jumps following the 9- and 17-cluster solutions. Because these solutions are hierarchically related, the cluster dendrogram (Fig. 7.7) provides insight into the degree of relatedness among different parts of the study area based on ceramic assemblage composition. Two of these cluster solutions are discussed here, as indicating the major consistent divisions within the study area.

The 4-cluster solution (Fig. 7.8) identifies two areas with high absolute Red ware densities, but with distinct Red ware assemblages: one located in the NE corner of the study area and comprising much of the Texcoco survey region (Cluster 3), and one in the SE corner, subdivided into southern (Cluster 1) and far southern (Cluster 4) zones. Both the northern and southern areas appear to have had active Red ware ceramic production and exchange systems, although they differ significantly in their stylistic preferences. In contrast, the intervening areas as well as the Chalco-Xochimilco lakebed region (all Cluster 2) have relatively low absolute densities of decorated Red wares and appear somewhat peripheral to both northern and southern systems.

The 9-cluster solution (Fig. 7.9) provides subdivisions within each of these areas. First, the low-density zone is subdivided into an extremely low-density lakebed area (Cluster 5) with an average of 19 Red ware sherds/ha, and a low-density area lying between the northern and southern systems (Cluster 4) with an average of 100 Red ware sherds/ha (Table 7.1). Based on its extremely low densities, the former appears to have had minimal interaction with either the northern or the southern system, while the latter bears some resemblance to both. Similarly, within the NE zone, two sub-areas of higher densities are identified in the SW and NE corners of the zone (Cluster 6). These areas

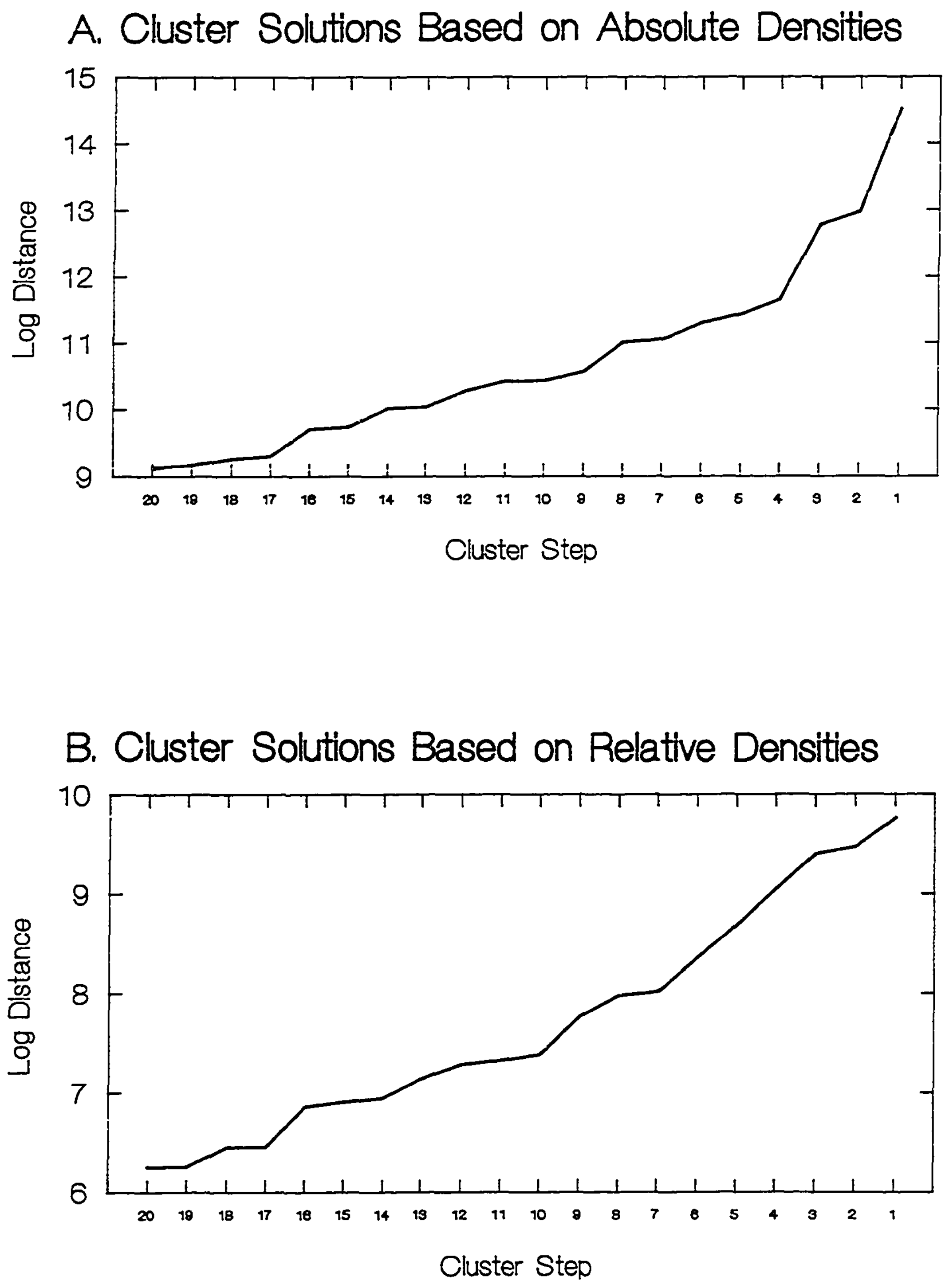


Figure 7.6. Scree plots for Early Aztec cluster analyses: **A.** cluster solutions based on absolute densities; **B.** cluster solutions based on relative densities.

```
                                     Cluster Solution
                       2 1 1 1 1 1 1 1 1 1 1 9 8 7 6 5 4 3 2 1
         Cluster       0 9 8 7 6 5 4 3 2 1 0
Zone    4    9     20
2       1    1      1  +---------I
        1    1      2  +---------I-----I
        1    1      3  +---I           I---------I
        1    1      4  +---I-----------I         I---I
        1    2      5  +-------------------------I   I
                                                     I
3       1    3      6  +-------------------I         I-I
        1    3      7  +-------------------I---------I I
                                                       I
4       2    4      8  +-------I                       I
        2    4      9  +-------I-----I                 I-I
        2    4     10  +-------------I-------I         I I
                                             I         I I
6       2    5     11  +---------------------I---------I I
                                                         I
5a      3    6     12  +-----I                           I
        3    6     13  +-----I-----------I               I-I
        3    6     14  +-----------------I---------I     I I
                                                   I     I I
5&5b    3    7     15  +-I                         I     I I
        3    7     16  +-I-------I                 I-----I I
        3    7     17  +---------I-----------------I       I-
                                                           I
1       4    8     18  +-----------I                       I
        4    8     19  +-----------I-----------I           I
        4    9     20  +-----------------------I-----------I
```

Figure 7.7. Dendrogram for Early Aztec cluster analyses based on absolute densities (only the last 20 steps are shown).

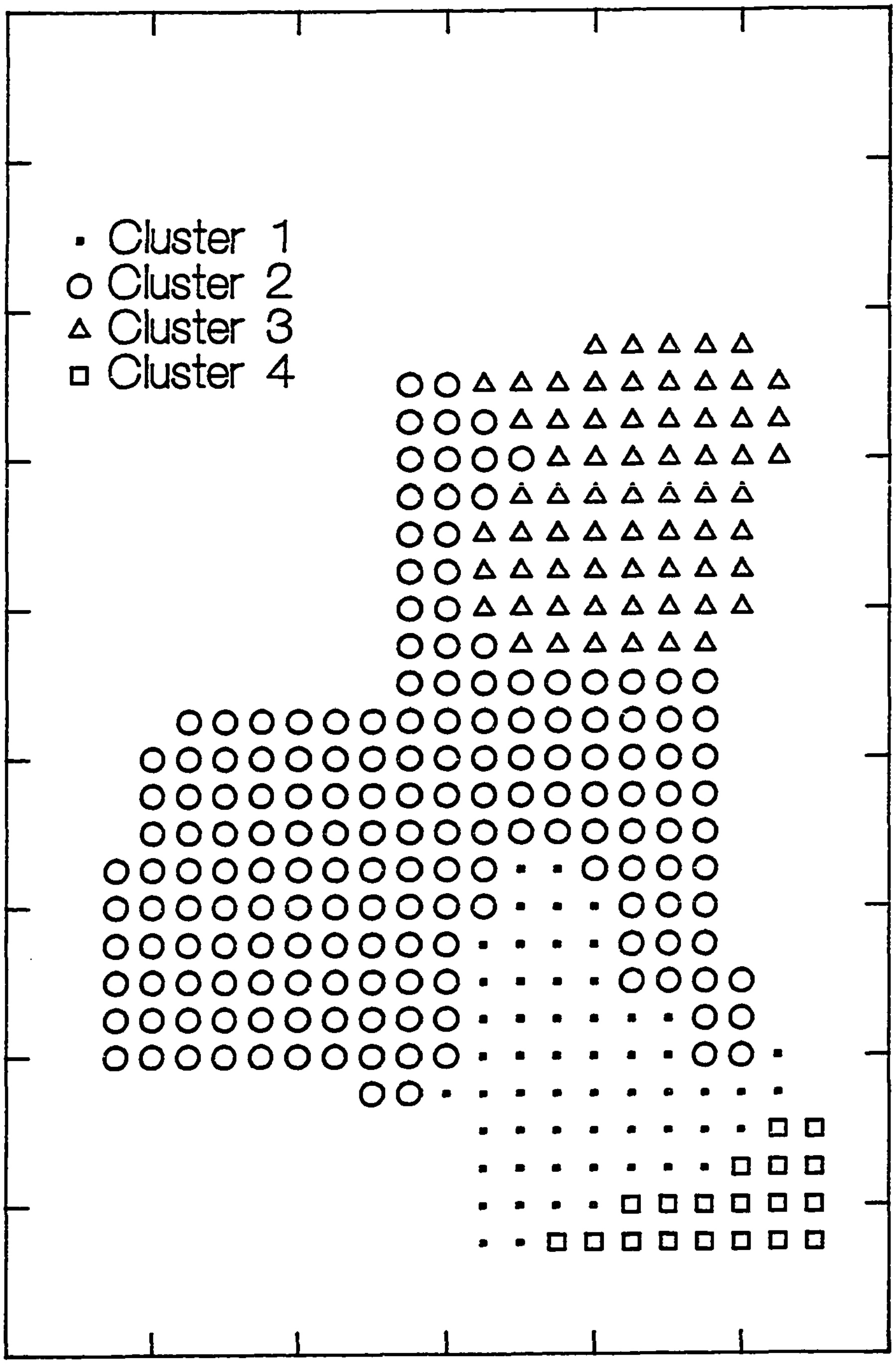


Figure 7.8. Cluster map for Early Aztec cluster analyses: 4-cluster solution based on absolute densities.

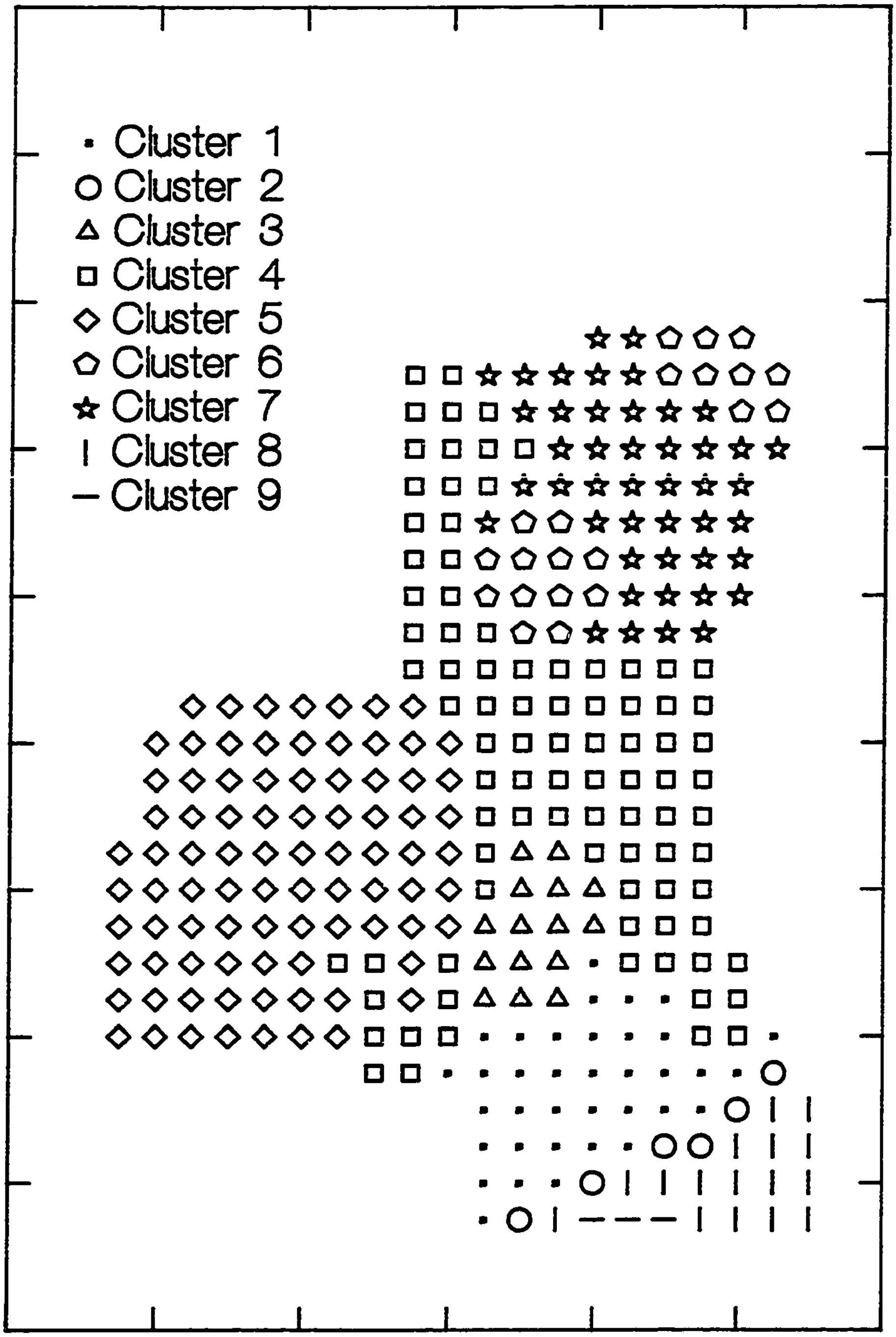


Figure 7.9. Cluster map for Early Aztec cluster analyses: 9-cluster solution based on absolute densities.

appear to have assemblage compositions similar to the surrounding area (Cluster 7), but differ in having higher absolute densities.

Finally, the SE zone is subdivided into three major clusters or parallel zones that have substantially different assemblage compositions. The south-central zone now includes two distinct areas (Clusters 1 and 3) as well as a zone of overlap (Cluster 2) with the far southern area (Clusters 8 and 9). This zone of overlap indicates that the far southern area, although it remains distinct throughout the cluster analysis, bears some affinity to adjacent zones in assemblage composition. In particular, this far southern zone shares higher densities of Black/Red Variants I and B, as well as Black/Red-Incised Variant A, with the adjacent zone to the north, represented by Clusters 1 and 2 (Table 7.1).

Table 7.1
Mean Absolute Densities for Early Aztec Ceramic Types for 9-Cluster Solution Based on Absolute Densities

Red Ware Variant	Cluster								
	1	2	3	4	5	6	7	8	9
B/R A	22.4	2.7	49.1	4.6	0.3	4.2	2.4	1.0	0.6
B/R B	42.9	38.2	29.8	19.5	1.4	35.8	14.7	46.2	81.8
B/R D	3.8	9.3	4.1	4.0	0.0	10.9	18.2	8.5	19.7
B/R E	25.7	25.0	2.6	2.3	1.3	1.3	0.4	24.9	54.7
B/R H	13.0	41.0	4.3	3.7	0.1	2.3	1.0	63.2	140.7
B/R-I	40.2	119.4	8.7	2.3	0.1	1.9	1.2	218.8	281.9
B/R-I A	114.0	20.2	6.3	1.7	0.4	1.2	0.5	33.8	22.3
B/R-I B	11.6	2.4	10.9	2.4	0.0	0.5	0.2	3.1	1.3
B/R-I C	3.7	0.3	16.0	1.9	0.3	1.2	0.6	0.0	0.0
B&W/R AW1	0.5	0.1	0.7	5.4	0.2	29.7	11.8	0.0	0.0
B&W/R AW2	9.1	5.0	9.9	6.5	2.3	17.0	18.0	12.3	2.7
B&W/R AN	12.5	2.2	25.0	8.8	2.8	4.3	3.7	4.8	0.5
B&W/R B	4.8	4.8	2.9	9.3	1.7	94.4	47.4	6.0	2.0
B&W/R C	3.7	1.1	7.1	1.5	0.9	7.0	10.3	2.2	5.0
B&W/R D1	0.5	0.2	1.0	6.3	1.2	13.6	10.3	0.0	0.0
B&W/R D2	1.5	0.0	1.7	0.6	3.8	3.0	1.4	0.0	0.0
B&W/R D3	5.3	0.8	3.4	10.3	0.0	19.1	7.2	0.2	0.3
B&W/R E1	2.7	0.4	13.2	1.2	0.1	5.0	1.0	0.0	0.0
B&W/R E2	14.6	4.5	45.9	5.9	1.9	5.3	6.3	4.3	2.0
B&W/R E3	1.4	0.3	4.5	1.9	0.1	1.1	0.9	0.2	0.0
Total	234.0	277.7	247.0	100.2	18.7	259.9	157.3	429.3	615.8

Cluster Results based on Relative Densities. The scree plot (Fig. 7.6b) for cluster solutions based on relative densities indicates a steady increase in the SSE following the 7-cluster solution, and lesser jumps in the SEE following the 10- and 14-cluster solutions. Of these, the 10-cluster and 14-cluster solutions are of particular interest, because they duplicate patterns recovered through analyses of absolute ceramic densities (Fig. 7.10). The 10-cluster solution based on relative densities (Fig. 7.11) bears remarkable similarities to the 4-cluster solution based on absolute densities (Fig. 7.8) discussed above. Both of these solutions make a primary division within the study area into NE, SE, and intervening zones. As in the previous analysis, the 10-cluster solutions identifies a NE zone (Cluster 9) encompassing much of the Texcoco survey region. Similarly, within the SE portion of the study area, this solution breaks out a south-central area (Cluster 2) and a far southern area (Cluster 1). Finally, this solution also identifies a broad intervening band (Cluster 3) extending between the NE and SE areas.

The two solutions based on absolute and relative densities do differ, however, in their treatment of the southwestern Lake Chalco-Xochimilco area. The cluster solution based on absolute densities identified this as an area with uniformly low densities of Early Aztec Red ware ceramics. The solution based relative densities, in contrast, divides this western area into a number of small highly distinct patches (Clusters 4-8). These small clusters presumably reflect the unreliable nature of percentage data in areas with very low ceramic densities and should not be interpreted as representing areas with distinct ceramic assemblages. None of these small patches, however, were identified as belonging to areas north, east, or south, and as a group they represent a separate branch of the dendrogram. In both analyses, therefore, the Lake Chalco-Xochimilco area remains distinct.

Similarly, the 14-cluster solution based on relative densities (Fig. 7.12, Table 7.2) bears some significant similarities to the 9-cluster solution based on absolute densities (Fig. 7.9). Particularly noteworthy is the division in both solutions of the SE zone into three

```
                                             Cluster Solution
                          2 1 1 1 1 1 1 1 1 1 1 9 8 7 6 5 4 3 2 1
             Cluster      0 9 8 7 6 5 4 3 2 1 0
Zone      10    14    20

1          1     1     1  +---------------------------I
                                                      I
2          2     2     2  +-----------------I         I
                                            I         I
3          2     3     3  +-----------------I-------I I-----I
                                                    I I     I
4          3     4     4  +-----I                   I I     I
           3     4     5  +-----I---------I         I-I     I
                                          I         I       I
4a         3     5     6  +---------------I---------I       I
                                                            I
6          4     6     7  +-I                               I-I
           4     6     8  +-I-----------I                   I I
           4     7     9  +-------------I-----------------I I I
           5     8    10  +---------I                     I I I
           5     8    11  +---------I-------------------I I-I I-I
           6     9    12  +---------------------I       I-I   I I
           7    10    13  +---------------------I-------I     I I
           8    11    14  +-----------I                       I I
           8    11    15  +-----------I-----------------------I I
                                                                I-
5&5a       9    12    16  +-------I                             I
           9    12    17  +---I   I-----------I                 I
           9    12    18  +---I---I           I---I             I
                                              I   I             I
5b         9    13    19  +-------------------I   I-------------I
                                                  I
6         10    14    20  +-----------------------I
```

Figure 7.10. Dendrogram for Early Aztec cluster analyses based on relative densities (only the last 20 steps are shown).

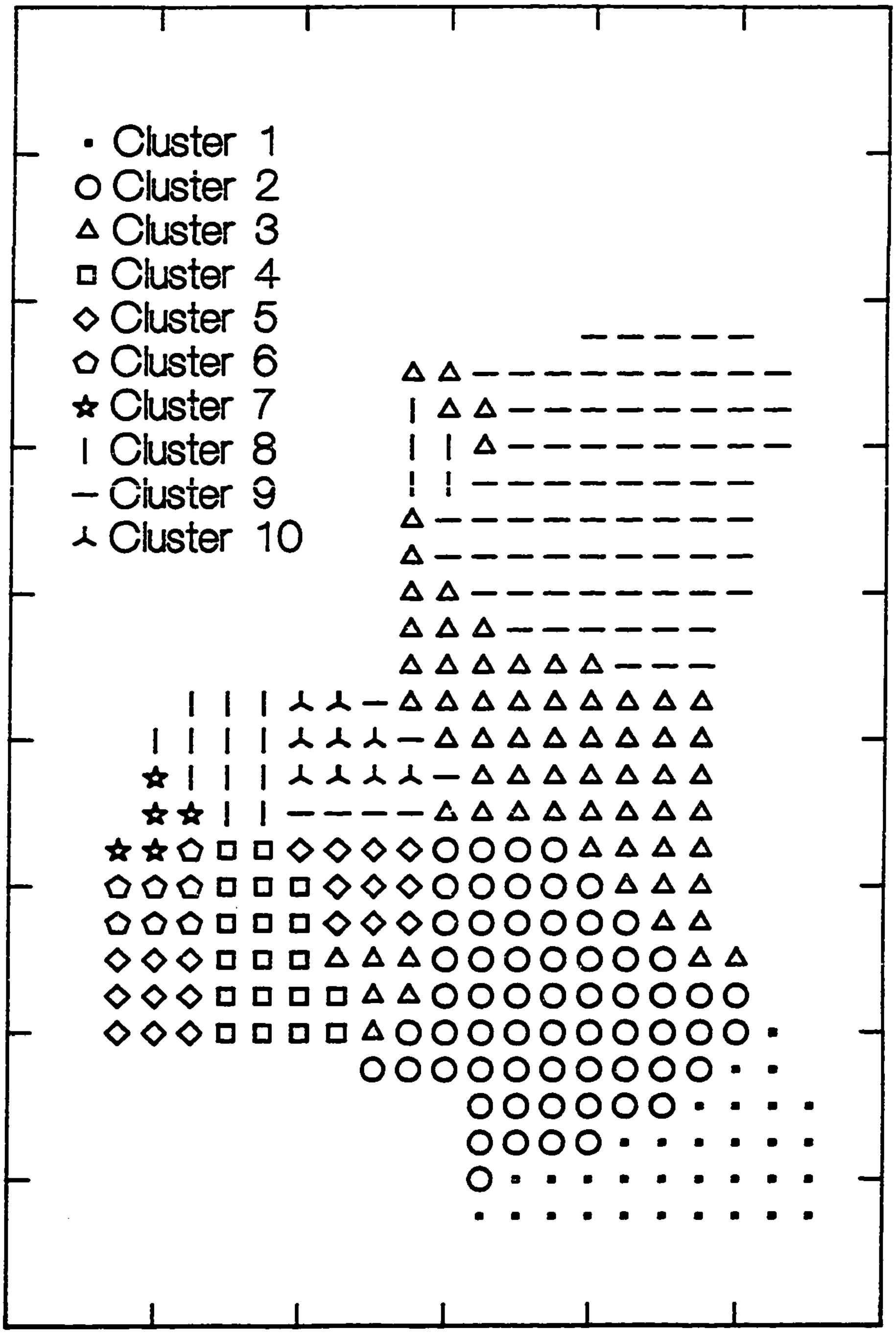


Figure 7.11. Cluster map for Early Aztec cluster analyses: 10-cluster solution based on relative densities.

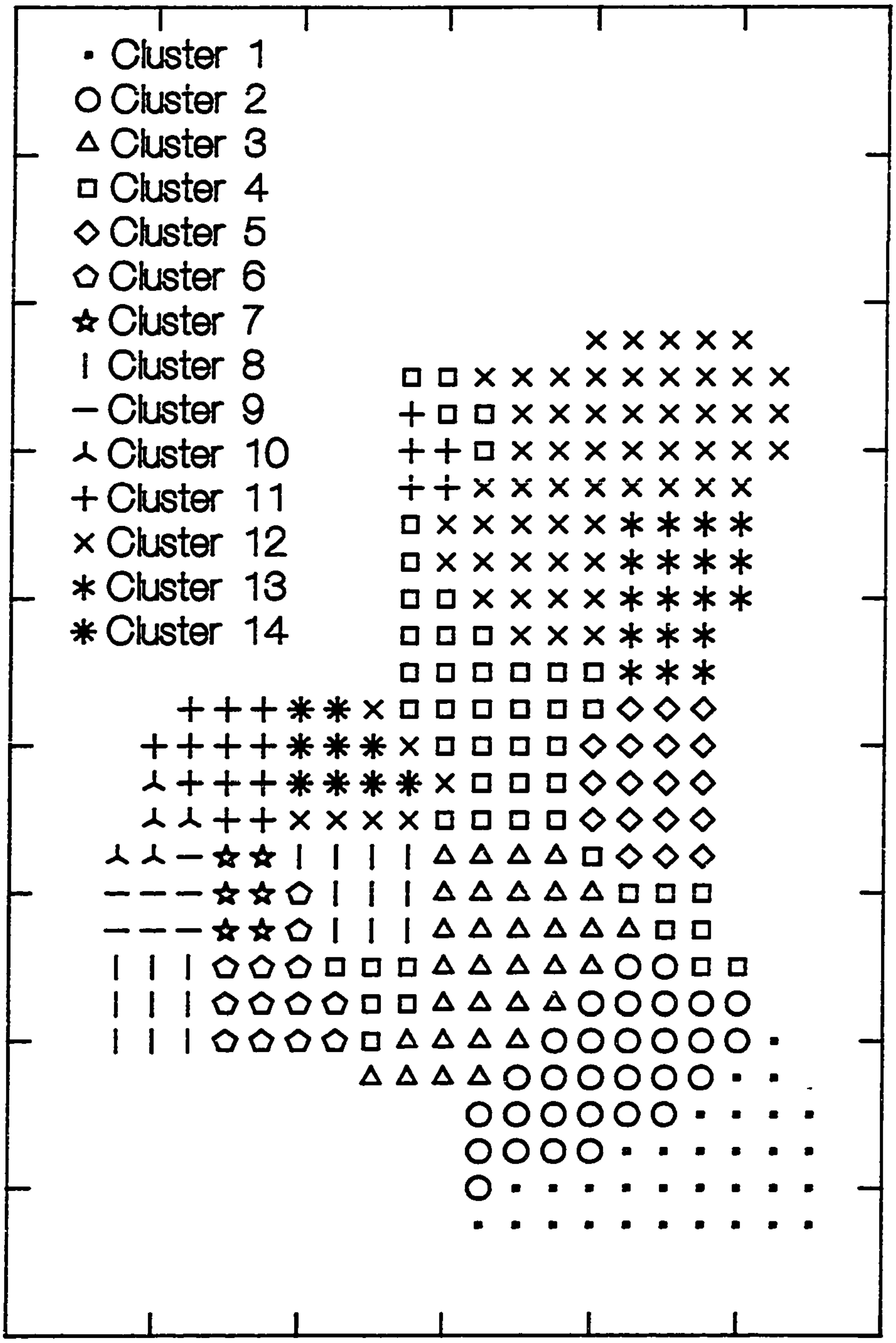


Figure 7.12. Cluster map for Early Aztec cluster analyses: 14-cluster solution based on relative densities.

Table 7.2
Mean Relative Densities for Early Aztec Ceramic Types for 14-Cluster Solution Based on Relative Densities

Red Ware Variant	Cluster													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
B/R A	0.8	8.6	19.0	4.3	2.5	0.5	0.0	0.2	0.0	0.0	0.0	1.3	2.0	1.3
B/R B	2.7	19.3	12.9	22.3	12.5	9.1	0.5	3.9	0.0	7.3	75.2	11.3	7.9	5.5
B/R D	2.6	1.8	1.5	4.1	3.0	0.0	0.0	0.0	0.0	0.0	0.3	5.1	17.7	0.0
B/R E	8.0	12.6	2.4	2.6	0.7	23.1	2.2	1.4	0.0	0.0	0.0	0.4	0.2	0.0
B/R H	5.2	5.0	1.5	1.8	7.5	0.5	0.0	0.1	0.0	0.0	0.0	0.7	0.8	0.0
B/R I	5.2	14.2	5.2	1.4	2.1	0.9	0.0	0.3	0.0	0.0	0.0	0.7	0.4	0.0
B/R-I A	7.2	5.8	4.8	1.8	1.4	0.9	0.0	3.4	0.0	0.0	0.0	2.2	0.5	3.8
B/R-I B	1.0	5.8	4.3	1.7	2.0	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.0
B/R-I C	0.1	1.6	6.1	2.2	1.2	0.9	0.9	2.4	0.2	0.0	0.0	0.4	0.9	0.0
B&W/R AW1	0.0	0.3	0.4	6.6	3.1	0.0	0.0	0.1	0.0	0.0	2.1	10 2	5.0	5.8
B&W/R AW2	2.4	4.7	3.2	6.1	7.2	8.4	23.0	10.7	36.3	10.0	0.4	6.7	15.4	0.1
B&W/R AN	1.0	6.1	7.9	6.7	12.9	26.7	51.8	10.3	6.4	0.0	4.2	1.9	3.5	1.2
B&W/R B	1.4	1.8	2.4	12.9	4.3	6.7	0.5	1.6	0.0	0.0	7.8	35.9	20.3	72.1
B&W/R C	0.5	1.3	2.9	2.4	0.5	0.5	1.2	1.2	22.0	75.4	5.3	4.7	6.5	5.0
B&W/R D1	0.0	0.2	0.5	6.9	9.5	6.1	1.5	8.6	0.0	0.0	0.4	6.2	5.8	2.5
B&W/R D2	0.0	0.7	0.9	1.3	0.2	8.6	2.0	47.9	10.6	0.6	2.6	2.0	0.4	0.0
B&W/R D3	0.3	1.7	2.9	5.0	21.6	0.0	0.0	0.0	0.0	0.0	1.5	6.6	3.5	0.0
B&W/R E1	0.2	1.6	3.6	1.5	0.3	0.0	0.0	0.0	0.0	0.0	0.1	1.2	0.5	1.2
B&W/R E2	1.3	5.2	15.6	6.9	5.3	6.6	15.4	7.6	24.2	6.7	0.1	1.9	8.2	1.4
B&W/R E3	0.1	1.5	1.7	1.7	2.2	0.4	0.9	0.2	0.2	0.0	0.0	0.5	0.6	0.0

parallel zones (where relative density Clusters 1, 2, and 3 correspond spatially to absolute density Clusters 2-8-9, 1, and 3, respectively). The two solutions disagree, however, in their subdivision of the NE zone. The cluster solution based on absolute densities identified two "hot spots" with higher sherd densities in the NE and SW corners. In contrast, the cluster solution based on relative densities identifies the SE corner of that zone (Cluster 13) as having a somewhat different assemblage composition, while identifying the "hot spots" as similar in composition to the remainder of the zone (Cluster 12).

Finally, the 14-cluster solution identifies within the intervening zone (Cluster 4) a distinct sub-zone along the eastern edge of the study area (Cluster 5). This zone is also recognized by finer-level solutions (e.g. the 13-cluster solution) based on absolute densities.

Synthesis and Map of Early Aztec Market Zones. A composite map of Early Aztec market zones was obtained by overlaying the cluster maps from the two different analyses and noting areas where the analyses conformed (Fig. 7.13). In general, the cluster analyses based on absolute and relative densities show a high degree of correspondence, and the close agreement in cluster placement indicates areas which both analyses classify as distinct. Although the boundaries of these areas show some slight differences, these discrepancies are minimal, usually only by a single grid point. These areas of agreement are the basis for defining market **zones**. Sub-zones were tentatively identified based on areas identified by either cluster analysis as having distinct assemblage characteristics.

The two cluster analyses concur in identifying six distinct zones within the study area during the Early Aztec period (Fig. 7.14). These are interpreted as distinct areas of ceramic exchange activity. In addition, 3 sub-zones were defined in order to further evaluate their possible significance.

The southeastern portion of the study area is subdivided into three parallel zones 1, 2, and 3. Overall, Zones 1-3 are characterized by generally high densities of Early Aztec Red wares (mean grid point density = 253 sherds/ha) and are surrounded by areas of

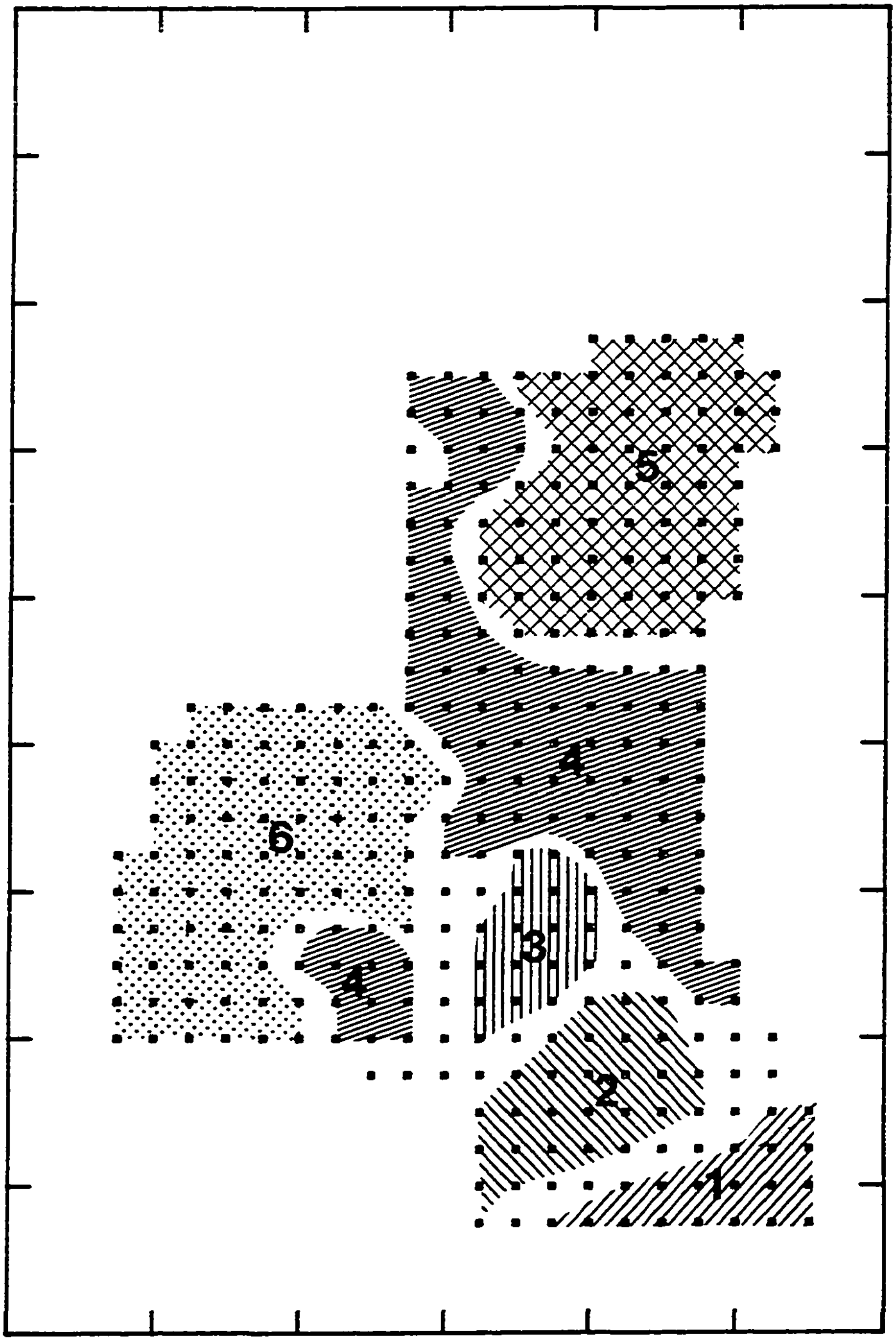


Figure 7.13. Overlay of Early Aztec cluster maps based on absolute and relative densities showing areas of agreement between cluster analyses. Numbers reflect market zone designations.

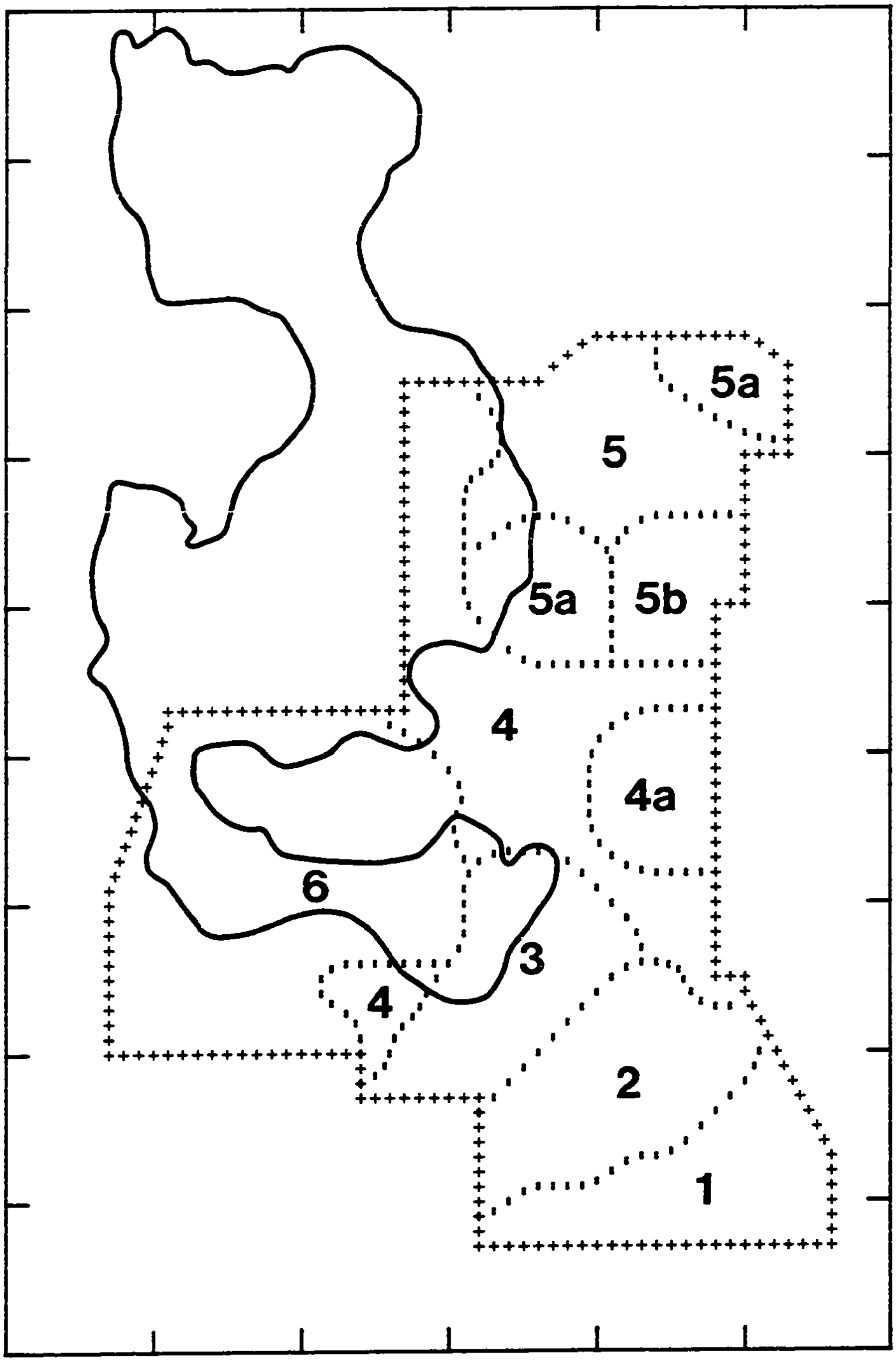


Figure 7.14. Final composite map of Early Aztec market zones.

significantly lower ceramic densities. Further, the assemblages are dominated by ceramic variants that were defined in the south and that have a limited representation outside of this region. In comparison with the north, there is a preponderance of Black/Red variants (particularly A, E, H, and I) and Black/Red-Incised variants. Only two Black&White/Red variants (AN and E2) are present in any quantity. Each zone, however, is characterized by higher relative densities of locally preferred variants (Table 7.3, Fig. 7.15). For example, Zone 1 has high densities of Black/Red Variants H and I, while Zone 2 has higher densities of Black/Red Variant E, and Zone 3 has substantially higher densities of Black/Red Variant A. In addition, the distinctiveness of the far southern Zone 1 may reflect exchange contacts with areas further south, outside the designated study area.

Intermediate between north and south and peripheral to both is Zone 4. This zone has low, but not extremely low, densities of Red ware ceramics (mean = 99 sherds/ha). Overall, Zone 4 appears to have been participating to some degree in both northern and southern spheres based on assemblage composition (Table 7.3, Fig. 7.16). With the southeast, Zone 4 shares a number of Black/Red and Black/Red-Incised variants (in low percentages), along with a preference for Black&White/Red Variant AN. With the north, Zone 4 shares a high percentage of Black&White/Red variants, especially Variants AW and B. Within this zone, Sub-zone 4a represent a localized area with denser ceramics and a somewhat different assemblage composition. Sub-zone 4a differs from Zone 4 in having substantially lower relative densities of Black/Red B and Black&White/Red B, and higher relative densities of Black&White/Red AN and D3.

The northeast contains a single zone (Zone 5), including the lakeshore and piedmont portions of the Texcoco survey region. Overall, this zone is characterized by fairly high Red ware sherd densities (mean absolute density=186 sherds/ha), and a predominance of Black&White/Red variants, particularly Variants AW, AN, B, C, D1 and D3 (Table 7.3, Fig. 7.17). Within this zone, the sub-zones labelled 5a represent areas with

Table 7.3A
Assemblage Composition for Early Aztec Market Zones:
Percentage Based on Type Counts at Sites Assigned to Zone

Red Ware Variant	Market Zone								
	1	2	3	4	4a	5	5a	5b	6
B/R A	2.1	10.5	23.0	3.5	0.0	2.7	3.2	5.9	0.0
B/R B	11.9	20.5	14.3	12.0	12.2	12.4	10.1	16.8	9.7
B/R D	2.5	1.7	2.3	7.8	0.0	6.8	5.1	10.9	0.0
B/R E	7.4	8.1	1.3	3.8	0.0	0.2	1.1	0.0	3.2
B/R F	0.4	0.4	0.0	1.3	0.0	0.2	0.1	0.0	0.0
B/R G	0.4	0.5	1.0	0.7	7.3	0.7	0.5	0.8	0.0
B/R H	13.6	3.3	3.0	1.3	7.3	1.6	0.8	0.0	0.0
B/R I	44.0	15.3	3.3	1.6	4.9	0.4	0.1	0.8	0.0
B/R-I A	9.1	5.3	4.0	3.1	2.4	0.4	1.9	0.0	3.2
B/R-I B	1.2	5.1	3.7	1.8	0.0	0.2	0.6	0.0	3.2
B/R-I C	0.0	2.4	8.7	0.9	0.0	0.7	0.8	0.0	6.5
B&W/R AW1	10.0	0.7	0.3	6.4	2.4	6.8	9.6	6.7	3.2
B&W/R AW2	22.1	4.9	5.3	6.4	9.8	5.8	7.0	16.8	9.7
B&W/R AN	0.8	5.5	7.3	9.3	12.2	3.6	3.8	4.2	9.7
B&W/R B	2.9	1.2	0.7	11.6	2.4	30.2	26.9	14.3	6.5
B&W/R C	0.8	1.3	0.3	2.9	0.0	6.3	3.2	9.2	6.5
B&W/R D1	0.0	0.5	0.3	9.6	7.3	7.9	8.3	5.0	6.5
B&W/R D2	0.0	0.5	1.3	1.6	0.0	0.9	2.3	0.8	19.4
B&W/R D3	0.0	1.7	0.7	3.8	24.5	6.3	7.4	1.7	0.0
B&W/R E1	0.0	1.9	3.7	2.2	0.0	1.8	2.3	0.8	0.0
B&W/R E2	0.4	6.9	12.0	5.3	2.4	2.5	3.9	4.2	6.5
B&W/R E3	0.4	0.8	3.0	2.5	4.9	1.3	0.9	0.8	3.2
B&W/R E4	0.0	0.9	0.3	0.5	0.0	0.2	0.0	0.0	3.2
Total Count	243	752	300	550	41	444	784	119	31

Table 7.3B
Assemblage Composition for Early Aztec Market Zones:
Percentage Based on Type Densities at Sites Assigned to Zone

Red Ware Variant	Market Zone								
	1	2	3	4	4a	5	5a	5b	6
B/R A	0.3	13.1	16.9	6.4	0.0	0.5	1.7	2.1	0.0
B/R B	11.6	17.5	13.2	30.7	9.5	7.6	13.8	8.4	5.8
B/R D	2.5	1.2	1.2	7.4	0.0	12.1	3.2	19.1	0.0
B/R E	6.7	8.8	1.0	1.5	0.0	0.1	0.7	0.0	3.5
B/R F	0.1	0.3	0.0	2.8	0.0	0.0	0.0	0.0	0.0
B/R G	0.3	0.2	2.5	1.2	5.7	0.1	0.4	0.9	0.0
B/R H	16.1	2.7	3.0	1.5	9.2	0.9	0.9	0.0	0.0
B/R I	48.7	14.5	3.8	0.7	2.3	1.8	0.0	1.1	0.0
B/R-I A	7.1	5.7	2.2	1.1	1.2	0.2	0.4	0.0	4.0
B/R-I B	0.7	5.5	4.0	3.4	0.0	0.1	0.1	0.0	0.4
B/R-I C	0.0	1.7	4.1	1.6	0.0	0.1	0.1	0.0	5.0
B&W/R AW1	10.0	0.2	0.2	5.4	3.3	6.8	12.0	5.3	0.4
B&W/R AW2	22.1	3.6	5.6	5.7	8.7	9.2	6.3	19.2	9.0
B&W/R AN	0.9	7.2	10.5	6.1	15.3	1.1	1.4	2.1	16.5
B&W/R B	1.8	1.9	0.2	9.2	1.2	39.5	38.4	16.4	10.3
B&W/R C	0.5	1.7	2.3	1.8	0.0	5.3	3.7	8.0	3.7
B&W/R D1	0.0	0.6	0.1	5.1	10.7	5.2	4.7	6.2	13.0
B&W/R D2	0.0	1.7	0.4	0.6	0.0	0.5	1.5	0.2	22.4
B&W/R D3	0.0	2.8	0.5	1.2	26.1	5.1	7.5	1.3	0.0
B&W/R E1	0.0	1.0	5.8	1.0	0.0	0.3	1.6	0.2	0.0
B&W/R E2	0.6	6.1	20.8	4.5	4.7	1.0	1.3	9.2	6.0
B&W/R E3	0.1	0.8	1.6	1.0	2.0	0.6	0.2	0.3	0.2
B&W/R E4	0.0	1.0	0.2	0.2	0.0	1.7	0.0	0.0	0.6
Mean Density	366	219	190	86	144	145	259	173	18

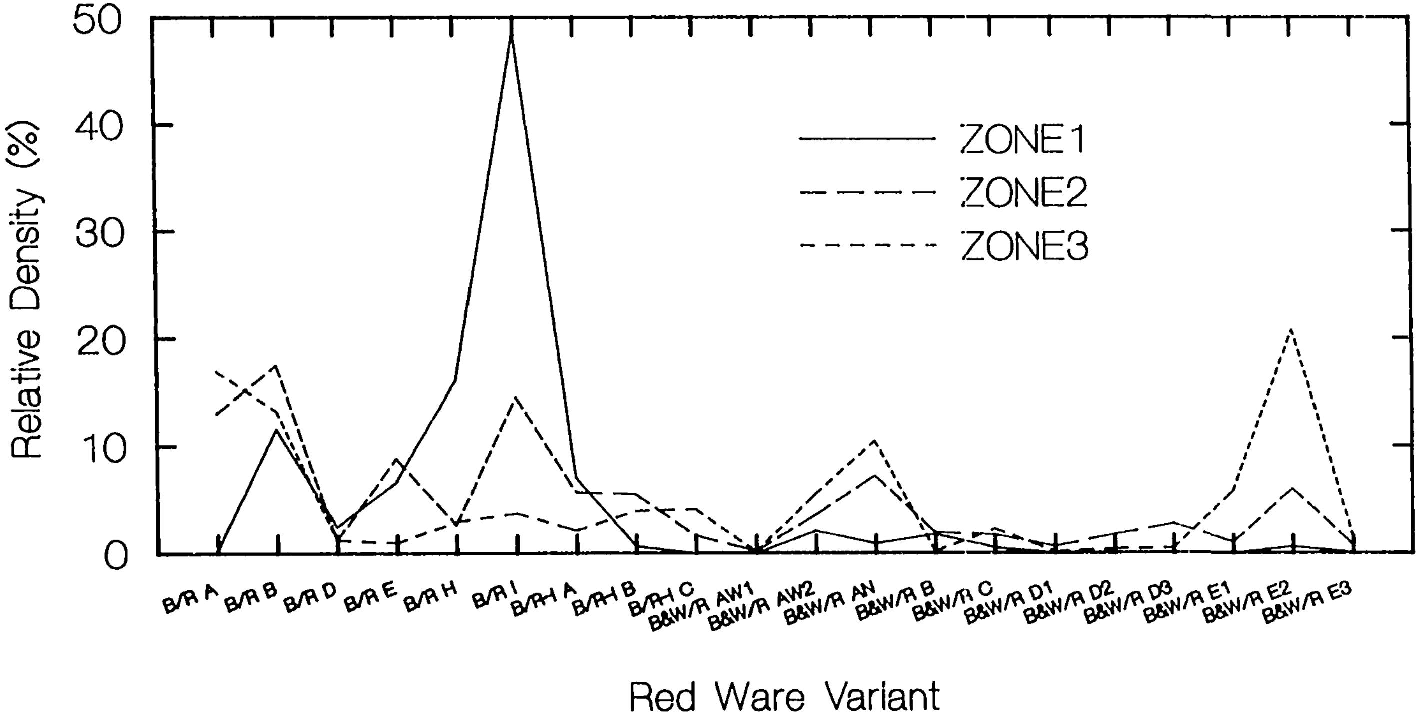


Figure 7.15. Assemblage composition for Early Aztec Zones 1-3. Percentages are based on absolute densities at grid points assigned to each zone, summed, and converted to % of total.

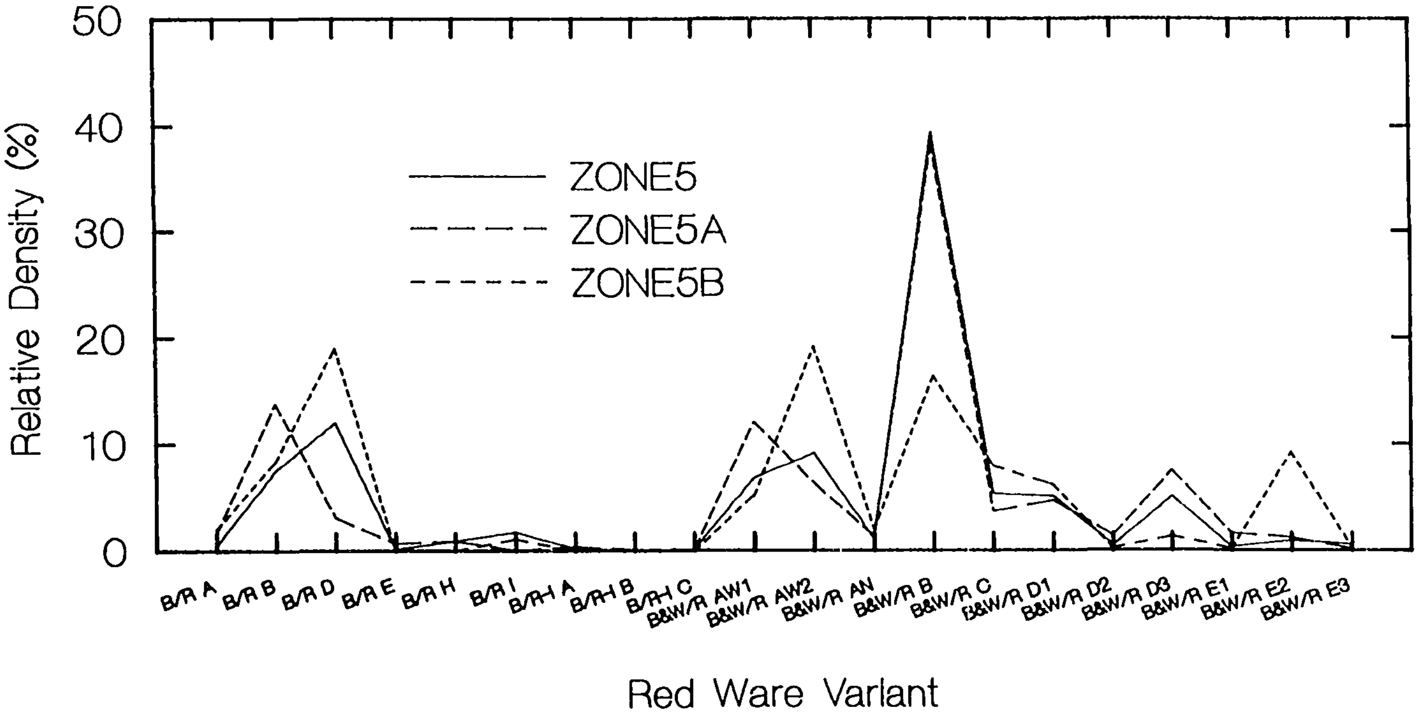


Figure 7.16. Assemblage composition for Early Aztec Zones 4 and 4a. Percentages are based on absolute densities at grid points assigned to each zone, summed, and converted to % of total.

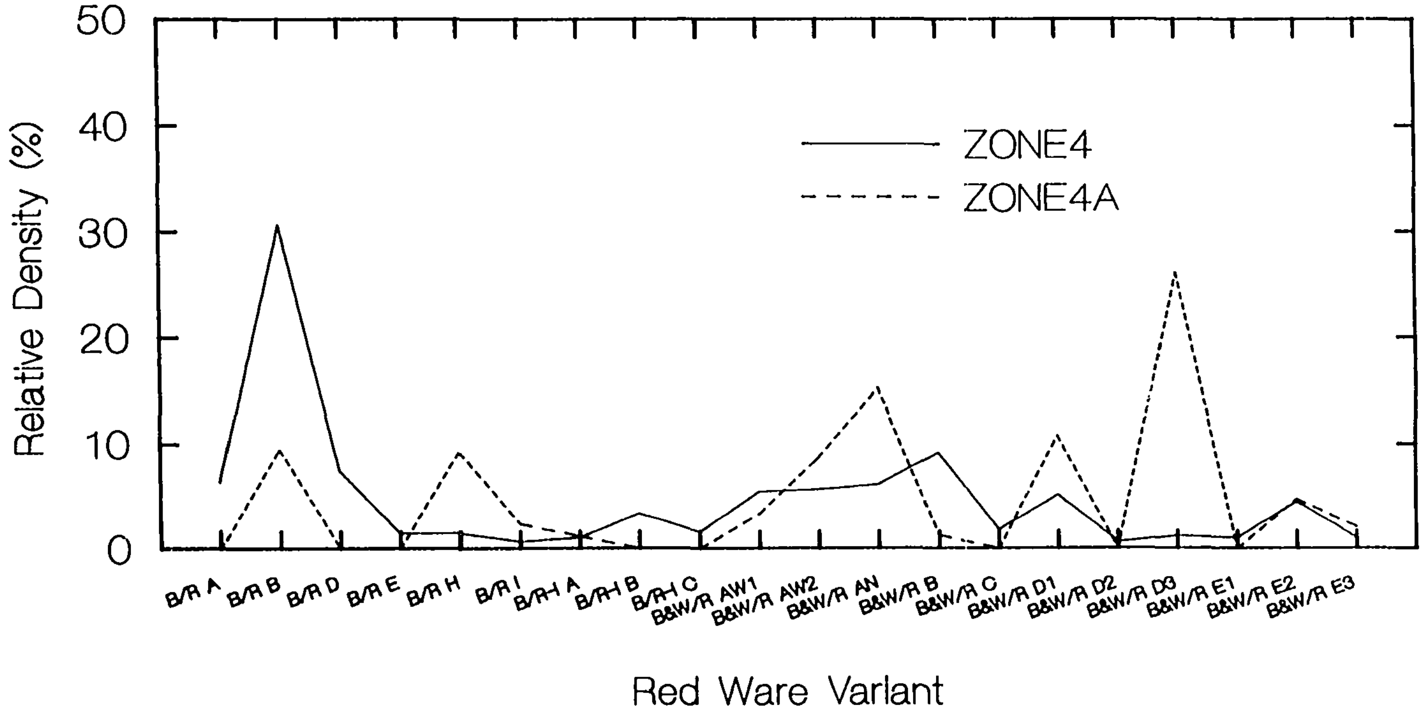


Figure 7.17. Assemblage composition for Early Aztec Zones 5, 5a, and 5b. Percentages are based on absolute densities at grid points assigned to each zone, summed, and converted to % of total.

higher sherd densities (mean=259 sherds/ha) that do not appear to differ significantly in assemblage composition. In contrast, Zone 5b differs in assemblage composition in having higher percentages of Black/Red Variant D and Black&White/Red Variant AW2, and correspondingly lower relative densities of Black&White/Red Variant B.

Finally, Zone 6 comprises the Chalco-Xochimilco lakebed and some adjacent lakeshore regions. This zone is characterized by very low Red ware densities (mean = 18 sherds/ha). The cluster analysis based on relative densities divided this zone into a number of small patches. This patchiness largely reflects the unreliable nature of percentage data in low density areas. However, it also suggests that the lakebed communities were not uniform in their patterns of Red ware consumption.

Characterizing Early Aztec Market System Structure

Scale. The cluster analyses indicate that during Early Aztec times, much of the eastern side of the Valley was divided among a number of small, distinct market zones, ranging in size from approximately 100 to 200 km^2 (Table 7.4). These market zones represent areas of relatively high ceramic densities and active Red ware production and exchange, and can be contrasted with the Chalco-Xochimilco lakebed characterized by very low Red ware ceramic densities and minimal participation in regional Red ware exchange.

Table 7.4
Areal Extent of Early Aztec Market Zones

Zone	Grid Sqs.	Area (km^2)	% of Total
1	32	200	10.1
2	30	188	9.5
3	29	181	9.1
4	59	369	18.6
4a	18	112	5.7
5	32	200	10.1
5a	21	131	6.6
5b	15	94	4.7
6	81	506	25.6

However, a check for possible regional subdivisions, based on Brainerd-Robinson agreement coefficients calculated between all pairs of market zones (Table 7.5), does not support the division of the study area into multiple distinct exchange systems. Rather, all zones show at least an intermediate level (Brainerd-Robinson coefficient > 100) of interaction with adjacent zones. Although zones at some distance from each other are highly dissimilar, no strong discontinuities in similarity coefficients were found between adjacent zones that might indicate boundaries between disarticulated systems.

Table 7.5
Matrix of Brainerd-Robinson Coefficients Indicating Degree of Similarity Among Early Aztec Market Zones

A. Based on type counts at sites assigned to each zone.

Zone:	1	2	3	4	4a	5	5a	5b	6
1	200.00	**109.51**	68.58	70.77	68.38	54.06	53.59	49.83	50.76
2		200.00	**136.41**	110.56	85.31	81.13	84.31	93.34	89.65
3			200.00	**110.69**	85.49	78.59	82.54	84.92	**100.54**
4				200.00	**112.59**	**149.51**	**153.54**	**141.02**	**129.40**
4a					200.00	96.02	96.02	88.58	101.05
5						200.00	**175.38**	**143.02**	97.98
5a							200.00	**134.44**	104.94
5b								200.00	103.84
6									200.00

B. Based on type densities at sites assigned to each zone.

Zone:	1	2	3	4	4a	5	5a	5b	6
1	200.00	**107.48**	68.94	56.99	68.00	45.47	49.22	36.83	48.38
2		200.00	**134.49**	118.68	100.17	64.05	73.08	66.13	82.73
3			200.00	**108.68**	101.08	67.37	74.58	73.54	**87.26**
4				200.00	**131.60**	**133.72**	**139.38**	**122.67**	**102.01**
4a					200.00	101.90	104.18	91.84	97.79
5						200.00	**178.02**	**142.76**	85.96
5a							200.00	**126.73**	78.49
5b								200.00	107.57
6									200.00

Note: Coefficients for adjacent zones have been highlighted.

Network. The degree of lateral movement of ceramics among these zones was based on the degree to which ceramic type distributions overlapped each other and crossed over market zone boundaries. For the most prevalent types, the density contour within which 75% of the type was located was mapped as representing the center of distribution for that type. A visual comparison of these areas revealed a pattern in which (1) several variants form highly overlapping distributions with other variants having distinct centers of distribution, and/or (2) several variants display almost identical patterns of distribution.

Within the SE portion of the study area, the predominant Red ware ceramic variants display a N-S gradient of highly overlapping distributions. The densest concentration of Black/Red Variant A falls within the Chalco and Tenango areas (Zones 3 and 2), while that of Black/Red E begins south of Chalco and extends south into the Amecameca region (areas associated with Zones 2 and 1) (Fig. 7.18). Black/Red Variants H and I are concentrated in the southernmost portion of the study area (Zone 1) and may well extend farther south out of the Valley of Mexico.

The Black/Red-Incised variants create a similar pattern of overlapping distributions (Fig. 7.19). Black/Red-Incised Variant C has the most northern extension and is the only Black/Red-Incised variant found in quantity north of Chalco. Black/Red-Incised B is concentrated farther south in the Chalco-Tenango area, while Black/Red-Incised A is farther south yet, in the Tenango-Amecameca region. The pattern of overlap in these southern variant distributions is summarized in Table 7.6.

Table 7.6
Distribution of Common Black/Red and Black/Red-Incised Variants in the South

	Black/Red				Black/Red Incised		
Zone	**A**	**E**	**H**	**I**	**C**	**B**	**A**
1		X	X	X			X
2	X	X				X	X
3	X				X	X	

X = high percentage of type found within market zone.

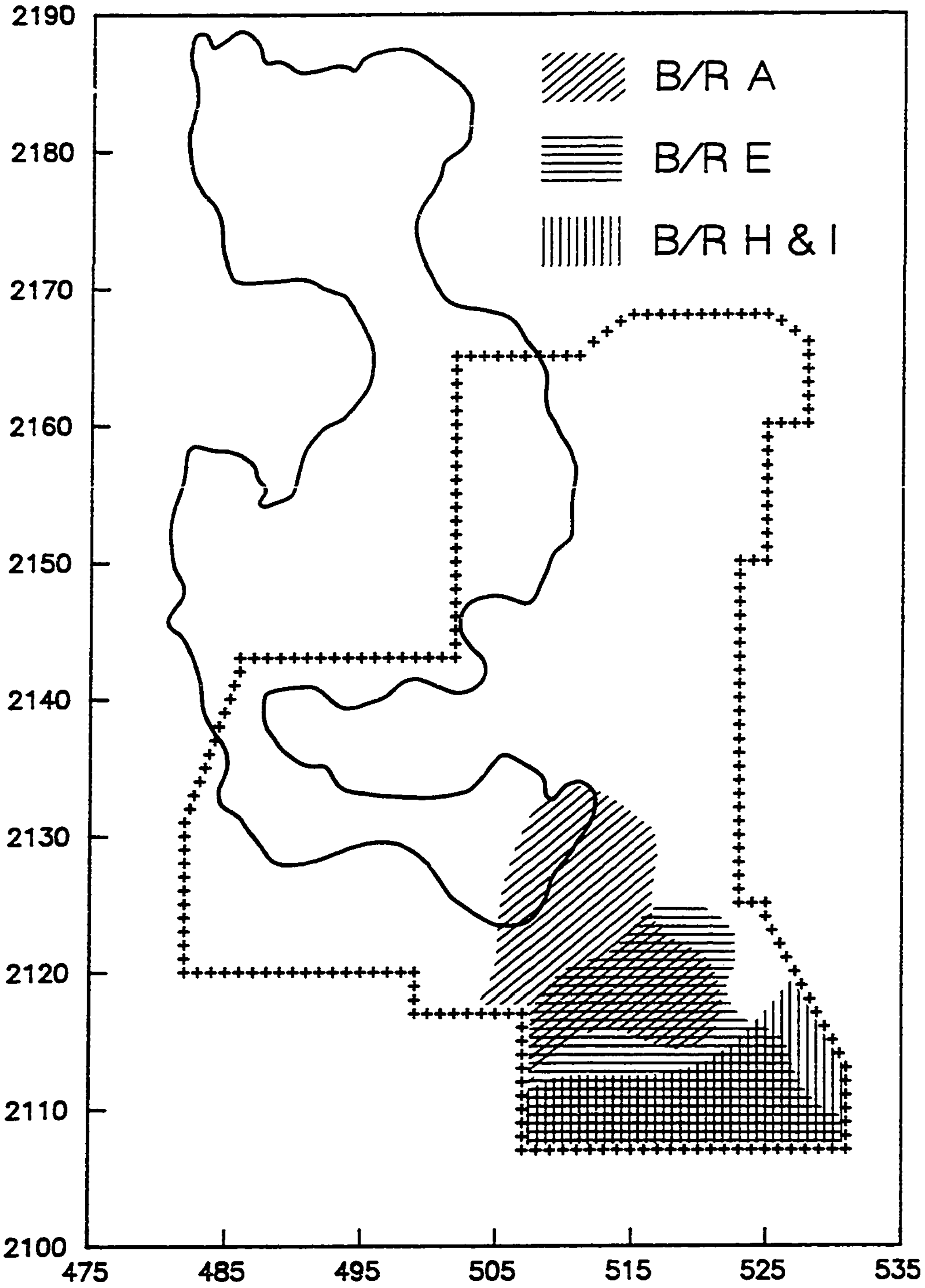


Figure 7.18. Overlap of Early Aztec Black/Red variant distributions in the south.

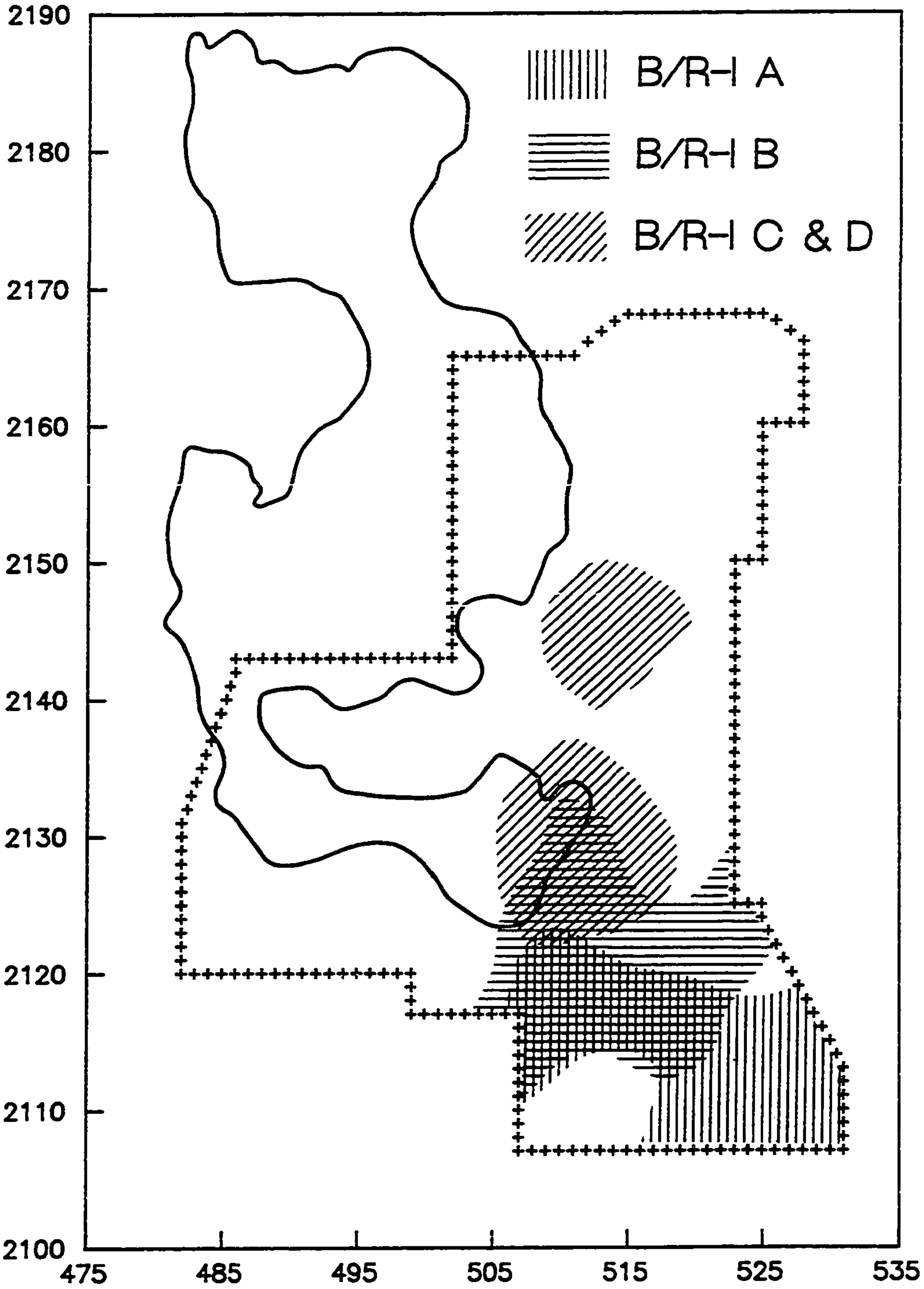


Figure 7.19. Overlap in Early Aztec Black/Red-Incised variant distributions in the south.

A similar degree of overlap in ceramic distributions in encountered within the northern portion of the study area (Zone 5). In this case, however, the centers of distribution for the predominant Red ware variants appear to reflect differences between settlements in the lower piedmont (Zone 5a) vs. those in the upper piedmont (Zone 5b). For example, Black&White/Red Variants AW1 and B show highly similar patterns of distribution concentrated in the Huexotla and Tepetlaoztoc areas identified with Zone 5a (Fig. 7.20a). In contrast, Black/Red Variant D and Black&White/Red Variant AW2 are both concentrated along the eastern slopes of the upper piedmont in Zone 5b (Fig. 7.20b). The area of overlap shared by these four types, however, is significant (Fig. 7.20a vs. 7.20b), indicating a high degree of interaction among the sub-zones.

The intervening area (Zone 4) shares types with both northern and southern spheres. For example, Black&White/Red Variants D1 and D3 are shared by the Huexotla area (Zone 5a) and Zone 4a, while Black&White/Red Variant AN is shared between Zone 4a and the Chalco area (Zone 3) to the south (Fig. 7.21).

The matrix of Brainerd-Robinson agreement coefficients between pairs of market zones presented above (Table 7.5) supports this interpretation of a well developed network among adjacent zones. In general, zones demonstrate greatest similarity with their nearest neighbors, and the degree of similarity decreases as separating distance increases. Within the south, Zone 3 is most similar to contiguous Zones 2 to the south and 4 to the north, Zone 2 shares high similarity coefficients with both Zones 1 and 3, while Zone 1 (the farthest south) is similar only to adjacent Zone 2. Within the north, Zones 5, 5a, and 5b share high similarity coefficients with each other and with adjacent Zone 4, but uniformly low coefficients with more distant zones to the south. Intervening areas (Zone 4 and 4a) have intermediate values and appear closer in assemblage composition to the north than to the south. The overall pattern is that of a chain of interaction, with no abrupt discontinuities in commodity flows.

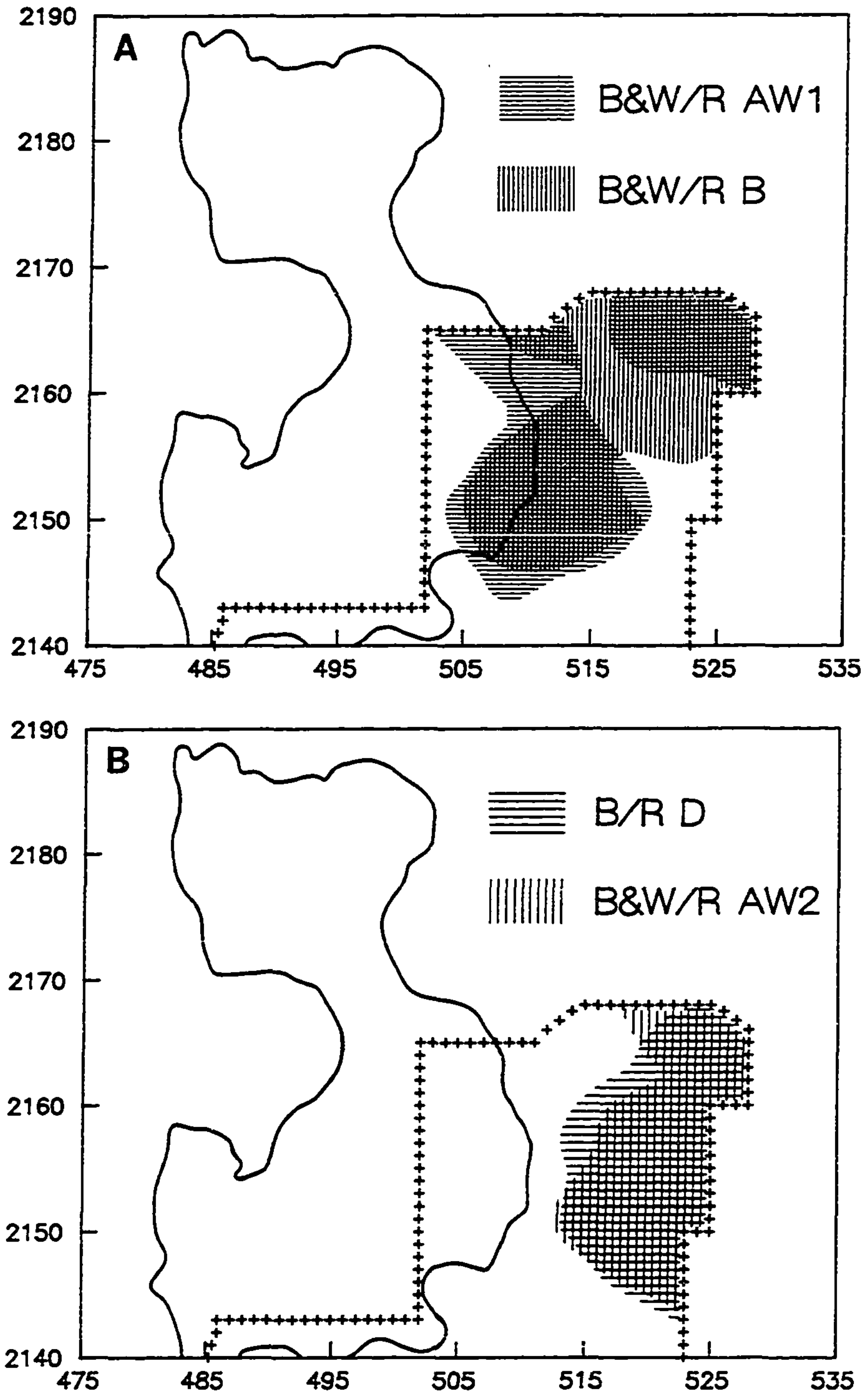


Figure 7.20. Overlap in Early Aztec Black/Red and Black&White/Red variant distributions in the north. **A.** Black&White/Red AW1 and B are associated with Zones 5a. **B.** Black/Red D and Black&White/Red AW2 are associated with Zone 5b.

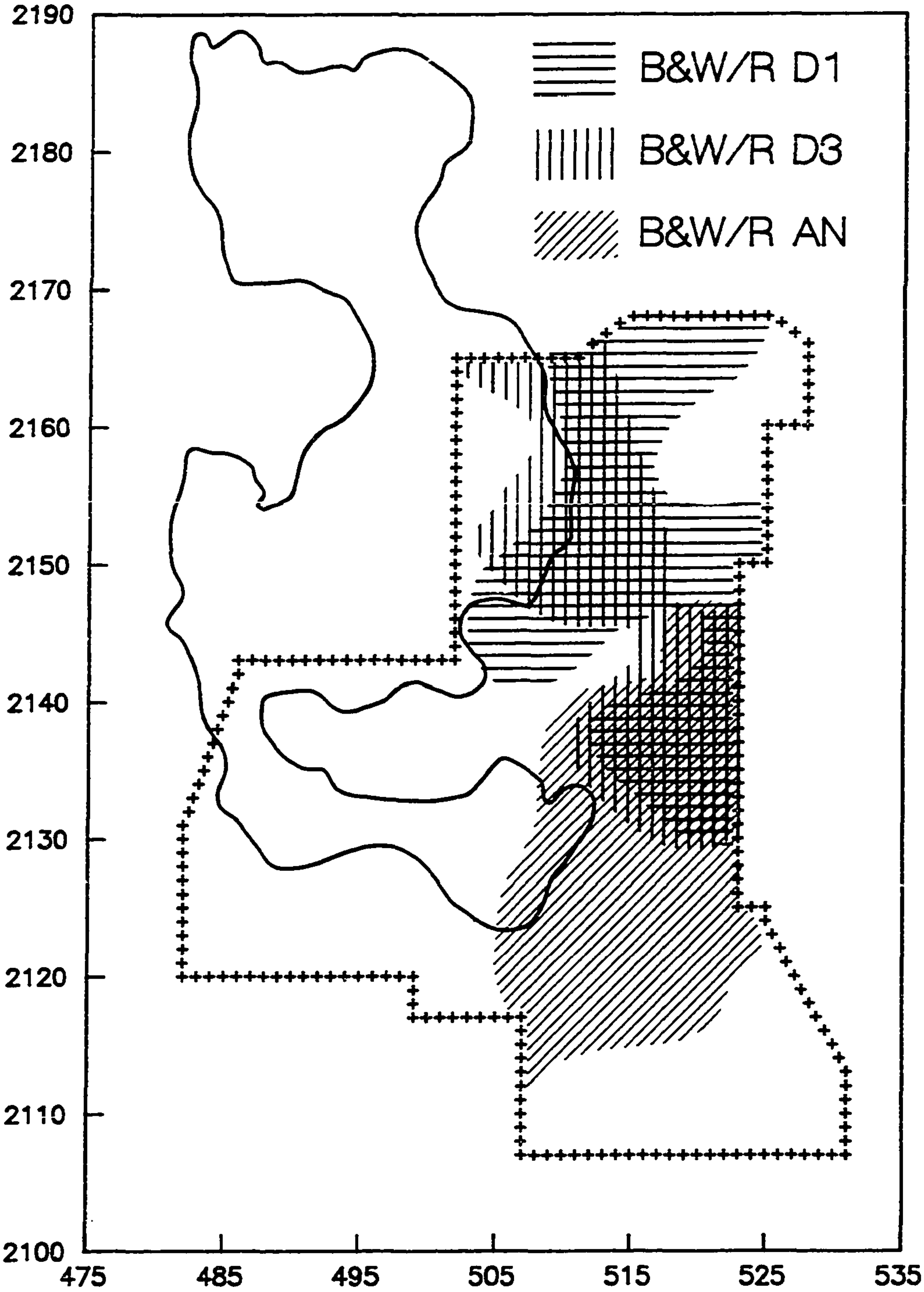


Figure 7.21. Overlap in Early Aztec Red ware variants between the north and the south. Black&White/Red D1 and D3 have largely northern distributions, but extend as far south as Zone 4a. Conversely, Black&White/Red AN has a largely southern distribution, but extends as far north as Zone 4a.

Hierarchy. Possible hierarchical relations among market zones were assessed from their differential access to a greater diversity and to higher quality ceramics. Assemblage richness as a measure of hierarchy was calculated based on the presence of 23 ceramic bowl variants and subvariants in site assemblages.[11] Attempts to fit a linear model to these data revealed that neither a log nor a semi-log transformation fully linearizes these data, as indicated by the arched distribution of residuals about the regression line. This persistent curvilinear relationship between richness and assemblage size is what we would theoretically expect where a "ceiling" of maximum richness has been reached beyond which further increases in sample size cannot increase richness.[12] In this case, a quadratic equation approximates the asymptotic character of the data, and provides a substantially better fit than the linear models as a basis for examining regional variability in richness.

The relationship of assemblage richness (i.e. the number of Early Aztec stylistic variants) and assemblage size is plotted in Figure 7.22 on a semi-log scale. This quadratic model provides an adequate fit for most cases (R^2=.89); however, a number of the largest collections fall above the regression line and so appear richer than expected based on assemblage size alone. These collections represent sites with somewhat greater access to the full diversity of Red wares. Approximately half of the large, more diverse collections are associated with city-state centers (as indicated by the circles in Figure 7.22), including the central and southerly administrative sites of Chimalhuacan, Ixtapaluca, Chalco, and Amecameca. Non-administrative sites falling in the more diverse group are villages from the Chalco-Tenango area associated with market Zones 2 and 3.

Because not all of the more diverse sites are political centers, diversity cannot be attributed solely to higher political status. Accordingly, possible spatial variability in richness was evaluated from (1) the distribution (relative to market zones) of residuals calculated from a common semi-log regression line, and (2) comparison of regression lines calculated for individual zones.

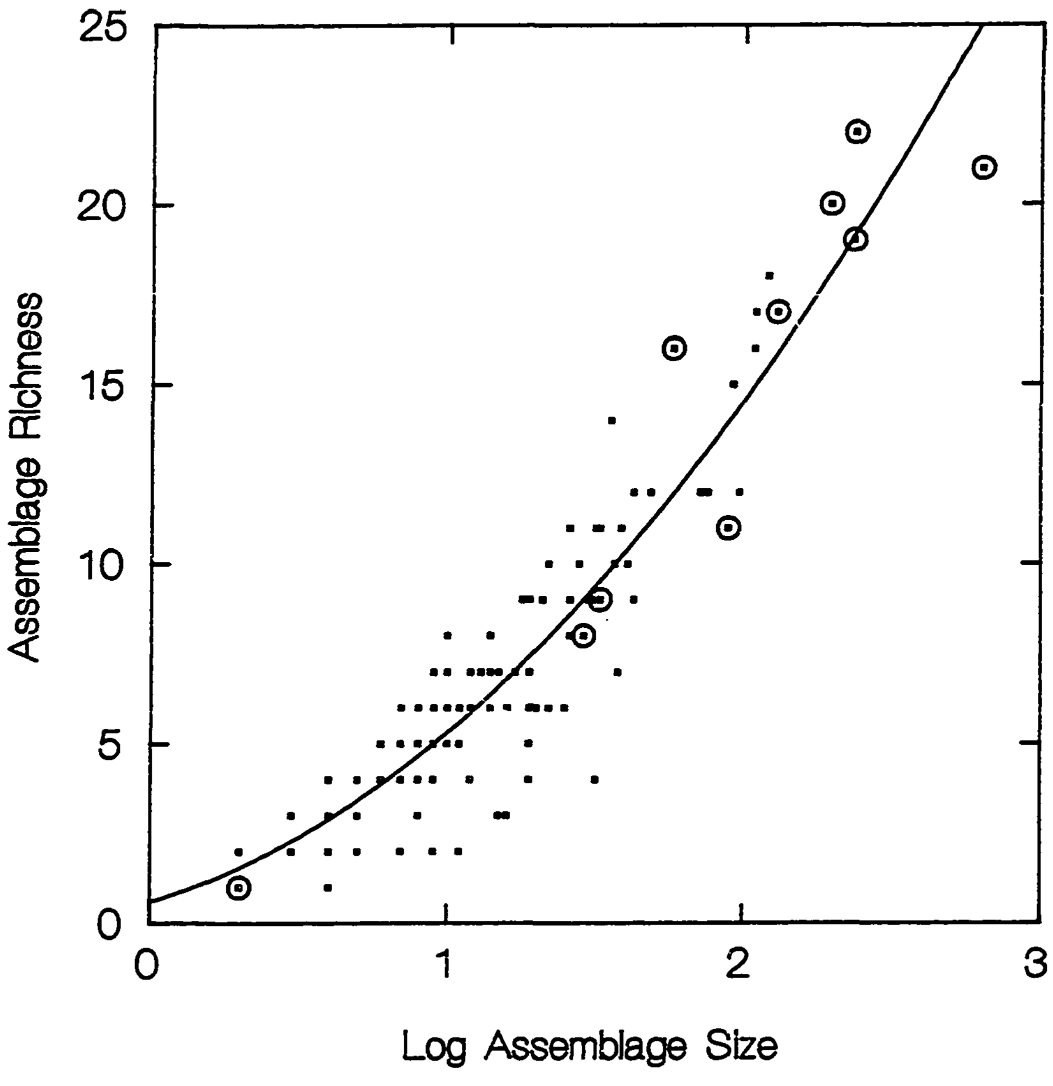


Figure 7.22. Bivariate plot of Early Aztec assemblage richness vs. assemblage size on a semi-log scale. Circled sites are Early Aztec political centers.

The mapped distribution (Fig. 7.23) of residuals relative to market zones reveals some spatial variability in assemblage richness. Overall, positive and negative deviations from expected are largely interspersed throughout the study area; however, several spatial concentrations of positive or negative residuals are apparent, suggesting areas with differential access to Red wares. First, Zones 2 and 3 in the south contain a large number of positive residuals, reflecting a concentration of sites with greater diversity. Zones 2 and 3 also contain all 5 non-administrative sites from the more diverse group. Conversely, Zone 1 at the far southern edge of the study area, contains a concentration of negative residuals, representing sites with low diversity. The only site with a positive residual in this zone is the administrative center Amecameca, a site that falls within the group of high diversity assemblages.

A visual comparison of slopes calculated for each market zone separately suggests that the regression line for assemblages in Zone 2 has a somewhat steeper slope, while that for Zone 1 is somewhat less steep. Regression lines for other market zones are strikingly similar, suggesting minimal differences in richness among Zones 3 through 6. A pair-wise comparison of slopes among all market zones supports this impression; t-test comparisons (Dixon and Massey 1969:207-209) indicate that differences in slope among zones are not statistically significant, except for between Zones 1 and 2.[13] It is particularly interesting that Zones 2 and 3 are not significantly steeper than other zones. Thus, although Zones 2 and contain a concentration of sites with greater diversity, these sites are not much more diverse than diverse sites in other market zones.

Differential access to higher-order goods as a measure of hierarchy was assessed from the distribution of ceramics requiring greater labor input. Early Aztec Red wares were divided into four groups based on the time needed to complete their decoration: (1) one color decoration, simple design; (2) one color decoration, complex design; (3) two color or two step decoration, simple design; and (4) two color decoration, complex design.

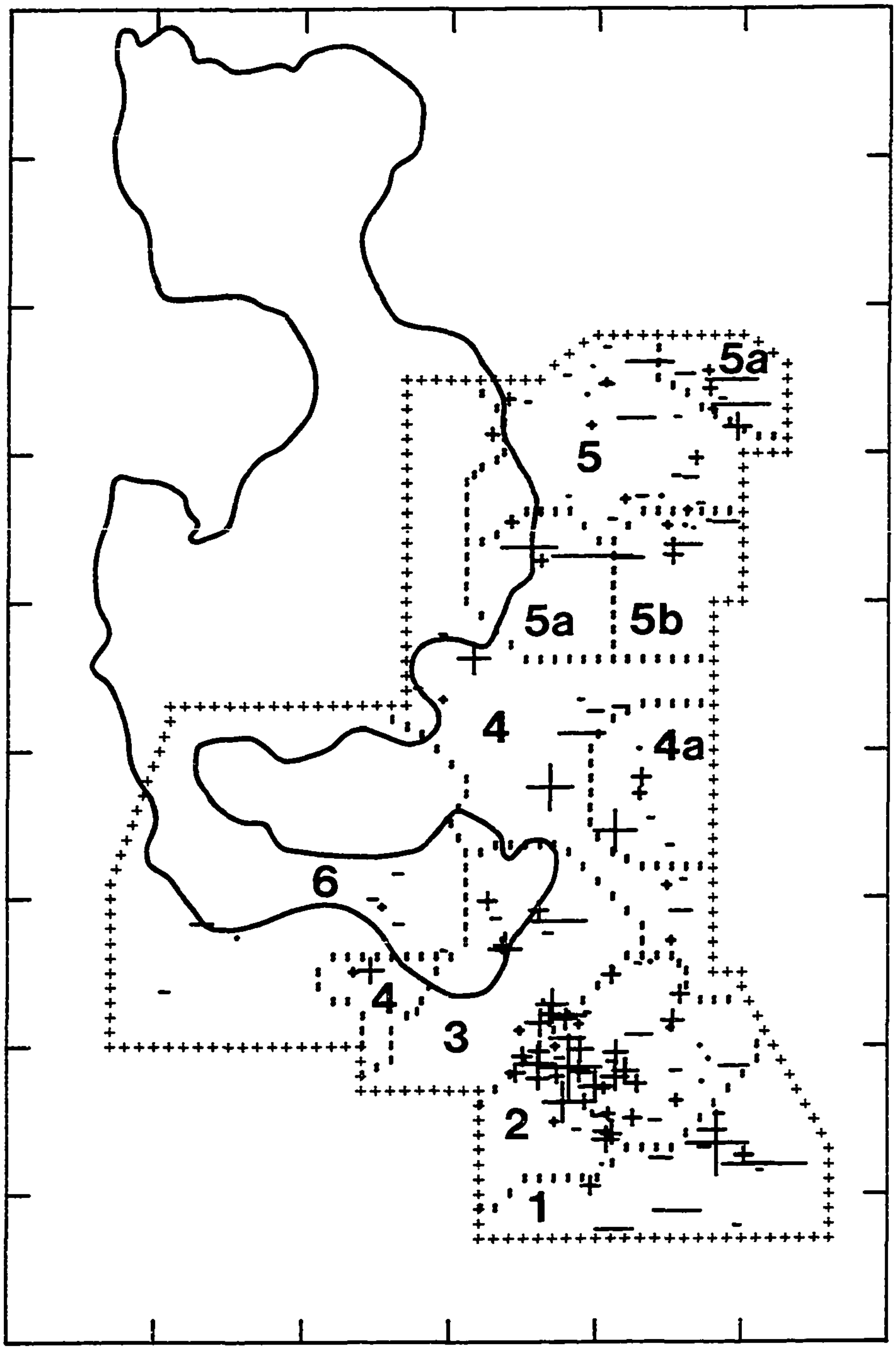


Figure 7.23. Map of richness residuals for sites relative to Early Aztec market zones. Sites are marked as having positive (+) or negative (–) residuals, while symbol size represents the degree of departure from expected assemblage richness based on assemblage size.

Differential access to these labor input groups was determined from the matrix of standardized X^2 residuals (Table 7.7), in which high positive residuals represent greater than expected access, and negative residuals represent lower than expected access. This matrix does indicate strong spatial differences in the access to ceramics of different levels of labor input, notably the high positive residuals for ceramics with low labor in the south (Zones 1-3) and for ceramics with higher labor input in the north (Zones 5-5b).

Table 7.7
Standardized X^2 Residuals for Ceramics of Different Labor Input Groups Relative to Early Aztec Market Zones

Labor Input Level[a]	Market Zone[b]								
	1	2	3	4	4a	5	5a	5b	6
1	**11.44**	**9.26**	**4.00**	-5.27	-0.74	-5.21	-8.42	-1.44	-2.12
2	0.72	1.34	-2.62	**3.35**	-0.41	-0.97	-2.20	0.89	-1.11
3	-2.96	1.53	**4.91**	**2.30**	-0.35	-2.96	-1.92	-2.32	1.61
4	-8.29	-9.79	-5.65	1.40	1.09	**7.07**	**9.75**	**2.44**	1.27

[a]Levels are as follows: 1 = 1 color simple (B/R A, B, H, I); 2 = 1 color complex (B/R D, E, F, G); 3 = 2 colors simple (B/R-I A, B, C; B&W/R D1, E2, E3, E4); 4 = 2 colors complex (B&W/R AW, AN, B, C, D2, D3, E1).

[b]Positive residuals >2.00 have been highlighted to clarify patterns of association between ceramic types and market zones.

In this case, however, access to "higher quality" ceramics may more accurately reflect regional preferences noted earlier: the prevalence of Black/Red and Black/Red-Incised types in the south, and the predominance of the more labor intensive Black&White/Red ceramics in the north. The use of more simple decoration on Red wares in the south may correspond to the local availability of polychrome ceramics, a very labor intensive type that may have demoted the status of Red wares. Thus, in the south, Red wares were not used as the highest quality vessels (a niche filled by the Chalco-Cholula polychromes) and so received less elaboration. In the north, in contrast, the near absence of a true polychrome tradition may have elevated Red wares to that role, in which case, a higher degree of elaboration (in the form of Black&White/Red) was employed.

In either case, the measures of diversity and differential access to higher quality goods do not concur in identifying some zones as having a hierarchical advantage. Areas with a somewhat greater diversity of Red wares do not also display a predominance of vessels requiring a greater labor investment.

In summary, evidence for hierarchical relations among market zones is not strong for the Early Aztec period. Although the regression analysis (Figure 7.22) indicated that some sites enjoyed better access to the full diversity of Red ware ceramics, differences in diversity among market zones are not pronounced. One area (comprising Zones 2 and 3) does appear somewhat more diverse; it seems unlikely, however, that this richness results from hierarchical advantage, for several reasons. First, this area does not show greater access to higher quality Red ware ceramics.[14] Further, based on the type distribution maps presented above, the concentration of positive residuals appears to lie in the area of overlap between multiple distribution zones. Thus, it is likely that the greater assemblage diversity of this area results from participation in more than one market-production zone. Finally, as will be discussed in Chapter 8, the INA analyses reveal the Chalco-Tenango area to have been a major center of Red ware ceramic production in the Early Aztec period. The somewhat greater diversity of this area may therefore represent a "supply zone" phenomenon, in which all sites in this area had improved access to Red wares owing to their proximity to a major production source for these ceramics.

Outside of the Chalco-Tenango area, there is a relatively uniform diversity among zones, and substantially greater diversity occurs only in administrative centers. This pattern suggests the absence of hierarchical relationships among market zones, and the presence of low level, local hierarchies within market zones. This latter characteristic is consistent with ethnohistoric data indicating that administrative centers also served as market centers for their dependent territories.

Relationship of Early Aztec Market Zones to Political Geography

A comparison of market zone boundaries and reconstructed city-state territories (Fig. 7.24) indicates a very poor spatial agreement between exchange interactions and political allegiance at the local level. This lack of congruence argues strongly that city-state boundaries were not restricting trade interactions.

A better fit between market zones and political boundaries is encountered at the confederation level. In the south, related market Zones 1-3 represent the Chalcan province, while in the north, Zone 5 and its closely related subzones represent the core area of the Acolhua confederation. Much of the intervening area (Zone 4) represents the buffer zone between the Chalca and Acolhua. The polities of this zone (Chimalhuacan, Coatepec, and Ixtapaluca) were initially allied with the south, but more enduringly with the north (*Anales de Cuauhtitlan* 1945:29; Gibson 1964:17; Parsons et al. 1982:81). This zone shares types with both north and south, but its assemblage composition conforms better with the north. Finally, the western area of Lakes Chalco-Xochimilco (Zone 6) corresponds to the confederation territories of the Culhua, Xochimilca, and Mixquica-Cuitlahuaca. The near absence of exchange interactions between Zone 6 and adjacent Zone 3 may reflect the high level of hostilities between these polities and the Chalca.

Market zones within either the Chalca or Acolhua confederation have higher degrees of interaction among themselves, but the gradation in Brainerd-Robinson coefficients from north to south indicates some degree of interaction even across confederation lines. There are, however, significant organizational differences between the north and south. Within the Chalcan area, market Zones 1 through 3 are relatively more distinct in terms of assemblage composition (range of Brainerd-Robinson coefficients 68-136). Further, each market zone can be associated with a single political center, although these centers are not centrally located relative to market zone boundaries. Zone 1 contains Amecameca, Zone 2 surrounds Tenango, while Zone 3 contains Chalco.

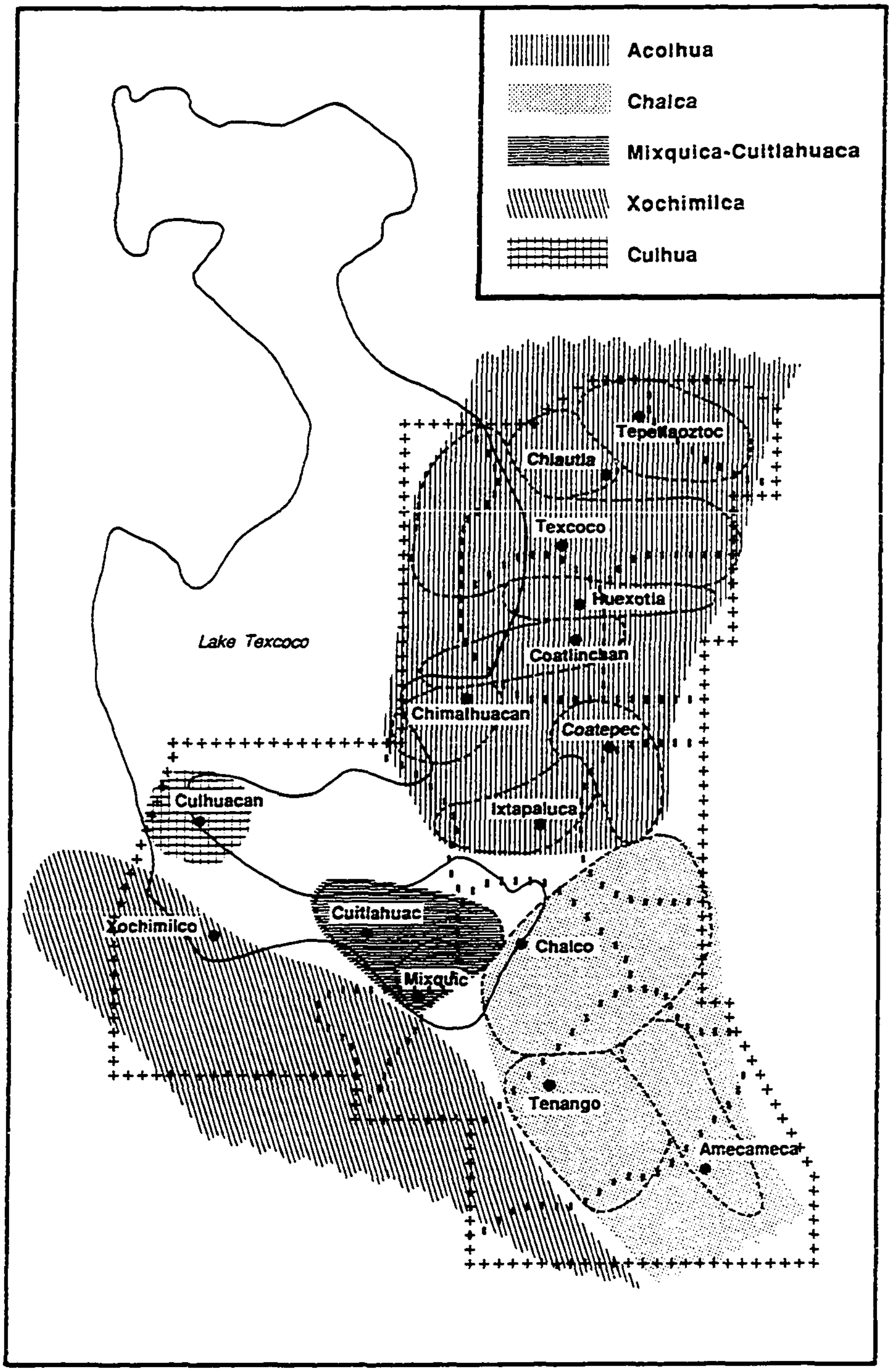


Figure 7.24. Comparison of Early Aztec market zones and political boundaries. Market zone boundaries are indicated by tick marks.

Within the Acolhua area, in contrast, there is a greater degree of similarity overall among market zones and subzones, as indicated by high Brainerd-Robinson coefficients (range = 134-175) and the fact that the cluster analyses did not agree on distinct subdivisions of this area. In addition, no clear correspondence of political centers with market zones exists, except possibly Huexotla-Coatlinchan with Zone 5a.

It can be hypothesized that the differences in economic organization between the Chalca and Acolhua confederations reflect, in part, differences in their pre-imperial political structure. For example, the Chalcan confederation is characterized as acephalous, containing a number of separate but equal city-states (Hodge 1984:139). This political separatism among Chalcan league members potentially encouraged the maintenance of distinct local traditions and expressions of ethnic identity (including ceramic decorative styles). In contrast, there is evidence to believe that the Acolhua confederation was somewhat hierarchically organized, with one city-state -- Coatlinchan -- serving as capital and directing the affairs of other city-states (Gibson 1964:17; Hodge 1984:139). This greater degree of political integration may have translated into an overall higher level of economic interaction among allied city-states.

Interpretation of Early Aztec Market System Organization

Of the three models proposed for market exchange during the Early Aztec period -- solar, network, and early stages of a hierarchically integrated market network -- the Red ware ceramic data lend strong support to the model of non-centralized network market system characterized by overlapping market zones. We can, on the one hand, readily eliminate competing models. The lack of congruence between market zones and local political boundaries (as reconstructed for this study) excludes the solar market system model from further consideration. Similarly, the presence of major divisions within the Valley (particularly the exclusion of the Lake Chalco-Xochimilco polities from participating in Red ware ceramic exchange) are not compatible with a model positing uninterrupted commodity flows within an integrated market network.

On the other hand, there is strong positive evidence for accepting the model of overlapping market zones unconstrained by local city-state political boundaries: the apparent high degree of network among adjacent zones, and the absence of hierarchical relations among zones. The overall structure of exchange interactions in the study area indicates the presence of a number of small market zones. While each zone is characterized by a distinctive combination (assemblage) of ceramic types, certain types are shared by neighboring zones. This underlying pattern in which ceramic distributions overlap each other as well as market zone boundaries strongly suggests a well developed market network. In contrast, evidence for hierarchical differences among zones is minimal. Rather, a number of political centers emerge as having differential access to Red ware ceramic exchange, and it is suggested that these served as centers of low-level market hierarchies for surrounding territories. In the Chalco-Tenango area, this pattern appears overlain by supply zone behavior, in which all sites have greater access to Red ware ceramics, owing to their proximity to a major production source for this ware.

In short, the Early Aztec pattern is consistent with a series of overlapping market zones, each serviced by a low-level market hierarchy in which city-state political centers served as important foci of exchange activities. Although market zones appear unconstrained by local city-state political territories, the boundaries between competing confederations limited ceramic exchange to some degree.

Comparison with Previous Studies of Early Aztec Ceramic Exchange

These conclusions are largely consistent with those of two earlier studies (Hodge and Minc 1990; Minc et al. 1994) of Early Aztec ceramics that utilized a different methodology. Both earlier studies examined the distribution of ceramic types relative to reconstructed political territories rather than attempting to empirically reconstruct market zones from ceramic distributions. These analyses did not permit a direct comparison of market zones relative to city-state polities, since polities were the unit of analysis; however, the impact of confederation-level political boundaries was assessed.

Based on a detailed study of the predominant Early Aztec Black/Orange types, we argued for two major features of market system organization in the pre-imperial period: (1) "the existence of a number of sub-regional market systems of varied size and with varying degrees of interaction or articulation between neighboring systems"; and (2) "the boundaries of the larger political confederations or alliances of city-state polities appear to have been the primary restriction on market exchange, as indicated by the spatial conformity between ceramic distribution and reconstructed political confederation territories" (Minc et al. 1994).

The distributions of the five major Black/Orange ceramic types define four main spheres of interaction during Early Aztec times (Minc et al. 1994). In the south, the Chalco, Mixquic, and Culhuacan Black/Orange types show virtually discrete distributions (Fig. 7.25), and these distributions conform closely to the Chalca, Mixquica-Cuitlahuaca, and Culhua confederation boundaries, respectively. In the north, the center of distribution for Geometric Tenayuca conforms spatially with the territory of the Acolhua confederation (Fig. 7.26).

This study found that Red ware distributions also reflect the constraints of confederation boundaries. Further, the boundaries so identified are in close agreement with those based on Black/Orange distributions (Table 7.8). The two studies therefore provide complementary lines of evidence pointing to the same general conclusions, and the degree of consensus between these studies suggests that the major organizational features of the Early Aztec market system have been identified.

In addition, however, this analysis of Red wares has refined our knowledge of Early Aztec market system organization in several important ways. First, it has altered our

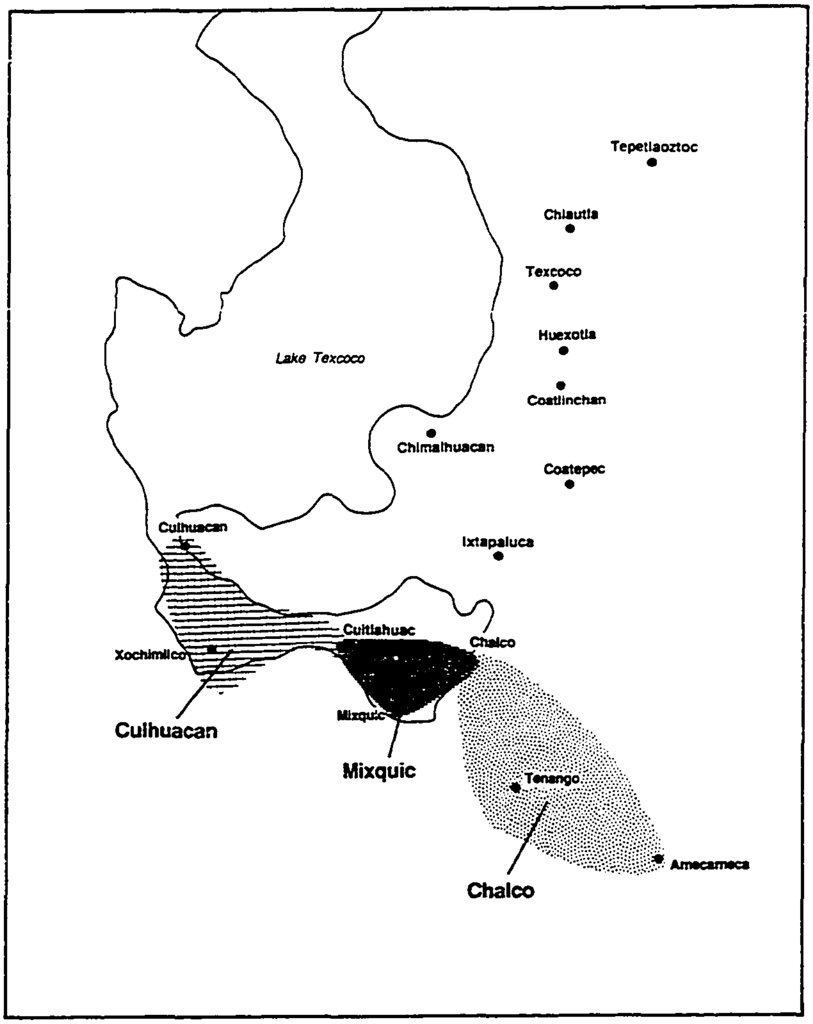


Figure 7.25. Distribution of Aztec I Black/Orange types [from Minc et al. 1994].

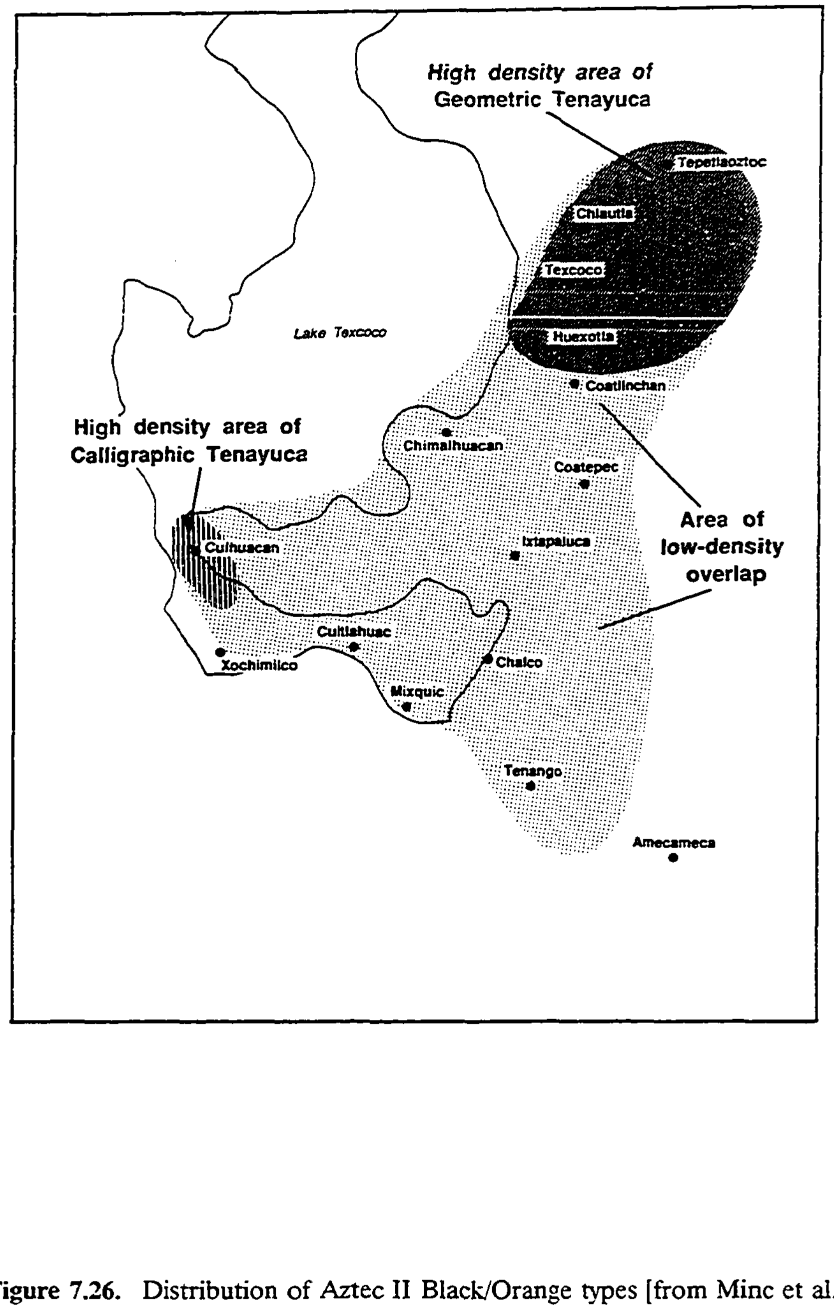


Figure 7.26. Distribution of Aztec II Black/Orange types [from Minc et al. 1994].

Table 7.8
Distribution of Predominant Ceramic Types
Relative to Political Confederation Territories

Confederation	Market Zones	Black/Orange Types	Red Ware Types
Acolhua	5, 5a, 5b	Geometric Tenayuca	predominantly B&W/R
Chalco	1, 2, 3	Chalco	predominantly B/R & B/R-I
Mixquica-Cuitlahuaca	6	Mixquic	minimal Red wares
Culhua	6	Culhuacan Calligraphic Tenayuca	minimal Red wares

view of exchange relations across confederation boundaries, by revealing that boundaries between confederations were not equally firm. Within the south, the boundary between the Chalcan confederation and polities to the west appears equally abrupt when viewed from either Orange wares or Red wares. In contrast, the boundary between the Chalca and polities to the north (i.e. the Acolhua) is distinct based on the presence or absence of Black/Orange types, but appears as a gradation in interaction based on Red ware types.

Second, the Red ware analyses provide a finer level of information concerning subregional market system organization. Of particular importance is the identification of a series of distinct market zones based on ceramic assemblage composition. Finally, this study was able to examine the relations among these market zones, both as a means for characterizing regional market system organization and for examining subregional variations in that organization.

In summary, the major features of Early Aztec market system organization as identified here are: (1) the presence of a series of overlapping market zones, each serviced by a low-level market hierarchy; (2) market zones that exhibit a well-developed market network, but no evidence of a regional hierarchy; and (3) market exchange that appears to have been unconstrained by local city-state political territories, although boundaries between competing political confederations limited ceramic exchange to some extent. Subregional variations in this organization include (1) a supply zone for Aztec Red wares in the Chalco-Tenango area, and (2) differences in the degree of interaction among market zones within the Chalca and Acolhua confederations, possibly reflecting their degree of political centralization during pre-imperial times.

The Regional Organization of Ceramic Exchange in the Late Aztec Period

Models for Late Aztec Market System Organization

The Late Aztec period represents a time of increasing political centralization in the Valley of Mexico, culminating with the consolidation of the Triple Alliance empire. Two long-standing models have been proposed concerning the impact of this political centralization on the structure of exchange relations within the Valley.

One school of thought argues that the break-down of former political barriers led to increased regional interaction and the development of a valley-wide **hierarchically integrated exchange network** (Blanton et al. 1981; Blanton 1994; M. Smith 1979). This view holds that administrative controls over exchange activities were minimal, and argues for the presence of both a well-developed market hierarchy and market network that moved goods efficiently throughout all parts of the Valley. The expected pattern here is that of nested market zones serviced by a hierarchical arrangement of central places.

A competing view argues that many production and exchange activities were centralized through administrative controls to direct flows of goods into the imperial capital, Tenochtitlan. According to proponents of this view, the primary commodity flows involved the movement of rural agricultural surpluses up the hierarchy into the urban center, in exchange for urban-produced craft goods that flowed back down the hierarchy to rural dependents (Hassig 1985; Santley 1986, 1991). The resulting market system is that of a unilineal **dendritic structure**, in which goods moved between levels of a well-developed market hierarchy, but not among sites of the same level, resulting in poor market network.

An alternative model developed in Chapters 4 and 5 argues that production and exchange were not under direct administrative control; however, considerable political meddling led to market imperfections that in turn altered the context of production and exchange activities. It was suggested here that the Late Aztec market system in the Valley of Mexico was structured by several factors, including: (1) the political imperative to control access to the exotic prestige goods which served as the primary insignia of wealth and prestige in society; (2) increasing tribute assessments in goods manufactured from non-local raw materials; and (3) rising urban food needs that created a high demand and good price for agricultural surpluses in urban centers.

Taken together, these factors resulted in a market system structure that directed the flow of rurally produced foodstuffs into urban centers in exchange for the raw materials needed to meet tribute requirements. Several authors have suggested that tribute requirements in manufactured goods were a significant factor stimulating market participation since tribute-payers were dependent on the market to obtain materials from non-local sources (Berdan 1975:27; Hicks 1987:99; Brumfiel 1987b:116). In addition, urban food needs set high, constant demands for agricultural surpluses such that the best market for these goods was predictably in the urban center. In conjunction with the role that urban centers played as sources of imported raw materials, the localized high demand for foodstuffs directed market traffic into the major centers, and undermined rural trade development by discouraging the movement of goods along lateral linkages among rural communities.

At the same time, political attempts to control exotic prestige goods as bases of wealth and prestige in society further stressed vertical flows over horizontal flows. By controlling the rights of markets to traffic in exotic and elite goods, imperial rulers were able to regulate the accumulation of wealth through market taxes in kind, and incidentally, to direct flows of rural produce into specific urban markets.

The convergence of political interests and urban needs significantly distorted market structure, resulting in the development of strong vertical linkages between urban centers and dependent communities at the expense of horizontal market articulation. The resulting market system is similar to the dendritic structure, but the existence of multiple large urban centers and dual political capitals suggests that multiple market hierarchies are possible. Specifically, the division of political control and economic influence between the two centers of empire -- Tenochtitlan and Texcoco -- argues for a possible dual market hierarchy within the Valley.[15]

In summary, the predictions generated for the Late Aztec period as part of this study include:

(1) The operation of a dual market hierarchy in the Valley, centered on the two dominant political, economic, and urban centers, Tenochtitlan and Texcoco. These market hierarchies will be apparent as two distinct zones of exchange interaction, formed by administrative controls over exotic goods and market locations, and reinforced by administrative divisions within the Valley that dictated the direction of tribute flows in both goods and services.

(2) Within each of these zones, market structure will be organized in a dendritic pattern, designed to channel agricultural produce and other foodstuffs up the hierarchy into the major urban centers.

Locating Late Aztec Market Zones from Patterns of Ceramic Distribution

The organization of Late Aztec ceramic exchange was examined by determining the number and location of distinct market zones, using unconstrained cluster analysis of spatial data, as described above. The cluster analyses were based on 8 Late Aztec Red ware bowl types and variants, including Black/Red Variant C, Late Profile Black/Red (Variants A, B, and E combined), Late Profile Black&White/Red (all variants combined), Black&White/Red Variant G, Yellow/Red, Black&White&Yellow/Red, White/Red, and

Black&Red/Tan. As for the Early Aztec period, two distinct cluster analyses were carried out, based on the absolute and relative densities of these Late Aztec ceramic units, and the results of the two distinct perspectives were integrated to provide a composite map of Late Aztec market zones.

Cluster Results based on Absolute Densities. The scree plot (Fig. 7.27a) for cluster solutions based on absolute densities indicates major jumps in the SSE following the 2- and 3-cluster solutions, and lesser jumps following the 6-and 8-cluster solutions. The relationships of these various solutions to each other is presented in the dendrogram for the last 20 clusters (Fig. 7.28). Three of these solutions will be discussed here as illustrating the major divisions within the study area.

The 3-cluster solution (Fig. 7.29) divides the study area into a zone of lower density ceramics (Cluster 1), and two zones of high density, Clusters 2 and 3. Together, Zones 2 and 3 comprise much of the Texcoco survey area; the division between these zones appears to parallel the transition from lower to upper piedmont. Although these three zones differ primarily in their total ceramic densities, differences in assemblage composition are also significant. The assemblages of Zones 2 and 3 are dominated by a single variant (Black/Red Variant C), while Zone 1 shows a relative paucity of this stylistic variant.

The 6-cluster solution (Fig. 7.30, Table 7.9) identifies two areas of higher ceramic densities in the northeast and southwest corners of the study area, separated by a zone with lower ceramic densities. Cluster 1 represents the intervening, low-density area (averaging 34 sherds/ha). Based on a contour map of total Late Aztec Red ware densities, Zone 1 corresponds closely to the area falling below the 100 sherds/ha contour line. The southwest (Cluster 2) represents an area with somewhat higher densities (averaging 166 sherds/ha) and a predominance of Late Profile vessels. The northeast is subdivided into four parallel clusters (Clusters 3-6); these zones represent a gradation in both total density

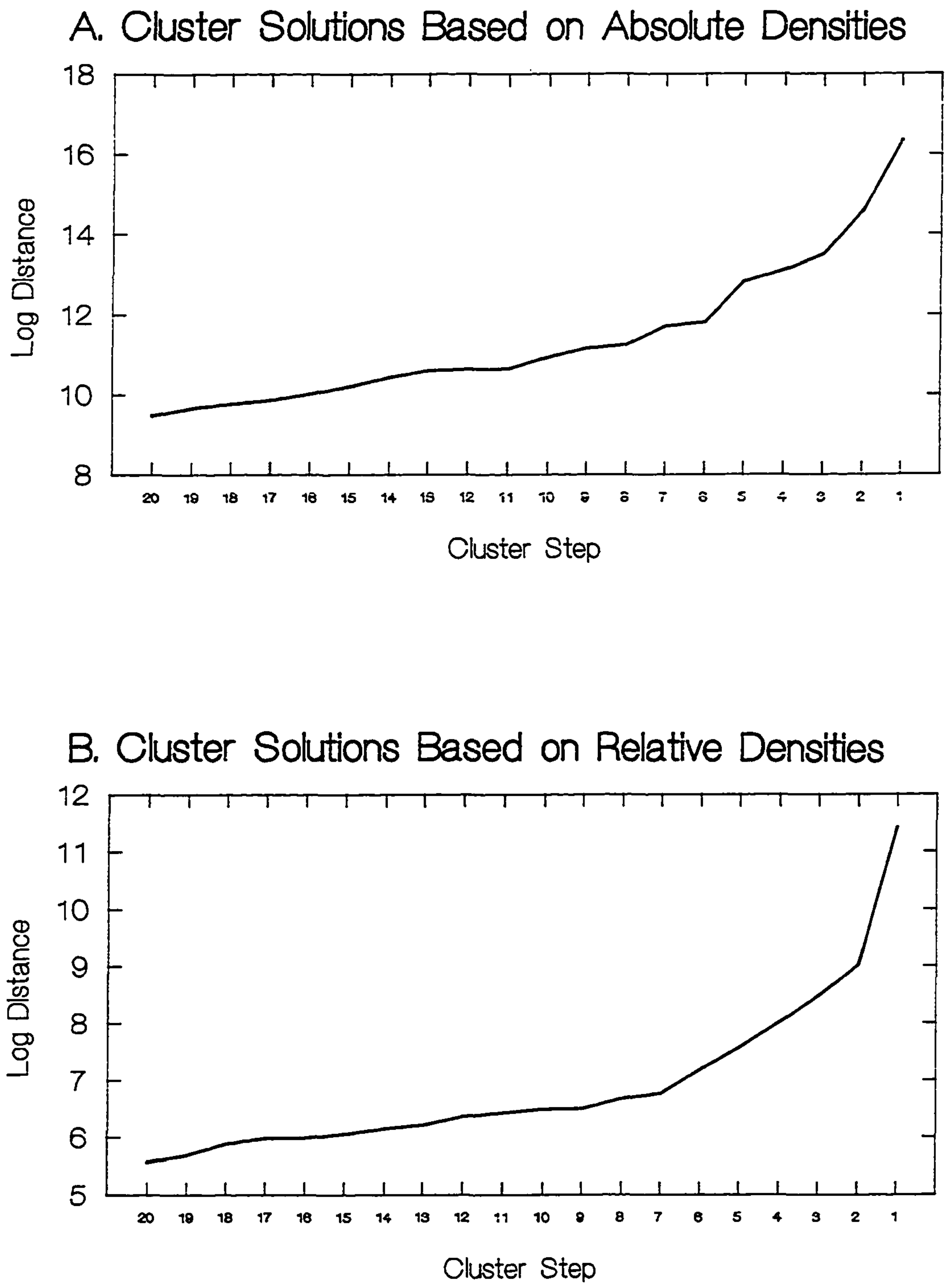


Figure 7.27. Scree plots for Late Aztec cluster analyses: **A.** cluster solutions based on absolute densities; **B.** cluster solutions based on relative densities.

```
                                       Cluster Solution
                            2 1 1 1 1 1 1 1 1 1 1 9 8 7 6 5 4 3 2 1
             Cluster        0 9 8 7 6 5 4 3 2 1 0
Zone      3    6    8   20

2&3       1    1    1    1   +---------I
(6)       1    1    1    2   +---------I-------I---------------I
          1    1    1    3   +-----------------I               I
                                                               I
1         1    2    2    4   +-I                               I
          1    2    2    5   +-I-----I-------------------I     I-I
          1    2    2    6   +-------I                   I     I I
          1    2    3    7   +---I                       I-----I I
          1    2    3    8   +---I---------------I-------I       I
          1    2    3    9   +-------------------I               I-I
                                                                 I I
3         2    3    4   10   +---------------I                   I I
          2    3    4   11   +---------------I-------------I     I I
                                                           I     I I
4&5       2    4    5   12   +-----------------------I     I-----I I
          2    4    5   13   +-----I                 I-----I       I
          2    4    5   14   +-----I-----------------I             I-
                                                                   I
4&5       3    5    6   15   +-------------I                       I
          3    5    6   16   +-------------I-------I---------I     I
          3    5    6   17   +---------------------I         I     I
                                                             I     I
4&5       3    6    7   18   +-----------I                   I-----I
          3    6    7   19   +-----------I-------------I-----I
          3    6    8   20   +-------------------------I
```

Figure 7.28. Dendrogram for Late Aztec cluster analyses based on absolute densities (only the last 20 steps are shown).

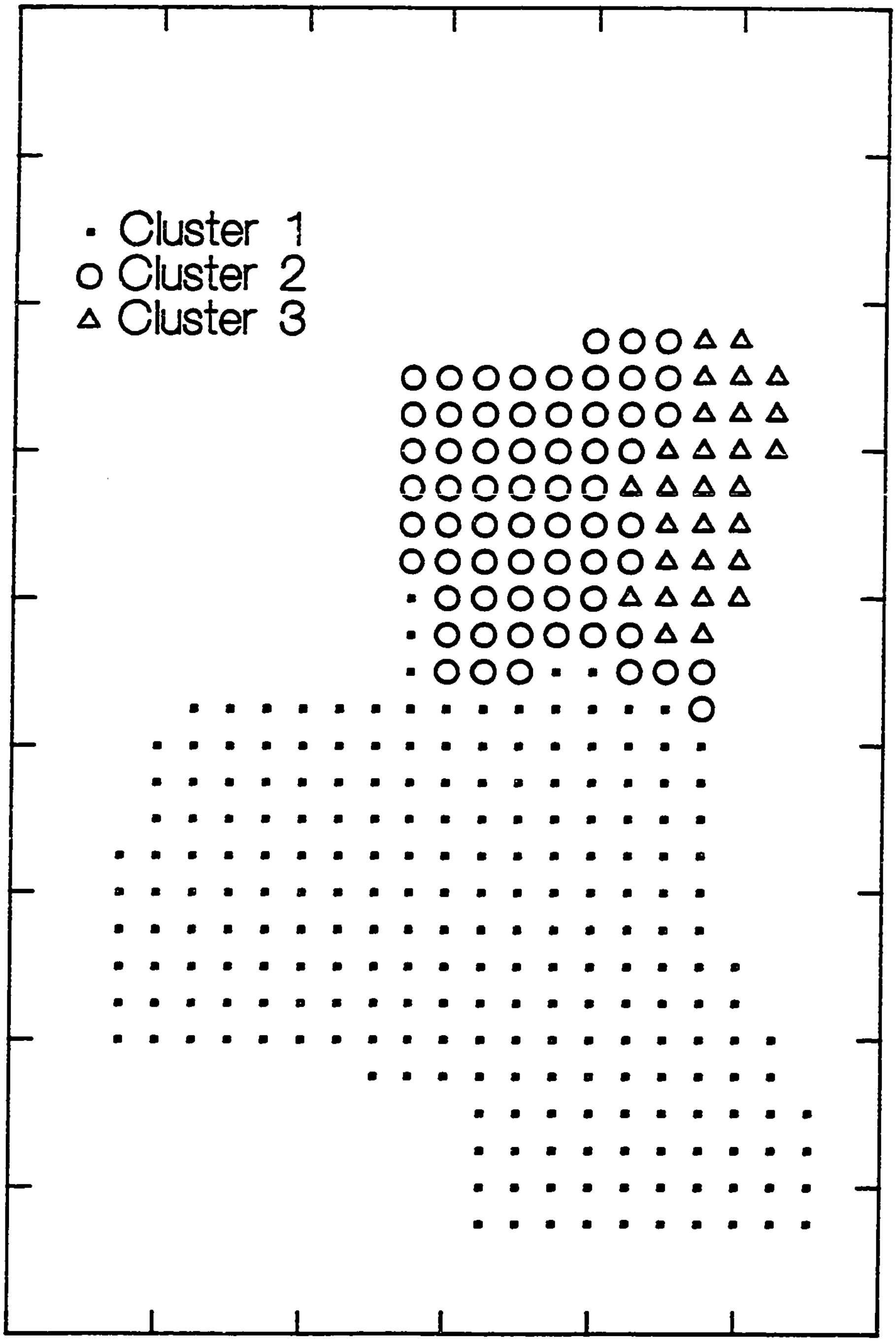


Figure 7.29. Cluster map for Late Aztec cluster analyses: 3-cluster solution based on absolute densities.

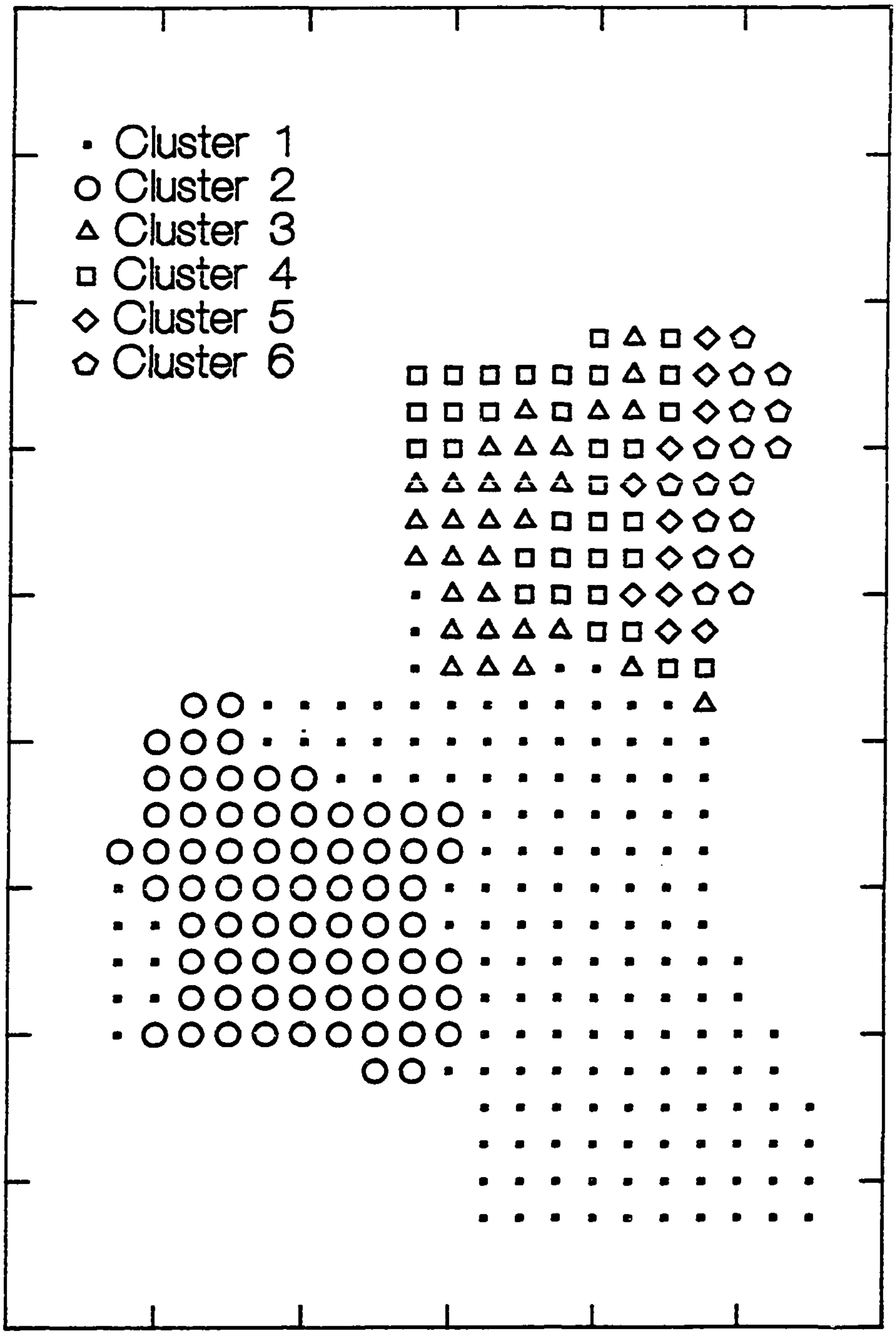


Figure 7.30. Cluster map for Late Aztec cluster analyses: 6-cluster solution based on absolute densities.

Table 7.9
Mean Absolute Densities for Late Aztec Ceramic Types for 5-Cluster Solution Based on Absolute Densities

Red Ware Type	Cluster					
	1	2	3	4	5	6
Black/Red C	13.0	7.0	8.4	206.0	420.6	613.4
Late Black/Red	7.0	61.5	9.8	4.8	1.3	2.6
Late B&W/R	9.1	75.0	6.0	3.5	3.3	5.4
B&W/R G	0.8	3.7	12.2	21.6	13.0	10.6
Yellow/Red	1.2	6.4	1.2	0.6	0.7	0.6
B&W&Y/Red	1.3	8.2	5.7	9.8	2.8	2.1
White/Red	0.6	3.3	0.0	0.0	0.0	0.0
Black&Red/Tan	0.4	0.0	12.0	11.6	39.7	48.9
Total Density	33.6	166.1	145.3	258.1	481.4	682.9
Grid Squares	154	71	31	33	11	17

and the predominance of Black/Red Variant C bowls. The 8-cluster solution (Fig. 7.31) similarly subdivides the southwest zone based on gradations in total ceramic density.

Cluster solutions beyond this point do not appear warranted based on the scree plot. Thus, the primary divisions within the study area based on absolute densities appear to be: (1) two areas of relatively higher density in the NE and SW that also differ in assemblage composition, separated by a zone of reduced Red ware consumption, and (2) concentric or parallel zonation within the higher-density areas based on differences in sherd density more than in assemblage composition.

Cluster Results based on Relative Densities. The scree plot (Fig. 7.27b) for clusters based on relative densities indicates a steady increase in the SSE for all clusters following the 7-cluster solution, with a final major jump at the 2-cluster solution. The major subdivisions within the study area can be seen through a comparison of three of these solutions (Fig. 7.32).

The 2-cluster solution (Fig. 7.33) neatly divides the study area in half along a diagonal line between NE (Cluster 1) and SW (Cluster 2). Grid squares associated with

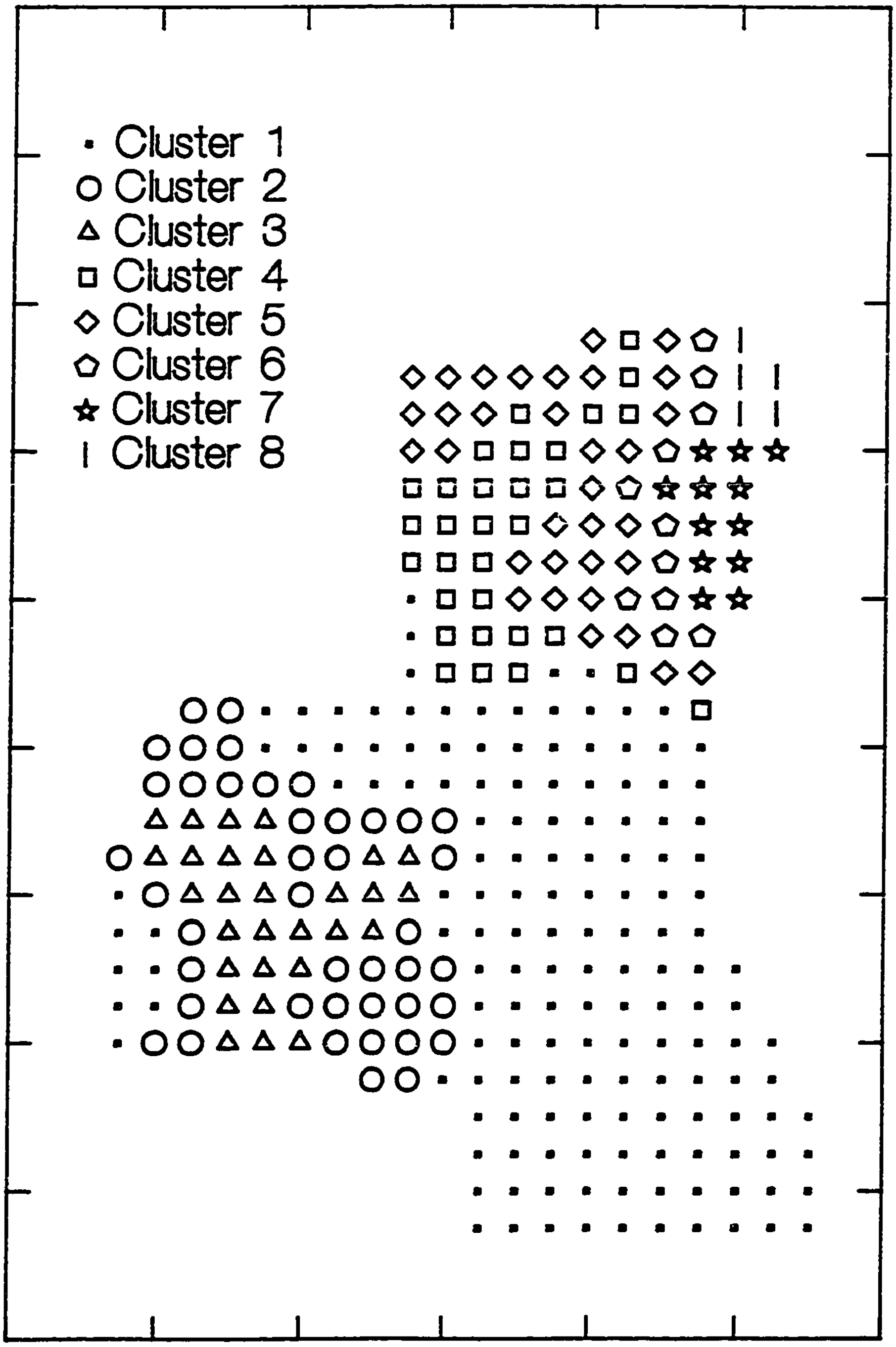


Figure 7.31. Cluster map for Late Aztec cluster analyses: 8-cluster solution based on absolute densities.

```
                                    Cluster Solution
                        2 1 1 1 1 1 1 1 1 1 1 9 8 7 6 5 4 3 2 1
         Cluster        0 9 8 7 6 5 4 3 2 1 0
Zone    2   4   7   20

4       1   1   1    1  +-I
(6)     1   1   1    2  +-I-----------I-------------------I
        1   1   1    3  +-------------I                   I
                                                          I
3&5     1   2   2    4  +-----I                           I
        1   2   2    5  +-----I-----I-----I               I
        1   2   2    6  +-----------I     I---I           I---I
        1   2   2    7  +-----------------I   I-----I     I   I
        1   2   2    8  +---------------------I     I     I   I
        1   2   3    9  +---------I                 I-----I   I
        1   2   3   10  +---------I-----------------I         I
                                                              I
2       2   3   4   11  +-----------------------------I       I-
        2   3   5   12  +-------I                     I-----I I
        2   3   5   13  +-------I-----------I---------I     I I
        2   3   5   14  +-------------------I               I I
                                                            I I
1       2   4   6   15  +---------------I                   I-I
        2   4   6   16  +---------------I---------I         I
        2   4   7   17  +-----------------------I I-----I   I
        2   4   7   18  +---I                   I-I     I---I
        2   4   7   19  +---I-------------------I       I
        2   4   7   20  +-------------------------------I
```

Figure 7.32. Dendrogram for Late Aztec cluster analyses based on relative densities (only the last 20 steps are shown).

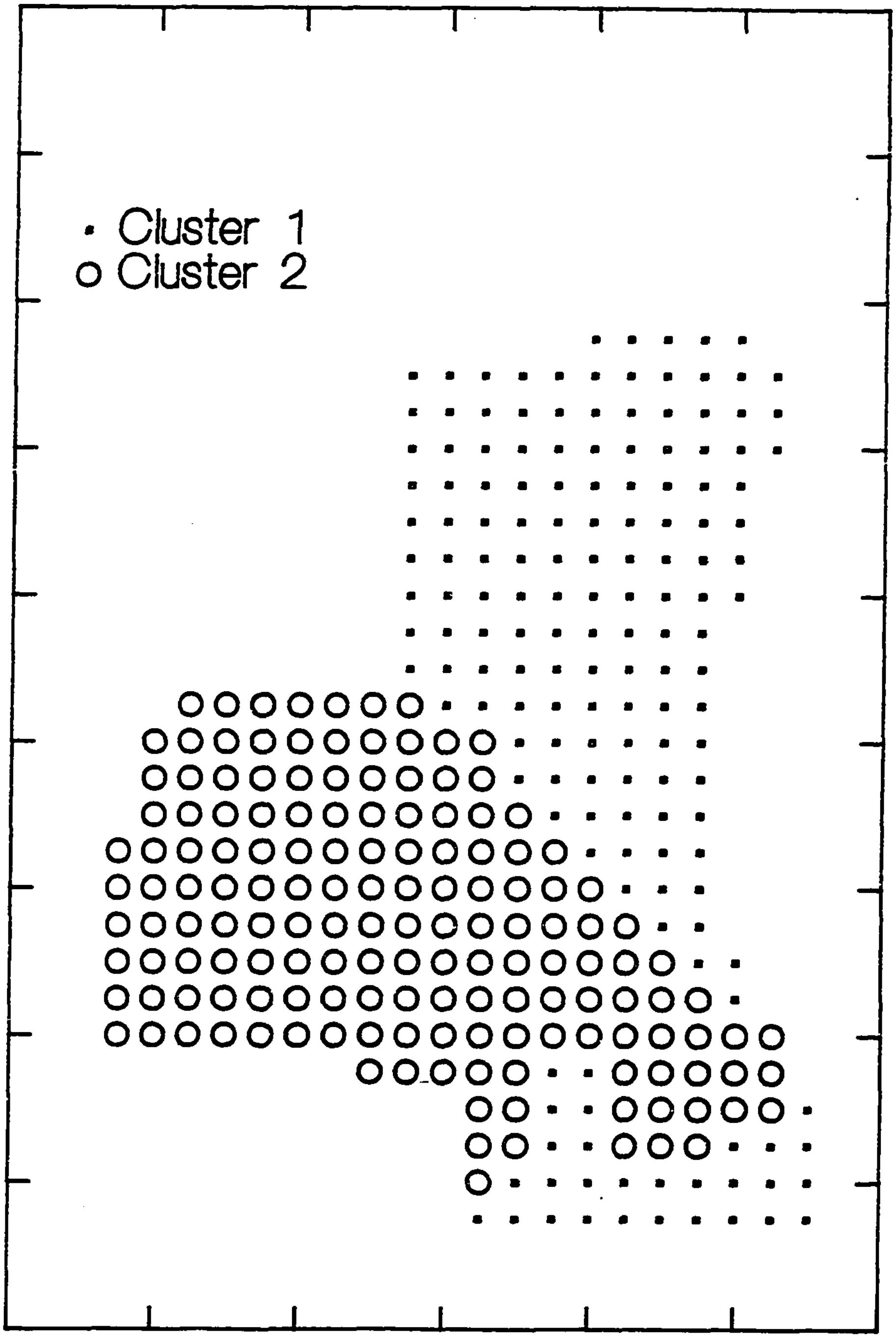


Figure 7.33. Cluster map for Late Aztec cluster analyses: 2-cluster solution based on relative densities.

Cluster 1 appear in the far southeastern corner of the study area as well. This primary division reflects the presence of two subregions with highly distinct ceramic assemblages during Late Aztec times: the area of Cluster 1 dominated by Black/Red Variant C and the area of Cluster 2 dominated by Late Profile Black/Red and Black&White/Red bowls.

The next major jump in SSE occurs following the 7-cluster solution, identifying that solution as the obvious next division of the data. At that level, however, the cluster map is sufficiently complex that it is difficult to visualize the larger scale patterning of interest. As a result, the 4-cluster solution is discussed here first as an intermediate solution, to demonstrate the basic divisions within the study area.

The 4-cluster solution (Fig. 7.34) subdivides both the NE and SW subregions into an "inner" and an "outer" zone, geographically. The NE divides into an inner Cluster 1 surrounded by Cluster 2, while the SW contains an inner Cluster 4 and a more peripheral Cluster 3. In both cases, the inner zone agrees closely with the higher density areas identified based on absolute densities. The relative ceramic densities for these clusters indicate that the inner zones have the most distinctive assemblage compositions as well: the assemblage of Cluster 1 consists of almost 90% Black/Red C, while that of Cluster 4 is greater than 80% Late Profile Black/Red and Black&White/Red (Table 7.10). In contrast, the assemblages of the two outer zones, Clusters 2 and 3, contain a greater mixture of these dominant types.

The 7-cluster solution (Fig. 7.35), while preserving these major divisions, additionally breaks out a number of small clusters along their interfaces. For example, Cluster 3 represents a certain degree of gradation along the boundary between the NE and SW spheres, while Clusters 2 and 4 appear transitional between the SE and far SE divisions. Similarly, Cluster 5 represents small patches at the periphery of Cluster 6, the cluster corresponding to the core zone for the SW sphere.

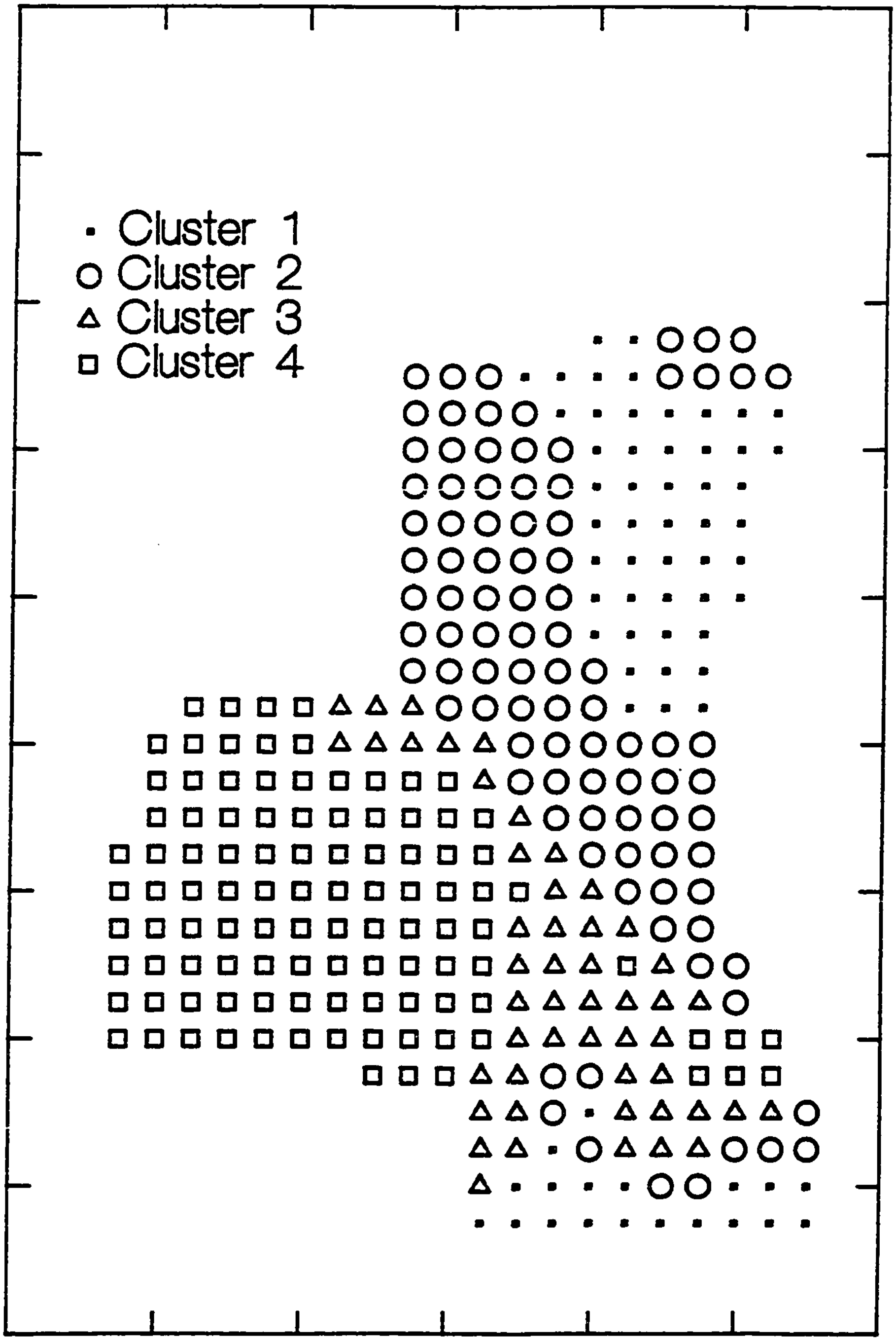


Figure 7.34. Cluster map for Late Aztec cluster analyses: 4-cluster solution based on relative densities.

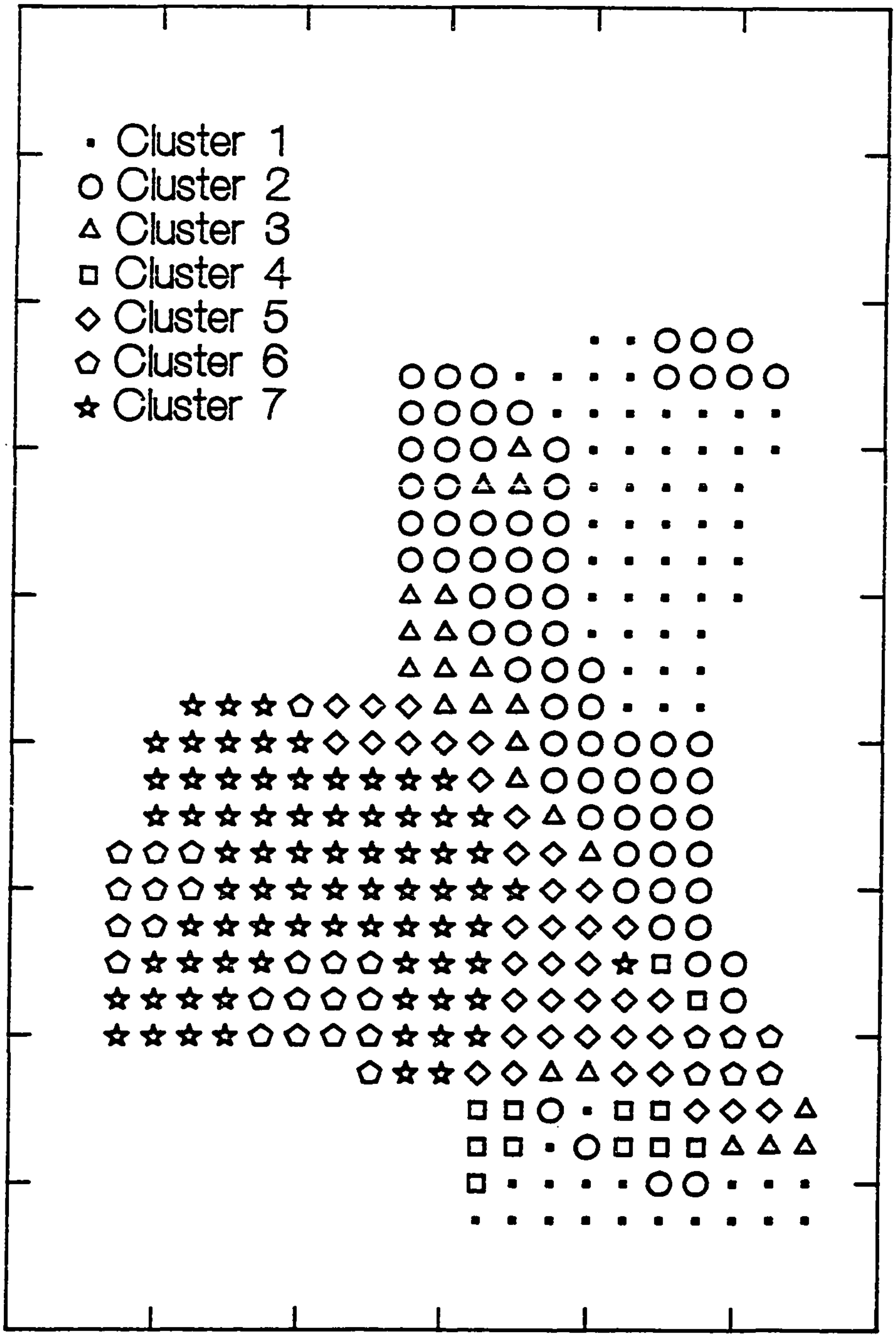


Figure 7.35. Cluster map for Late Aztec cluster analyses: 7-cluster solution based on relative densities.

Table 7.10
Mean Relative Densities for Late Aztec Ceramic Types for 4-Cluster Solution Based on Relative Densities

Red Ware Type	Cluster			
	1	2	3	4
Black/Red C	88.5	65.8	35.3	6.0
Late Black/Red	2.3	6.6	26.7	35.1
Late B&W/R	2.1	7.4	31.2	47.8
B&W/R G	2.5	6.0	2.0	1.5
Yellow/Red	0.6	3.2	1.5	3.0
B&W&Y/Red	0.9	5.7	2.8	4.1
White/Red	0.0	0.0	0.3	2.4
Black&Red/Tan	3.0	5.4	0.2	0.0

These smaller clusters do not modify or enhance our understanding of the basic structural divisions captured by the 4-cluster solution. Thus, the major features as identified by cluster analyses based on relative densities appear to be: (1) the subdivision of the study area into two spheres based on the relative dominance of Late Profile vessels vs. Black/Red Variant C; and (2) the subdivision of each of these spheres based on the mix of these dominant types with other, low frequency Red wares.

Synthesis and Map of Late Aztec Market Zones. A composite map of Late Aztec market zones was obtained by comparing the cluster maps from the two different analyses and noting areas in which they were in agreement (Fig. 7.36). Although there are substantial areas of overlap in cluster boundaries denoting areas which both analyses classify as distinct, the cluster analyses based on absolute and relative densities do not show the high degree of correspondence for the Late Aztec as noted for the Early Aztec. This is largely because the Late Aztec ceramic collections present such a broad range of variation in absolute densities that cluster solutions based on absolute densities reflect major differences in total ceramic density while ignoring significant variability in assemblage composition. Thus, as noted above, the primary divisions recognized by the

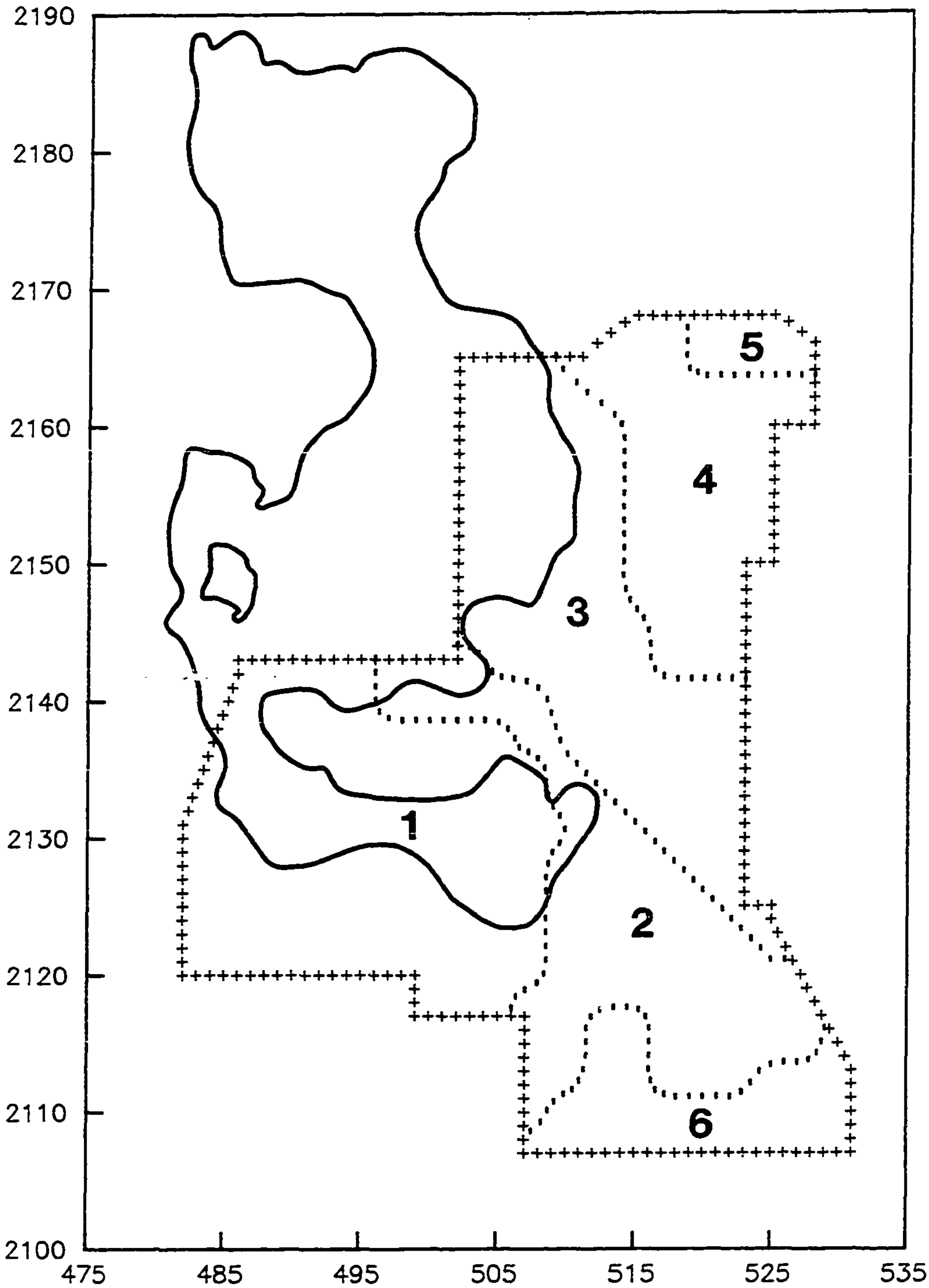


Figure 7.36. Composite map of Late Aztec market zones. Zones 1 and 2 comprise the SW sphere, while Zones 3-5 comprise the NE sphere.

cluster analyses based on absolute densities were gradations in the total volume of ceramics, while those based on relative density reflect differences in assemblage composition. Accordingly, for areas where the analyses do not agree, the delineation of market zone boundaries most closely follows the 4-cluster solution based on relative densities.

The two cluster analyses concur in identifying two highly distinct areas in the SW and NE corners of the study area. The boundaries of these areas as defined by the two cluster analyses show some slight discrepancies, but usually only by a single grid point. This degree of congruence between cluster analyses indicates that these two areas are distinctive both in assemblage composition and in the total volume of Red ware ceramics consumed.

Between these two areas lies a broad zone identified as having lower densities of Late Aztec Red ware ceramics. Based on characteristics of assemblage composition, however, this lower density zone can be divided diagonally in half, into zones closely affiliated with adjacent high density areas. Thus the study area is initially divided into two major spheres associated with the SW and NE, and subsequently subdivided into separate zones. Overall, six market zones were defined for the Late Aztec period based on the cluster analyses (Fig. 7.36).

The SW sphere, comprising the Lake Chalco-Xochimilco area, is subdivided into a higher density core zone (Zone 1) and a lower density periphery (Zone 2). Zone 1 encompasses much of the western and central portions of the lakebed and adjacent lakeshore plain, and was identified by both cluster analyses as an area with distinctive assemblage characteristics. Zone 2 contains the very eastern end of Lake Chalco and extends into adjacent areas to the southeast. This zone represents the area covered by Cluster 3 (in the 4-cluster solution based on relative densities), but contains small islands of Cluster 4. For purposes of clarifying the larger patterning, these islands were ignored.

Both Zones 1 and 2 share a high percentage of Late Profile Black/Red and Black&White/Red vessels: the assemblage of Zone 1 contains 80% Late Profile Red ware types, while that of Zone 2 contains 60-70% (Table 7.11, Fig. 7.37A). The composition of the remaining percentage, however, differs markedly between these zones. The balance of Zone 1's assemblage is a mix of primarily high value, low frequency Red ware types, including Yellow/Red and Black&White&Yellow/Red. In contrast, the balance of Zone 2's assemblage is largely Black/Red Variant C, the dominant type to the north. Total Red ware densities decline markedly from Zone 1 to Zone 2, from an average of 283 sherds/ha vs. 137 sherds/ha respectively.

Table 7.11A
Assemblage Composition of Late Aztec Market Zones:
Percentages Based on Type Counts at Sites Assigned to Zone

Red Ware Type	Market Zone					
	1	2	3	4	5	6
Black/Red C	3.5	21.2	67.7	89.6	78.4	100.0
Late Black/Red	32.9	27.7	2.4	0.6	1.2	0.0
Late B&W/Red	48.7	46.0	9.0	0.6	0.6	0.0
B&W/R G	2.3	0.7	12.3	5.6	4.7	0.0
Yellow/Red	5.8	0.7	1.7	0.2	0.3	0.0
B&W&Y/Red	4.1	3.6	3.0	0.5	0.6	0.0
White/Red	2.6	0.0	0.0	0.0	0.0	0.0
Black&Red/Tan	0.0	0.0	3.9	2.8	14.1	0.0
Total Sites	76	65	40	35	5	23

The NE portion of the study area is subdivided into Zones 3-5 (Fig. 7.36). The cluster analyses based on absolute densities divided the NE into a series of clusters reflecting a gradation in the total volume of ceramics from east to west. In contrast, the relative density cluster solutions recognized a two-fold division based on assemblage composition that is utilized here as the basis for delineating market zone boundaries.

Zone 3 extends N-S along the lakeshore plain, and is identified with Cluster 2 (in the 4-cluster solution based on relative densities). Zone 4, comprising the piedmont areas

Table 7.11B
Assemblage Composition of Late Aztec Market Zones:
Percentages Based on Type Densities at Sites Assigned to Zone

Red Ware Type	Market Zone					
	1	2	3	4	5	6
Black/Red C	2.3	30.6	65.2	93.8	68.1	100.0
Late Black/Red	34.1	26.3	5.4	0.2	0.5	0.0
Late B&W/Red	46.4	38.7	4.7	0.5	1.5	0.0
B&W/R G	2.5	1.2	10.8	2.1	2.7	0.0
Yellow/Red	3.7	0.1	1.9	0.1	0.2	0.0
B&W&Y/Red	8.1	3.1	7.2	0.2	1.3	0.0
White/Red	2.9	0.0	0.0	0.0	0.0	0.0
Black&Red/Tan	0.0	0.0	4.8	3.1	25.6	0.0
Total Density	12730	2241	4500	15760	3100	148

Note: Both TX-A-56 (Texcoco) and TX-A-87 (Huexotla) assigned to Zone 3.

east and north Texcoco, corresponds to Cluster 1. A number of major sites, including Texcoco, Huexotla, and Coatlinchan fall on or very near the boundary between Zones 3 and 4. Finally, Zone 5 represents a small area in the NE corner of the study area. This zone was also identified by Cluster 1 (along with Zone 3) based on its somewhat lower percentage of Black/Red Variant C, but is here delineated as a separate zone because it is spatially separate from the bulk of that cluster.

All three northern zones are dominated by a single ceramic type, Black/Red Variant C. These zones differ, however, in the percentage of this dominant type and the corresponding percentage of higher quality, low frequency Red wares (Table 7.11, Fig. 7.37B). Zone 3 contains the highest percent and a broader mix of higher status wares, while Zones 4 and 5 are relatively disadvantaged in these ceramics even though they have substantially higher Red ware ceramic densities overall. Zone 5 further appears distinctive in having a higher percentage (14-25%) of Black&Red/Tan; however, in terms of total assemblage composition, this small zone appears most similar to Zone 4 (see Table 7.13 below).

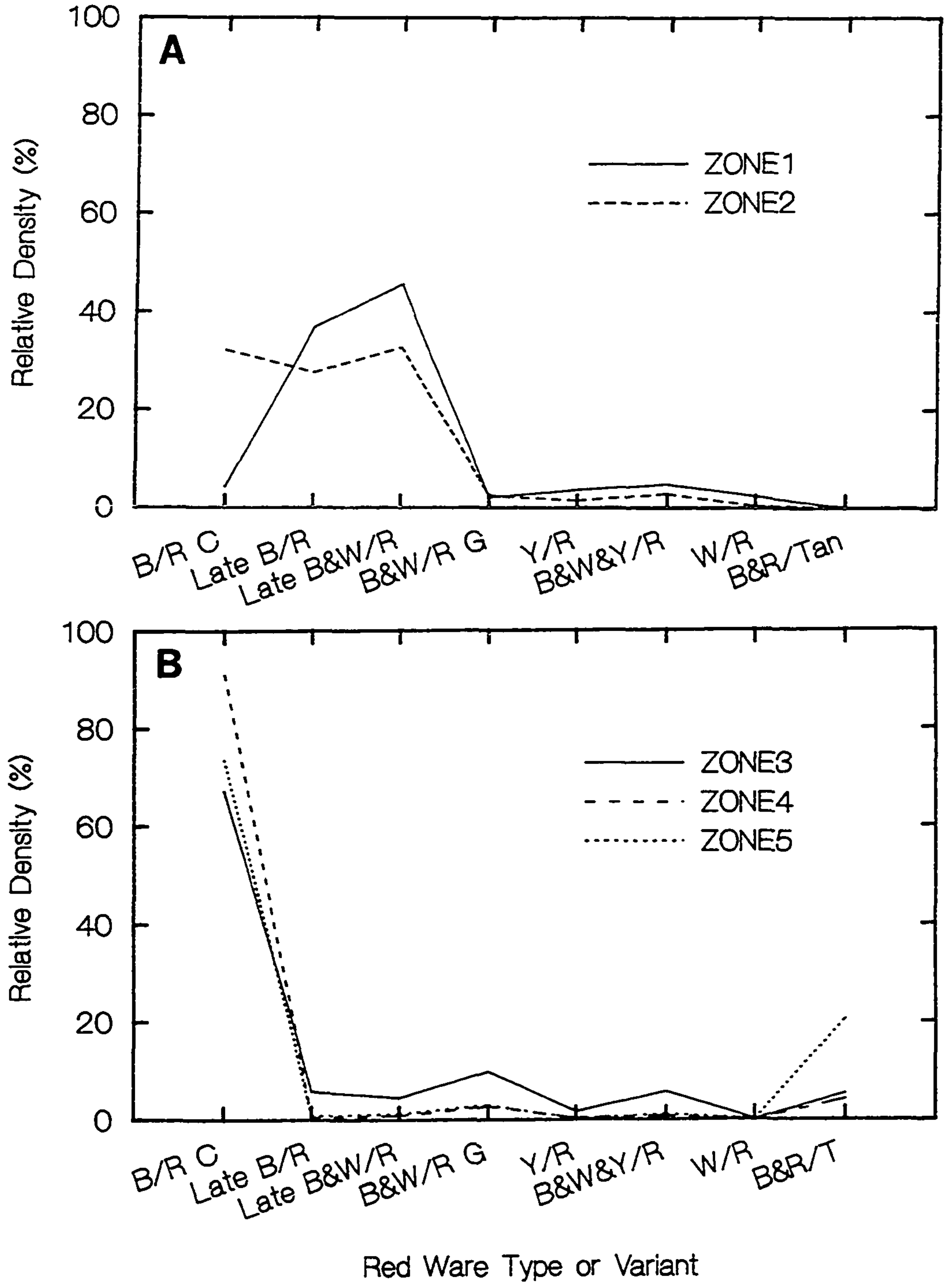


Figure 7.37. Assemblage composition for Late Aztec market zones: **A.** Zones 1 and 2; **B.** Zones 3, 4, and 5. Percentages are based on absolute densities at grid points assigned to each zone, summed, and converted to % of total.

Finally, Zone 6 represents an area in the extreme SE corner of the study area that appears similar in assemblage composition to Zone 4 in the NE corner of the study area. Both the NE and extreme SE areas formed part of the same cluster based on relative densities; however, because the SE represents a spatial disjunction, it was designated as a distinct zone. Zone 6 has extremely low ceramic densities; however, the few Red ware ceramics found there are uniformly the Black/Red Variant C (Table 7.11). This zone may well represent an area at the very margins of the Valley of Mexico exchange system.

Characterizing Late Aztec Market System Structure

Scale. The cluster analyses suggest a two-tiered hierarchical division of the study area during Late Aztec times: a primary division between the SW and NE halves of the study area, and a secondary division within each of these into distinct zones. In contrast to the Early Aztec period, smaller subdivisions of the study area were not consistently recognized by the Late Aztec cluster analyses. Thus Late Aztec market zones are significantly larger than those found for the Early Aztec period (Table 7.12, cf. Table 7.4).

Table 7.12
Areal Extent of Late Aztec Market Zones

Sphere	Zone	Grid Sqs.	Area (km^2)	% of Total
SW	1	98	612	31
SW	2	57	356	18
NE	3	77	481	24
NE	4	49	306	16
NE	5	7	44	2
?	6	29	181	9

The matrices of Brainerd-Robinson coefficients (Table 7.13) support the two-level division suggested by cluster analysis based on relative densities. Coefficients are high (> 140) between zones belonging to the same sphere, but low across the boundary between SW and NE spheres. This pattern of sharp discontinuities between spheres indicates that they were relatively separate systems, and raises questions about the organization of exchange at two different levels. First, was the relationship between the SW and NE spheres that of distinct, co-equal systems or was the relationship hierarchical in nature? Second, how was market exchange structured among zones within each sphere?

Table 7.13
Matrix of Brainerd-Robinson Coefficients Indicating Degree of Similarity Among Late Aztec Market Zones

A. % Based on type counts at sites assigned to zone

Zone	1	2	3	4	5	6
1	200.00	164.66	43.98	15.77	17.28	7.00
2		200.00	74.18	47.90	49.42	42.34
3			200.00	156.12	158.14	135.36
4				200.00	175.72	179.24
5					200.00	156.87
6						200.00

B. % Based on type densities at sites assigned to zone

Zone	1	2	3	5	4	6
1	200.00	143.30	47.94	10.76	16.68	4.56
2		200.00	90.09	65.61	70.30	61.26
3			200.00	142.75	152.42	130.38
4				200.00	148.67	187.63
5					200.00	136.30
6						200.00

Note: Both TX-A-56 and TX-A-87 assigned to Zone 3.

Network. The degree of lateral movement of ceramics among these zones was based on the degree and spatial configuration of overlap among ceramic type distributions relative to each other and to market zone boundaries. Density contour maps were examined to determine the movement of goods at two levels -- between and within the major exchange spheres.

Interactions between the major exchange spheres were monitored from the dominant types for the Late Aztec period: Black/Red C and the Late Profile Black/Red and Black&White/Red types. Together these types comprise 85% of the Late Aztec Red ware ceramics. The density contours representing the area within which 95% of these types occur based on density measures were mapped as representing their centers of distribution (Fig. 7.38).

As expected, the Late Profile variants are concentrated in the SW, while Black/Red C concentrates in the NE. A visual comparison of these distributions, however, further reveals that even at this high level (i.e. the 95% density contour) there is only a minimal degree of overlap between these predominant types. Rather, the two main types appear to conform to a shared boundary -- the boundary that runs diagonally between the NE and SW spheres. This pattern of non-overlapping distributions substantiates the presence of two large scale and largely discrete exchange systems in the study area during Late Aztec times.

The area where these major types do overlap is also of interest. This area consists of a lobe extending eastward from Lake Texcoco into Zone 3, and includes the major sites of Texcoco, Huexotla, Coatlinchan, and Chimalhuacan. Its location suggests that the major area of interaction between the NE and SW exchange systems focused on these major political centers.

At a finer spatial scale level, the distributions of the lower frequency Red wares were utilized to clarify the nature of exchange interactions within each of these systems. Within the SW, ceramic distributions form a series of concentric zones centered on Lake Xochimilco (Fig. 7.39). The most prevalent Late Profile Black/Red and Black&White/Red types have the widest distribution throughout Lakes Chalco-Xochimilco and the adjacent lakeshore plain (Zone 1). The lower frequency Yellow/Red and Black&White&-Yellow/Red have distributions more narrowly distributed within the lakebed, while Black&White/Red Variant G is restricted in its distribution to the western end of Lake Xochimilco. This pattern of concentric distributions strongly suggests that these ceramics were distributed from a common source; the area of greatest overlap locates that source in or near western Lake Xochimilco.

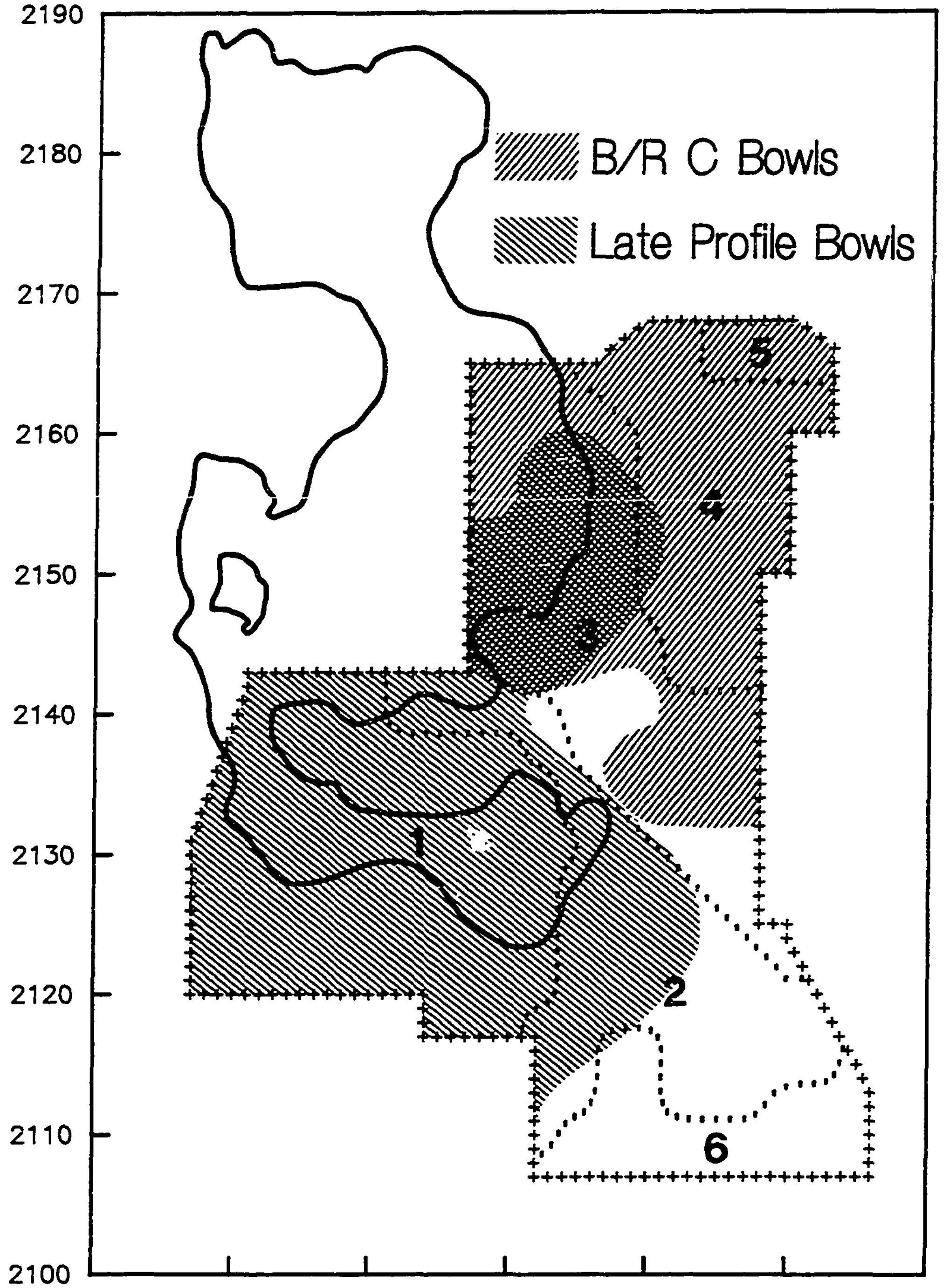


Figure 7.38. Density distribution of predominant Late Aztec ceramic types relative to market zone boundaries: Late Profile bowls and Black/Red Variant C mapped at 95% level.

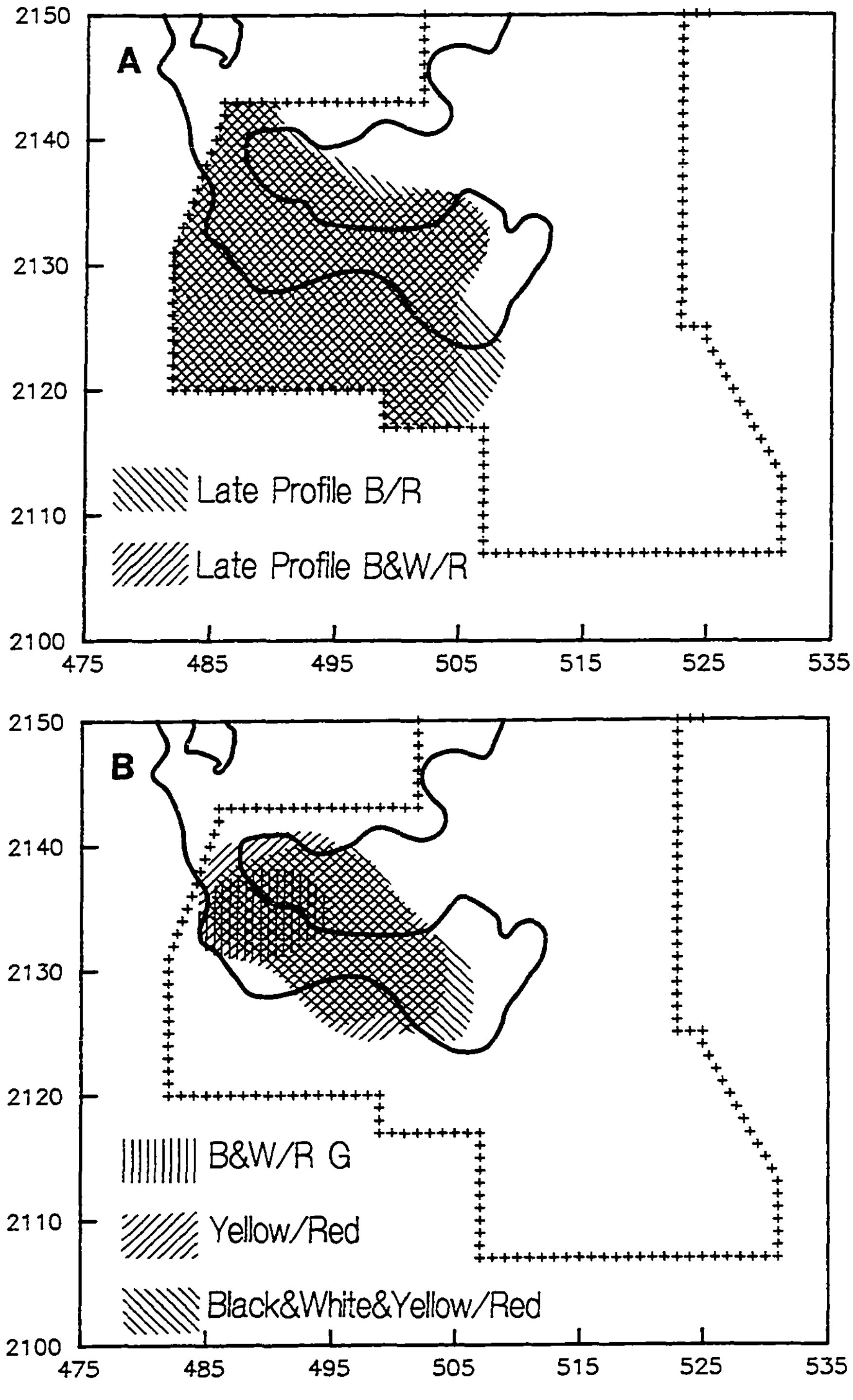


Figure 7.39. Density distribution of Late Aztec ceramic types within the SW sphere: **A.** Late Profile Black/Red and Black&White/Red (mapped at 75% contour level); **B.** Black&White/Red G, Yellow/Red, and Black&White&Yellow/Red (mapped at 75% contour level).

Based on the INA analyses (Chapter 8), the types with the broadest distributions in Lakes Chalco-Xochimilco are those that were locally produced, while non-locally produced types have the most restricted distribution. The concentric distributions therefore represent three distinct classes of ceramics that differ in value (based on production source and decorative complexity) and hence in availability. In order of increasing value and decreasing distribution these classes are: (1) locally produced, lower quality (Late Profile Black/Red and Black&White/Red); (2) locally produced, higher quality (Yellow/Red and Black&White&Yellow/Red); and (3) non-locally produced, higher quality (Black&White/Red G) ceramics. Only the lowest quality types cross the boundary from Zone 1 to Zone 2, indicating reduced flow of goods at this boundary.

These concentric distributions support the interpretation of (1) a single or predominant source area for all types located in western Lake Xochimilco, and (2) a decline in the availability and quality of Red ware ceramics with distance from that source. Further, no type appears to have a center of distribution in Zone 2, from which it circulated to Zone 1. This lack of reciprocity between zones indicates unequal exchange relationships. Taken together, the spatial configuration of concentric overlap and lack of reciprocity between zones are more consistent with hierarchy than with network.

A different pattern emerges from ceramic distributions in the NE. Here, type distributions suggest several distinct centers of distribution, associated with market zone areas. Types associated spatially with Zone 3 are Black&White&Yellow/Red and the Late Profile Red ware types. The northern distribution of the Black&White&Yellow/Red extends along the east shore of Lake Texcoco, inland to encompass Texcoco, Huexotla, Coatlinchan, and Chimalhuacan; the eastern edge of this distribution corresponds to boundary between Zones 3 and 4 (Fig. 7.40A). The northern distribution of Late Profile Black/Red and Black&White/Red vessels shows a similar boundary when mapped at a

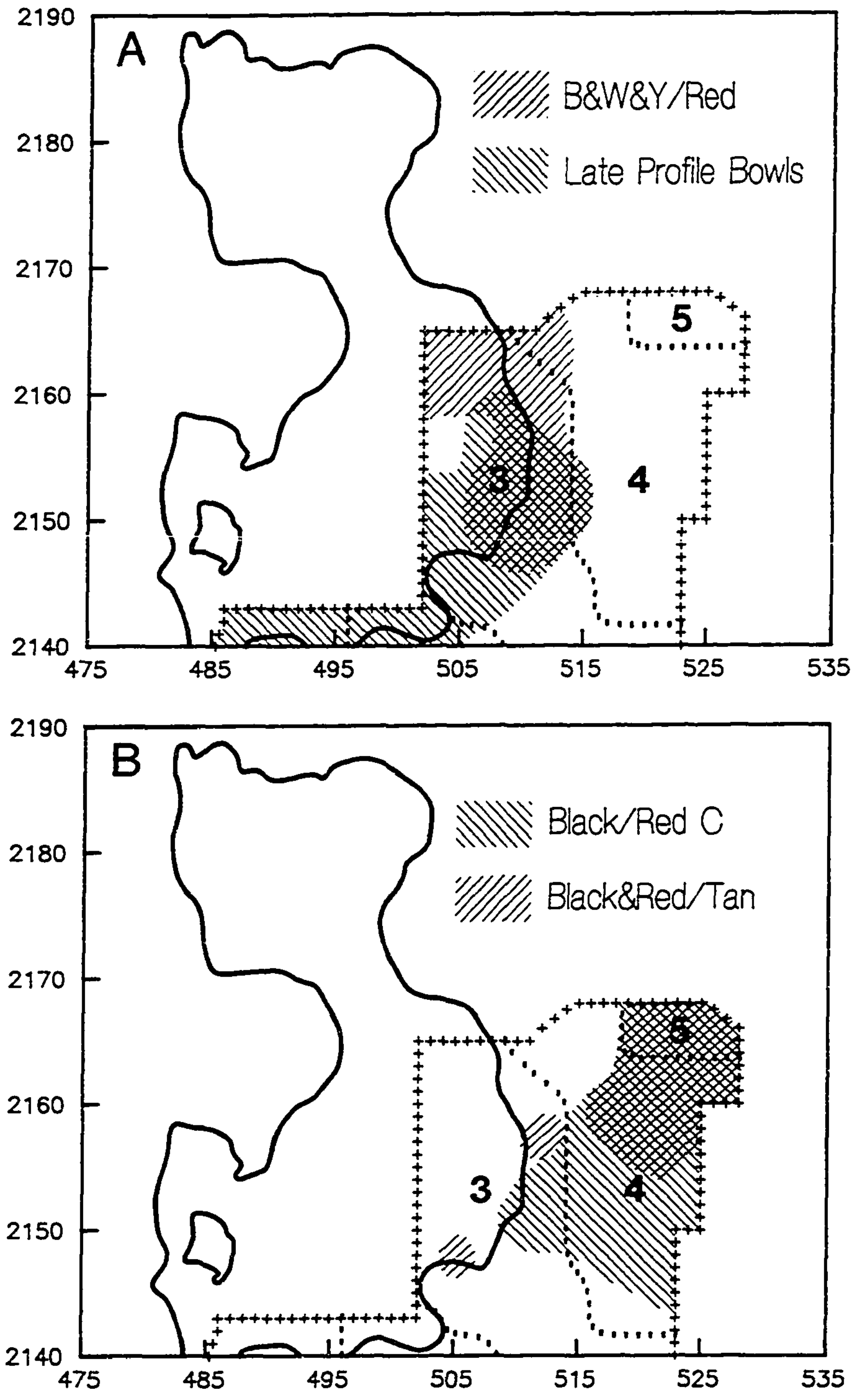


Figure 7.40. Density distribution of Late Aztec ceramic types within the NE sphere: **A.** Black&White&Yellow/Red (mapped at 75% level) and Late Profile bowls (mapped at 95% level); **B.** Black/Red C and Black&Red/Tan (both at 75% level).

higher level (95% level). Thus, all of these three types appear to have a northern distribution largely confined to Zone 3.

A second set of distributions is associated with Zones 4 and 5. The numerically dominant type, Black/Red C, is largely concentrated in the piedmont areas along the eastern edge of the study area within Zones 4 and 5 (Fig. 7.40B). One of the lower frequency types -- Black&Red/Tan -- shows a similar distribution. This type is concentrated in the extreme NE corner of the study in Zone 5, but extends well into Zone 4; it also occurs in patches near the major sites of Texcoco and Chimalhuacan in Zone 3. Although the distributions of both types cross into Zone 3, they are largely distinct from the Late Profile Variants and Black&White&Yellow/Red. The shared type distributions between Zones 4 and 5 underlie the somewhat greater similarity of these zones to each other (as illustrated by the Brainerd-Robinson coefficients), and separate both of these units from Zone 3.

In contrast to the preceding types, Black&White/Red G has a northern distribution extending throughout much of the NE, although it appears to be centered on the major sites of Texcoco, Huexotla, and Coatlinchan. Thus, Black&White/Red G is the only low frequency type that was widely distributed across the boundary between Zones 3 and 4.

Although the type distributions associated with Zone 3 vs. Zones 4 and 5 are largely distinct, they share a sizable area of overlap. This area of overlap is centrally located, and encompasses several major sites, including Texcoco, Huexotla, and Coatlinchan. The location of overlap suggests that the highest level of interaction among these zones was at the geographical and political center. Elsewhere, the persistence of localized distributions suggests a reduced level of lateral integration between zones.

Based on the results of the INA analyses (Appendix V), it further appears that the NE zones were participating in regional exchanges of ceramics to different degrees. Those trace-element results indicate that types with a northern distribution restricted to Zone 3 are largely imported from the south, although some Late Profile vessels were locally produced in the north as well. In contrast, the types associated with Zones 4 and 5 (Black/Red C and Black&Red/Tan) are of local manufacture. The widely-distributed Black&White/Red G was locally produced at a source associated with the site of Texcoco. Thus, Zone 3 appears to have had access to non-local as well as local ceramics, while Zones 4 and 5 were consuming almost exclusively locally produced goods.

In summary, although the patterns differ, both the SW and NE spheres appear to be characterized internally by relatively poor lateral articulation between zones. Both contain type distributions that conform to, rather than cross, zonal boundaries. The two spheres differ, however, in their internal organization. The SW sphere appears to have been supplied by one major distribution center located in Zone 1, and both local and imported ceramics appear to have been distributed from this zone to the more peripheral Zone 2. In contrast, in the NE, multiple centers of distribution are apparent, and local and imported ceramics circulated to some extent through different systems.

Hierarchy. Possible hierarchical relations among market zones were assessed from two measures: (1) differential access to a broader range of goods or assemblage richness; and (2) differential access to higher-order goods, defined here as higher quality goods requiring higher levels of labor input.

Assemblage richness as a measure of hierarchy was calculated based on the presence of 18 ceramic bowl types and variants in Late Aztec assemblages.[16] The relationship of assemblage richness and assemblage size is plotted on a semi-log scale in Figures 7.41A and 7.41B. Examination of these plots suggests the existence of two sub-populations with different regression lines. Sites belonging to Zones 1 and 2 form a regression line with a much steeper slope than do the majority of sites in Zones 3-5. This difference in slopes indicates that the SW and NE spheres differ significantly in richness; percentage composition data (Table 7.11) reveal that they differ significantly in assemblage

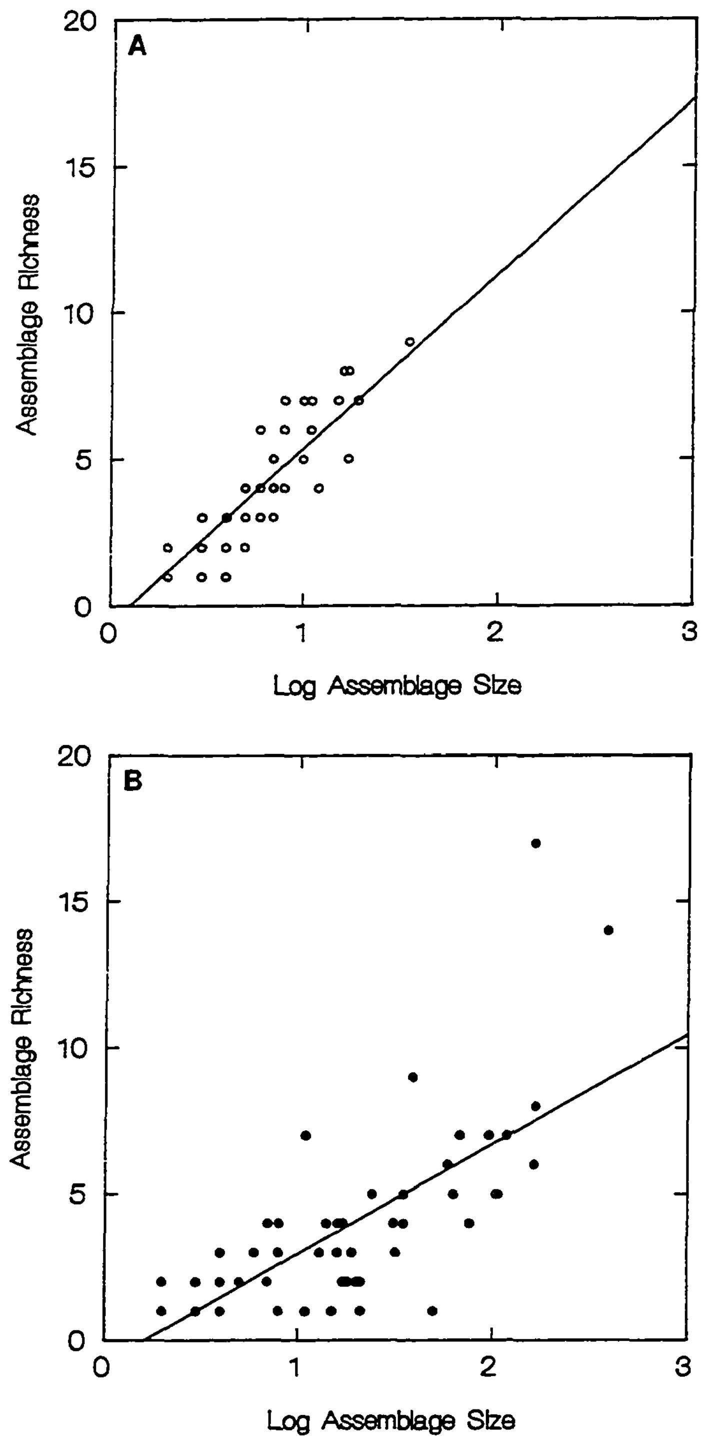


Figure 7.41. Bivariate plots of Late Aztec assemblage richness by assemblage size: **A.** SW sphere (Zones 1 and 2); **B.** NE sphere (Zones 3-5).

evenness as well. Sites in the SW have richer assemblages, but assemblages are also more even. In contrast, sites in the NE have assemblages heavily dominated by a single type (Black/Red Variant C) and so seem less diverse overall. However, a handful of sites from the NE seem to conform better to the regression line formed by assemblages in the SW, indicating that these NE sites are equally rich.

By forcing these cases into a single regression model, the spatial patterning in assemblage richness is clear (Fig. 7.42). Sites in Zones 1 and 2 have predominantly positive residuals (82-86% of sites), while Zones 3-5 have a higher proportion of negative residuals (43-74% of sites). Relationships between zones within each sphere can be examined as well. Within the SW sphere, differences in richness between zones appear insignificant: both zones display similar high percentages of positive residuals. In contrast, within the NE sphere, strong differences in richness are apparent among zones. Zone 3 contains a greater percentage of sites (57%) with positive residuals, and contains all of the most diverse assemblages identified as positive outliers from the regression line in Figure 7.41B. In contrast, Zones 4 and 5 contain a much higher percentage of negative residuals (72% of sites). Further, the richer assemblages in Zone 3 come from the full range of site sizes, from small hamlets to large political centers. Smaller sites showing greater than expected diversity are located along the lakeshore, suggesting that access to a greater diversity of ceramic types is in part related to proximity to Lake Texcoco. Inland, the richer assemblages represent sites of higher political status. These differences in richness within the NE suggest that Zone 3 may have enjoyed a hierarchical advantage over Zones 4 and 5.

Hierarchical relationships between zones are further substantiated by data on their relative access to higher-order goods, i.e. to ceramics requiring higher levels of labor investment. Late Aztec Red wares were divided into three basic groups according to the amount of time needed to complete the decoration. These were: (1) one color decoration,

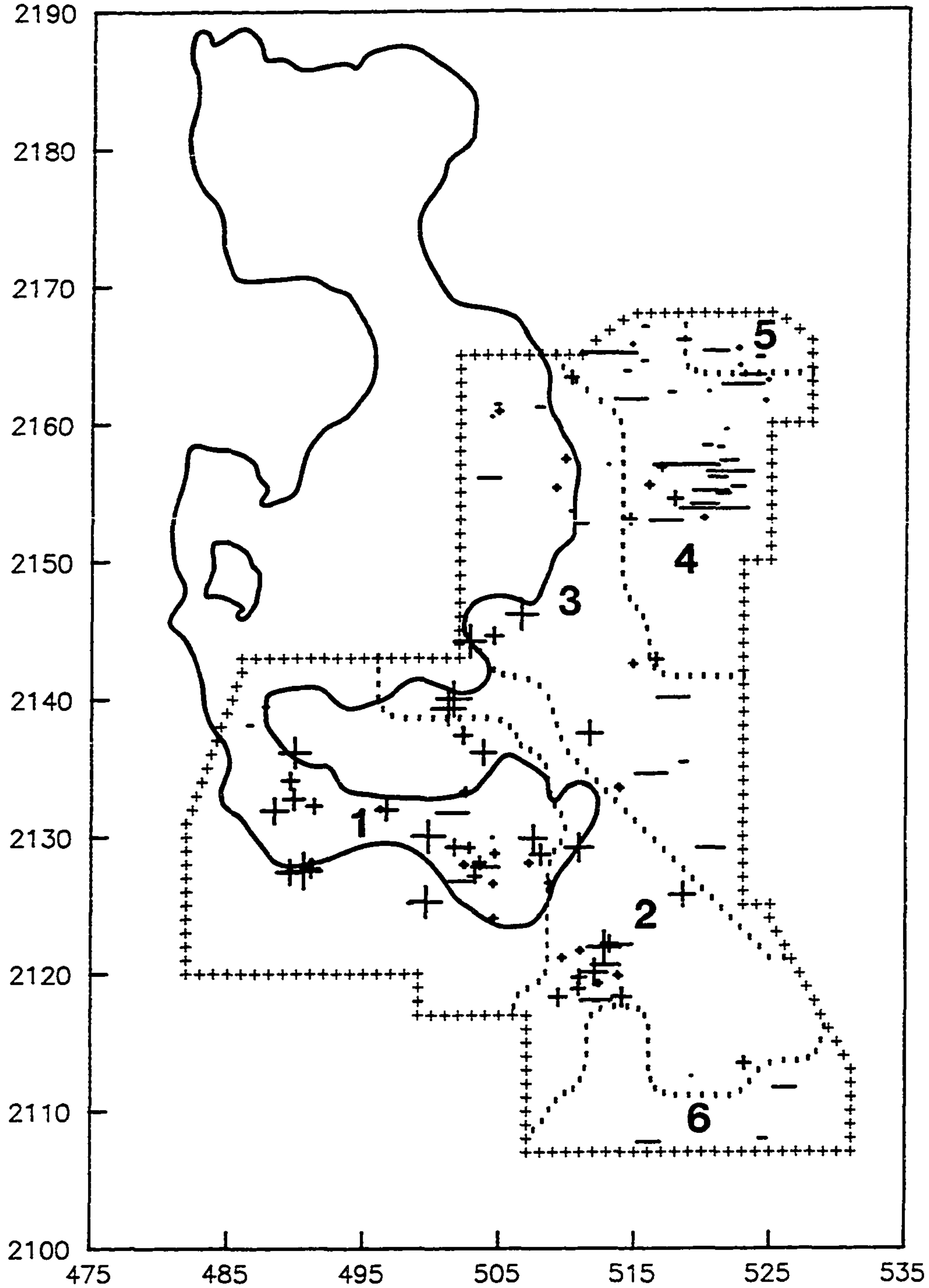


Figure 7.42. Map of richness residuals for sites relative to Late Aztec market zones. Residuals have been calculated relative to a common regression line to illustrate regional differences in richness. Sites are marked as having positive (+) or negative (–) residuals, while symbol size represents the degree of departure from expected assemblage richness based on assemblage size.

simple to somewhat complex design (Black/Red C and Late Profile Black/Red); (2) two color decoration, simple to complex design (Late Profile Black&White/Red); and (3) two-three step decoration, complex to very elaborate design (Black&White/Red G, Yellow/Red, Black&White&Yellow/Red, White/Red, and Black&Red/Tan).

Both the SW and NE spheres appear to have retained distinct regional traditions of the more labor-intensive elite ceramics. The SW has a disproportionate amount of Yellow/Red, Black&White&Yellow/Red, and White/Red ceramics. In contrast, the NE utilized the elaborate Black&White/Red Variant G, Black&White&Yellow/Red, and Black&Red/Tan. Within each sphere, however, differences in access to these higher quality goods is strong between zones. In the SW, Zone 1 has significantly greater than expected counts of Yellow/Red, Black&White&Yellow/Red, and White/Red (Table 7.14), while Zone 2 has lower than expected counts. Similarly, in the NE, Zone 3 has greater than expected counts of Black&White/Red G and Black&White&Yellow/Red, while Zones 4 and 5 have significantly less than expected of these elaborate types. However, Zone 5 appears to have a disproportionate amount of Black&Red/Tan. This may reflect sampling error based on the small number of sherds from this zone; alternatively, it may reflect a higher status area associated with the political center Tepetlaoztoc.

Two significant points emerge here: First, in both spheres, one zone appears to have enjoyed significantly greater access to higher class ceramics than the other, a pattern consistent with a hierarchical relationship of one zone over another. Second, in each case, the peripheral zone consumed locally produced elite goods only, a pattern that strongly suggests market ties only to their own core zone.

In summary, multiple lines of evidence suggest a well-developed hierarchy existed between market zones within the same sphere. In the SW, Zone 1 appears to have been the center of distribution for most ceramic types consumed in this sphere, and it enjoyed access to greater quantities of higher-class ceramics than did the more peripheral Zone 2.

Table 7.14
Standardized X^2 Residuals for Ceramics of Different Labor Input Levels Relative to Late Aztec Market Zones

Red Ware Type	Market Zone						X^2	N
	1	2	3	4	5	6		
Lower Input:								
Black/Red C	-14.24	-6.45	0.61	**8.87**	**2.75**	1.11	332.27	1685
Late Black/Red	**17.99**	**9.08**	-5.02	-7.35	-3.92	-0.70	501.40	181
Late B&W/Red	**19.33**	**11.31**	-2.64	-10.06	-5.93	-0.92	646.00	312
Higher Input:								
B&W/Red G	-3.23	-2.76	**5.83**	-1.51	-1.52	-0.70	57.07	177
Yellow/Red	**6.60**	-0.73	0.50	-3.17	-1.72	-0.32	57.41	38
B&W&Y/Red	**2.73**	1.37	**2.11**	-3.13	-1.74	-0.37	26.79	51
White/Red	**7.09**	-0.69	-1.70	-1.81	-1.06	-0.16	58.04	9
Black&Red/Tan	-3.70	-2.34	-0.15	-1.96	**9.02**	-0.53	104.61	102

Note: Positive residuals >2.00 have been highlighted to clarify patterns of association between ceramic types and market zones.

Similarly, in the NE, Zone 3 is characterized by greater assemblage richness and greater access to elite ceramics than the more peripheral Zones 4 and 5. In contrast, evidence for hierarchical relationships between spheres is not strong. Both areas retained their distinctive stylistic traditions of elite and more mundane Red ware ceramics, arguing for their separate but equal status. Further, although the SW contains richer assemblages overall than does the NE, the SW did not consume significantly greater percentages of the highest-class ceramics than did its northern neighbor (Table 7.11). Taken together these patterns suggest two relatively separate systems within which vertical ties were well-developed and predominated over lateral ties.

Relationship of Late Aztec Market Zones to Political Geography

A comparison of market zone boundaries and imperial tribute territories (Fig. 7.43) indicates a close spatial agreement between Triple Alliance political divisions and exchange interactions at the regional level. Specifically, the strong boundary between the

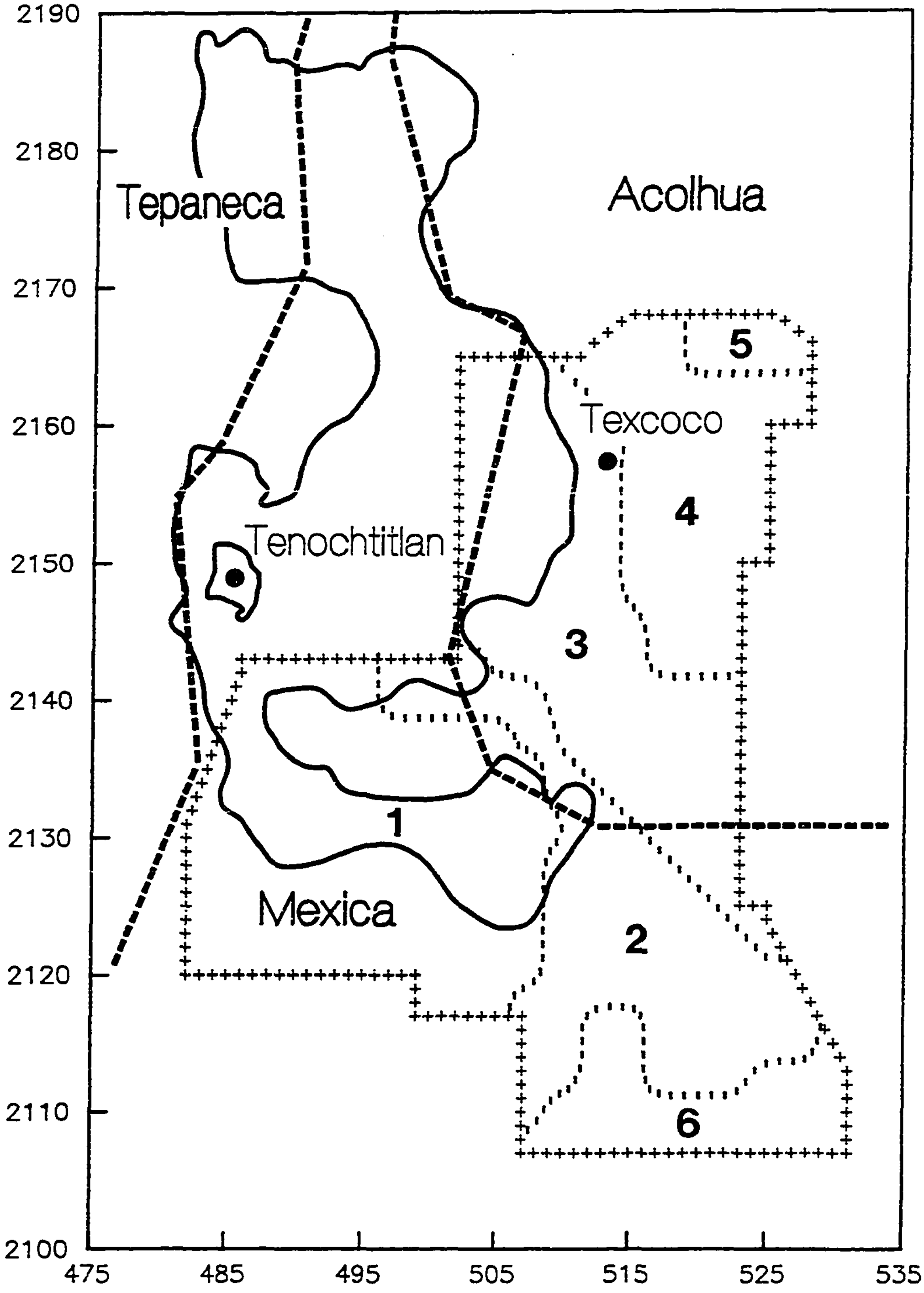


Figure 7.43. Comparison of Late Aztec market zones and Triple Alliance political divisions. The boundary between the SW and NE spheres conforms closely to the division between areas of Mexica and Acolhua control.

SW and NE spheres discussed here conforms well to the political division of territory between the two centers of empire, Tenochtitlan and Texcoco.

The area under the political jurisdiction of the Mexica and owing tribute to Tenochtitlan comprises the southern portion of the study area, and is clearly associated with Zones 1 and 2 (i.e. the SW sphere). Within this sphere, the concentration of ceramic types at the western end of Lake Xochimilco may well reflect a source immediately outside the study area, i.e. at Tenochtitlan itself. If this is so, then the concentric density distributions of Aztec Red wares described above indicate a decline in their availability with distance from that imperial center. The distribution of local political centers (Fig. 7.44) relative to these distributions suggests that many lower-order centers were outside the zone of ready access, and thus did not play a major role in increasing the availability of higher quality or imported goods.

In contrast, the area under Acolhua control and owing tributary obligations to Texcoco comprises the NE portion of the study area, associated with Zones 3-5. Although the NE sphere is largely independent, it did import some higher quality ceramics from the SW sphere. In particular, the ceramic density distributions (e.g. Fig. 7.40A) suggest an influx of more labor intensive ceramics into those areas of the Acolhua domain that are closest to Tenochtitlan. The greater assemblage richness and concentration of higher quality ceramics at sites along the Texcoco lakeshore plain may well result from their proximity to Tenochtitlan. Further to the interior in Zones 4 and 5, assemblage diversity is restricted to locally produced ceramics. An interesting feature of the NE is the location of a number of local political centers on or very close to the boundary between Zones 3 and 4 (Fig. 7.44). Thus, in contrast to the SW, local centers here may have functioned as important intermediaries between the disadvantaged interior and areas more fully drawn into regional exchange.

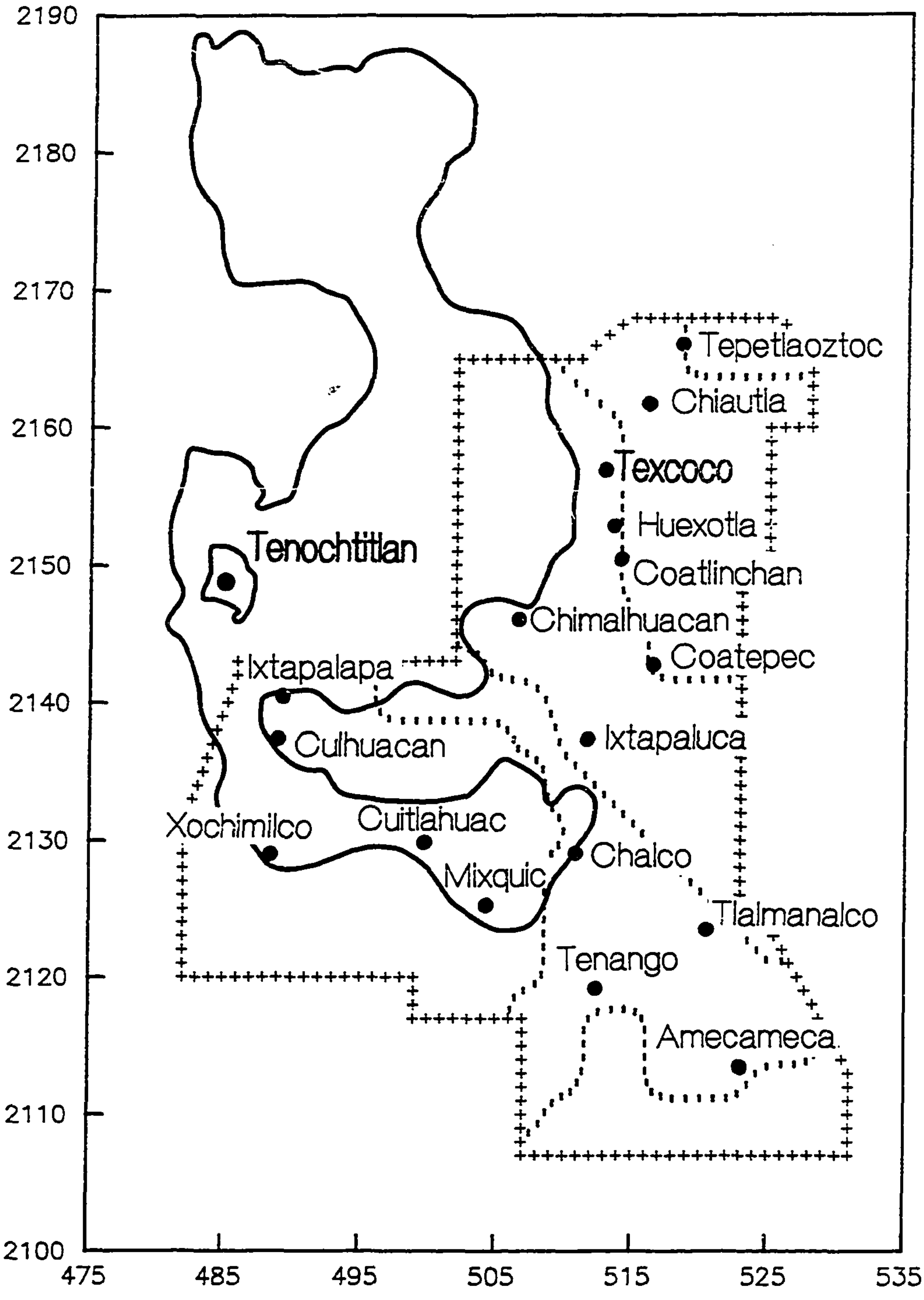


Figure 7.44. Distribution of Late Aztec political centers relative to market zones. Note the location of major Acolhua political centers along the boundary between Zones 3 and 4.

Interpretation of Late Aztec Market System Organization

Of the two long-standing models proposed for market exchange during the Late Aztec period -- integrated market network and dendritic -- the Red ware ceramic data clearly support a model of dendritic market organization. However, the data depart from the generally proposed version of the dendritic model to suggest not a unilineal dendritic system, but a dual dendritic hierarchy focused on the two major centers of empire, Tenochtitlan and Texcoco. This dual hierarchy was anticipated in Chapter 5 based on the division of political and economic power within the Valley between these two centers.

Both the integrated market network and dendritic models assume a high level of regional market integration during Late Aztec times; we can therefore reject both of the models based on the strong divisions apparent between the SW and NE portions of the study area. The presence of two relatively distinct spheres of interaction within the study area seriously undermine interpretations of Late Aztec market system organization that assume uninterrupted commodity flows within an integrated market network. Similarly, these same strong divisions contradict arguments that the entire Valley was unified into a single hierarchical system serving the needs of Tenochtitlan.

In contrast, this study provides evidence (i.e. the reduced degree of network between adjacent zones and well-developed hierarchical differences between zones within the same sphere) for a dual market hierarchy within study area. The overall structure of Late Aztec exchange interactions indicates the presence of two largely distinct spheres, each subdivided into a core zone and a periphery. Ceramic distributions show sharp boundaries along this division between spheres, and only a small degree of overlap between zones with each sphere. This underlying pattern in which ceramic distributions conform to a common boundary suggests a poorly developed market network.

Moreover, the evidence for a hierarchical relationship within each sphere is strong. In both cases, the affluent core zones (adjacent to Tenochtitlan and Texcoco) enjoyed greater access to higher quality ceramics and to imported ceramics. Their peripheries, in contrast, appear relatively disadvantaged: they consumed high quality ceramics in much reduced proportions, and then, only those that were of local manufacture.

There are, however, significant differences in the internal organization of the SW (Mexica) and NE (Acolhua) spheres. A primary difference involves the degree to which commodity flows were centralized or funneled into and out of a single center as indicated by the number of distribution centers found in each sphere. In the SW or Mexica zone, ceramic types appear to have been dispersed from a single distribution area in western Lake Xochimilco, presumably reflecting their source at Tenochtitlan just to the north. In the NE, multiple distribution centers were indicated (Fig. 7.40B), reflecting sources associated with each zone as well as a source (apparently centered on Texcoco) supplying all zones.

It can be hypothesized that the differences in economic organization between the Mexica and Acolhua spheres reflect, in part, differences in the relative balance of political and economic power within each sphere. If we include Tenochtitlan as part of the SW sphere, then this single urban center clearly dominates the area in terms of population size and concentrated demand for rural produce. The centripetal pull of this primate urban center on commodity flows is illustrated by the large number of prehispanic roads and canals that directly channeled goods from Lakes Chalco-Xochimilco into the imperial center (Linné 1948; Santley 1986, 1991; Blanton 1994).

In contrast, in the Acolhua area, although political control was centralized at Texcoco, population was distributed among a number of large city-state centers. Thus, the centripetal pull of urban centers on rural produce was divided among a number of centers, and the pull of Texcoco was accordingly diluted. It therefore seems likely that, while hierarchical relationships were present between market zones, commodity flows in the Acolhua sphere were less centralized. This is reflected in the organization of prehispanic transportation routes: the major roads in this area run generally N-S, connecting this line of administrative centers to each other, as well as to Texcoco (Linné 1948).

To summarize, the Late Aztec pattern is consistent with a model of market system organization in which vertical flows predominate over horizontal ones. However, the data deviate from the standard dendritic model in indicating the existence of two distinct market hierarchies, associated with the two dominant centers of the imperial core. The data therefore best fit the model proposed in this study -- that of a dual dendritic market system; however, subregional differences in the degree of centralization of commodity flows indicate that other factors (such as the size distribution of urban populations) should be incorporated into the model.

Comparison with Previous Studies of Late Aztec Ceramic Exchange

The conclusions reached in this study are clearly at variance with long-standing notions about Late Aztec market system organization in the Valley of Mexico. The apparent standardization and ubiquity of Aztec III or Tenochtitlan Black/Orange ceramics have long been interpreted as resulting from their distribution through a regional market system centered on Tenochtitlan. Although analysts have disagreed on whether the organization of that system was better characterized as an integrated market network (based on the distribution of settlements as economic central places) or a dendritic system (e.g. based on network analysis of Aztec roads), the basic premise of a single unified system has not generally been questioned.

More recently, however, indications of regional subdivisions within the Valley have come to light. An examination of assemblage composition for Late Aztec city-states along the eastern side of the Valley revealed that the city-states of Ixtapaluca, Chalco, Tenango, and Amecameca (comprising the SE quarter of the Valley) had lower proportions of Late Aztec Orange ware than those to the north (Hodge and Minc 1990). This apparent decline in the rate of consumption of "imperial-style" ceramics with distance from

Tenochtitlan led us to conclude that participation in the valley-wide exchange system of Tenochtitlan Black/Orange ceramics was not uniform, nor was it coterminous with the extent of imperial control (Hodge and Minc 1990:431).

In a more detailed study, Hodge (1990, 1992) found that a significant percentage of Black/Orange III ceramic vessels bear, in addition to their standardized wall decoration, a variety of rim motifs. An examination of the spatial distribution of these motifs revealed that some motifs were universally distributed, while others were concentrated in the northern, central, or southern parts of the Valley. These concentrations of specific motifs in discrete areas indicate that localized or subregional distribution systems were in operation. Based on the restricted geographic distribution of a number of motifs, Hodge was able to dismiss the proposition that a single centralized distribution system circulated all Black-on-Orange ceramics (Hodge 1992:440).

Further, Hodge argued that motif distributions conformed better to the major political divisions within the Valley than to market zones as reconstructed based on central place analyses. The political divisions considered by Hodge were fivefold: the Acolhua, the Chalca, the Mixquica-Cuitlahuaca, the Xochimilca, and the Culhua confederations. The degree of similarity among these political divisions is not discussed. However, an analysis of motif distribution by regional survey zone (after Hodge 1992:441, Table 2) reveals that some areas of the Valley are more similar than others. The matrix of Brainerd-Robinson coefficients for the four survey zones (Table 7.15) shows the Texcoco survey region to be relatively dissimilar from all survey zones to the south (B-R coefficients ≤ 95). In contrast, there is a higher degree of similarity among the three more southerly survey zones, where B-R coefficients range from 132 to 152. Thus, the Black/Orange motif data indicate a significant break in exchange interactions between the Acolhua area controlled by Texcoco and more southerly portions of the Valley controlled by Tenochtitlan.

Table 7.15
Matrix of Brainerd-Robinson Coefficients Indicating Degree of Similarity Among Survey Regions Based on Aztec III Black/Orange Ceramic Motifs

	Texcoco	Ixtapalapa	Chalco	Xochimilco
Texcoco	200.00	95.02	88.23	78.63
Ixtapalapa		200.00	153.16	131.87
Chalco			200.00	152.38
Xochimilco				200.00

Note: Data from Hodge (1992:441, Table 2).

These spatial divisions within the Valley correspond closely to those reported in the significant early study of stylistic variability in Aztec maguey spindle whorls (M. Parsons 1972, 1975). In this study, M. Parsons concluded that the definite geographic patterning in spindle whorl distribution corresponded to the major sociopolitical divisions within the Valley of Mexico. Depending on the chronological relationships among the stylistic types, a basic threefold or twofold division of the Valley was noted:

> (1) Type I whorls reflect the Tenochca/Mexica zone of influence, including the cities of Tenochtitlan, Tlatelolco, and Tlacopan, as well as the area north and northeast of them. The presence of Type I whorls in the Xochimilco and Ixtapalapa areas may indicate that the settlements directly south of Tenochtitlan in western Lake Xochimilco were also drawn into this zone.
>
> (2) Type IIA,B,D whorls represent the Acolhua zone, centered on Texcoco but extending north to the Teotihuacan Valley and south to the Ixtapalapa peninsula.
>
> (3) Type IIC-CC whorls are associated with the Chalca zone, extending SE from the Ixtapalapa peninsula and including the important cities of Chalco, Amecameca, and Tlalmanalco (M. Parsons 1975).

If Type IIC-CC is chronologically earlier, then we have a twofold division within the Valley of Mexico between the two big power centers in the Triple Alliance: Tenochtitlan and Texcoco (M. Parsons 1975:215). In this twofold division, the Chalca zone appears to have been participating to some extent in both spheres.

The analyses of Late Aztec Red wares presented here support these previously reported indications of regional subdivisions of the Valley under Aztec rule. Like these earlier studies, the Aztec Red wares indicate a strong division of the Valley into areas controlled by Tenochtitlan and Texcoco. In addition, the analysis of Red wares has extended our knowledge of Late Aztec market system organization in two important ways. First, the methodology employed here was not constrained (as were earlier studies) by predefined units of analysis (such as survey zones or city-state territories). Rather, by mapping the distributions of Red ware types, this study was able to independently determine and map boundaries between distribution systems within a portion of the Valley. Second, this study focused on the nature of exchange relationships between and within these spheres. Of particular importance here is evidence pointing to the sharp boundary in exchange interactions between the Mexica and Acolhua spheres as well as differences in the organization of exchange within each of these spheres.

In summary, the major features of Late Aztec market system organization as identified here are: (1) two distinct spheres of exchange interaction involving the SW and NE portions of the study area; (2) the spatial conformity of these areas to territories controlled by Tenochtitlan and Texcoco, respectively; (3) the poor degree of lateral integration among zones between and within each sphere; and (4) strong hierarchical relationships between zones of the same sphere. Subregional variations in this organization include an apparent greater degree of centralization of commodity flows in the SW (the area under Mexica control), in contrast to a more significant role for local administrative centers in the NE (the area under Acolhua control).

Continuity and Change in Aztec Market System Organization

Regional market system organization before and after the consolidation of the Aztec empire reveals areas of major change as well as strong continuities. To recapitulate briefly, the Early Aztec market system apparently consisted of a series of small market zones, each serviced by a low-level market hierarchy and displaying a high degree of lateral integration with adjacent market zones. The Early Aztec market system appears most consistent with the model of overlapping market zones, in which market exchange was relatively unconstrained by local city-state political territories, although boundaries between competing political confederations limited ceramic exchange to some extent.

During Late Aztec times, in contrast, the study area was divided into two major spheres of exchange interaction, associated with the two major centers of empire, Tenochtitlan and Texcoco. Within each sphere, exchange interactions were largely vertical, between a dominant, affluent core and a disadvantaged periphery. In comparison with the Early Aztec period, there appears to have been a definite decrease in the lateral movements of goods between adjacent market zones. The Late Aztec regional market system thus best fits a model of a dual dendritic system, but with regional variations reflecting the balance of power and hence the degree of centralization realized within each sphere.

A comparison of the Early and Late Aztec exchange interactions suggests that the imposition of imperial rule was accompanied by significant changes in market system organization. In terms of the three primary dimensions, these organizational changes involved: (1) an increase in the scale of market zones from multiple small zones during the Early Aztec to two large spheres during Late Aztec times; (2) a decrease in the degree of market network or lateral commodity flows between zones; and (3) a concomitant strong increase in market hierarchy or vertical commodity flows.

On the other hand, considerable continuity in market system organization is apparent in the conformity of market zones to political boundaries -- a factor that suggests that in both periods, political forces played a major role in restricting or structuring exchange interactions. During the Early Aztec, confederation boundaries between the Acolhua, the Chalca, and polities of the Lake Chalco-Xochimilco basin significantly inhibited exchanges of ceramic vessels. During Late Aztec times, Triple Alliance divisions between the Tenochca/Mexica and the Acolhua (based in part on earlier confederation boundaries) presented equally severe constraints on consumer movements.

What then, can be said concerning the impact of imperial political concerns on the functioning of the Aztec market system? Several generalizations are offered here. First, the division of exchange interactions between areas controlled by Tenochtitlan and Texcoco suggests continued competition between these two centers of empire. Judging from the portion of the Valley examined here, the Aztec imperial core was clearly not dominated by a single economic center. Rather, Texcoco appears to have retained a significant degree of autonomy with regards to the economic dealings within her hinterland.

Further, the conformity of exchange boundaries with political divisions argues that the controls exerted by these two centers to constrain consumer movements were political in nature, rather than involving economic incentives alone. Thus, the documentary sources citing legislative and normative controls that potentially limited market exchange -- including enforced market attendance, the prohibition on exchange outside the market, the necessity to propitiate the patron deity of the regional market, and limitations on how far individuals could travel to honor a market god and attend the market (Durán 1971:273-277) -- are substantiated in this study.

Finally, the relatively sharp boundaries in commodity exchange (in comparison with the Early Aztec period) indicate that controls over consumer movements increased with political centralization. This is consistent with the argument that, as political concerns for limiting access to elite prestige goods intensified, and as administrative imperatives for channeling rural produce into urban areas grew, the market structure was increasingly distorted to satisfy both political interests and urban needs. Although the specific mechanisms and controls remain hypothetical, the result was the development of strong vertical linkages between urban centers and dependent communities -- linkages that permitted imperial and urban development but potentially furthered rural under-development.

Notes to Chapter 7

[1]The ideal method of monitoring commodity exchanges in a prehistoric context is to distinguish the products of different production sources and map the distribution and frequency of goods from their point of origin. INA analyses of trace elements in ceramic clays make such an approach feasible for monitoring ceramic exchange. It may therefore seem strange that the INA analyses of Aztec ceramics included in this study are not put to this use. However, without a much larger sample size, INA analyses cannot provide the level of spatial detail desired. Accordingly, insights gained from the INA analyses are used to supplement the spatial analyses of ceramic exchange based on stylistic distributions, while the bulk of the INA results are reserved for a second topic -- the organization of ceramic production -- presented in Chapter 8.

[2]Within a regional system, market locations near the edges of a network are always disadvantaged, owing to a reduction in the number of adjacent market centers. For example, in the optimal packing situation, a centrally located market center is linked to six adjacent market zones. In contrast, a market center on the edge of the regional system will be linked to only half that number. It is not expected, however, that this "edge effect" will appear as a distinctive zone.

[3]The obvious exception occurs in colonial contexts where a dendritic system designed to supply a foreign market is imposed over indigenous marketing systems. For example, Bohannan and Bohannan (1968:219) and Jones (1976) found that some commodities were distributed through a solar system, while others were distributed through a larger dendritic central-place hierarchy. The solar pattern describes the distribution of subsistence goods produced and stored throughout the countryside, while the dendritic pattern apparently describes the distribution of goods produced in concentrated areas and tied to the international import-export economy (C. Smith 1976a:38).

[4]The order of a good inversely reflects the demand for that item: lower-order goods are commodities of more frequent demand, while higher-order goods are commodities of less frequent demand.

[5]Density distribution maps for Red ware ceramics types and variants analyzed in this study are presented in Appendix VI.

[6]Alternatively, density values for site locations can be interpolated from the smoothed density grids and utilized as input to the cluster analyses, such that groups of sites are identified by the cluster analysis.

[7]For each type, type densities at grid points were determined and the grid points sorted in descending order. Grid points were then summed consecutively and cumulative percentages calculated. The densities associated with the 75% and 95% level were noted, and the contour lines for these densities were mapped as indicating the area within which 75-95% of the type occurred, based on density estimates. These areas of high density were interpreted as centers of distribution for the various types.

[8]An alternative approach for separating the sample-size effect from true diversity is the sampling approach proposed by Kintigh (1984; see also Rhode 1988; McCartney and Glass 1990). The sampling approach requires a great deal of prior knowledge about the underlying frequency distribution of the population sampled, before the effect of sample

size on the richness of samples drawn from that population can be estimated by repeated random sampling. In particular, Rhode (1988) has shown that estimates of expected richness using the sampling method are strongly affected by artifact class evenness. In contrast, the regression approach used here does not require this level of prior knowledge and merely requires that the data meet the assumptions of regression analysis (including linearity, independence of observed values, and normal distribution of residuals about the regression line).

[9]The choice of a log vs. a semi-log model largely depends on which transformation yields a better linear fit with the data (Diamond and Case 1986:560-561). The log-log scale generally linearizes relations better than other transformations, but the semi-log transformation also fits many of the data. An important difference, however, is that the log-log scale emphasizes differences between low-richness samples and de-emphasizes differences among high-richness samples, while the semi-log scale gives a more balanced treatment. In addition, the log model excludes samples with a richness value of 1, while these can be included in a semi-log model. This study examined both models to assess their fit with the data. Where both approaches seemed appropriate, I used the semi-log model in order to preserve differences among richer collections, since these are also the larger (and presumably more representative) collections.

[10]Specifically, Blanton suggests that the "transport principle" appears to have been operative in determining the locations of secondary centers. The transport principle (or K=4 system) locates lower-level centers between two higher-level centers, minimizing transport costs by minimizing the number of roads that must be constructed between centers. This system seems to be most efficient for servicing agglomerated settlements with bulk goods and is the most common pattern of hierarchical central place network (C. Smith 1974:174-175).

[11]Ceramic units included in the assessment of Early Aztec assemblage richness were: Black/Red Variants A, B, D, E, F, G, H, and I; Black/Red-Incised Variants A, B, and C/D; and Black&White/Red Variants AW1, AW2, AN, B, C, D1, D2, D3, E1, E2, E3, and E4.

[12]The asymptotic character may be accentuated in this data set by the relatively low maximum richness and the broad range of assemblage sizes.

[13]The absence of statistical significant results from a generally low difference in slope and/or high within-zone variance.

[14]The distribution of Chalco-Cholula polychrome (a high labor-investment ware) relative to market zones remains unknown at present, but this information will prove invaluable in evaluating hierarchical differences among market zones.

[15]The division of power among the Triple Alliance capitals changed over time, with Tenochtitlan clearly emerging as the dominant center by A.D. 1500 (see Chapter 4). However, our view on the relative power of Tenochtitlan may be slanted by the preponderance of Tenochca documents on this topic.

[16]Ceramic units included in the assessment of Late Aztec assemblage richness were: Black/Red Variant C; Late Profile Black/Red Variants A, B, and E; Late Profile Black&White/Red Variants AW, AN, B, C, D1, D2, D3, E3, F; Black&White/Red Variant G; Yellow/Red, Black&White&Yellow/Red, White/Red, and Black&Red/Tan.

CHAPTER 8

RECONSTRUCTING THE REGIONAL ORGANIZATION OF AZTEC RED WARE CERAMIC PRODUCTION

Goals of Analyses

This chapter examines the organization of Aztec decorated ceramic production within the Valley in order to assess how the reorganization of regional market exchange altered the context of craft production. In Chapter 5 of this work, it was argued that market system structure is a major determinant of the regional organization of craft production for market exchange, while consumer demand and individual ability to produce for that demand determine local strategies of market participation and commodity production. Knowing the structure of the regional market system should therefore enable us to predict certain features of the regional organization of craft production, while information on population nucleation and agricultural regime may enable us to predict variation in market participation within that regional pattern.

The methodology employed in examining the organization of production is Instrumental Neutron Activation (INA) analyses of Aztec Red ware ceramics. Because clay sources carry a signature of trace elements characteristic of the specific parent material from which the clay was derived, examination of the trace-element composition of ceramics potentially enables the archaeologist to identify ceramics that were produced from the same clay source, or conversely, to distinguish ceramics produced by different production sources (e.g. Harbottle 1976; Bishop and Neff 1989; Arnold et al. 1991). Trace-element analyses can therefore determine the number and probable locations of production centers for Aztec Red ware ceramics. Further, the ceramic products themselves can be examined in order to characterize those centers in terms of their relative scale of production, as well as their stylistic and technical variability.

As in the preceding chapter, the approach is diachronic, with the goal of reconstructing organizational features of ceramic production before and after consolidation of the Aztec empire. Ceramic pastes are examined for two archaeological periods, the pre-imperial Early Aztec period and the imperial Late Aztec period. The resulting trace-element data serve as the basis for examining organizational change in ceramic production and distribution systems from two perspectives. First, the INA results are used to confirm the patterns of ceramic exchange identified through stylistic and spatial analyses in the preceding chapter. Because both the locus of production and the provenience of consumption are known for these ceramic samples, we can trace patterns of distribution with fair accuracy. However, there are too few data points (due to the expense of INA analysis) to provide the level of detail obtained through spatial analyses based on type distributions. Thus, the INA samples can serve as a valuable check on (but not as the basis for reconstructing) regional patterns of ceramic distribution.

A second and more important use of the INA results is examine the organization of ceramic production along several key dimensions through time and enable us to determine the degree to which imperial integration and market system reorganization altered pre-existing production systems. Specific organizational features examined include: (1) location and degree of centralization (how many ceramic sources produced Red wares and how were they distributed?); (2) scale (what was the relative volume produced by each source?); (3) intensity and routinization (how standardized was the product of each source?), and (4) product specialization (was each source producing the same range of ceramic vessel types?).

The analysis begins by examining the organization of specialized craft production as measured along key dimensions of variability under different regional exchange systems.

Working from this background, the patterns of regional exchange (as evaluated in the preceding chapter) are combined with considerations of consumer demand and resource variability to predict specific organizational features of craft production for both the Early Aztec and Late Aztec periods.

The methods for monitoring change in the organization of craft production are then discussed, and these methods are applied to Red ware ceramics of the Early Aztec and Late Aztec periods. For both the Early Aztec and Late Aztec periods, a brief review of relevant market system models and their associated features of craft organization is provided, followed by an examination of the organization of ceramic production. Finally, aspects of change and continuity between Early Aztec and Late Aztec periods are described and discussed.

The Organizational Dimensions of Specialized Craft Production

The organization of craft production can be examined along a number of dimensions. Key dimensions of variability identified by other researchers include the context and distribution of producers, the scale and intensity of productive efforts, and the kind and quality of goods produced (Brumfiel and Earle 1987; Costin 1991; Pool 1992) (Table 8.1). Briefly, **context** refers to whether producers are attached to the household of a patron, or whether they are independent producers manufacturing goods for exchange to a non-specific demand crowd. **Distribution** characterizes the location of producers relative to each other and to the consumers they serve. A primary difference here is between dispersed and nucleated production loci; nucleated loci may also be centralized (or not) relative to administrative and population centers.

The **scale** of craft production encompasses considerations of the size and output of productive enterprises, from small-scale individual or household activities to large-scale factories (Peacock 1982; Tosi 1984). A correlate of scale is the principle of labor recruitment: small-scale operations tend to utilize familial labor, while larger-scale operations rely on hired labor. The **intensity** of production refers to the proportion of productive time devoted to that activity, and ranges from part-time to full-time. In general, scale and intensity of production covary (Rice 1991:270); thus we expect small, familial enterprises to be part-time endeavors, and large workshops to be full-time operations. Finally, the **kind of good** refers to the range and quality of goods produced to attract and meet consumer demand.

Table 8.1
Dimensions Characterizing the Organization of Craft Specialization

Dimension	Definition	Scale
CONTEXT	affiliation of producers	attached vs. independent
CONCENTRATION	distribution of producers in regional perspective	dispersed <---> nucleated
SCALE &	size of production group	small <---> large
COMPOSITION	principle of labor recruitment	kin-based <---> wage labor
INTENSITY	percent of productive efforts	part-time <---> full-time
KIND OF GOOD	quality of product based on labor and time invested	simple <---> elaborate

The distribution, scale, and intensity of production, as well as the kind of good produced, respond to different stresses, depending on whether the context of production is attached or independent (Brumfiel and Earle 1987:5). Attached specialists produce goods for a patron who ensures that the specialists' basic needs are met. For these producers, the emphasis in manufacture is likely to be on labor-intensive production of special-purpose or prestige items. In contrast, independent specialists support themselves and their families by producing goods for exchange. Their productive efforts are accordingly guided by concerns for economic efficiency and security. In the discussion that follows, the assumption is made (based on ethnohistoric sources) that most producers of utilitarian commodities in Aztec society were independent and that the organization of commodity production was structured by their attempts to attain economic security and sufficiency.[1]

Modeling Market System Participation and the Organization of Craft Production

Craft production, as part of a strategy for meeting subsistence needs and rising tribute demands, clearly responds to multiple factors. In Chapter 5, however, it was argued that within agrarian societies decisions concerning specialized production and market participation (what to produce and how much) were largely conditioned by three interrelated considerations. These were (1) market system structure (whether the market system was structured to deliver subsistence goods needed in return for specialized production); (2) consumer demand (whether the nature and volume of demand was sufficient to support specialized production and whether the producer could meet that demand); and (3) agricultural productivity (whether the overall productive capacity could support non-agriculturalists and whether the specific agricultural regime created incentives and opportunities to engage in supplemental forms of production). Of these, market system structure emerged as critical in bringing together primary and secondary producers, and thus in determining the location, scale, and intensity of craft enterprises.

How, then, does market system structure affect the organization of craft production? From ethnographic and historical examples we can develop some preliminary expectations for the regional organization of production under different market system structures.

In a **solar market system**, exchange interactions are dominated by an urban market center (that is also the locus of administration), serviced by several small rural market places. Primary commodity flows are vertical between center and subordinate communities, with minimal horizontal flows linking peasant communities directly.

These centralized flows enable the center to provision itself with rurally produced foodstuffs; however, the center has limited rural redistributive capabilities in primary produce as the center generally consumes all (Appleby 1976). Because rural ("peasant") producers cannot depend on the urban market for redistribution of necessities, they attempt to produce their own food supply and maintain a high level of market independence. Urban classes, in contrast, are largely dependent on the market for rural produce and realize that the food necessary for their support will be available in the market only to the extent that peasants must sell it to provision themselves with goods available only in the urban center (C. Smith 1976d:341). Thus, if the urban population is to survive, the urban center must ensure voluntary market participation through monopoly control of some goods necessary for rural producers and/or have the means to legislate and enforce involuntary market participation.

Urban attempts to encourage rural market participation are frequently associated with urban monopoly production. Urban monopoly production typically focuses on crafts that are essential for peasant survival, but that utilize imported or purchased materials or require a greater investment in technology (e.g. cloth, liquor, furniture, iron tools, etc.). Monopoly control is exercised in part through superior access to imported materials, in part through superior purchasing power (the costs of which are partially underwritten by consignments from the local elite), and in part through prohibiting competing rural craft production (T. Smith 1973). The urban producers serve both the local rulers and the community, and may work in a semi-attached position to the household of the lord. Further, these specialists were not necessarily full-time producers; many had landholdings as well from which they derived subsistence support.[2]

If Aztec ceramics were produced as an urban monopoly within a solar market system, production would be concentrated and centralized in the urban administrative center.[3] Although the scale of production would remain small, the limited number of producers in combination with a greater intensity of production could lead to a more standardized product. However, producers would serve a broad range of consumers and therefore produce a broad range of different quality goods to meet their various needs.

The organization of a **non-centralized** or **network market exchange system** facilitates horizontal exchanges between adjacent communities within a region. Rural markets are distributed efficiently in space and synchronized temporally, so that members of a dispersed rural population may make regular visits to more than one market-place. There is, however, no regional market hierarchy: all markets are more or less equivalent with respect to meeting local needs.

The absence of a market hierarchy leads to poor regional articulation and the uncoordinated movement of goods and price information. Although goods can and do travel great distances through the market network, information on supply and demand moves too slowly through a network system to function as a reliable basis for making production decisions. It follows that market prices in network systems cannot articulate a broad division of labor (C. Smith 1976a:40-41). As a result, rural producers place high priority on maintaining local self-sufficiency.[4]

While craft production is restricted by the emphasis on basic self-sufficiency in staple foodstuffs, handicrafts and other home-made goods (such as prepared foods) do enter the market system (Arnould 1982:36-38; Bohannan and Bohannan 1968:209)). Such craft production is regionally dispersed and on a small scale. The individual or family is the basic production unit, and members work on a part-time and/or seasonal basis. In contrast to a solar market system, multiple producers exist for the same basic commodity, and produce that commodity in small lots, thereby generating more variable goods. Further, producers face greater competition for consumers than under conditions of urban monopoly production. Although these producers remain generalists within their trade, such competitive conditions may call forth a greater labor investment per vessel to attract consumer interest (Feinman et al. 1984).

In **dendritic market systems**, trade flows vertically up and down a well-developed hierarchy, but horizontal connections among communities at the same level of the hierarchy are minimal. The system is efficient for channeling goods into the regional center, but is highly inefficient in distributing rural goods to rural consumers, since all goods must first flow to and from the primate center (C. Smith 1976a:34-35). This inefficiency increases with distance from the center. The result is the differential integration of communities into the regional system based on their distance from the primate center: peasants near the core are advantaged in their production-marketing operations, while peasants in the outer zones are seriously disadvantaged.

The organization of craft production varies accordingly. The core zone around the primate center displays a high level of market participation and market dependence. Craft and trade specialization is the norm, and even rural enterprises tend to be specialized and oriented toward cash crops (C. Smith 1976b, 1989). In the center itself, large productive enterprises are supported, and urban craft monopolies may be encouraged as a means for securing urban supplies of rurally produced foodstuffs. Large workshops producing a large volume of goods may, owing to economies of scale and division of labor, produce items more efficiently and inexpensively than smaller operations, thereby undercutting potential rural competitors. The unusual development of the core zone thus corresponds to and contributes to the poor development of its surrounding hinterland and lays the foundation for an urban-rural symbiosis in craft goods (Johnson 1970).

The rural periphery displays low market participation. Poor development of market network in the hinterland reduces dependence on the market system either as an outlet for products or as a source of desired goods. Horizontal trade is possible, but each rural area is dependent on the supply and demand fortunes of its local area, since trade with other rural regions becomes unwieldy and costly (French 1964:57; C. Smith 1976a:34-35). C. Smith (1976b:281) characterizes the peripheries of dendritic systems as rating low on economic alternatives: nonagricultural opportunities are few and craft-trade occupations are very limited. This is not due to a lack of local production resources, but to the fact that the local marketing organization does not provide adequate channels for disposing of surplus or specialized goods. As a result, one finds subsistence farming combined with petty commodity or handicraft production (e.g. pottery, baskets, salt, and the like) (C. Smith 1976d:341).

The dendritic market structure thus creates a dual pattern of craft organization at the regional level. For many craft goods, production is concentrated and centralized in the core zone, where it is organized in large workshops and conducted on a full-time basis. In the periphery, craft production exists as an important supplement to subsistence agriculture, but is organized as an individual or household industry, and is dispersed in peasant villages throughout the rural hinterland. The scale of production is accordingly small, and is carried out on a part-time and/or seasonal basis. Producers in the two regions also potentially differ in production strategy and market breadth. Specialists in the core zone can supply a broad range of consumers with different levels of purchasing power, or they may increase their efficiency by focusing their efforts on a small sub-set of these consumers. In contrast, craft producers on the periphery necessarily produce low-cost goods needed by their neighbors.

Complex, interlocking market systems or **hierarchically integrated market networks** are characterized by both well-developed market hierarchy and network. In such an integrative system, the efficient movement of goods and price information throughout the region potentially articulates a complex division of labor, thereby fostering processes of production specialization and intensification. Any producer can specialize in the production of a single salable commodity, secure in the knowledge that the market will supply other necessities on a dependable and affordable basis (C. Smith 1976d:354; Plattner 1989:203).

Specialization is achieved at two levels. First, integrative market systems articulate a broad division of labor between primary and secondary producers, strengthening patterns of urban-rural symbiosis. Second, they articulate different productive potentials among primary producers, leading to specialized production of whatever cash crops the locale is best suited to produce. These circumstances also reward intensification of effort in both primary and secondary production. In the latter, the greater efficiency of economies of scale will favor the emergence of full-time, larger-scale craft production enterprises.[5]

Finally, given that a large territory will be fully and competitively serviced, one can expect such productive enterprises to be distributed in both urban and rural locations. In this case, production costs are balanced against marketing costs to determine the optimal production location. Although a centrally located production site benefits producers by transferring transportation costs and risks to the consumer (Costin 1991:14), rural production sites may in fact be favored by lower taxation rates, rents, and labor costs, in addition to considerations of resource proximity (C. Smith 1976d:355; T. Smith 1973).

Methods for Reconstructing the Organization of Ceramic Production

The four different regional market systems presented above generate potentially observable differences in both the organization of independent craft production, as measured in terms of the number of producers, their location in rural vs. urban settings, and their relative scale and intensity of production, as well as in the range and quality of goods produced (Table 8.2). Many details of these models are not directly measurable with the regional data base at hand; however, the models provide us with the basis for predicting and evaluating (a) spatial patterns at the regional level, and (b) temporal trends across major changes in market system organization.

The Data Base: Aztec Red Ware Ceramics

The regional organization of ceramic production was explored using Instrumental Neutron Activation (INA) analyses of Aztec Red ware bowls dating from the Early Aztec and Late Aztec periods. These data are supplemented where possible with published information on Aztec Black/Orange ceramics (Hodge et al. 1992, 1993; Minc et al. 1994).

Table 8.2
The Organization of Craft Production under Different Market Systems

System	Number	Distribution	Scale	Intensity
SOLAR	monopoly	nucleated	individual/ small workshop	part-time/ full-time
NETWORK	multiple	dispersed	individual	part-time
DENDRITIC Core:	monopoly	nucleated near primate center	household/ workshop	full-time
Periphery:	multiple	dispersed	individual	part-time
COMPLEX INTERLOCKING	multiple	dispersed	workshop/ factory	full-time

Although these ceramics represent only one commodity, Red ware ceramics were a major prehispanic industry; ceramics in general constitute one of the most prevalent artifact classes encountered archaeologically. Thus, the patterns identified for this production system will have to be taken into consideration by any future models of Aztec craft production. In addition, their patterns of manufacture have implications for the larger arena of craft production. As Costin (1991:13) argues, "if the nature of the demand determines many of the features of the organization of production, ... then it follows that any one product will have an optimal mode of production and similar products with similar demands will be produced in similar ways." Significantly, we can expect that competing producers (those supplying the same category of goods to the same market) will most likely be organized in the same way (cf. Santley et al. 1989; Stigler 1968).

A total of 252 Red ware bowls were selected for the INA analysis, including examples of the most common decorative types and variants (Table 8.3). Types and

Table 8.3

Sample Sizes for Red Ware Types and Variants Included in INA Analysis

Black/Red-Incised	33
Variant A	10
Variant B	8
Variant C	7
Variant D	8
Black/Red	92
Variant A	13
Variant B1	10
Variant C1	16
Variant E	13
Variant H	8
Variant I	9
Late A	6
Late E	13
Basins	4
Black&White/Red	107
Variant AW	14
Variant AN	13
Variant B	10
Variant C	13
Subvariant D1	7
Subvariant D2	1
Subvariant D4	3
Subvariant E1	2
Subvariant E2	12
Subvariant E3	4
Variant F	14
Variant G	9
Indet. Early	1
Indet. Late	4
Yellow/Red	12
Black&Red/Tan	8
Total Red Ware	252

variants were selected for inclusion based on their relative importance in the regional assemblage, and to represent a range of potential status levels. Individual samples were selected from regional survey collections now housed in the UMMA, with an eye to providing a judgmental cross-section of the types and variants from throughout their geographic range.

Element concentrations were determined for the following 27 elements: As, Ba, Ce, Co, Cr, Cs, Eu, Fe, Hf, K, La, Lu, Na, Nd, Ni, Rb, Sb, Sc, Sm, Sr, Ta, Tb, Th, U, Yb, Zn, Zr. These trace elements constitute the suite of the more precise, intermediate and long half-life elements standardly used in the analysis of ceramic material. Because INA analyses are somewhat technical, much of the more tedious discussion of these analyses (including sample preparation, irradiation, element counts, and group formation/refinement procedures, as well as background information on geological and cultural sources of paste variability) are presented in Appendix V. This chapter interprets the trace-element data within the theoretical framework established earlier both to confirm the patterns of ceramic exchange identified through stylistic analyses and to examine the organization of ceramic production along the dimensions of distribution, scale, and intensity. The specific methods employed in these analyses are discussed below.

Identification of Ceramic Production Sources

Fundamental to the analysis of the organization of ceramic production is the identification of clay sources representing distinct production loci as determined from their distinct geochemical signatures. This procedure involves two steps: (1) the identification of homogeneous compositional groups of ceramics based on trace-element concentrations, and (2) the association of these groups with specific clay sources or production loci.

Compositional analyses utilized the 17 most precise elements (Ce, Co, Cr, Cs, Eu, Fe, Hf, La, Lu, Rb, Sc, Sm, Ta, Tb, Th, Yb, and Zn). Principal components analysis was employed to identify the primary dimensions of variability inherent in the chemical composition of the Red ware ceramic samples. Preliminary clay groups were then defined using cluster analysis to group samples according to similarities in their principal component scores.

Subsequent refinement and corroboration of these preliminary groups involved multivariate statistical criteria to assess internal consistency or homogeneity. Probabilities of group membership were determined based on the Mahalanobis D^2 statistic, a measure of the multivariate distance between that case and the group centroid relative to the dispersion of other group members around the centroid. Samples with low probability of group membership were removed using iterative applications of the multivariate distance statistic, until internally consistent or homogeneous core groups emerged. Finally, canonical discriminant analysis was utilized to verify the separation of core groups and classify non-core members into the most likely clay group.

It should be emphasized at this point that the production loci so identified represent distinctive clay sources, not necessarily discrete production units. That is, more than one producer or workshop may have utilized the same local clay source. Characteristics of these production loci (including the scale and intensity of production) therefore reflect the aggregate of producers using a given clay source.

Distribution of Producers

The distribution of producers was assessed in a regional perspective from the location of production loci relative to each other, to market zones, and to features of political geography. The approximate location of production sources was determined from the distribution and concentration of products from that source. Assuming (in conformance with the so-called "criterion of relative abundance" [Rice 1987:177, 413]) that frequency declines with distance from the source, the general location of a production source can be reconstructed from the spatial distribution of sherds bearing similar geochemical signatures. These production locations are unfortunately rather coarse-grained, given the geographic scale of geochemical variability in the basin. Accordingly, provenience labels are given for each source with the understanding that these reflect regional and not site-specific production locales.

Assessing Scale and Intensity of Production

The relative **scale** of production was evaluated from the number of different production sources identified for Red ware ceramics and their relative contribution or percent of total output. The obvious contrast here is between many small production sources and fewer large ones, representing smaller and larger scale operations, respectively. We are partly constrained here by total INA sample size and by our inability to define clay groups based on only a few samples. A more significant problem is that INA analyses do not provide information of the organization of production within each clay source. While we can identify different production locations, we cannot distinguish different producers utilizing the same clay source within each location.

With this *caveat* in mind, however, we can tentatively examine changes in scale from changes in the ratio of production loci to consuming population. In this case, a decrease in the number of production areas (assuming that total demand has not declined) is associated with an increase in scale, since fewer sources must produce a greater volume each to sustain the same level of production (Costin 1991:22; Feinman 1982, 1986; Henrickson and Blackman 1992:133).

The relative **intensity** of production is measured from the relative standardization within the ceramic product. Arguments commonly used to link more intensive production to a more uniform product are twofold (Arnold and Nieves 1992; Attas et al. 1982; Balfet 1965; Blackman et al. 1993; Costin 1991:33-34; Hagstrum 1985; Rice 1981:200-221, 1991:268-272; Sinopoli 1988, 1989). First, more intensive manufacture involves the use of fewer, full-time producers over more, part-time producers. Fewer producers generate less individual variability in both unconscious motor habits and skills and in consciously made decisions regarding form and decoration, and/or the selection of raw materials, leading to a more uniform product. Second, more intensive production frequently results in the routinization of production, where one step of the production process is completed at a time by a single individual. This increased efficiency also leads to increased uniformity.

Standardization may affect raw-material selection and processing (resulting in more uniform paste composition), vessel forming techniques (resulting in more uniform vessel proportions and dimensions), and surface decoration (resulting in a more consistent execution and repertoire of design elements) (Rice 1991:274). Costin (1991:34-35) warns, however, that product standardization can result from other processes as well. In particular, where style communicates information, some markets may demand a standardized design or decoration to demonstrate group affiliation. Standardized forms may also be easier to package, store, and transport. Consequently, our best choice is to confine analyses of variability to aspects that reflect unconscious patterning, such as motor skills, subtle differences in technology, and slight differences in raw materials.

In this study, variability in paste composition is used to determine variability in producers' choice and processing of ceramic clays. For each production source, the within-group variance, expressed as the coefficient of variation (C.V.), was determined for each trace element and a profile of variation within each source prepared (C.V. = 1 σ/mean $\times$ 100). As an index of compositional homogeneity, low C.V.s reflect more uniform composition (associated with more intensive production), while higher C.V.s reflect more variable composition (associated with less intensive, presumably household level production).

Standardization and variability are, of course, relative. How uniform must paste composition of an assemblage be before the label of "standardized" can be accepted? Previous studies have utilized two standards: standard reference materials and cross-cultural studies of ceramics produced within an intensive workshop context. Standard reference materials are highly homogeneous substances of known chemical composition prepared by the National Bureau of Standards that are used as a check on analytical precision and accuracy in INA studies. These samples provide realistic minimum values for C.V.s calculated from highly standardized materials. Second, researchers working with ceramic vessels clearly produced within an intensive workshop context have found variability in both metric and compositional measures to be less than 10% (Blackman et al. 1993; Longacre et al. 1988:Table 1). Compositional variability within vessels of the same production event exhibited variability on the order of only 2-3% for many trace elements, a level comparable to that found in the standard reference materials (Blackman et al. 1993).

Some clay sources, however, are inherently more variable than others (Hector Neff, personal communication). In this case, diachronic comparisons of variability within a given source are valuable. In the absence of technological change, an increase or decrease in variability through time among products made from the same source most likely indicates a change in production intensity (Arnold and Nieves 1992; Attas et al. 1982; Blackman et al. 1993).

A second measure of production intensity was producer assemblage stylistic variability. As Hagstrum (1985) argues, vessel decoration is an aspect of production that potters tend to execute in a regular way in order to simplify and facilitate the decorating process. The result is a more efficient mode of production, but also a more limited repertoire of design elements. Taken to its extreme, the result is product specialization, in which the producer focuses his/her energies on a small sub-set of the total designs and forms produced and used within the society as a means of intensifying production (Rice 1987:190; 1991:262-263; Costin 1991).[6]

The degree to which a producer focused on a specific product within the regional assemblage was measured from the degree of association between specific types or variants and particular production loci as represented by clay groups. A simple chi-square (X^2) test of association between ceramic types or variants and clay groups was utilized to test this association, and the percentage of types or variants showing a significant association was compared across producers. The results are presented as standardized X^2 residuals (indicating the degree of departure from expected values as standard normal deviates), with high positive residuals representing a high degree of association. Clay groups showing a higher percentage of significant associations were interpreted as representing producers following a strategy of greater product specialization and hence a more intensive production regime.

Evaluating Quality of Goods

The kind and quality of goods produced to attract and meet consumer demand is largely consumer driven (Arnold 1985:229-230). That is, the needs and purchasing power of consumers dictate what constitutes a salable product and thus what a producer will attempt to manufacture. On the other hand, independent producers generally face competition to meet consumer demand, and structure their productive efforts to meet consumer demand in as cost-efficient a manner as possible.

For independent producers, a primary consideration in balancing consumer demand and competition between producers is labor investment, i.e., the amount of time, energy, and/or raw materials expended in production per unit of output (Costin 1991:37).[7] Several researchers have argued that cost-effective production is essential for survival in a specialized system, thus reduced labor investment is seen as a natural consequence of competition between producers (Hagstrum 1985; Rice 1987:203). Conversely, other researchers see labor investment as inversely related to competition. According to this view, highly competitive situations lead to higher labor investment and product elaboration, as specialists try to differentiate their wares from those of their competitors, while reduced competition between producers leads to lower labor investment, because there is no need to produce a superior product (Foster 1965; Feinman 1986; Feinman et al. 1984).

An alternative way to view labor investment is as a function of the targeted demand crowd. Independent specialists produce for a general market of potential consumers whose economic, social, and political statuses determine both purchasing power and type of goods desired. In this view, labor investment will in part depend on the segment(s) of the demand crowd that the producer is servicing. Producers can remain competitive and make their products more attractive either by increasing product value while holding cost steady, or by decreasing product cost (Arnold 1985; Rice 1981, 1991:266). The first strategy leads to elaboration, while the second leads to a reduction of labor input resulting in a serviceable, but low-cost product. Where the choice of strategy depends on the purchasing power of the targeted consumers and where that purchasing power is not uniform throughout society, we might expect various producers to employ a variety of competitive strategies ranging between cost-minimization (simplification) and value-maximization (elaboration) (see Rice 1981:223 for a similar argument).[8]

The decorative quality of ceramic goods is measured from the relative labor investment per vessel, as estimated from design complexity and the production step index, an ordinal measure that ranks vessel types according to the time taken to complete their production (Feinman et al. 1981). For each chronological period, all Red ware types and variants are ranked according to the number of steps taken to complete their decoration, and grouped into labor investment classes. Simpler, one-color designs represent a relatively low labor investment, while more elaborate, multi-color designs represent a higher labor investment.[9]

Finally, it should be emphasized that all these scales are relative, not absolute, measures of organization (Table 8.4). Thus, although I attempt to characterize the organization of production and evaluate the degree of fit with specific models, greater emphasis will be placed on organizational change through time.

Table 8.4
Measures for Characterizing Craft Organization Employed in This Study

Dimension	Measure
Context	ethnohistoric data on the location of producers and their degree of dependence on elites
a. attached	production loci associated with elite households; production on consignment for lords
b. independent	production loci not associated with elite residences; production for market exchange
Distribution/ Concentration	number and location of production loci in regional perspective
a. dispersed	multiple clay sources, with distinct locations
b. nucleated	few clay sources, with similar locations
Scale	number and relative output of production loci
a. small	many production sources, each contributing a small percentage of total regional output
b. large	fewer production sources, each contributing a greater percentage of total regional output
Intensity	relative routinization and standardization of product
a. part-time	variable ceramic paste composition; little evidence of product specialization
b. full-time	standardized ceramic paste composition; evidence of product specialization
Quality	amount of labor invested in application of decoration
a. low quality	low values on the production step index
b. higher quality	higher values on the production step index

The Regional Organization of Ceramic Production in the Early Aztec Period

Predicting Features of Early Aztec Ceramic Production

The opportunities for full-time, intensive craft specialization appear to have been limited for the Early Aztec period largely owing to poor regional articulation of market activities. Both market system structures proposed for this period -- the solar market system and the network system -- lack integration along a key dimension. The sharply bounded solar market system lacks horizontal articulation within its boundaries and between adjacent systems, while the network system lacks a regional hierarchy to coordinate price information and flows of goods from areas of surplus to areas of deficit. Under conditions of poor market articulation, opportunities to engage in specialized production are limited, and independent craft producers generally work at their craft as secondary to subsistence agricultural production.

Nor do other incentives to specialized production appear to have been strongly developed at the regional level. Several large city-state centers did provide aggregated consumer demand for both craft goods and agricultural produce. However, agricultural production remained largely extensive during the Early Aztec period (Parsons et al. 1982:345, 383). Although the origins of intensive *chinampa* cultivation in Lake Chalco date to the Early Aztec period, *chinampas* appear to have been constructed on a very limited scale and confined to areas immediately surrounding the larger population centers such as Mixquic, Xochimilco, and Chalco (Armillas 1971; Parsons et al. 1982:344; Rojas Rabiela 1983, 1984). It therefore seems unlikely that there was a large body of intensive agriculturalists to supply and/or support full-time craft specialists throughout the region as a whole.

Overall, we can therefore expect relatively small-scale operations functioning on a part-time and/or seasonal basis as individuals attempted to maintain economic self-sufficiency through agricultural production. In the INA data, we can expect evidence of multiple smaller producers, with little routinization of production steps, resulting in a low level of standardization and little product specialization.

The two market systems commonly applied to the Early Aztec period can be expected to differ, however, in the spatial organization of craft production enterprises. If Early Aztec exchange was organized through a solar market system, we can expect a close association between administrative centers and craft production, visible as conformity in number and location between city-state centers and production loci identified through INA analyses. In contrast, if Early Aztec exchange was structured as a network market system (as indicated by the reconstruction of market exchange in the previous chapter), production would not be restricted to administrative centers but would respond to consumer demand (i.e. population density). In this context we can expect a greater number and dispersal of production locations at the regional level. Further, under urban monopoly conditions of a solar market system, we could expect a higher degree of product standardization owing to the limited number of producers, and a strategy of lower labor investment, while the greater number of competing producers within a network system will lead to lower standardization, but higher labor input per vessel.

Early Aztec Clay Group Identification and Location

Red Wares. A sample of 147 Red ware bowls dating to the Early Aztec period were analyzed for trace-element composition. From these, the clay group identification procedures recognized six Red ware ceramic sources, labeled Early Aztec Red Ware Groups 1A, 1B, 1C, 1D, 2, and 3.

A strong bimodality in Cr led to the initial division of samples into a high Cr group (labeled Early Aztec Group 1, N=98) associated with the Chalco-Tenango-Amecameca area (Fig. 8.1), and a low Cr group (N=49) associated with sites of the Texcoco survey region (Fig. 8.2). This preliminary division based on Cr reflects strong regional differences in Red ware clays between north and south. In particular, the high Cr

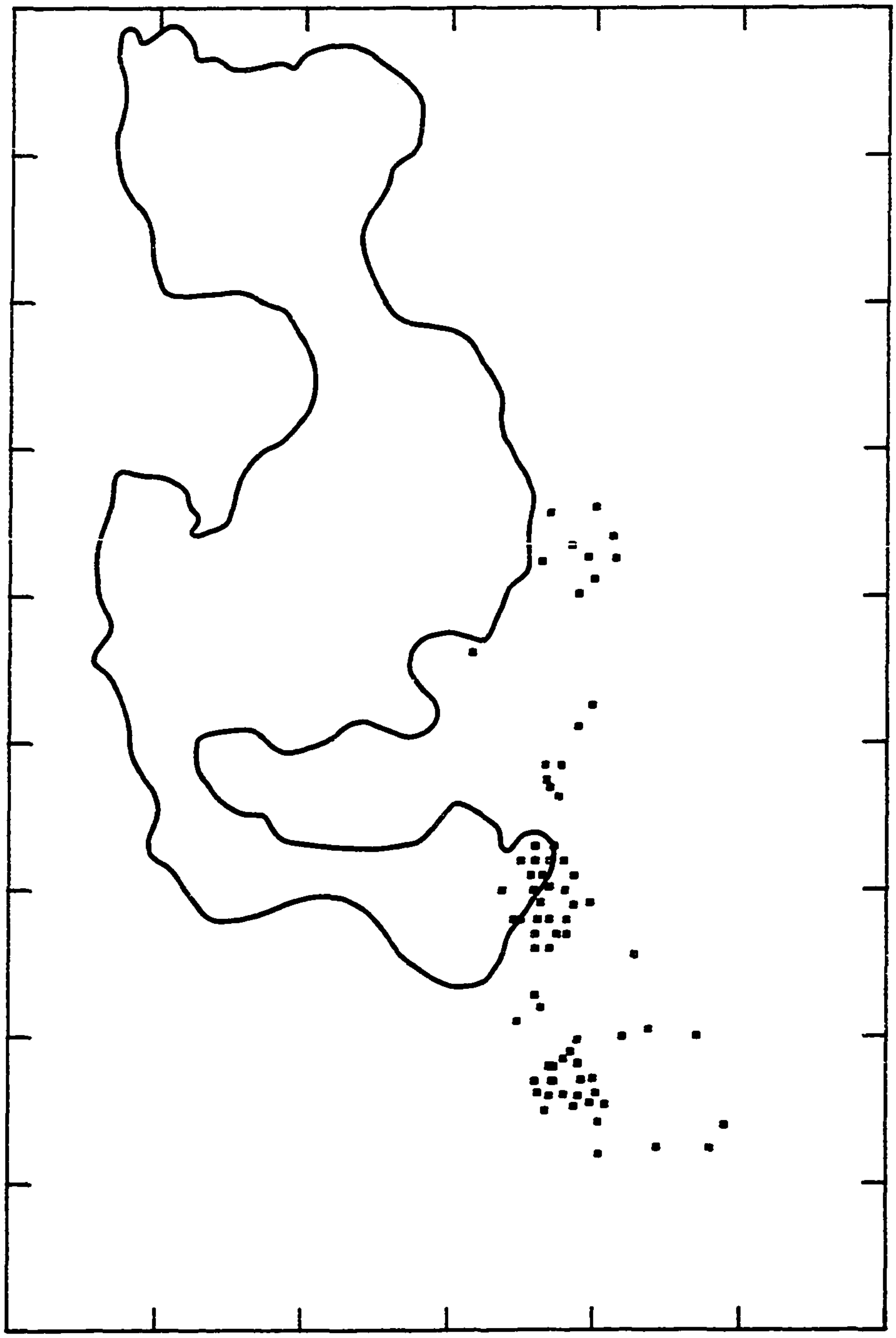


Figure 8.1. Spatial distribution of INA samples belonging to Early Aztec Red Ware Clay Group 1. (Locations have been jittered slightly to show overlap of data points. Jittering introduces a small amount of random variation in point location so that points having identical locations are plotted with unique locations close to their original point.)

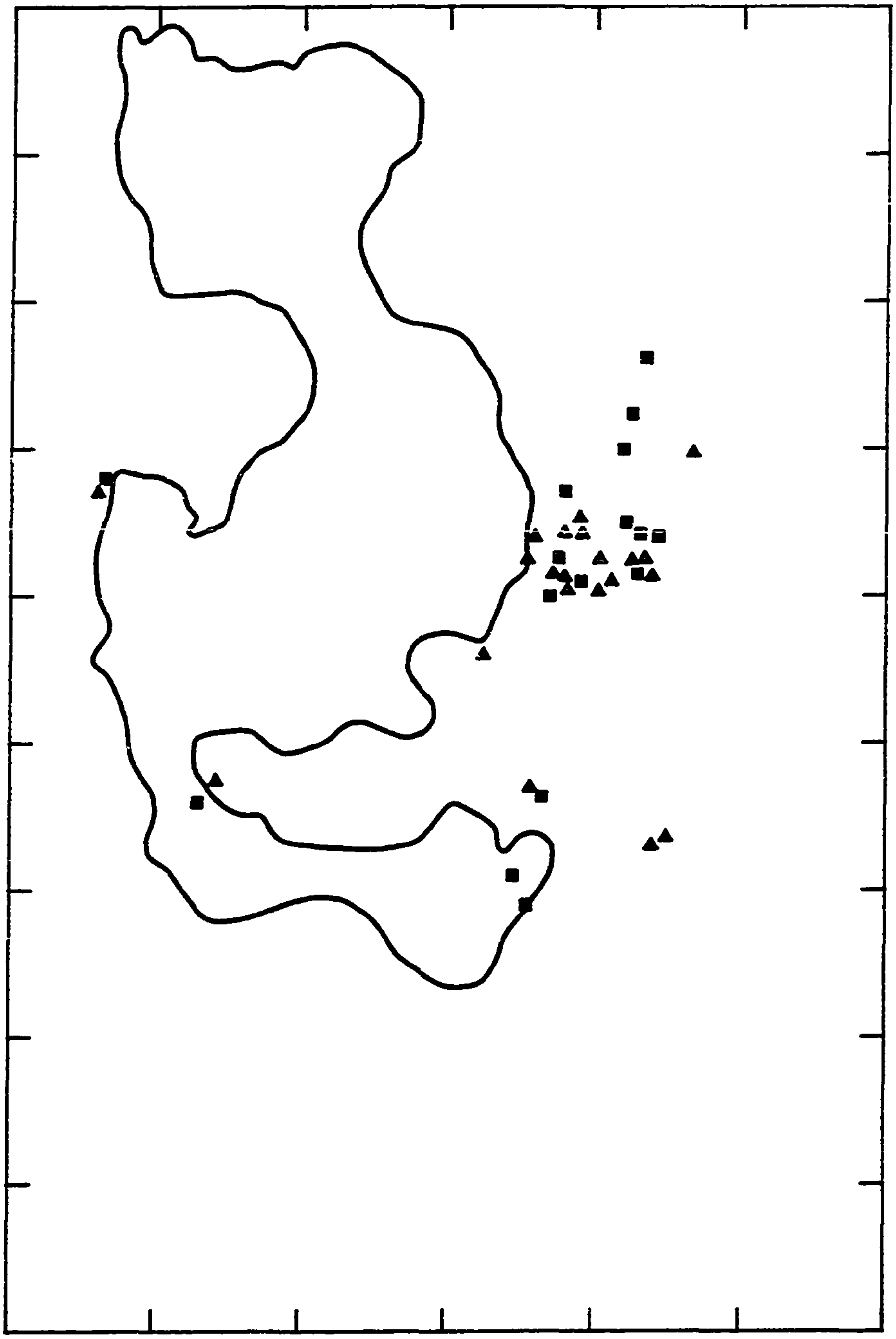


Figure 8.2. Spatial distribution of INA samples belonging to Early Aztec Red Ware Clay Group 2 (triangles) and Group 3 (squares). (Locations have been jittered slightly to show overlap of data points.)

content of southern ceramic samples may well reflect the concentration of basaltic bedrocks that typically contain minerals high in that element.

Subdivisions were also initially apparent within the low Cr group, based on bimodal values for Fe, and higher and lower Fe groups (labeled Early Aztec Groups 2 and 3, respectively) were defined. Subdivisions of the southern Early Aztec Group 1 were not as readily apparent, although multivariate statistical measures indicated the presence of four internally consistent and homogeneous clay groups (Groups 1A, 1B, 1C, and 1D). However, a significant number of samples belonging to the larger Group 1 could not be satisfactorily assigned to one of these subgroups. These unclassified samples may represent the products of other (as yet unidentified) clay sources from which we have too few samples to identify a coherent group. If this is the case, then Red ware production in the south was also carried out in a number of small-scale operations.

Orange Wares. Previous analyses of Early Aztec Black/Orange ceramics (Minc et al. 1989, 1994; Appendix V) examined a sample of 72 sherds representing five distinct stylistic types: Chalco Black/Orange, Mixquic Black/Orange, Culhuacan Black/Orange, Geometric Tenayuca, and Calligraphic Tenayuca. The INA group formation procedures identified three regional production loci for these ceramics, and a close correspondence between production source and stylistic type. Within the southern Valley, a southeastern source area (associated with eastern Lake Chalco) was identified for the production of both Chalco and Mixquic Black/Orange, while a southwestern source (associated with the site of Culhuacan) produced both Culhuacan and Calligraphic Tenayuca Black/Orange. A third, northerly source (showing a close geochemical signature with clays from Texcoco), produced Geometric Tenayuca. Outside the designated study area, other researchers report a western basin (Tenayuca) source and a northern (Xaltocan) source for Early Aztec Black/Orange ceramics, although the stylistic types produced at these sources is not fully known (Hodge et al. 1993; Elizabeth Brumfiel, personal communication).

Inter-Ware Comparisons. Substantial differences exist in paste composition between Early Aztec Orange wares and Red wares. Univariate comparisons of element concentrations in Orange ware and Red ware samples revealed that these wares differ significantly on a majority of elements. In general, the Orange wares have a much smaller range of variation in element concentrations relative to Red wares.

The fact that the two Early Aztec wares are geochemically distinct implies a level of specialization based on different clays and/or different production loci. In addition to their geochemical differences, the very limited sample of sherds examined through petrographic analysis suggests that Early Aztec Red wares have a somewhat coarser paste than do Early Aztec Orange wares, in that they contain a greater percentage of aplastic inclusions. These paste differences may represent natural variability in clay texture, as between well-sorted lakebed clays and more poorly sorted and coarser piedmont clays, suggesting different locations for the producers of Orange wares and Red wares.[10] In addition, there is minimal overlap in vessel shape across wares: Orange ware shapes include dishes, *molcajetes*, basins, plates, and bowls, while Red wares are largely restricted to bowls and *copas*. Although both wares are used for bowls, the bowls have distinctive profiles and size ranges. The transfer of decorative motifs across wares is also extremely rare. This differentiation by vessel shape and decoration supports the interpretation that these wares were manufactured by distinct sets of producers with different ceramic-making traditions.

Insights into Early Aztec Ceramic Exchange

The distributions of ceramics produced at these various sources confirm several important aspects of Early Aztec exchange delineated in Chapter 7. The conformity of Early Aztec Orange ware types to confederation boundaries has already been discussed in that chapter. The geographic distribution of Red ware INA samples similarly indicate that boundaries between political confederations strongly limited exchange interactions. For example, 77% of southern Red wares (Early Aztec Group 1) were recovered within the Chalcan confederation, while 75% of northern Red wares (Early Aztec Groups 2 and 3) were found within the Acolhua confederation. The INA data also replicate the relative degree of exchange interaction among confederations found based on stylistic analyses. Most exchanges occurred between the Chalca and the Acolhua; ceramic exchanges with the Culhua and other lakebed polities were minimal.

The distributions of Red ware INA samples also support the conclusions reached in Chapter 7 concerning the organization of exchange within both the Acolhua and Chalca confederations. The products of specific producers were not strictly associated with a single market zone, but appear to have circulated through several different market zones, a finding consistent with the wide spread and relatively unconstrained distribution of ceramics through a series of overlapping market zones.

Assessing the Organization of Early Aztec Ceramic Production

Distribution and Concentration. The INA results indicate the existence of six different production sources for Early Aztec Red wares and three distinct production sources for Early Aztec Black/Orange ceramics within the study area. At the regional level, then, ceramic production is clearly not centralized: there are multiple loci producing decorated ceramics and these appear to have been supplying different portions of the Valley.

Nor does production appear to have been centralized within these sub-regions, since multiple producers appear to have been supplying Red wares, although their precise location is difficult to assess. In the Acolhua territory, the products of Red Ware Groups 2 and 3 have largely overlapping distributions (associated with market Zone 5). However, within this market zone, Early Aztec Red Ware Group 2 is tentatively linked with the Huexotla area, in that this clay group appears to have been a primary producer of the B&W/R Variant B -- a variant that overwhelmingly predominates in collections from this site. Early Aztec Red Ware Group 3 has a slightly more northerly distribution and is tentatively associated with the Texcoco area.

In the south, the products of Early Aztec Red Ware Groups 1A-1D have highly similar ranges of distribution as well. However, the non-uniform distribution of their products relative to market zones (Table 8.5) suggests that these producers were located to serve somewhat different areas in the south. Specifically, the products of Group 1C show a significant association with Early Aztec market Zone 1, and this clay source appears to have been a primary producer of Black/Red Variant I, a variant largely distributed in the far southern portion of the study area. Although the degree of association is weaker, Group 1A is positively associated with Zones 1 and 2, Group 1D with Zones 2 and 3, and 1B with Zone 3. Thus, producers appear to have serviced a series of overlapping ranges.

Table 8.5
Distribution of Early Aztec Red Ware Clay-Group Products Relative to Market Zones

Clay Group	Early Aztec Market Zone							X^2	N
	1	2	3	4	5	6	West		
Early 1A	1.65	1.47	-0.48	1.04	-1.55	-0.99	-0.70	10.03	34
Early 1B	-1.16	0.78	**2.05**	0.18	-2.10	0.62	-0.52	11.25	19
Early 1C	**4.19**	-1.29	0.94	-0.91	-1.72	1.46	-0.36	26.16	9
Early 1D	-0.41	1.57	1.30	-0.68	-1.48	-0.77	-0.55	7.89	21
Early 2	-1.31	-2.11	-2.59	1.19	**3.60**	0.38	1.12	28.64	24
Early 3	-1.22	-1.97	-1.59	-0.68	**3.46**	0.52	1.28	22.30	21

Note: X^2 values > 11.07 are significant at the .05 level. Cell values represent the degree of departure from a uniform distribution in standard deviations; values >2.00 indicate a strong association between clay group and market zone.

Scale. Measures of scale refer to both the number of producers and their relative contribution or productive capacity. For the Early Aztec sample, 87% of vessels could be assigned to one of six distinct sources indicating that the major production loci have been identified. The contribution of each production source ranges from 6% to 23% of the total output (Table 8.6). While Early Aztec Red ware Clay Group 1A produces somewhat more (23%) and Group 1C somewhat less (6%), the contribution of the other four sources is remarkably even (13-16%). Thus, while there is variability in scale among production loci, the general pattern is most consistent with a number of small production areas.

Table 8.6
Contribution of Early Aztec Production Loci to the Total Regional Ceramic Assemblage

Clay Group	N	%
Early 1A	34	23.1
Early 1B	1	12.9
Early 1C	9	6.1
Early 1D	21	14.3
Early 2	24	16.3
Early 3	21	14.3
Uncl. S	12	8.2
Uncl. N	4	2.7
Uncl.	3	2.1
Total	147	100.0

Intensity. The relative intensity (part-time vs. full-time) of production was assessed in part from the relative routinization of clay preparation and hence the standardization of ceramic pastes. Table 8.7 presents the coefficients of variation for element concentrations for the six Early Aztec Red ware production sources and for two standard reference materials (NBS-SRM-1633A and Ohio Red Clay). These values indicate that a few elements (particularly Rb, Ta, Tb, and Zn) are consistently more variable than others. In examining the less variable elements, it is also apparent that some clay groups are consistently more variable than others.

In particular, the two northern Early Aztec Red ware groups (2 and 3) are significantly more variable than the four southern groups (1A-1D) (Figs. 8.3 and 8.4). For the two northern groups, less than a third of the elements have coefficients of variation below the 10% level (the level associated with standardized workshop production), while

Table 8.7
Early Aztec Red Ware Clay Groups:
Coefficients of Variation for Trace-Element Concentrations

Element	Clay Group								Standard	
	1A	1B	1C	1D	2	3	S	N	1633A[a]	Ohio Red[b]
Ce	4.8	5.6	3.6	6.0	9.4	16.9	2.0	2.5	1.0	3.6
Co	12.0	13.2	6.4	10.8	18.1	10.9	19.6	17.7	1.1	3.3
Cr	5.3	5.1	3.4	6.5	11.6	16.9	0.5	0.5	2.1	4.1
Cs	11.7	14.0	11.9	15.5	14.8	17.8	3.1	1.9	4.9	3.3
Eu	5.2	6.0	5.5	6.6	14.2	8.3	12.0	12.5	2.8	4.8
Fe	3.4	3.7	3.3	2.8	6.6	6.5	1.3	2.1	1.0	2.1
Hf	4.7	3.9	4.2	4.4	7.2	7.9	10.9	15.5	3.4	3.5
La	4.5	8.7	4.9	7.8	13.8	14.0	2.3	2.4	1.4	2.0
Lu	8.2	7.4	7.4	12.9	14.7	11.9	3.3	2.3	4.5	6.0
Rb	18.1	12.9	25.8	12.8	19.8	16.0	8.5	2.9	11.8	8.4
Sc	3.8	6.8	3.0	5.1	8.1	7.6	2.4	2.4	0.9	2.1
Sm	4.4	6.6	5.5	6.8	13.0	8.1	6.5	5.8	3.1	2.4
Ta	11.3	10.5	9.4	17.9	13.0	19.5	4.1	2.6	11.6	12.0
Tb	26.3	23.0	26.6	25.5	24.8	18.0	42.6	20.5	13.2	19.3
Th	4.2	4.4	3.8	4.8	10.6	10.7	0.7	1.2	2.3	3.0
Yb	9.3	8.8	12.5	9.7	15.4	15.3	2.7	2.5	3.8	3.3
Zn	11.2	11.1	8.9	12.6	14.0	20.6	8.5	3.7	7.7	17.4

[a]NBS-SRM-1633A.

[b]Ohio Red Clay.

for the four southern sources, 60-76% of their elements fall below 10%. The southern Red wares appear comparable to the Early Aztec Black/Orange producers, which have 71-88% of their elements with coefficients of variation less than 10% (Table 8.8, Fig. 8.5).

The greater variability in the northern Red ware sources could reflect a higher level of natural variability in northern clay sources. At the regional level, however, ceramics from the north and south appear equally variable and have almost identical patterns of coefficients of variation (Table 8.7). Further, among the Orange wares, the northern (Texcocan) clay source is comparable in variability to that of Chalco and Culhuacan (Table 8.8, Fig. 8.5). Thus it appears unlikely that northern Red ware clays were inherently more variable than elsewhere.

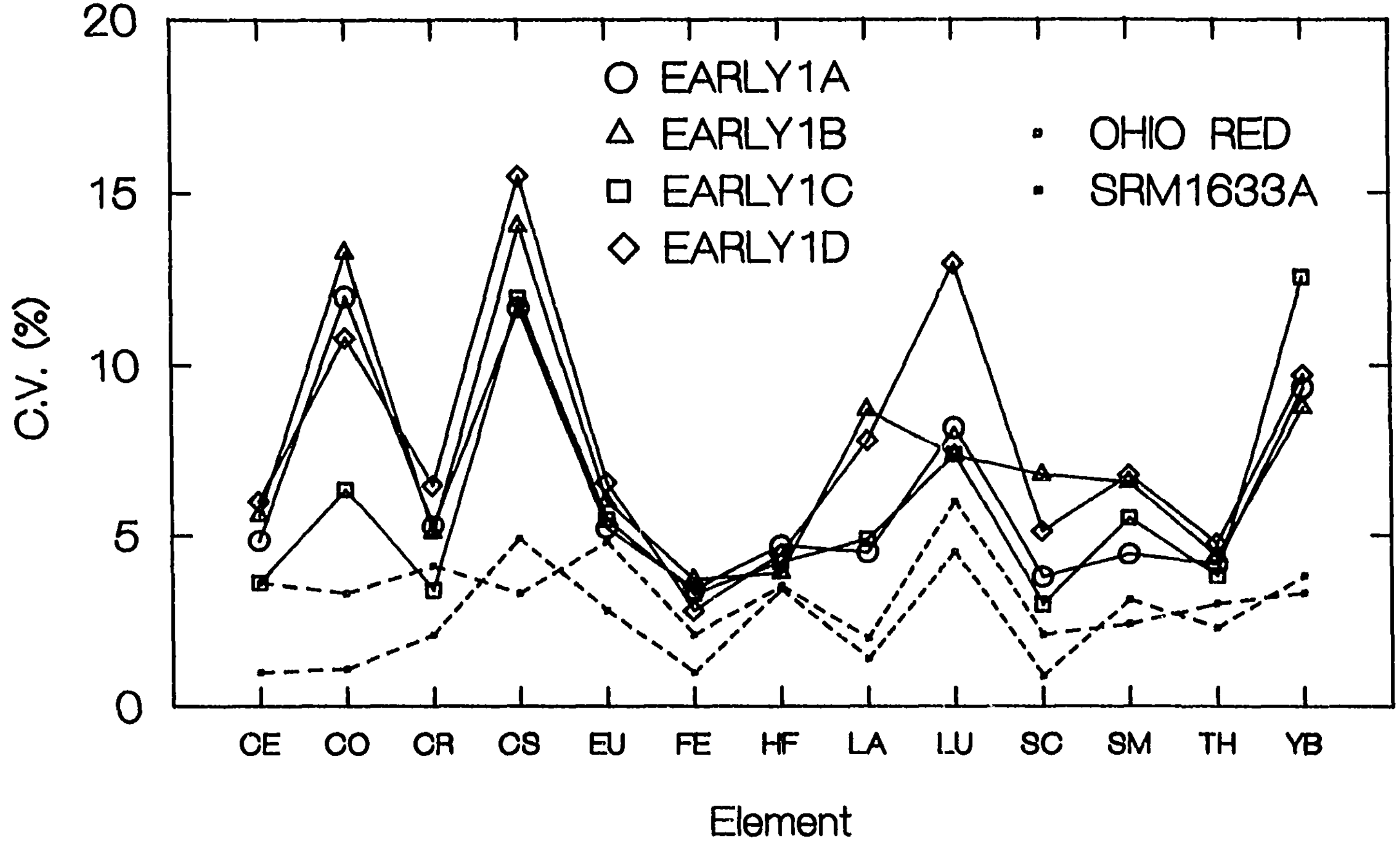


Figure 8.3. Coefficients of variation for element concentrations found in Early Aztec Red Ware Clay Groups 1A, 1B, 1C, and 1D, as well as in two standard reference materials (NBS-SRM-1633A and Ohio Red Clay).

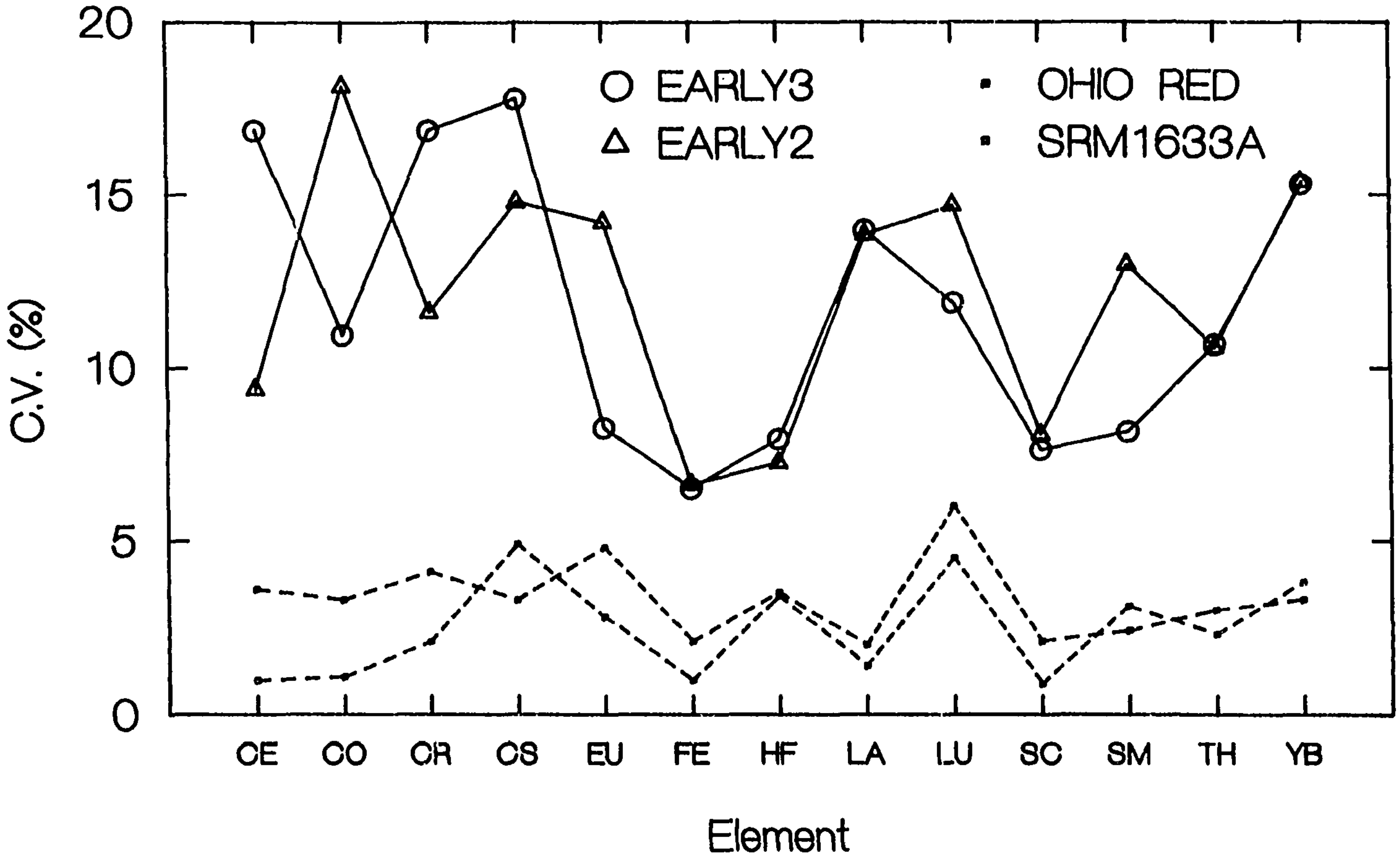


Figure 8.4. Coefficients of variation for element concentrations found in Early Aztec Red Ware Clay Groups 2 and 3, as well as in two standard reference materials (NBS-SRM-1633A and Ohio Red Clay).

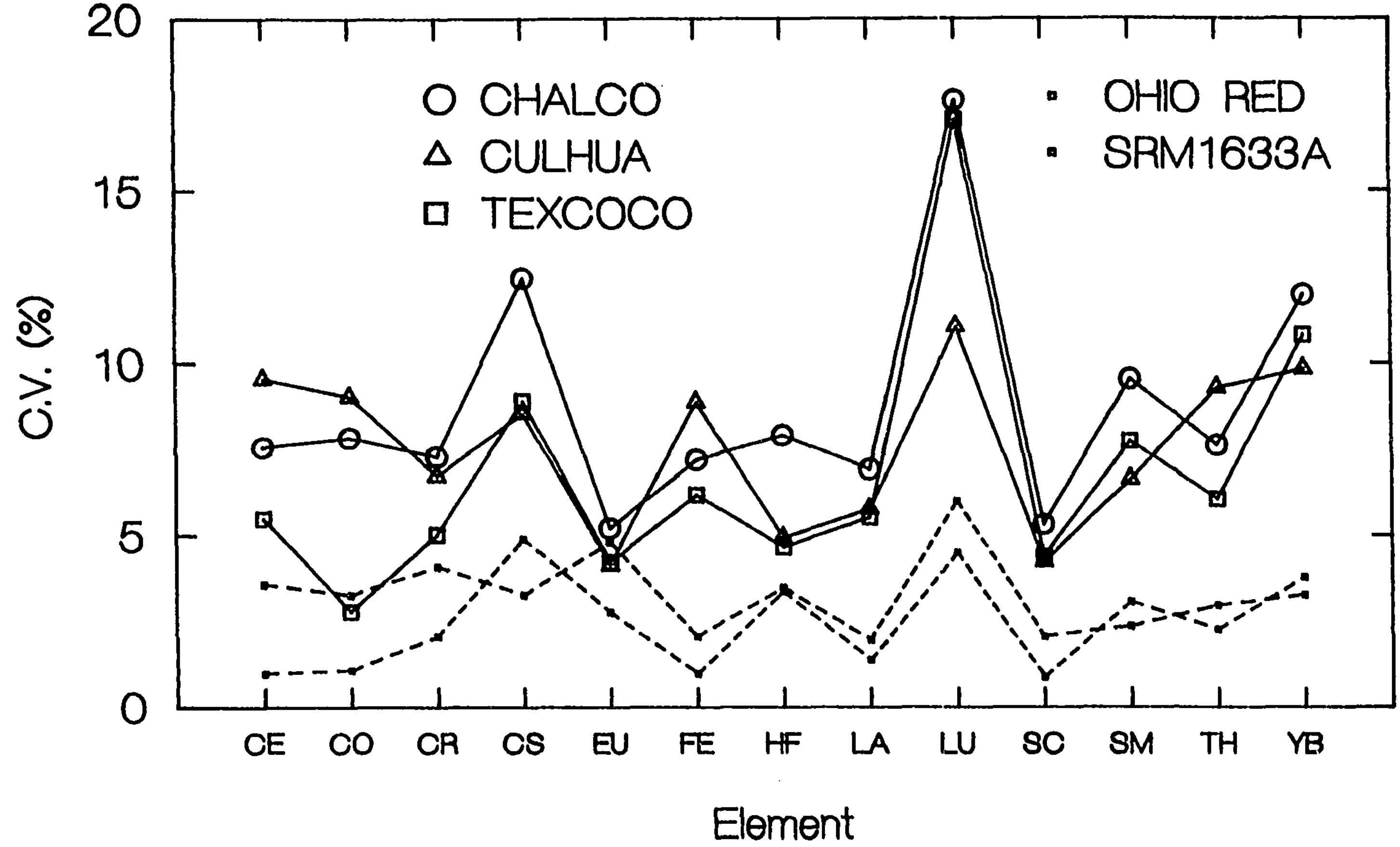


Figure 8.5. Coefficients of variation for element concentrations found in Early Aztec Black/Orange Chalco, Texcoco, and Culhuacan clay groups, as well as in two standard reference materials (NBS-SRM-1633A and Ohio Red Clay).

Table 8.8
Early Aztec Black/Orange Clay Groups:
Coefficients of Variation for Trace-Element Concentrations

Element	Clay Group			Standard	
	Chalco	Culhuacan	Texcoco	1633A[a]	Ohio Red[b]
Ce	7.6	9.6	5.5	1.0	3.6
Co	7.8	9.0	2.8	1.1	3.3
Cr	7.3	6.7	5.0	2.1	4.1
Cs	12.4	8.6	8.9	4.9	3.3
Eu	5.2	4.1	4.2	2.8	4.8
Fe	7.2	8.9	6.2	1.0	2.1
Hf	7.9	4.9	4.7	3.4	3.5
La	6.9	5.8	5.5	1.4	2.0
Lu	17.6	11.0	17.1	4.5	6.0
Rb	9.9	10.3	11.7	11.8	8.4
Sc	5.3	4.2	4.4	0.9	2.1
Sm	9.6	6.6	7.7	3.1	2.4
Ta	10.4	8.0	8.2	11.6	12.0
Tb	13.1	9.8	12.9	13.2	19.3
Th	7.6	9.3	6.1	2.3	3.0
Yb	12.0	9.8	10.8	3.8	3.3
Zn	9.4	6.2	6.9	7.7	17.4

[a]NBS-SRM-1633A.

[b]Ohio Red Clay.

Alternatively, the higher level of variability may indicate that northern Red ware production was not as routinized and hence not as intensive as in the south. Red wares certainly constituted a less important part of the northern Early Aztec assemblage than of the southern assemblage (Hodge and Minc 1990), and as will be discussed below, northern sites were importing a significant portion of their Red wares from the south. Taken together, these indicators suggest that the Red ware industry in the north was less well developed than in the south.

A secondary measure of intensity was product specialization as assessed from the focus of a production source on a limited range of decorative wares, types, or variants. The apparent differences between Red wares and Orange wares in paste, forms, and decorative motifs are strongly indicative of product specialization by ware. In contrast, the evidence for product specialization within Red wares is not strong. Clear regional preferences for different Red ware types existed: northern sites favored Black&White/Red, while the south placed a greater emphasis on Black/Red-Incised and Black/Red (Hodge and Minc 1990). In spite of this, the matrix of standardized X^2 residuals (Table 8.9) indicates a close association between clay source and type for only two cases. Early Aztec Group 1D shows a preference for Black/Red-Incised variants, while Early Aztec Group 2 shows a concentration on Black&White/Red. Sample sizes are not sufficiently large to evaluate specialization by decorative variant; however, the spatial distributions of variants illustrated in Chapter 7 indicate that certain areas favored certain decorative styles. The extent to which this represents a division of labor by producer is unknown.

Table 8.9
Standardized X^2 Residuals Indicating Degree of Association Between Early Aztec Clay Groups and Red Ware Ceramic Types

Red Ware Clay Group	Red Ware Type			X^2	N
	B/R-I	B/R	B&W/R		
Early 1	-0.42	0.80	-0.44	1.02	12
Early 1A	0.86	1.07	-1.63	4.52	34
Early 1B	-0.61	-0.32	0.75	1.05	19
Early 1C	0.69	0.97	-1.42	3.43	9
Early 1D	**2.43**	0.88	-2.61	13.53	21
Early 2	-1.46	-2.26	**3.18**	17.37	24
Early 3	-1.71	-0.57	1.79	6.46	21
Early Uncl.	0.34	-0.33	0.06	0.23	7

Note: total X^2 values > 5.99 are significant at the .05 level; cell values > 2.00 indicate a strong association between clay group and ceramic type.

Quality of Goods. Based on the amount of time needed to complete the decoration, Early Aztec Red wares were divided into four labor-input groups: (1) one color decoration, simple design (Black/Red A, B, H, I); (2) one color decoration, complex design

(Black/Red D, E, F, G); (3) two color or two step decoration, simple design (Black/Red-Incised A, B, C; Black&White/Red D1, E2, E3, E4); and (4) two color decoration, complex design (Black&White/Red AW, AN, B, C, D2, D3, E1).

The distribution of the total Early Aztec Red ware assemblage relative to these classes is somewhat top-heavy: the highest labor input class has the greatest representation in surface survey collections (Table 8.10). However, all identified production sources were producing the full range of labor investment levels, indicating that all production loci represented in this study were supplying the same general range of consumers and following the same general marketing strategies.

Interpretation of Early Aztec INA Results

As noted above, it is difficult to characterize the organization of decorated ceramic production in absolute terms, since most measurements are on relative scales. Accordingly, a primary goal for the Early Aztec period is to establish a baseline with which to compare the Late Aztec results.

In terms of location and concentration of production, Early Aztec production appears to fall toward the dispersed end of the scale. Multiple regions were producing both Orange wares and Red wares; further, for Red wares, multiple production sources were active within each region. The scale of production is more difficult to characterize, but the number of production loci involved in Red ware production is suggestive of a higher ratio of producers to consumers, and hence a smaller-scale enterprise.

With respect to the intensity of production, the degree of paste standardization is less than that reported for "mass-produced" ceramics for which element coefficients of variation fall below 10% (Blackman et al. 1993). However, Orange ware pastes and southern Red ware pastes approach this level of standardization for a majority of elements and appear less variable than anticipated. Northern Red ware pastes were clearly less standardized, suggesting that Red ware production was a less well developed industry here than elsewhere. Finally, although the evidence for product specialization by ware is unequivocal, production loci were not strongly specialized by type or variant. Nor were different production areas targeting different levels of purchasing power within the consumer population.

Table 8.10
Composition of Early Aztec Ceramic Assemblage by Labor Input

Level 1: 1 color decoration, simple design

Black/Red A	216	
Black/Red B	454	
Black/Red H	90	
Black/Red I	247	
Total	1007	(27.8%)

Level 2: 1 color decoration, more complex design

Black/Red D	152	
Black/Red E	115	
Black/Red F	13	
Black/Red G	23	
Total	303	(8.4%)

Level 3: 2 color/step decoration, simple design

Black/Red Incised	439	
B&W/R D1	169	
B&W/R E2	168	
B&W/R E3	47	
B&W/R E4	13	
Total	836	23.1%

Level 4: 2 color decoration, more complex design

B&W/R AW	514	
B&W/R AN	175	
B&W/R B	447	
B&W/R C	95	
B&W/R D2	46	
B&W/R D3	134	
B&W/R E1	64	
Total	1475	40.7%

Note: Type counts are based on the total Early Aztec Red ware assemblage recovered from regional surveys.

These organizational features of decorated ceramic production are not inconsistent with what we would expect under a poorly integrated market system, that of a number of small scale, low-to-medium intensity production enterprises. However, the number and regional distribution of sources conform better to a network market system than to a solar market system, in that there is no clear conformity between political territories and production loci as would be expected under an administered system. Rather, the production sources were located to service different but largely overlapping distribution zones. In addition, the degree of elaboration of Early Aztec Red wares may reflect competition among producers to capture consumer demand, a strategy unnecessary under urban monopoly conditions. All of these dimensions, however, become more fully interpretable in comparison with the Late Aztec period.

The Regional Organization of Ceramic Production in the Late Aztec Period

Predicting Features of Late Aztec Ceramic Production

The opportunities for full-time, intensive craft specialization appear to have expanded during the Late Aztec period owing to greater regional articulation of market activities, urbanization, and intensification of agricultural production. The market system structures proposed for the Late Aztec period (the dendritic market system and hierarchically integrated network) represent an increasing scale of economic integration, that potentially supported an increased scale and intensity of ceramic production enterprises. In addition, the Late Aztec period saw the emergence of true urban centers generating concentrated consumer demand for both agricultural and craft products, and the development of intensive forms of agricultural production capable of supporting a substantial non-agricultural sector.

The proposed market systems differ markedly, however, in how regional integration would be structured and hence in the regional distribution of production opportunities. Under a hierarchically integrated exchange network, increased market participation and hence potential increase in demand for goods could support full-time specialists in urban centers and/or market places throughout the Valley. In contrast, under a dendritic market structure, opportunities to engage in full-time production generally decrease with distance from the primate center, creating an advantaged core zone and a disadvantaged periphery.

Although it was anticipated that the Aztec case would most closely resemble a dendritic structure, it was expected to differ from the standard dendritic model in two significant ways. The first (demonstrated in the previous chapter) is the operation of a dual dendritic market hierarchy in the Valley, centered on the two dominant political, economic, and urban centers, Tenochtitlan and Texcoco. The second proposed difference highlighted in Part I is that the major factor generating centripetal flows of agricultural surpluses into those centers was not necessarily an urban monopoly on craft production, but the availability of exotic raw materials required to complete tribute assessments.

Under the conditions of this model, it was not predicted that craft production would be monopolized by Tenochtitlan and Texcoco. Rather, craft production is viewed as part of a strategy for meeting subsistence needs and rising tribute demands. The model therefore predicts two general patterns of craft production and market participation for the study area based on agricultural regime and ability to produce for an urban market.

In areas such as the southern *chinampa* district dominated by intensive agricultural systems, where producers would have less time and less incentive to engage in supplemental economic activities, we can expect that the intensification of agriculture would both support and rely on the emergence of full-time craft specialists located in urban centers.

In contrast, in areas dominated by less productive and/or more extensive agriculture, such as the Texcocan piedmont, rural producers have both more time and more incentive to engage in craft production as one means of buffering and/or bolstering their income. In these areas, a strategy of diversification in both primary and secondary production is expected, observable from the rural development of "cottage industries" in craft items to supplement agricultural output. Demand and support for urban produced goods declines accordingly. As a result, we can expect evidence of craft production in both urban and rural settings, but the scale and intensity of production and the demand population targeted will differ.

In either context, urban producers are expected to be a full-time industry and to produce a greater volume of goods. Further, their products will exhibit higher quality workmanship and technical standardization -- traits associated with frequently replicated tasks. In the INA analyses, this type of production will be recognized by the presence of fewer, but larger production sources, and a higher level of standardization in paste characteristics.

In addition, urban craftsmen are expected to produce a full range of goods because they have access to consumers of a full range of socio-economic statuses. They will therefore design and produce vessels for a diverse range of purchasing powers that vary in labor intensity and hence in cost. Ceramic assemblages produced by urban craftsmen will contain vessel types exhibiting a range of labor investments, as measured by production-step indices.

Where rural craft production exists to supplement agricultural income, producers pursue their craft as a part-time household industry. Such an industry is expected to have a lower volume of production, and less control or technical standardization. In the INA analyses, this type of production will generate a pattern of more, smaller production sources, demonstrating more variable paste characteristics. Further, rural producers have contacts primarily with other rural consumers with low purchasing power, and are therefore expected to produce a serviceable but relatively inexpensive product to meet their needs. Products of rural producers will accordingly reflect a production strategy that is low in labor intensity and diversity. Ceramic assemblages produced by rural craftsmen are expected to contain primarily vessel types ranking low on the production-step measure of labor investment.

Late Aztec Clay Group Identification and Location

Red Wares. A sample of 101 Red ware bowls and 4 basins dating to the Late Aztec period were analyzed for trace-element composition. In comparison with the Early Aztec sample, the Late Aztec sample of Red wares proved more difficult to divide into distinct compositional groups, owing in large part to a decreased dispersion of some element concentrations. Petrographic analysis of a limited sample of Red ware sherds indicated a significant reduction in the size and number of aplastic inclusions in Late Aztec Red wares, indicating the use of more refined clays. The removal of naturally occurring aplastic inclusions effectively removed a significant portion of the source's geochemical signature as well, making recognition of that source more difficult.

In the final analysis, the clay group identification procedures recognized four Red ware ceramic sources, labeled Late Aztec Groups 1, 2, 3, and 4. Multivariate measures achieved adequate group separation between all four groups; however, a number of unclassified samples showed affiliations to both Group 1 and Group 4, indicating a close geochemical relationship between these two sources. Overall, a significant proportion of samples (29%) remained unclassified as to one of the four sources, suggesting that other production loci were operative as well.

The number of unclassified sherds is particularly high among lower status vessels, represented by Black/Red Variant C (the dominant type for the Texcoco region) and Black/Red basins. Many of these vessels appear as extreme outliers relative to confidence intervals for identified clay groups, although some show mixed affiliations. Cluster analyses indicate that these vessels fall into a number of small, tight groups relatively dissimilar to other such groups. Although the small size of these groups precluded statistical verification of group membership and separation, it would appear that multiple small-scale producers were the primary manufacturers of these more utilitarian vessels, although larger-scale production centers concentrating on the production of higher class vessels were involved in their production as well.

Spatially, Groups 1 and 4 are associated with the southwestern portion of the study area, including Lakes Chalco-Xochimilco, while the products of Group 2 are concentrated in the Texcocan heartland. Group 3 is concentrated in sites west of Lake Texcoco, in an area where our samples of Early Aztec Red wares is extremely limited. Overall, the INA analyses revealed surprisingly little continuity in the production loci of Red ware ceramics from Early Aztec to Late Aztec times. Although direct comparisons of Early and Late Aztec Red wares are hampered by differences in paste texture that potentially alter the geochemical signature of clay sources, it appears that major shifts occurred in the production locations of this ware through time. Five out of six Early Aztec Red ware sources appear to have discontinued production of this ware in the Late Aztec period. Conversely, regions with no apparent history of Red ware production became major producers of these vessels during the Late Aztec period.

The notable exception to this trend occurs within the Texcoco region. In spite of differences in paste texture, there is a marked similarity in the geochemical signatures of Early Group 3 and Late Group 2, arguing for strong continuity within the Texcoco source through time. Such similarities are not found, in contrast, within the southern Red wares. Although both Late Groups 1 and 4 have a southern origin, their geochemical signatures differ substantially from the Early Aztec southern clay groups. This difference is consistent with a shift in the location of production from the southeastern (Chalco-Tenango-Amecameca) to the southwestern portion of our study area through time. The precedents of the western Lake Texcoco source remain unknown due to the current lack of Early Aztec Red ware ceramic material from this area.

According to historic records, at least 6 cities in the Valley of Mexico were major producers of ceramics in early colonial times: Tenochtitlan-Tlatelolco, Texcoco, Cuauhtitlan, Azcapotzalco, Huitzilopochco, and Xochimilco (Barlow 1951; Gibson 1964:350; Branstetter-Hardesty 1978:26). It is likely that these centers represent the continuation of a late prehispanic tradition.[11]

In attempting to identify our Late Aztec clay groups with known centers of pottery production, only the association of Late Aztec Group 2 with Texcoco is fairly secure based on trace-element comparison with modern potters' clay samples from that city. At a more tentative level, it is likely that Late Aztec Groups 1 and 4 represent historic centers in the southwestern portion of the Valley, such as Huitzilopochco and Xochimilco. Late Aztec Group 3, in contrast, may well represent Azcapotzalco (since sherds sampled from that site fall within this clay group) or perhaps the more northerly Cuauhtitlan, a colonial producer of Red wares. If this is the case, we have yet to identify a clay signature for ceramics produced in the imperial capital, Tenochtitlan-Tlatelolco. It is possible, however, that the imperial capital produced only the highest quality and highest status vessels whose limited distribution did not permit their inclusion in this study.

Orange Wares. Published INA analyses of Late Aztec Orange wares (Hodge et. al. 1992, 1993) report that Late Black/Orange clay sources have geochemical profiles quite similar to previously identified Early Black/Orange production sources, indicating (a) a greater degree of continuity in Orange ware production loci through time than was found for Red wares, and (b) that the two wares remain geochemically distinct in Late Aztec times. However, not all early sources continued to produce with equal vigor during the later period. In particular, the Chalcan source appears to have declined markedly from its earlier level of productivity, a trend paralleling the fate of the Chalcan Red ware industry. Thus, within the study area, the major late Black/Orange producers were located at

Texcoco and Culhuacan/Ixtapalapa, with an additional western basin source tentatively associated with Tenochtitlan.

Insights into Late Aztec Ceramic Exchange

The distributions of ceramics produced at these different ceramic sources confirm several important features of market exchange during the Late Aztec period as described in Chapter 7. First, the geographic distribution of INA samples support the division of the study area into two major market spheres with relatively little exchange interaction between these spheres. This is evident from the fact that ceramic vessels from the same clay group were distributed within fairly limited areas -- a factor that has enabled us to determined the locus of production from the concentrated distribution of the products. The producers supplying the SW sphere, Groups 1 and 4, had 78-80% of their products distributed within market zones 1 and 2 (Table 8.11). Similarly, Group 2 (associated with the Texcoco area) had 77% of its products fall within market zones 3 and 4 comprising the NE market sphere.

Table 8.11
Distribution of Ceramic Samples Belonging to Different Late Aztec Clay Groups Relative to Market Sphere

Red Ware Clay Group	Market Sphere			Total	% Local
	SW	NE	West		
Late 1	18	4	1	23	78
Late 2	2	20	4	26	77
Late 3	1	0	17	18	96
Late 4	8	2	0	10	80
Late 1/4	8	1	0	9	89
Late Uncl.	6	9	0	15	--

In addition, ceramic samples from sites west of Lake Texcoco indicate that a third market sphere operated on this side of the lake basin. This is an area outside the designated study area for which we have limited information on Red ware ceramic styles and their distributions. However, the INA data indicate a distinctive production source (Group 3) for this area and relatively little ceramic exchange between western Lake Texcoco and the market spheres defined within the study area. Only 6% of Group 3's products were found in sites outside the western Lake Texcoco area. Overall, the INA data support the interpretation of regional exchange that divides the Valley into several large and largely non-overlapping market spheres during Late Aztec times.

Assessing the Organization of Late Aztec Ceramic Production

Distribution and Concentration. The INA data indicate the existence of four major production sources for Late Aztec Red wares: one in the Texcoco region, one located to the west of Lake Texcoco, and two within the southwestern lakebed area (Fig. 8.6). The presence of multiple production loci supplying different portions of the Valley is clear evidence that ceramic production was not centralized in the Late Aztec period. However, production appears to have been somewhat more centralized within each region than during the Early Aztec period. A single major producer is apparent in both the Texcoco and the western Lake Texcoco regions, while the southwestern region was supplied by two distinct production sources.

In addition, the discontinuity in clay sources through time indicates a major shift in the location of Red ware production under Aztec rule, closer to the centers of imperial power. Three of the four Late Aztec production sources identified (Late Aztec Groups 1, 3, and 4) have distributions along the western and southwestern portions of the Valley, indicating that the region near the imperial capital of Tenochtitlan became a major zone producing Red ware ceramics. The remaining production center (Group 2) appears to have been located in or near Texcoco, the empire's second city. In contrast, Red ware production in the politically peripheral southeastern Valley (a major area of Early Aztec production) was discontinued.

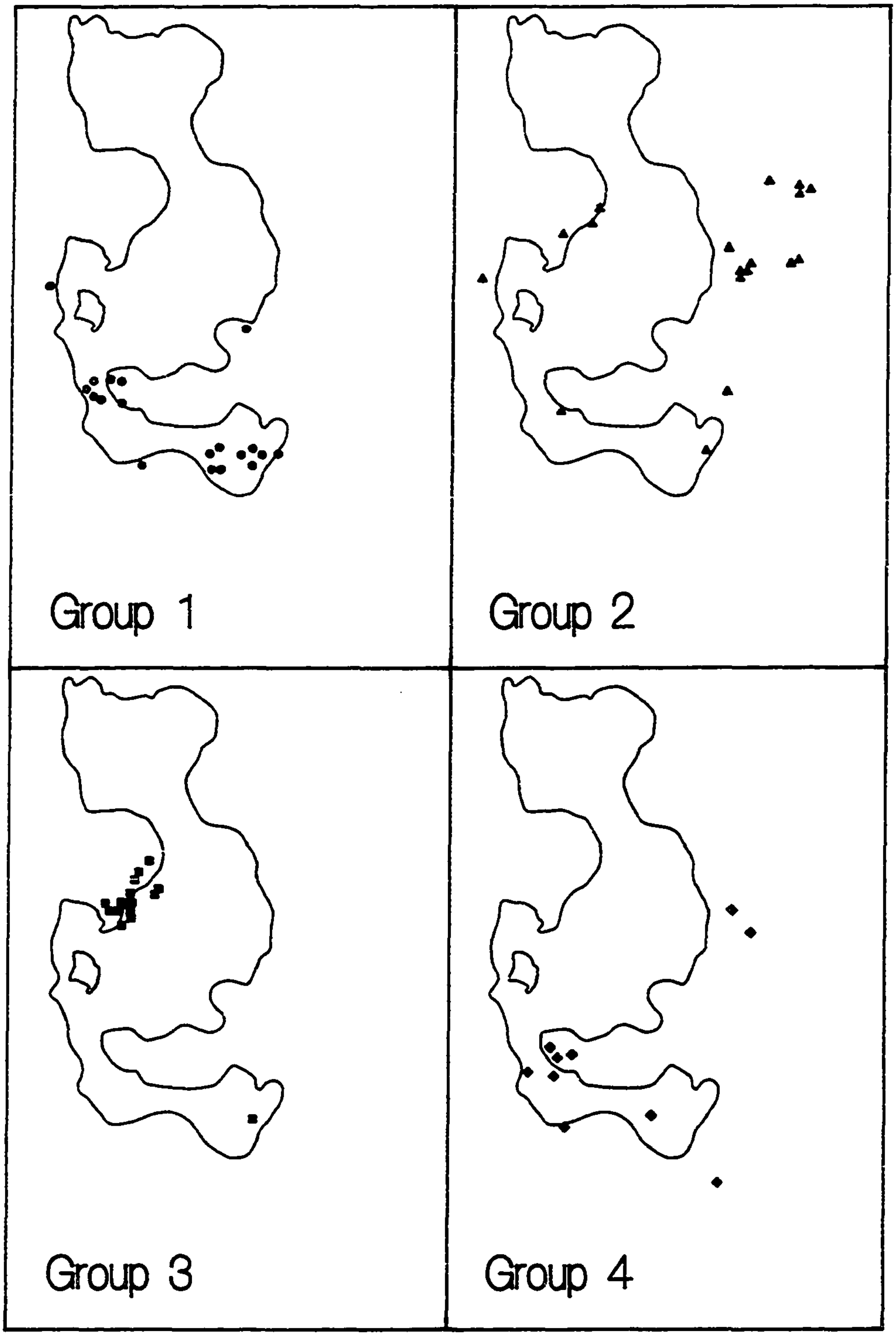


Figure 8.6. Spatial distributions of INA samples belonging to Late Aztec Red Ware Clay Groups. (Locations have been jittered slightly to show overlap of data points.)

Scale. For higher status Red ware vessels, four major production loci were identified for the Late Aztec period; 79% of the samples could be assigned to one of these sources, while an additional 10% showed strong affiliations to both southwestern sources. Three of these production areas had roughly equivalent levels of output accounting for 17-25% of the total Late Aztec sample each, while the fourth was significantly smaller (Table 8.12). The evenness of these values is comparable to those of the Early Aztec period. However, there appears to have been a major decrease in the number of production loci through time, from six locations to three, within the study area. This reduction in number suggests a corresponding increase in their total volume of output and thus an increase in their scale of production during the Late Aztec period.

Table 8.12
Contribution of Late Aztec Production Loci to the Total Regional Ceramic Assemblage

Clay Group	N	%
Late 1	20	19.0
Late 2	26	24.8
Late 3	18	17.1
Late 4	10	9.5
Uncl. 1&4	9	8.6
Uncl.	22	21.0
Total	105	100.0

In contrast, relatively few of the lower status Red ware vessels (represented by the common Black/Red Variant C bowls) could be assigned to a production source. Although all Black/Red Variant C samples were drawn from the Texcoco survey region, less than half of the samples appear to belong to the major production source for that region, Late Group 2. Rather, their highly variable trace-element compositions suggest that these ceramics were produced by a number of small-scale manufacturers, although this conclusion remains tentative due to the small sample size of this class of vessels.

Intensity. Judging from the coefficients of variation for element concentrations (Table 8.13), the Late Aztec production loci do not show a general decrease in paste variability relative to the Early Aztec sources. Some production loci are more variable than others (Fig. 8.7). The least variable sources (Late Groups 2 and 4) have 59-65% of their elements with coefficients of variation falling below the 10% level, a percentage comparable to the Early Aztec. Similarly, the two more variable sources (Late Groups 1 and 3) have only 23-47% of their elements with C.V.s less than 10%, again similar to the most variable of the Early Aztec sources.

Table 8.13
Late Aztec Red Ware Clay Groups:
Coefficients of Variation for Trace-Element Concentrations

Element	Clay Group				Standard	
	1	2	3	4	1633A[a]	Ohio Red[b]
Ce	16.0	7.6	12.6	9.2	1.0	3.6
Co	22.4	19.3	14.8	11.6	1.1	3.3
Cr	9.8	8.6	9.5	3.5	2.1	4.1
Cs	16.7	10.6	12.4	13.5	4.9	3.3
Eu	11.8	6.8	10.7	9.1	2.8	4.8
Fe	11.0	5.1	5.9	5.1	1.0	2.1
Hf	8.3	6.0	9.0	4.4	3.4	3.5
La	14.8	9.6	13.4	7.4	1.4	2.0
Lu	14.7	9.8	14.9	12.7	4.5	6.0
Rb	10.4	13.1	9.7	21.4	11.8	8.4
Sc	6.1	3.5	6.1	4.5	0.9	2.1
Sm	14.2	7.2	13.4	8.2	3.1	2.4
Ta	11.9	12.7	8.6	11.3	11.6	12.0
Tb	23.8	17.0	18.8	14.0	13.2	19.3
Th	9.3	6.1	9.9	7.1	2.3	3.0
Yb	15.3	8.7	12.9	9.8	3.8	3.3
Zn	11.0	13.2	6.6	15.2	7.7	17.4

[a]NBS-SRM-1633A.

[b]Ohio Red Clay.

However, for the one case where we have clear continuity in clay source from early to late times (i.e. the Texcocan source), there is a noticeable decline in variability,

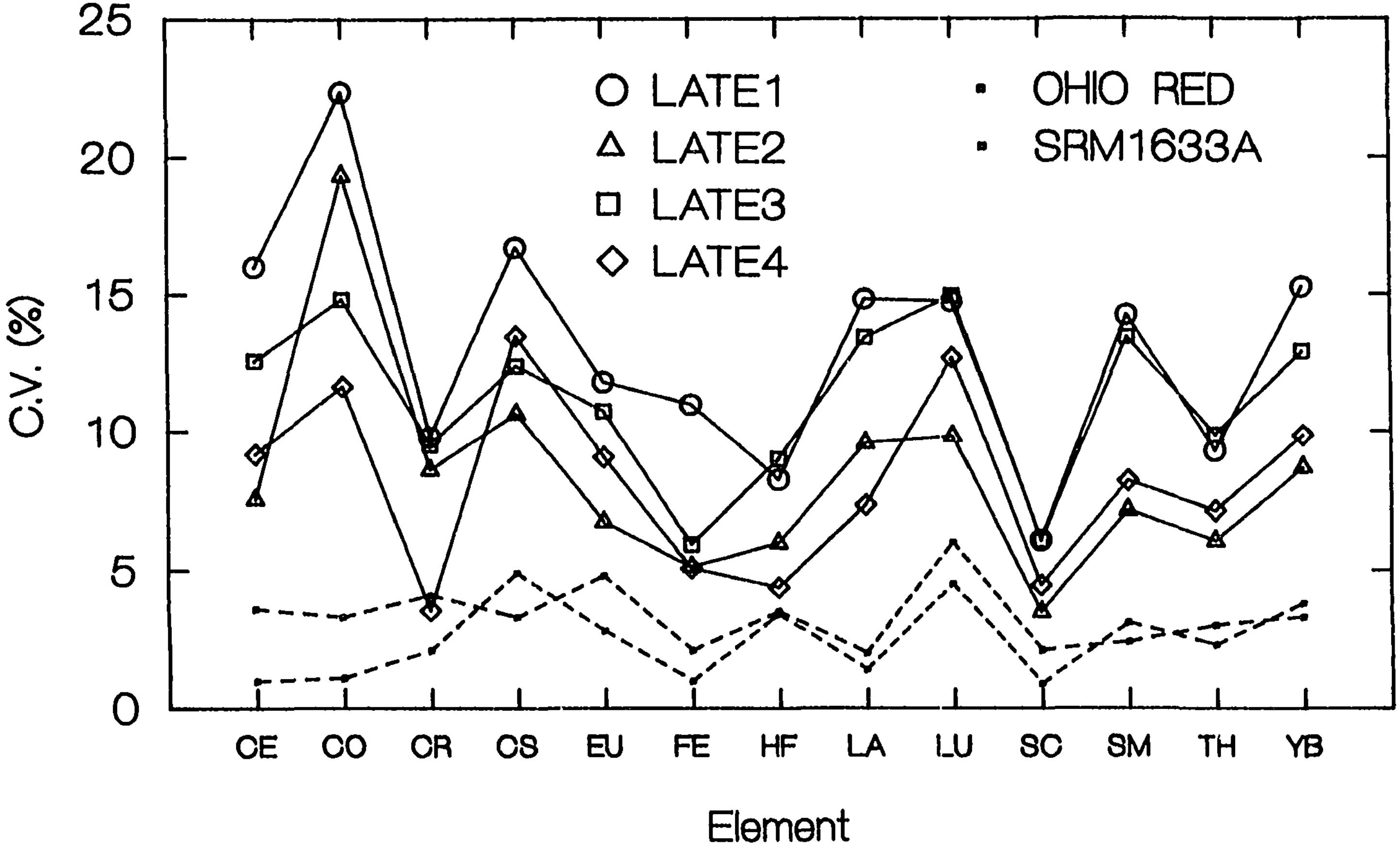


Figure 8.7. Coefficients of variation for element concentrations found in Late Aztec Red Ware Clay Groups 1, 2, 3, and 4, as well as in two standard reference materials (NBS-SRM-1633A and Ohio Red Clay).

consistent with an increased level of routinization and standardization of clay preparation. Early Group 3 had only 29% of the elements falling below 10%, while for Late Group 2 this increased 65% (Table 8.13, Fig. 8.8).

The degree of standardization also varies by quality of vessel. The lower quality Black/Red Variant C vessels are less standardized as a group, a finding consistent with the interpretation that these ceramics were manufactured by multiple, small-scale producers. A lack of standardization is also apparent in the decoration of this variant. Although the so-called comb motif is quite simple, it varies considerably from vessel to vessel in placement and orientation, as well as in the number, width, and length of lines of lines making up the comb element (Parsons 1966:215-216; Plates 66-68).

The Late Aztec Red ware sources do, however, show a significant trend toward increased product specialization. The matrix of standardized X^2 residuals (Table 8.14) shows a clear association between production source and ceramic type for most cases. Although Late Group 1 was producing a mix of Late Profile Black/Red and Black&White/Red as well as Yellow/Red, the other southern producer, Late Group 4, appears to have concentrated on the production of Black&White/Red vessels. The Texcocan area producer, Late Group 2, focused on two low frequency types: the elaborate Black&White/Red Variant G and Black&Red/Tan. Finally, Late Group 3, located west of Lake Texcoco, concentrated on Late Profile Black/Red bowls. There is also some evidence of within-region specialization for the Texcoco region; Late Group 2 focused on higher status vessels, while the lower class Black/Red Variant C was produced elsewhere.

Quality of Goods. As for the Early Aztec, Late Aztec Red ware bowls were divided into a number of labor input classes based on the number of steps required to complete their decoration. These classes were: (1) one color decoration, simple design, simple profile (Black/Red C); (2) one-two color decoration, simple to somewhat complex design, bolstered profile (Late Profile Black/Red and Black&White/Red); and

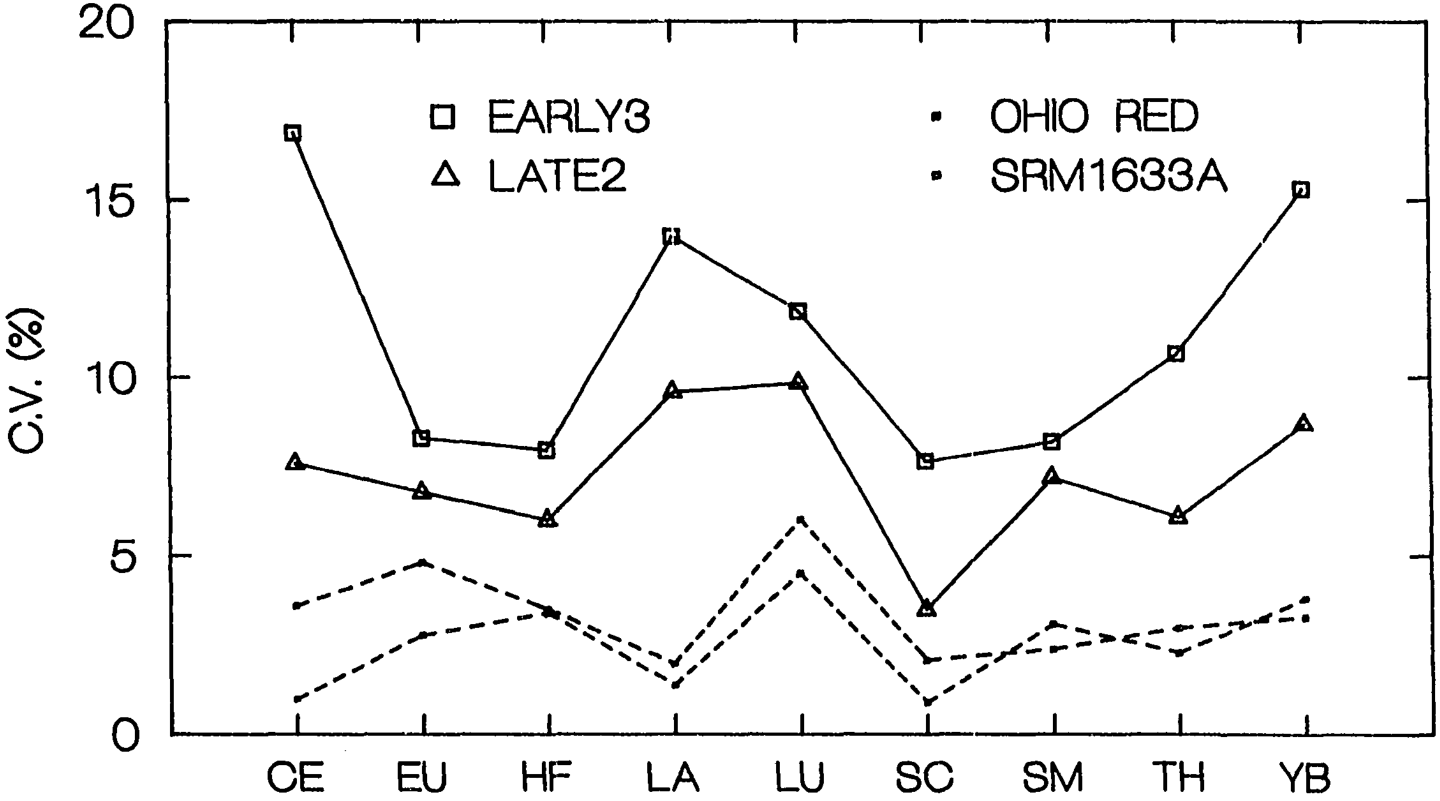


Figure 8.8. Coefficients of variation for element concentrations found in Early Aztec Red Ware Clay Group 3 and Late Aztec Red Ware Clay Group 2, as well as in two standard reference materials (NBS-SRM-1633A and Ohio Red Clay). The two clay group profiles show a significant decrease in variability within the Texcocan clay source from Early Aztec to Late Aztec times. (Only the most precise rare earth and related elements are included.)

Table 8.14
Standardized X^2 Residuals Indicating Degree of Association Between Late Aztec Clay Groups and Red Ware Ceramic Types

Red Ware Clay Group	Red Ware Type						X^2	N
	B/R C	Late B/R	Late B&W/R	B&W/R G	Y/R	B&R/ Tan		
Late 1	-1.73	0.50	0.67	-0.60	1.03	-0.47	5.35	20
Late 2	1.06	-2.28	-1.75	**2.39**	-0.07	**3.41**	26.77	26
Late 3	-1.60	**3.04**	-0.45	-1.24	0.67	-1.17	15.32	17
Late 4	-1.22	0.00	**2.32**	-0.95	-1.10	-0.89	9.78	10
Late 1/4	-1.16	-0.60	**2.09**	0.21	-1.04	-0.85	7.91	9
Late Uncl.	**3.83**	-0.32	-1.37	-0.49	-0.11	-1.20	18.36	18
Total	15	20	36	9	12	8		101

Note: Each row is calculated as 1-way table with 5 d.f.; total X^2 values > 11.07 are significant at .05 level. Cell values >2.00 represent a strong association between clay group and ceramic type.

(3) two-three step decoration, complex to very elaborate design (Black&White/Red G, Yellow/Red, Black&White&Yellow/Red, White/Red, and Black&Red/Tan).

In contrast to the Early Aztec period, simpler vessels now dominate the regional assemblage (Table 8.15). Further, Late Aztec production loci did not produce the full range of labor input classes. Only higher quality vessels were manufactured by production loci in the *chinampa* zone (Late Clay Groups 1 and 4), and this focus on more elaborate vessels may reflect the greater purchasing power of this area. In the Acolhua area, in contrast, the Red ware industry bifurcates into two distinct status levels with different modes of production. The more elaborate vessels were manufactured within a single dominant and centrally located production source (Late Group 2), while the very simple vessels were produced by a number of smaller production loci.

Interpretation of Late Aztec INA Results

The INA data indicate significant changes in the organization of decorated ceramic production during Late Aztec times. Although production of Aztec Red wares was not

Table 8.15
Composition of Late Aztec Ceramic Assemblage by Labor Input

Level 1: 1 color decoration, simple design, simple profile

Black/Red C	1685	65.9%

Level 2: 1-2 color decoration, simple/moderate design, bolstered profile

Late Profile B/R	181	19.3%
Late Profile B&W/R	312	

Level 3: 2-3 color decoration, somewhat complex/very elaborate design

B&W/Red G	177	14.8%
Yellow/Red	38	
White/Red	9	
B&W&Y/Red	51	
Black&Red/Tan	102	

centralized, there is an apparent shift in production locations nearer to the centers of empire: Tenochtitlan and Texcoco. In addition, for higher status vessels, there is evidence for an increase in the scale of production and in the degree of product specialization, a strategy associated with greater efficiency and more intensive production. A general increase in paste standardization, associated with greater routinization and intensity of production, was not found, although a significant increase in standardization was noted within the Texcocan source, the one source with clear continuity in production from Early to Late Aztec times.

Contrasts exist, however, within the Late Aztec period if we compare Red wares of different qualities. The organization of production appears to have been more centralized, larger scale, and more intensive for higher status (more elaborate) ceramics, consistent with a workshop level of production. In contrast, the production of the simpler, lower status ceramics appears to have been dispersed and relatively smaller scale, consistent with production within the individual household or small-scale workshop.

Finally, there are regional differences in the organization of production and in marketing strategy, apparent in the amount of labor invested in decorating ceramic vessels and potentially reflecting different segments of the demand crowd targeted. The *chinampa* zone was serviced by two major producers of higher status wares, with no apparent production of (nor consumption of) the least elaborate Red wares. In contrast, the Texcoco region was supplied by one major production source for higher status, elaborate vessels and multiple smaller-scale producers of lower status, simpler vessels.

Of the models proposed for market exchange during the Late Aztec period -- the hierarchically integrated market network and dendritic systems -- the Red ware data on the organization of production are most consistent with expectations for craft production under a dendritic market system. In contrast to expectations for the regionally integrated market network, large productive enterprises in the full range of goods do not emerge, nor are such enterprises widely distributed throughout the Valley. Rather there is an apparent difference in the scale and intensity of production by quality of good as noted above. Further, most production appears to have been restricted to a few locations and spatially concentrated near the dominant political centers.

These characteristics are consistent with a region differentially integrated into a vertically structured dendritic market system, in which opportunities to engage in craft production were dictated both by proximity to the dominant urban center and by ability to produce foodstuffs for that urban market. Under a dendritic system, opportunities to engage in larger scale and more intensive craft production are much greater near the urban core, and the apparent shift in Red ware production location nearer to centers of imperial power presumably reflects the superior economic potential of those areas.

In addition, the uneven ability to meet the high urban demand for agricultural produce supported different levels of market participation within the Valley. In the *chinampa* zone, Red ware production was carried out by several larger production loci and involved vessels with more elaborate decoration, possibly geared to the greater purchasing power of the *chinamperos*. Within the Texcoco region, in contrast, a major production center for higher status vessels did exist, but the dominant ceramic type was the simplified Black/Red Variant C, apparently produced in numerous smaller workshops dispersed throughout the region.

Continuity and Change in Aztec Red Ware Production and Distribution

The INA data indicate both strong continuities as well as major changes in the regional organization of ceramic production and exchange from before and after incorporation into the Aztec empire. The major trends are summarized below.

Changes in Ceramic Exchange Through Time

The INA data support the major conclusions reached for the regional reorganization of exchange under Aztec rule based on the spatial distributions of ceramic stylistic types and variants. The provenience information on production location provided by the INA analyses, however, supplements those conclusions with several interesting findings.

First, the major boundary that inhibited exchange between the Acolhua and areas south during the Early Aztec period persists during the Late Aztec period, and the percentage of ceramics crossing that boundary remains virtually unchanged from early to late times. It is particularly significant that there is no apparent increase in exchange interactions across this ethnic and political border as would be expected under a *pax imperica*. Again, this suggests that the Acolhua area retained some level of economic autonomy in spite of its position within the Triple Alliance secondary to Tenochtitlan.

Second, some areas of the Valley appear to have balanced import/export ratios, while others do not (Table 8.16). Specifically, the Acolhua area has similar import and export rates and these are constant from the Early Aztec to the Late Aztec period. In contrast, the south exported significantly higher levels of Red ware than it imported, in both the early and late periods, suggesting that the south continued to specialize in Red ware production.

For the Early Aztec, the evidence suggests long distance trade in complementary ceramic types. Both the Acolhua and the Chalcan areas were producing both Orange and Red wares, but in different proportions (Hodge and Minc 1990), perhaps because clay sources best suited to these different wares were not equally available in both regions. The north favored Orange wares while the south favored Red wares.

Table 8.16
Import and Export Rates for Regions Producing Early and Late Aztec Red Wares

Direction	Early Aztec			Late Aztec		
	SE	SW	N	SE	SW	N
Export[a]	23%	--	24-25%	--	13-19%	23%
Import[b]	5%	--	26%	--	8%	17-26%

[a]Export = % of INA clay group found in foreign territory.
[b]Import = % of local INA assemblage produced extra-locally.

Each area exported more of the ware that it produced in greatest abundance, while importing more of the type it produced in lesser amounts (Table 8.17). Based on stylistic analyses, Chalcan Orange ware (Chalco Black/Orange) constituted <4% of the total Acolhua Black/Orange assemblage (Minc et al. 1994:Table 5). Yet INA analyses indicate that Chalcan Red wares constituted 23% of the Acolhua Early Aztec Red ware assemblage. In the south, the opposite is true: Acolhua-made orange wares (Geometric Black/Orange) make up about 10% of the Orange ware assemblage (out of a total of 21% imported Orange ware types), while Acolhua Red wares make up only 4% of the red wares sampled from the Chalcan confederation. Thus it appears that the Acolhua area was exporting a greater volume of Orange wares and importing Red wares, while the Chalcan area was exporting a greater volume of Red wares and importing Orange wares.

Table 8.17
Importation Rates for Early Aztec Decorated Wares

Region	Orange Ware	Red Ware
Acolhua	<4% Chalco Black/Orange	≈26% Chalcan Red ware
Chalca	≈10% Geometric Black/Orange (out of 21% total foreign)	5% Acolhua Red ware

Note: Black/Orange figures are based on % of Orange ware assemblage;
Red ware figures are based on % of INA sample.

Imbalanced ceramic exchange is also apparent during Late Aztec times: the south continued to export more Red wares than it imported. Data on Late Aztec Black/Orange production (Hodge et al. 1993) may reveal whether the flows of Red wares were balanced with Orange wares as they were in the Early Aztec period.[12]

Changes in Ceramic Production Through Time

The INA data on Aztec Red wares also indicate a number of significant changes in ceramic production through time, as discussed above. Most obvious are the decline in the number of production loci (indicating an increased scale of production for existing locations) and the lack of continuity in production locations from Early to Late Aztec times (reflecting a spatial reorganization and concentration of ceramic production nearer to the imperial capitals). While the INA data do not indicate a decisive, overall increase in the level of standardization through time, a clear change was noted within the Texcoco source from early to late times. The greater level of product specialization noted can also be interpreted as evidence of a greater intensity of production during the Late Aztec period.

Regional differences in ceramic production become apparent in the Late Aztec period, as the higher urban demand for rurally produced foodstuffs and the proliferation of intensive agricultural practices created new (and regionally varied) opportunities for market participation. In the southern lakebed *chinampa* district, intensive agriculture decreased the incentives to engage in supplemental craft production and increased the ability to exchange agricultural produce for other goods desired. The emergence of several major Red ware production sources, and the uniformly more elaborate Red wares produced in this area, may reflect a higher level of purchasing power among the chinamperos.

In the less productive Texcoco region, a dual pattern was encountered, apparently involving both urban and rural production. A major production source at Texcoco manufactured the full range of Red ware bowls of different qualities (although it appears to have concentrated on the higher status vessels) and this centrally advantaged location displays clear evidence for more intensive and larger scale production. In contrast, the poorer and relatively disadvantaged hinterland largely consumed a simple, low cost ceramic type that was manufactured in a number of smaller production sources, exhibited more variable paste characteristics, and presumably represents a part-time household industry to supplement agricultural income.[13]

Discussion and Conclusions

Comparable studies of the regional organization of production for other commodities do not yet exist for the central Valley. Rather, previous archaeological investigations of craft production have tended to be site-specific in scope, focusing on a major urban center and some nearby dependent communities. The difference in scale between the regional patterns identified here and the more localized patterns identified by others make a direct comparison of results difficult. However, these scalar differences are complementary, and taken together, these studies can provide a more complete view of the organization of craft production.

For example, detailed studies at two major sites within the Valley, Huexotla and Xico, Brumfiel (1976, 1980, 1985, 1986) found an apparent decline in craft production and market participation from Early to Late Aztec times, accompanied by evidence of more intensive agricultural production. However, Brumfiel found no indication of where craft production was taken up. Although pottery was not a craft monitored by Brumfiel, the general decline in the volume of craft production noted by her would be consistent with the larger-scale patterns encountered in this study.

At the regional level, the INA data indicate a decrease in the number of Red ware production sources, with a corresponding increase in the concentration of production and in the scale of production associated with each source. This concentration is also consistent with the ethnohistoric reports that certain cities were famous for their ceramics, suggesting that this craft was restricted to a few locations. Although Brumfiel could not, from her local perspective, determine where craft production was taken up, in the regional perspective, we can see how and where production locations shifted for some commodities.

The INA data are of limited utility, however, at finer spatial scales. While we can evaluate the relative scale, intensity, and distribution among production locations, the organization within each production source remains largely unknown from INA studies, owing to the coarse scale of geochemical variability within the Valley. That is, we can identify and characterize different production locations, but we cannot necessarily distinguish or characterize different producers utilizing the same clay source within each location. For information on the organization of production within each production location, we are dependent on intra-site analyses.

At Huexotla and Xico, systematic surface surveys of tools and debitage associated with the manufacture of craft goods revealed that craft production was either non-specialized or a part-time activity (Brumfiel 1987b). Similarly, a wide variety of craft activities is reported for the site of Otumba, all apparently household enterprises (C. Charlton 1991, 1994; T. Charlton et al. 1991, 1993). Although a few high-demand utilitarian goods (such as maguey fiber and ceramic figurines) appear to have been produced on a full-time basis, many others (including cotton thread, obsidian bifaces, ceramic censers, and spindle whorls) were a part-time industry (T. Charlton et al. 1991, 1993:Table 1).

A particularly interesting pattern is reported by Spence (1985) for obsidian production at Late Postclassic Teotihuacan. Although obsidian production increased under Aztec rule, the increased output was generated by an increase in the number of part-time specialists, rather than by the emergence of full-time specialist producers. There was, however, a decided shift in the location of workshops during Late Aztec times from outlying communities toward the urban center (1985:114-115). These findings may explain why an overall increase in standardization of ceramic pastes (reflecting an increased intensity of production) was not observed in this study: although production became spatially concentrated, the basic unit of production within some locations may have remained the household or small workshop. If this were the case, then degree of variation among numerous small producers could have clouded any decrease in variability owing to an increasing intensity of production.

Overall, the INA data provide a regional perspective not previously available on the organization of craft production. This perspective provides a regional context for localized studies and allows us to examine spatial variability in the organization of production. Although this perspective offers certain advantages of larger spatial scale, the results must be interpreted in light of (and seen as complementary to) intra-site analyses.

Notes to Chapter 8

[1]The limited ethnohistoric data on ceramic production indicate that potters (along with most other craft producers) were men (Barlow 1951; Hicks 1994), and that they generally pursued their craft on an independent basis, although they gave the products of their labor in tribute (Hodge 1984:74; Scholes and Adams 1957:36-37). At contact, several cities were famous for their pottery; within these centers, ceramic producers occupied specific residential wards or barrios. Barrios occupied by ceramic craftsmen (along with other craftsmen) are reported for Tenochtitlan-Tlatelolco (Branstetter-Hardesty 1978:26; Caso 1956:18-21), Cuauhtitlan (Branstetter-Hardesty 1978:27; Barlow 1951), and Xochimilco (Gibson 1964:351).

The organization of production within barrios is unknown. However, in an early colonial court case, four male potters of Cuauhtitlan **jointly** presented their claim to the judge concerning a considerable debt owed for pottery produced (Barlow 1951). This case suggests that small workshops employing several producers may have been the typical unit of production.

In addition, Sahagún (1950-1982) suggests a division of labor among potters based on level of skill. For example, the clay worker or *çuquichiuhqui* is characterized as an artist skilled with his hands (Book 10:42) who makes and sells a large variety of ceramic forms (*ollas*, basins, braziers, bowls, ladles), both slipped and plain earthenware (10:83). The accompanying illustration (Book 10, #136) shows the *çoquichiuhqui* surrounded by serving vessel forms: simple bowls, *copas*, and tripod support dishes. In contrast, the griddle maker (*comalnacac*) appears to have been restricted to making griddles or *comales*, the most utilitarian and simple of earthenware vessels (Book 10:83).

Overall, pottery production does not appear to have been a high status profession. Since pottery was a craft ignored by most chroniclers, it is possible that pottery making ranked among the less-skilled crafts (Branstetter-Hardesty 1978:28). Potters are certainly not mentioned among the higher status craftsmen sought out by rulers to enrich their city. Conversely, the Texcoco market was famous for its "fine" pottery (Berdan 1875:197-198; Durán 1967, Vol. I:181-182), indicating that potters probably occupied a range of social standings corresponding to the quality of the goods they produced.

In total, the documents provide minimal information on the distribution, scale, and intensity of ceramic production. Accordingly, these must be addressed via archaeological analyses using a combination of INA and spatial analyses.

[2]In 13th century England, craft specialists worked on consignment for their lord in exchange for certain services, but they also worked independently for the general community (Homans 1945:285-287; Wolf 1966:39). In this case, only two such specialist services were noted: the miller and the blacksmith, both high-technology services for their day. When economic incentives failed to ensure the miller's monopoly rights to grind grain, these rights were upheld by law; hand-mills were outlawed in order to guarantee both the miller and the lord (who received a portion as payment or tax, respectively) their annual flour supply (Homans 1945:285-286). A similar pattern of semi-attached specialists is projected for the early Greek city states prior to the 6th century B.C., especially for metal-working and other skilled crafts (Starr 1977:80-81).

[3]Crafts not deemed essential to securing urban food supply are produced in rural areas. These goods are non-subsistence items targeted primarily at other peasants (Tax 1953); the production is therefore one of lower investment and lower risk than that taken by urban producers. The unit of production is the individual or household and craft production is strictly secondary to that of agriculture.

Carol Smith (1976a:33, 1976d:342) argues that one pattern of rural production common in (and perhaps unique to) administered solar marketing systems is community specialization in peasant commodities. In this pattern, also called sectional production, all households within a community produce the same craft item such as pottery or baskets (or more narrowly, a specific pottery type or vessel form), exchanging the products among communities within the solar marketing system (Nash 1966:64-72; Rice 1987:187; C. Smith 1974:176-177; Wolf 1966:40-41).

Ecological diversity of resources does not explain this pattern, but an administered market structure may. Because the solar market system structure does not foster horizontal (peasant-to-peasant) exchanges of foodstuffs, peasant market dependence is potentially low. However, inter-community craft specialization reduces local self-sufficiency in non-subsistence goods and creates an artificial symbiosis between rural segments and hence dependency on the urban market center as the nexus of redistribution. This market dependency is obviously advantageous to the urban center which benefits through both market taxes and increased flow of market traffic into the center.

Community-wide specialization is particularly prevalent in Latin America, and Collier (1975:176-177) argues that it may be a consequence of abuses within the *repartimiento* system of the late colonial period, in which craft products were distributed in bulk between communities, through forced sales and purchases via colonial administrators (see also Gibson 1964:94-96). This bulk movement of craft items clearly encouraged community specialization; it may also have been built upon a pre-existing pattern, pre-dating the Spanish conquest.

If ceramics were produced as a peasant commodity, production would be located in rural communities. When rural production is specialized by community, production is also spatially concentrated. Under sectional production, the production unit is the individual household, however, a high level of intra-community production regulation may occur. Many such communities produce highly standardized versions of a product and innovation is discouraged to reduce competition as well (C. Smith 1976d), resulting in a product as apparently standardized or uniform as that produced under an urban monopoly.

[4]Most market activity involves the exchange of locally produced foodstuffs, not as necessities but as opportunities for varying the staple food and vegetable diet (Gezann 1978:191; Wood 1978). This rural trade is made possible and desirable by variations in physical conditions, local cultural factors, and dietary preferences. In some areas, distinct altitudinal and crop-producing zones are the basis of exchange between distinct resource zones, but more subtle factors generate opportunities for exchange as well. For example, micro-climatic variations may create variability in ripening times, thus stimulating trade in maize within a maize-producing area.

[5]Several authors (e.g. Renfrew 1977b:9; Rice 1987:191) have argued that while large-scale production rests on effective distribution mechanisms, effective exchange mechanisms do not necessarily call forth large-scale operations. Rather, scale relates to relative efficiency,

itself a function of the technology used and the level of workshop output (Sanders and Santley 1983). As Costin (1991:15-16) notes, if per-unit costs can be lowered through sharing expensive technology, through buying resources in bulk, or by task specialization within the workshop, then workshop size may increase to take advantage of economies of scale. In the absence of any of these incentives, there may be little advantage to larger workshops.

[6]Some researchers have justifiably criticized diversity measures of style as indicative of production organization. For example, Rice (1989:113) cautions that "Stylistic and decorative data are extremely sensitive to a broad range of social-interactional phenomena...Thus, a clear one-to-one relationship in the decorative attribute system and the actual productive arrangements, especially intensiveness, is unlikely." Similarly, Costin (1991:34) warns that different kinds of goods are often geared toward different markets, some of which demand individuality and others of which may tolerate or demand standardization. Their concerns, however, are with total assemblage diversity, not (as is the case here) with the extent to which a producer focuses on a portion of that assemblage.

[7]A closely linked aspect of production strategy is that of market breadth, i.e. the range of functional types manufactured by a single producer, a variable that relates to the volume of consumer demand. In the case of low consumer demand, producers may survive through part-time production (thereby reducing dependency on specialty production for survival) and/or through generalized production (by carrying multiple goods, each with a different demand threshold, consumer demand can be multiplied). Conversely, in the case of high consumer demand, production may be increased by focusing on a single functional class of product. Thus, for functional variability, market breadth varies inversely with consumer demand. Because this study examined only one functional class -- Red ware bowls -- the range of functional shape classes manufactured by the same producer could not be assessed.

[8]In this case, we must conceptually separate relative labor investment from the efficiency (or standardization) of its application, and hypothesize that while labor intensity varies with targeted demand crowd, efficiency varies with the scale and intensity of production.

[9]The production-step index does not necessarily reflect indigenous categories or judgements on the relative worth of a ceramic type or variant. Ceramics may been more or less valuable because they came from a specific locale, were made by a particular artisan, display a particular motif, or were a particular color. An in-depth study of Nahuatl terms and representations of ceramic vessels would be necessary to clarify the emic categorizations of Aztec pottery.

[10]Orange ware and Red ware production sources assigned to the same general area bear some geochemical similarity. For example, within their respective wares, the southern Red Ware Group 1 and Chalco Black/Orange source are high in Cr, while the northern Red Ware Groups 2 and 3 and the Texcoco Black/Orange source are low in Cr.

[11]It is not well known, however, what types of ceramics these centers produced. Texcoco was famous for its "fine" pottery (Berdan 1975:197-198; Durán 1967, Vol. I:181-182). The ceramic wares from Cuauhtitlan graphically depicted in 1564 include *ollas*, pitchers, bowls, human-head jars, and tripod dishes (Gibson 1964:350). In the colonial era, Cuauhtitlan potters produced, among a range of utilitarian vessels, special red jars (*jarros colorados de*

Cuauhtitlan muy particulares) suggesting a tradition of Red ware production (Gibson 1964:350-351; Branstetter-Hardesty 1978:27-28; *Anales de Cuauhtitlan* 1945, Para. 128).

[12]The exchange in complementary goods may hint at regional specialization, although the small volume of ceramics exchanged between regions makes true "price articulation" in the Early Aztec period seem unlikely.

[13]Equally interesting (if somewhat more difficult to interpret) are the changes in Aztec Red ware ceramic assemblage diversity through time. Most noticeable in the overall decrease in number of decorative variants and subvariants from Early (N=22) to Late (N=16), suggesting an overall simplification of the Red ware assemblage. This reduction is most evident at the bottom end of the labor input scale, where a number of relatively simple designs (Black/Red Variants A, B, D, E, H, and I) are replaced by a single variant, Black/Red Variant C. This reduction in total number of variants in part reflects the fact that types and variants associated with the Chalcan sources (Black/Red-Incised and the simple Black/Red variants) are discontinued as that source ceased production in the Late Aztec period. In contrast, Early Aztec designs common in the Texcoco region (including many of the Black&White/Red variants) are applied to a new vessel form, i.e. the late profile bowl, and continue in use throughout the Late Aztec period.

In contrast to the process of reduction or simplification of the assemblage involving lower labor investment vessels, innovations (new types and variants) are all higher class ceramics and generally very elaborate (e.g. Black&White/Red Variants F and G; Yellow/Red, Black&White&Yellow/Red, and White/Red).

CHAPTER 9

SUMMARY AND CONCLUSIONS

Significant changes occurred in the organization of Red ware ceramic production and exchange systems under Aztec rule that are indicative of changes within the regional market system of the imperial core. While marketing systems are formed by the exchange and movement of a wide range of goods, we can begin to understand the major structural features of the regional market system by following in detail the movements of one commodity, in this case, decorated ceramics. As a subset of the regional market system, this one commodity clearly cannot reflect the total complexity of the larger system, but it does reflect the basic organizational features of that system since production and exchange of ceramics were constrained by that structure.

This study approached change in the organization of ceramic production and exchange (and hence in the larger market system) with two goals in mind: description and explanation. The first goal entailed an in-depth analysis of the regional organization of Red ware ceramic production and exchange before and after consolidation of the Aztec empire. This analysis involved:

* characterizing the organization of these systems along key dimensions of variability;

* using those dimensions to assess the fit of Early and Late Aztec data to specific models of production and exchange; and

* evaluating the degree and kind of organizational change from Early to Late Aztec times.

To these ends, the spatial distributions of Red ware ceramic types were mapped and analyzed to reconstruct the organization of the exchange systems through which these vessels moved, while trace-element analyses of ceramic pastes were employed to examine the organization of decorated ceramic production on a regional scale. Diachronic changes in the organization of these production and exchange systems are seen as indicative of the extent to which the larger commodity marketing system was restructured under Aztec rule.

The danger of this two-point comparison, however, is that it implies but does not demonstrate a causal linkage between Aztec imperialism and market system reorganization. Thus the broader and more challenging intent of this study was to relate the observed changes in economic organization to the political processes of empire formation and consolidation within the imperial core. By viewing production and exchange as integrated systems, we can relate their organizational features to the decision-making environment of producers and examine how political strategies and activities altered that environment.

The linkages between political process and market economy were assessed through three main steps:

* identifying (through documentary sources) the resources of primary importance to the imperial elite in their strategies of political consolidation;

* predicting how administrative controls over these key resources potentially altered the context of production and exchange through both direct and indirect channels; and

* evaluating microlevel responses in productive organization and strategies using the archaeological record.

The ethnohistoric model developed for the Aztec suggested that political attempts to consolidate power altered market system structure within the Valley by controlling the flows of a few key resources (i.e. the exotic prestige goods used to cement political relations) and the locations of the major markets through which these goods entered the regional system. The restructuring of the market system in turn affected opportunities for craft production. Thus the line of causality explored here is: political process --> market system structure --> organization of craft production.

A brief overview of Aztec Red ware ceramic production and exchange systems and their organizational features as determined in this study follows, as well as an assessment of the degree of organizational change encountered. Once the major changes have been outlined, their relationship to the political processes of empire formation and consolidation can be evaluated.

Summary of Results

The Organization of Red Ware Ceramic Production and Exchange in the Early Aztec Period

During the Early Aztec period, ceramic exchange best fits the model of a network market system characterized by a series of small, overlapping market zones. Spatially unconstrained cluster analyses identified a number of distinct market zones along the eastern side of the Valley. These zones were all actively engaging in the production and distribution of Early Aztec Red wares (based on the densities of these ceramics recovered), but had distinctive assemblage compositions. The analyses identified other areas, however, (including much of the Lake Chalco-Xochimilco basin) that were apparently not participating in Early Aztec Red ware exchange.

The relations among these market zones are consistent with the regional organization of exchange under a network market system. The Early Aztec market zones exhibit well-developed lateral integration, in that the mapped ceramic distributions displayed a series of overlapping areas of concentration that were shared between adjacent market zones. Conversely, there is no evidence of hierarchical ties among market zones to articulate commodity flows throughout the larger area. Some zones had richer (more diverse) assemblages and some contained more labor intensive ceramics, but no area consistently displayed superior access to the full diversity and wealth of Red ware types such as would result from hierarchical advantage in a regional system.

At the political level, Early Aztec market exchange appears to have been unconstrained by local city-state territories. Ceramic type distributions indicate that consumers moved freely among city-states belonging to the same confederation, and market zone boundaries generally cross-cut political territories. However, several market zones do appear associated with specific administrative centers, a finding consistent with ethnohistoric data indicating that political centers also served as market centers for their dependent territories. Thus it is probable that each market zone was serviced by a low-level market hierarchy, headed by the local administrative center.

In contrast to city-state units, boundaries between competing political confederations limited ceramic exchange to some degree. Multiple type distributions conform to, rather than cross, confederation boundaries, indicating that exchanges decreased across these territorial limits. While the trace-element analyses confirm that a low volume of ceramic exchange did take place between the Acolhua and Chalca confederations, both of these areas had minimal exchange contacts with the Mixquica-Cuitlahuaca, Xochimilca, and the Culhua confederations.

The INA analyses also indicate that organization of Early Aztec decorated ceramic production is consistent with what we would expect under a poorly integrated market system, that of multiple, smaller-scale production enterprises dispersed throughout the region. Within the study area, six different production sources were identified for Aztec Red wares and three for Black/Orange ceramics. The distribution of these Early Aztec production sources reveals decorated ceramic production to have been regionally dispersed in the study area: two regions (the Acolhua and the Chalca) produced Red wares, while three (the Acolhua, Chalca, and Culhua) produced Orange wares. Further, for Red wares, multiple production sources were active within each region, and these production sources apparently were located to service different but largely overlapping distribution zones. Thus production was clearly not centralized at a regional nor even at a confederation level.

The scale of production is difficult to characterize from our regional perspective: INA analyses in the Valley of Mexico can identify different clay sources but cannot discriminate between multiple users of the same source. However, the high number of production loci involved in Red ware production implies that each source supplied a smaller segment of the total consuming population, and hence operated as a smaller-scale enterprise.

Measures of routinization (as reflecting the relative intensity of production) are similarly constrained. However, paste composition was less variable than anticipated for both Orange wares and southern Red wares; overall, the level of standardization in clay preparation suggests either a more routinized, intensive operation, or the consistent use of selected clay deposits. Northern Red ware pastes were clearly less standardized, and Red ware production there may have been a less well developed industry than elsewhere.

Finally, although producers were clearly specialized by ware (with Orange and Red wares coming from distinct clay sources), production sources for Red wares reflect a generalist strategy. Each Red ware source produced a full range of decorative styles as well as vessels of different levels of labor investment. Overall, these organizational features of decorated ceramic production conform to what we would expect given the limited opportunities for specialized production within a poorly integrated regional market system.

The Organization of Red Ware Ceramic Production and Exchange in the Late Aztec Period

During the Late Aztec period, significant changes occurred in the organization of decorated ceramic production and exchange systems. In contrast to the well-developed network and poorly developed market hierarchy of the Early Aztec period, ceramic exchange in the Late Aztec period moved through a market system characterized by poor network and well-developed hierarchy. As a result, the regional market system of the imperial core could be termed dendritic in structure. However, the existence of two relatively independent market spheres argues for an alternative interpretation, in which two such dendritic market hierarchies were operative. Further, the congruence between these market spheres and the major political divisions within the Valley strongly suggests that these dual market systems were centered on the two big powers of the Triple Alliance: Tenochtitlan and Texcoco.

The spatially unconstrained cluster analyses initially divided the study area into two largely distinct market spheres, located in the NE and SW portions of the study area. These spheres have very different Red ware assemblages: the NE sphere is dominated by a single type, the relative simple Black/Red Variant C, while the SW sphere contains primarily Late Profile Black/Red and Black&White/Red vessels. The mapped distributions of these major ceramic types reveal a sharp boundary along the division between spheres, and only a small area of overlap where they co-occur, indicating minimal ceramic exchange interaction between these systems.

The NE and SW spheres conform closely to territories under Acolhua and Mexica control, respectively. This spatial congruence between political territory and market territory implies that the Triple Alliance divisions retained a higher degree of economic autonomy within their provincial territories than previously thought. While this finding echoes Carrasco's (1978:16) observation that the Triple Alliance appears more economically unified from the outside than from within, the existence of two relatively independent market spheres contradicts established views on the Aztec which almost uniformly posit a single, integrated exchange system within the Valley.

Each sphere was subsequently subdivided (based on finer distinctions in ceramic assemblage composition) into a core zone and a periphery. In the NE sphere, the core zone extends along the lakeshore and contains the Triple Alliance capital Texcoco, while the periphery extends east up the Texcocan piedmont. In the SW, the core zone falls in the western end of Lake Xochimilco, adjacent to the imperial center of Tenochtitlan, while the periphery extends east and then SE through the Chalco, Tenango, and Amecameca areas.

Within each sphere, vertical interactions dominated over lateral interactions among zones. Again, the mapped type distributions reveal that many ceramic distributions conform to, rather than cross, market zone boundaries, indicating that lateral exchange among zones of the same sphere was poorly developed. In contrast, the evidence for a hierarchical relationship within each sphere is strong. In each case, the affluent core zone enjoyed greater access to higher quality ceramics and to imported ceramics. The peripheries, in contrast, appear relatively disadvantaged: they consumed higher-quality ceramics in much reduced proportions, and then, only those that were of local manufacture. Overall, these organizational features suggest that the Late Aztec regional market system best fits a model of a dual dendritic system, associated with the two major centers of empire, Tenochtitlan and Texcoco.

In summary, the comparison of Early and Late Aztec exchange interactions reveals that the imposition of imperial rule was accompanied by significant reorganization of the regional market system. Major organizational changes included: (1) an increase in the scale of market zones from multiple small zones during the Early Aztec to two large spheres during Late Aztec times; (2) a decrease in the degree of market network or lateral commodity flows between zones; and (3) a concomitant strong increase in market hierarchy or vertical commodity flows.

The trace-element studies reveal similarly marked changes in the organization of ceramic production during Late Aztec times. At the regional level, the most obvious changes involve a reduction in the number of Red ware production centers (implying a corresponding increased scale and concentration of production in remaining locations) and the relocation of Red ware production nearer to the imperial capitals.

Only three major production sources for Late Aztec Red ware ceramics were identified within the study area: one within the Texcoco region and two operating within the SW core zone. A fourth production source supplied sites west of Lake Texcoco, a portion of the Valley outside the focus of this study. However, a significant number of ceramic samples could not be classified to one of these four sources, indicating the existence of other, smaller production loci as well.

Assuming that the total demand for Red wares did not decline (and the high densities of this ware recovered indicate that it did not), the decrease in the number of major Red ware production sources implies a corresponding increase in the scale of production associated with each source. It also reflects an increasing concentration of production into a few locations, a trend that is particularly apparent within market spheres. In the NE sphere, a single major producer at Texcoco replaced the two Early Aztec suppliers for this area. In the south, the four Early Aztec Red ware production locations are replaced by two distinct Late Aztec production sources.

This concentration reflects a major shift in the locations of Red ware production under Aztec rule, closer to the centers of imperial power. Three of the four Late Aztec production sources identified were located along the western and southwestern portions of the Valley, indicating that the region near the imperial capital of Tenochtitlan became a major zone producing Red ware ceramics. The remaining production center was located in or near Texcoco, the empire's second city. In contrast, Red ware production in the politically peripheral southeastern Valley (a major area of Early Aztec production) was discontinued. Under a vertically structured market system, we would expect opportunities for craft production to be greatest near the core; the general shift in ceramic production locations nearer to the dominant centers of empire is support for that predicted pattern.

In spite of this concentration and centralization, however, overall changes in the intensity of production are not indicated. The degree of paste standardization generally remains close to Early Aztec levels for the major production sources, although a decisive improvement was noted within the Texcoco source from early to late times. This generally negative evidence for greater routinization may reflect only the difficulties encountered in attempting to compare clay sources with inherently different levels of geochemical variability. Alternatively, it suggests that the basic unit of production within each source did not drastically increase in scale and routinization. This latter interpretation is consistent with research reports from Teotihuacan (Spence 1985) and Otumba (Charlton et al. 1991, 1993; C. Charlton 1994; Nichols 1991, 1994) where higher productivity in craft manufacture during Late Aztec times was achieved through an increased number of producers, not a change in scale: the basic unit of production remained the small household or barrio workshop. On the other hand, ceramic producers were becoming somewhat more specialized in the type of good they manufactured and thus were more narrowly targeting the segment of the demand crowd they supplied. This greater level of product specialization could be interpreted as evidence of a greater intensity of production during the Late Aztec period.

Finally, significant differences exist during the Late Aztec period in the organization of ceramic production for Red ware vessels of different qualities. The production of higher status (more elaborate) ceramics appears to have been more centralized, larger scale, and more routinized, consistent with a workshop level of production. In contrast, the production of the simpler, lower status ceramics appears to have been dispersed, relatively small scale, and less standardized, consistent with production within the individual household or small workshop. For example, samples of the simple Black/Red Variant C could not be assigned to one of the four major production sources, nor did they form a cohesive group on their own. Rather, as a group, these samples have highly variable paste composition, suggesting that they are the products of a number of small-scale production sites or individual producers utilizing clay sources dispersed throughout the hinterland. Taken as a whole, the organization of Late Aztec Red ware production is consistent with expectations for craft production within a dendritic market system, in which opportunities to engage in more intensive craft production are greatest near the urban core and decline with distance from the major urban center(s).

Market Economy and Political Process

How, then, do these changes relate to the political environment surrounding imperial consolidation? As we have seen, prior views on the degree of political involvement in the Aztec market system have tended to characterize regional production and exchange either as a commercial system (reflecting minimal administrative interference) or as a centralized, administered system (reflecting extensive, direct governmental controls). However, multiple lines of evidence indicate that neither a commercial nor an administered model adequately characterizes market system organization in the Valley of Mexico.

Rather than perpetuate existing dichotomous approaches, this study sought to determine specific points of articulation between political process and economic rationality as these were played out in the market system. At the conceptual level, the inquiry focused on the interaction between two different scales of activity: **macrolevel political forces**, consisting of the policies and actions of the dominant imperial elite that potentially affect society as a whole, and **microlevel economic forces**, comprising the rational responses of individual or corporate producers to the altered economic conditions engendered by imperial rule. In terms of this framework, the goal was to identify specific strategies of Aztec political integration and examine how attempts to implement these strategies altered the decision-making environment of market system participants within the Valley.

The ethnohistoric record on the Aztec indicates that the regional market system played a central role in resolving two major administrative problems within the imperial core: political consolidation and urban supply. Resolution of the former depended in part on the imperial rulers' ability to control key resources that constituted the bases of power and authority within society. Control over these "strategic" resources supported and legitimized the dominant position of the emerging imperial elite, and enabled imperial rulers to manipulate political relations among traditional rulers in order to foster their dependence on (and compliance with) the imperial core.

Two of the predominant elite prestige items distributed by the state to engage the cooperation of political dependencies were richly embroidered cotton blankets and clothing, and warrior costumes ornately covered with tropical bird feathers. The raw materials for these prestige items were imported into the imperial core under state auspices where they were introduced into the local market systems. The prestige items were then manufactured by subject populations and given in tribute to imperial tax stewards. In this circuit, the tribute-payers who produced these prestige items were dependent on the market system to obtain non-local raw materials to produce the manufactured goods required in tribute. The market system, as a source of exotic raw materials, was therefore essential to the production of these "necessary luxuries" for the state and hence essential to imperial strategies of political consolidation.

The successful consolidation of imperial control generated a second, if more mundane administrative problem: the rapid demographic growth of the imperial core. Supported initially by the influx of imperial tribute, Tenochtitlan, Texcoco, and other cities soon exceeded the support capacities of those tribute revenues (Berdan 1975:264; Calnek 1978a). As a result, imperial economic goals were reformulated away from initial and more narrow imperial concerns for supporting and manipulating political dependents, to consideration of the broader problem of urban supply within the expanding imperial core. Along with tribute assessments and state-sponsored agriculture, the market system was a major source of foodstuffs for urban centers and appears to have played a critical role in alleviating the problem of urban supply.

The problems of urban supply and controls over exotic prestige items were linked in a circuit involving both tribute and market systems. A well-recognized feature of tribute requirements in finished prestige goods is that their production stimulated market participation (Berdan 1975; Hicks 1987; Brumfiel 1987b). My analysis furthered argued that the transformation of exotic raw materials into the prestige items demanded in tribute also helped to alleviate the problems of urban supply by generating flows of desired foodstuffs into urban markets. The need to procure exotic raw materials to meet tribute requirements stimulated rural agricultural production as a medium of exchange, while urban control over non-local goods provided the balance of payments. By directing the flows of exotic raw materials, the imperial rulers were able to concentrate exchanges of agricultural produce for exotic raw materials in major urban centers where these foodstuffs became accessible to urban populations.

Because market exchange was central to both imperial and urban interests, the market system experienced regional growth and expansion under Aztec rule. This growth was structured, however, by the administrative strategies for political consolidation and economic integration of which it was a key component. Overall, the convergence of political interests and urban needs significantly distorted market structure, resulting in the development of strong vertical linkages between urban centers and dependent communities at the expense of horizontal market articulation.

In the political arena, the regional market system was essential in the transformation of exotic raw materials into the elite prestige goods given in tribute and dispersed by the imperial elite as political currency. At the same time, however, the market system (as a source of exotic materials and of wealth items in general) posed a threat to state control over sources of wealth and power in society.

In response, the state attempted to control and limit the flow of wealth through the market system in key ways (Fig. 9.1). Oligopolistic controls (established through

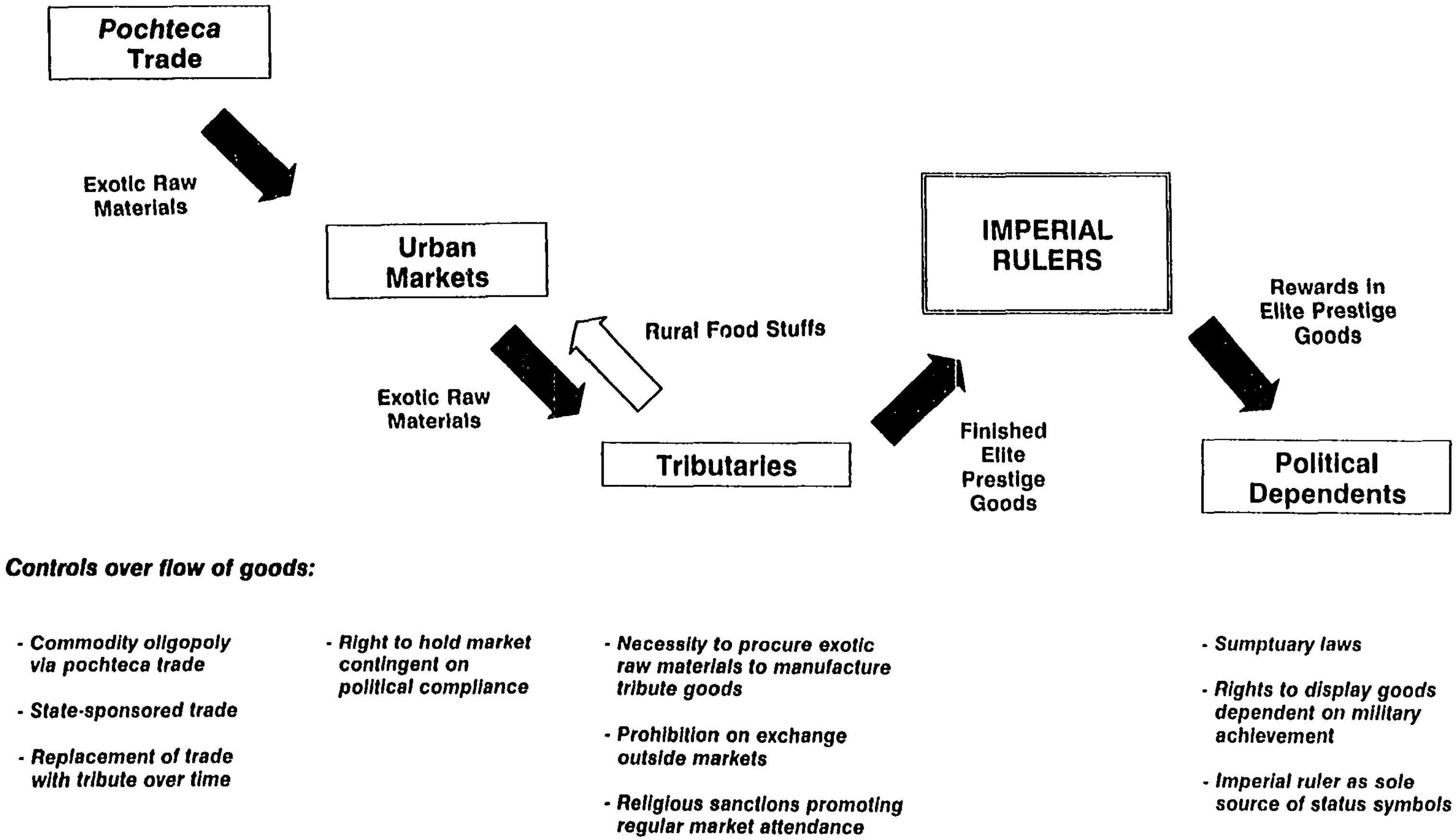


Figure 9.1. Schematic overview of the transformation of exotic raw materials into tribute goods, and administrative controls over the flows of those goods.

imperial tribute and state-sponsored *pochteca* trade) regulated the entry of exotic raw materials into the Valley and directed these goods to the imperial capitals. Within the Valley, access to wealth items was controlled by limiting trade to established market places, where trade could be supervised and market taxes collected by political authorities. In addition, the rights to hold a market were contingent on political compliance, thereby limiting exchanges (and market taxes) in the lucrative wealth items to politically sanctioned places in the landscape.

In the economic arena, required market attendance (enforced through both religious sanctions and imperial decrees), as well as the necessity to procure raw materials for tribute goods, served to increase market system participation and stimulated the production of desired agricultural produce as a medium of exchange. By controlling the availability of needed exotic raw materials, the imperial elite were able to increase, direct, or concentrate the flows of foodstuffs to market locales where they could be utilized by urban populations. Thus imperial tribute assessments intentionally or unintentionally were key factors in creating centripetal flows of foodstuffs into major urban centers.

Overall, the alignment of political and economic interests emphasized vertical commodity flows between political center and dependent communities, designed to channel agricultural produce and other foodstuffs up the hierarchy into the major urban centers in exchange for exotic raw materials only available in those central locations. Under these conditions, it was predicted that regional market system structure would be organized in a dendritic pattern. However, given the division of political and economic power between the two dominant centers of empire, the operation of a dual market hierarchy was anticipated for the Valley, centered on Tenochtitlan and Texcoco.

The Late Aztec Red ware analyses confirm these predictions. The anticipated dual market hierarchies are apparent as two distinct spheres of exchange interaction whose boundaries are congruent with administrative divisions within the Valley. The NE sphere, dominated by relatively simple Black/Red Variant C, is associated with the Acolhua domain. In contrast, the SW sphere, corresponding spatially with territory controlled by Tenochtitlan, displays a distinct Late Aztec Red ware assemblage dominated by Late Profile Black/Red and Black&White/Red vessels. Both spheres display a more affluent core zone and a relatively disadvantaged and dependent periphery. Thus, within each sphere, vertical interactions apparently predominated while lateral interactions among zones were poorly developed.

At a more refined level, it was anticipated that these market imperfections, in turn, would affect strategies of market participation by the rural populace (the microlevel responses). Although the rural population was necessarily drawn into the market system to meet tribute assessments, their degree of market participation and market reliance depended on their ability to produce for the urban market. Accordingly, the model predicted that rural responses were largely constrained by the productivity of their agricultural resources, resulting in two distinct patterns of market participation and commodity production within the Valley.

In areas of less productive and less reliable rain-fall agriculture, such as the Texcocan heartland, rural producers have a limited ability to produce for urban food demands and hence a more limited ability to participate in the urban market system. The agriculturalist's low productivity translates into low purchasing power and limited ability to buy goods produced in or imported into urban centers. Without steady rural demand for urban craft goods, specialist producers of utilitarian commodities are not well supported in the center, although the urban concentration of elite would support specialists producing higher class and better quality goods. At the same time, rural attempts to diversify productive activities to supplement low or variable agricultural income may include petty or part-time commodity production in the form of cottage industry.

In this case, a dual pattern of craft production in both urban and rural settings was anticipated, but both the scale and intensity of production, as well as the demand population targeted, was expected to differ. Craftsmen located in or near urban centers were expected to engage in more intensive production and to produce a greater volume of goods, while rural producers would engage in their craft only part-time, producing a smaller volume and more variable product. Further, urban craftsmen were expected to produce higher class and better quality goods because they have access to consumers with higher socioeconomic statuses and purchasing powers, while rural producers were expected to produce serviceable but relatively inexpensive products to meet the needs of rural consumers with relatively lower purchasing power.

In contrast, in areas of more intensive agricultural production (such as the highly productive *chinampa* zone of Lakes Chalco-Xochimilco), rural producers are better suited to participate in urban market exchange and to utilize surpluses to purchase desired goods in addition to materials required to meet tribute assessments. Further, agriculturalists in areas of more intensive cultivation would have less time and less incentive to boost their income by engaging in supplementary production, so they become more dependent on external sources for those goods.

In this context, full-time specialists of a broad range of goods would be supported. Because commerce is concentrated in urban centers, full-time specialists would be best supported in those central locations, leading to a pattern of rural-urban symbiosis in primary-secondary production. Accordingly, it was anticipated that craft production within the southern lakebed area would be centralized, potentially on a larger scale, and more intensive. Further, producers were expected to manufacture a full line of goods to meet the full range of consumer preferences in appearance and cost.

Again, these predictions are largely borne out by the data on Aztec Red ware production and exchange. In the NE (Texcocan) market sphere, a dual pattern of ceramic production was encountered, apparently involving both urban and rural locations. The major production source at Texcoco manufactured the full range of Red ware ceramics (although it appears to have concentrated on the higher status and more labor intensive vessels) and this centrally advantaged location displays clear evidence for more intensive and routinized production consistent with a workshop level of production. In contrast, the poorer and relatively disadvantaged hinterland largely consumed a simple, low cost ceramic type that apparently was manufactured in a number of smaller production sources, exhibited more variable paste characteristics, and presumably represents an individual or household industry.

In contrast, in the SW sphere (encompassing the *chinampa* district), the ceramic industry involved uniformly more labor intensive Red ware ceramics, with no apparent production of (nor consumption of) the lower quality Red wares. The emergence of several major production sources for these ceramics implies that an environment more conducive to specialized craft production emerged within the *chinampa* district, and the greater labor investment visible in southern ceramics may reflect the greater purchasing power of these intensive agriculturalists. Although the INA data do not confirm a shift to more routinized production characteristic of large workshops, the centralization of ceramic production within the core zone is clear.

Conclusions

What, finally, can be said concerning the extent of market system reorganization engendered by the rise of the empire and the degree to which that reorganization served to perpetuate imperial rule? The market system was of vital concern to the empire both politically and economically, and thus it was structured by both political and economic needs. The imperial elite attempted to regulate the market system in order to consolidate their own control over the exotic prestige items that functioned as primary bases of power and authority. In addition, the market system was critical in meeting urban food needs, and the transformation of exotic raw materials into the prestige items demanded in tribute also helped to alleviate the problems of urban supply by generating flows of desired foodstuffs into urban markets.

The convergence of political interests and urban needs significantly distorted market structure, resulting in the development of strong vertical linkages between urban centers and dependent communities at the expense of horizontal market articulation. The result was not a strictly administered system, however. Most of the administrative controls were the indirect effects of imperial attempts to control a few extremely valuable and strategic resources utilized by the imperial rulers to manipulate political dependencies. But these indirect controls generated imperfections in the regional market system structure that had important consequences for commodity production and exchange within the Valley. Thus, while the resulting market structure contributed to political stability and urban growth, ultimately it may have hindered regional market system development and economic integration of the imperial core.

POLITICAL ECONOMY AND MARKET ECONOMY UNDER AZTEC RULE: A REGIONAL PERSPECTIVE BASED ON DECORATED CERAMIC PRODUCTION AND DISTRIBUTION SYSTEMS IN THE VALLEY OF MEXICO

Volume II

by

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APPENDICES

APPENDIX I

TABLES WITH SITE INFORMATION FOR STUDY AREA

Table I.1
Valley of Mexico Survey Sites Included in Study

Site Number	Site Location[a]			Environmental Zone[b]	Site Type[c]	Area (ha)	Pop.
	North UTM	East UTM	Elev. (m)				
TEXCOCO SURVEY REGION							
TX-A-1	2160.60	504.30	2250	Island	Hamlet	4.0	80
TX-A-2	2161.00	504.80	2240	Lksh. Pl.	Sm. Hamlet	1.0	20
TX-A-3	2161.50	504.70	2255	Island	Hamlet	8.0	100
TX-A-6	2161.30	507.80	2260	Island	Cer. Center	30.0	0
TX-A-9	2163.70	508.90	2250	Lksh. Pl.	Sm. Hamlet	1.0	20
TX-A-10	2163.50	510.20	2260	Lksh. Pl.	Sm. Village	36.0	300
TX-A-14	2161.90	514.60	2290	L. Pied.	Sm. Village	15.0	150
TX-A-16	2164.80	515.60	2290	L. Pied.	Sm. Village	6.0	200
TX-A-17	2164.00	514.30	2325	L. Pied.	Lg. Village	115.0	600
TX-A-18	2165.30	512.90	2335	L. Pied.	Hamlet	3.0	50
TX-A-21	2165.90	514.70	2360	L. Pied.	Sm. Village	55.0	500
TX-A-22	2164.70	515.60	2290	L. Pied.	Sm. Village	13.0	0
TX-A-23	2167.20	515.60	2360	L. Pied.	Sm. Village	18.0	150
TX-A-24	2166.20	518.50	2400	L. Pied.	Reg. Center	450.0	13500
TX-A-25	2165.40	520.90	2345	L. Pied.	Lg. Village	115.0	1200
TX-A-26	2165.60	522.60	2445	L. Pied.	Sm. Village	10.0	150
TX-A-27	2164.40	522.70	2395	L. Pied.	Sm. Village	17.0	300
TX-A-28	2165.00	524.20	2540	U. Pied.	Lg. Village	75.0	1200
TX-A-30	2163.30	524.80	2555	U. Pied.	Lg. Village	100.0	1500
TX-A-31	2161.80	524.60	2580	U. Pied.	Lg. Village	50.0	700
TX-A-34	2163.70	523.60	2410	L. Pied.	Hamlet	6.0	60
TX-A-36	2163.00	522.90	2400	L. Pied.	Sm. Hamlet	1.0	10
TX-A-38	2162.50	520.40	2345	L. Pied.	Lg. Village	65.0	650
TX-A-40	2162.40	517.60	2315	L. Pied.	Lg. Village	100.0	1500
TX-A-42	2156.10	504.10	2240	Lksh. Pl.	Sm. Hamlet	2.0	0
TX-A-43	2154.10	505.10	2240	Lksh. Pl.	Sm. Hamlet	3.0	0
TX-A-44	2155.10	506.80	2240	Lksh. Pl.	Hamlet	2.0	40

Table I.1
Valley of Mexico Survey Sites Included in Study (continued)

Site Number	Site Location[a]			Environmental Zone[b]	Site Type[c]	Area (ha)	Pop.
	North UTM	East UTM	Elev. (m)				
TX-A-46	2155.40	508.70	2240	Lksh. Pl.	Sm. Village	20.0	200
TX-A-47	2157.00	507.90	2240	Lksh. Pl.	Hamlet	5.0	100
TX-A-49	2157.50	509.60	2250	Lksh. Pl.	Sm. Village	25.0	300
TX-A-52	2153.70	510.30	2240	Lksh. Pl.	Hamlet	3.0	60
TX-A-53	2152.80	511.10	2245	Lksh. Pl.	Sm. Village	25.0	500
TX-A-56	2157.10	513.00	2275	Lksh. Pl.	Reg. Center	450.0	25000
TX-A-57	2155.60	516.00	2335	L. Pied.	Sm. Village	50.0	400
TX-A-58	2154.60	517.90	2385	L. Pied.	Sm. Village	100.0	500
TX-A-59	2154.20	520.10	2495	L. Pied.	Lg. Village	75.0	750
TX-A-60	2155.20	520.90	2505	U. Pied.	Sm. Village	20.0	200
TX-A-61	2155.20	519.70	2575	L. Pied.	Cer. Center	5.0	0
TX-A-64	2156.90	516.90	2340	L. Pied.	Sm. Village	35.0	400
TX-A-65	2157.10	518.00	2335	L. Pied.	Sm. Village	25.0	300
TX-A-66	2157.10	519.30	2360	L. Pied.	Sm. Village	50.0	400
TX-A-69	2158.50	520.30	2455	L. Pied.	Sm. Village	30.0	400
TX-A-70	2158.40	521.30	2510	U. Pied.	Hamlet	7.0	60
TX-A-72	2159.70	521.70	2560	U. Pied.	Lg. Village	400.0	8000
TX-A-75	2155.40	523.80	2665	U. Pied.	Hamlet	4.0	40
TX-A-76	2157.40	521.90	2585	U. Pied.	Sm. Village	15.0	250
TX-A-77	2156.60	522.00	2535	U. Pied.	Hamlet	7.0	70
TX-A-78	2155.50	522.60	2565	L. Pied.	Lg. Village	100.0	1500
TX-A-79	2154.30	523.00	2595	L. Pied.	Hamlet	11.0	100
TX-A-80	2155.00	521.50	2595	L. Pied.	Sm. Village	30.0	150
TX-A-81	2156.20	521.10	2505	U. Pied.	Sm. Village	30.0	300
TX-A-84	2153.00	517.20	2600	U. Pied.	Sm. Hamlet	0.9	15
TX-A-85	2153.90	520.80	2525	U. Pied.	Sm. Hamlet	0.9	15
TX-A-86	2153.20	520.10	2520	U. Pied.	Sm. Village	20.0	300

Table I.1
Valley of Mexico Survey Sites Included in Study (continued)

Site Number	Site Location[a] North UTM	East UTM	Elev. (m)	Environ-mental Zone[b]	Site Type[c]	Area (ha)	Pop.
TX-A-87	2153.10	514.60	2430	L. Pied.	Reg. Center	840.0	23000
TX-A-99	2142.90	516.60	2420	L. Pied.	Loc. Center	85.0	2500
TX-A-100	2142.60	514.90	2335	L. Pied.	Cer. Center	5.0	0
TX-A-101	2143.40	513.90	2420	L. Pied.	Cer. Center	1.0	0
TX-A-106	2143.40	504.50	2240	Lksh. Pl.	Hamlet	1.0	0
TX-A-107	2144.20	502.80	2240	Lksh. Pl.	Sm. Village	32.0	400
TX-A-108	2144.60	504.60	2520	U. Pied.	Cer. Center	0.1	0
TX-A-109	2146.20	506.60	2245	Lksh. Pl.	Reg. Center	260.0	12000
TX-A-110	2147.80	504.50	2240	Lksh. Pl.	Sm. Village	17.0	250
IXTAPALAPA SURVEY REGION							
IX-A-2	2140.13	517.85	2400	L. Pied.	Hamlet	8.0	20
IX-A-7	2138.18	518.00	2400	L. Pied.	Sm. Hamlet	0.9	10
IX-A-9	2137.07	517.88	2425	L. Pied.	Hamlet	11.0	110
IX-A-11	2141.15	513.95	2350	L. Pied.	Hamlet	10.0	100
IX-A-15	2139.15	509.78	2560	U. Pied.	Cer. Center	0.1	0
IX-A-26	2137.50	511.78	2375	Lksh. Pl.	Loc. Center	90.0	1630
IX-A-34	2136.45	506.00	2240	Lksh. Pl.	Hamlet	4.0	40
IX-A-35	2137.70	505.72	2260	L. Pied.	Cer. Center	0.1	0
IX-A-37	2140.20	505.18	2250	L. Pied.	Sm. Village	24.0	480
IX-A-38	2139.72	503.20	2250	Lksh. Pl.	Hamlet	2.0	20
IX-A-41	2140.00	501.60	2250	Lksh. Pl.	Sm. Village	20.0	450
IX-A-42	2140.22	500.65	2240	Lksh. Pl.	Hamlet	4.6	115
IX-A-43	2140.22	500.22	2240	Lksh. Pl.	Sm. Hamlet	0.1	10
IX-A-44	2139.28	501.18	2280	L. Pied.	Hamlet	3.6	50
IX-A-47	2137.32	502.35	2350	L. Pied.	Sm. Hamlet	0.1	10
IX-A-49	2136.57	503.60	2270	L. Pied.	Sm. Hamlet	0.1	10
IX-A-53	2136.05	503.85	2250	Lksh. Pl.	Lg. Village	29.0	725

Table I.1
Valley of Mexico Survey Sites Included in Study (continued)

Site Number	Site Location[a] North UTM	East UTM	Elev. (m)	Environmental Zone[b]	Site Type[c]	Area (ha)	Pop.
IX-A-57	2133.57	501.75	2240	Lksh. Pl.	Hamlet	3.0	30
IX-A-59	2139.60	498.90	2250	L. Pied.	Sm. Hamlet	0.9	20
IX-A-63	2140.47	497.85	2240	Lksh. Pl.	Sm. Hamlet	0.1	15
IX-A-67	2139.38	492.78	2240	Lksh. Pl.	Lg. Village	38.0	963
IX-A-69	2139.88	489.32	2245	Lksh. Pl.	Loc. Center	30.0	2800
IX-A-70	2139.40	487.70	2240	Lksh. Pl.	Loc. Center	?	1100
IX-A-72	2137.43	488.25	2240	Lakebed	Reg. Center	65.0	3250
CHALCO SURVEY REGION							
CH-AZ-2	2135.38	518.68	2450	L. Pied.	Hamlet	4.1	80
CH-AZ-3	2134.53	516.27	2350	L. Pied.	Lg. Village	64.0	1280
CH-AZ-4	2133.53	513.95	2270	L. Pied.	Hamlet	3.8	40
CH-AZ-6	2133.58	519.97	2500	U. Pied.	Sm. Hamlet	0.5	10
CH-AZ-10	2130.85	519.75	2360	L. Pied.	Sm. Hamlet	1.1	15
CH-AZ-11	2131.25	520.90	2420	L. Pied.	Sm. Hamlet	0.2	10
CH-AZ-12	2130.63	520.18	2380	L. Pied.	Sm. Hamlet	0.7	10
CH-AZ-14	2129.75	518.77	2300	L. Pied.	Hamlet	2.5	40
CH-AZ-15	2129.13	520.72	2375	L. Pied.	Sm. Village	13.9	140
CH-AZ-17	2127.13	520.02	2310	L. Pied.	Hamlet	4.3	30
CH-AZ-20	2125.70	518.65	2290	L. Pied.	Hamlet	4.3	90
CH-AZ-21	2125.60	517.82	2295	L. Pied.	Hamlet	6.0	60
CH-AZ-22	2125.10	518.85	2300	L. Pied.	Hamlet	11.7	120
CH-AZ-23	2123.53	520.65	2385	L. Pied.	Loc. Center	80.0	4000
CH-AZ-25	2121.75	520.15	2500	U. Pied.	Sm. Hamlet	0.9	20
CH-AZ-25	2121.75	520.15	2500	U. Pied.	Sm. Hamlet	0.9	20
CH-AZ-26	2121.28	520.02	2530	U. Pied.	Sm. Hamlet	1.1	10
CH-AZ-29	2120.78	517.95	2470	L. Pied.	Sm. Hamlet	1.4	20
CH-AZ-30	2120.04	522.10	2550	Ameca.	Sm. Hamlet	0.7	10

Table I.1
Valley of Mexico Survey Sites Included in Study (continued)

Site Number	Site Location[a] North UTM	East UTM	Elev. (m)	Environmental Zone[b]	Site Type[c]	Area (ha)	Pop.
CH-AZ-31	2119.16	522.68	2490	Ameca.	Sm. Hamlet	1.8	20
CH-AZ-32	2118.66	524.50	2500	Ameca.	Sm. Hamlet	0.5	10
CH-AZ-35	2117.61	522.22	2480	Ameca.	Hamlet	2.7	30
CH-AZ-36	2118.36	520.40	2610	U. Pied.	Sm. Hamlet	1.5	15
CH-AZ-39	2115.41	523.47	2470	Ameca.	Hamlet	2.8	30
CH-AZ-40	2114.29	522.97	2460	Ameca.	Sm. Hamlet	0.9	10
CH-AZ-41	2113.41	523.30	2470	Ameca.	Loc. Center	400.0	20000
CH-AZ-42	2113.16	522.40	2460	Ameca.	Sm. Hamlet	0.3	10
CH-AZ-44	2112.61	525.17	2480	Ameca.	Sm. Hamlet	1.1	10
CH-AZ-48	2112.01	526.59	2510	Ameca.	Sm. Hamlet	1.2	10
CH-AZ-50	2112.06	526.17	2500	Ameca.	Sm. Hamlet	0.8	10
CH-AZ-51	2111.61	526.29	2520	Ameca.	Hamlet	9.5	100
CH-AZ-57	2107.88	524.72	2440	Ameca.	Sm. Hamlet	0.9	10
CH-AZ-59	2108.86	520.53	2520	U. Pied.	Hamlet	2.9	30
CH-AZ-63	2107.61	516.25	2500	L. Pied.	Sm. Hamlet	1.0	20
CH-AZ-65	2110.58	514.62	2700	U. Pied.	Cer. Center	0.3	0
CH-AZ-66	2112.01	515.40	2500	L. Pied.	Hamlet	4.1	100
CH-AZ-67	2112.46	519.40	2480	L. Pied.	Cer. Center	0.7	30
CH-AZ-70	2116.33	520.43	2450	L. Pied.	Sm. Hamlet	0.4	10
CH-AZ-72	2114.96	519.00	2430	L. Pied.	Sm. Hamlet	1.1	15
CH-AZ-74	2113.31	516.28	2440	L. Pied.	Sm. Hamlet	1.5	20
CH-AZ-75	2113.66	515.70	2450	L. Pied.	Sm. Hamlet	0.7	10
CH-AZ-76	2114.01	516.07	2435	L. Pied.	Hamlet	8.5	90
CH-AZ-79	2115.11	517.50	2420	L. Pied.	Sm. Hamlet	0.7	10
CH-AZ-82	2115.96	517.90	2415	L. Pied.	Sm. Hamlet	1.5	20
CH-AZ-86	2114.91	516.05	2440	L. Pied.	Hamlet	7.0	80
CH-AZ-87	2114.21	515.40	2440	L. Pied.	Sm. Hamlet	0.7	10
CH-AZ-88	2115.41	515.82	2430	L. Pied.	Sm. Hamlet	0.4	10

Table I.1
Valley of Mexico Survey Sites Included in Study (continued)

Site Number	Site Location[a]			Environ-mental Zone[b]	Site Type[c]	Area (ha)	Pop.
	North UTM	East UTM	Elev. (m)				
CH-AZ-90	2117.46	517.78	2525	U. Pied.	Lg. Village	26.7	540
CH-AZ-93	2118.31	517.03	2475	L. Pied.	Sm. Village	19.1	300
CH-AZ-94	2117.91	516.30	2430	L. Pied.	Lg. Village	41.8	840
CH-AZ-96	2119.58	516.37	2430	L. Pied.	Sm. Hamlet	0.9	30
CH-AZ-97	2118.96	516.10	2405	L. Pied.	Hamlet	6.0	100
CH-AZ-100	2117.16	515.53	2380	L. Pied.	Hamlet	1.2	10
CH-AZ-102	2115.29	515.30	2425	L. Pied.	Hamlet	7.3	70
CH-AZ-103	2115.54	514.78	2430	L. Pied.	Sm. Village	23.8	240
CH-AZ-106	2114.36	513.70	2455	L. Pied.	Sm. Hamlet	2.6	30
CH-AZ-107	2116.23	514.25	2435	L. Pied.	Hamlet	9.8	100
CH-AZ-108	2117.26	514.97	2380	L. Pied.	Sm. Village	7.5	150
CH-AZ-111	2116.21	512.72	2500	L. Pied.	Sm. Village	32.0	320
CH-AZ-112	2114.88	512.13	2510	U. Pied.	Sm. Hamlet	1.0	15
CH-AZ-119	2117.51	509.05	2750	U. Pied.	Sm. Hamlet	0.8	15
CH-AZ-120	2118.21	509.47	2710	U. Pied.	Sm. Village	21.0	200
CH-AZ-126	2119.31	509.93	2605	U. Pied.	Hamlet	6.7	70
CH-AZ-127	2118.81	511.00	2530	U. Pied.	Lg. Village	65.3	700
CH-AZ-128	2119.66	511.07	2490	L. Pied.	Sm. Village	21.0	200
CH-AZ-130	2120.01	512.20	2385	L. Pied.	Sm. Village	19.7	200
CH-AZ-131	2119.21	512.50	2420	L. Pied.	Loc. Center	13.4	150
CH-AZ-132	2117.96	512.32	2490	L. Pied.	Hamlet	6.9	100
CH-AZ-136	2118.31	513.87	2380	L. Pied.	Sm. Hamlet	0.5	10
CH-AZ-137	2118.23	514.20	2370	L. Pied.	Hamlet	3.1	30
CH-AZ-138	2118.58	513.15	2390	L. Pied.	Hamlet	4.1	50
CH-AZ-139	2119.79	513.95	2350	L. Pied.	Hamlet	4.9	50
CH-AZ-140	2117.81	511.00	2610	U. Pied.	Hamlet	11.2	100
CH-AZ-141	2120.56	513.03	2330	L. Pied.	Hamlet	2.1	30
CH-AZ-144	2120.58	510.70	2430	L. Pied.	Hamlet	6.0	60

Table I.1
Valley of Mexico Survey Sites Included in Study (continued)

Site Number	Site Location[a]			Environmental Zone[b]	Site Type[c]	Area (ha)	Pop.
	North UTM	East UTM	Elev. (m)				
XOCHIMILCO SURVEY REGION							
CH-AZ-148	2121.08	509.75	2440	L. Pied.	Hamlet	10.2	100
CH-AZ-152	2121.61	511.13	2350	L. Pied.	Hamlet	6.9	70
CH-AZ-154	2121.50	513.85	2300	L. Pied.	Hamlet	5.7	50
CH-AZ-157	2122.28	514.40	2290	L. Pied.	Hamlet	2.4	30
CH-AZ-158	2122.05	514.12	2290	L. Pied.	Sm. Hamlet	1.2	20
CH-AZ-160	2122.10	513.32	2290	L. Pied.	Hamlet	1.5	30
CH-AZ-161	2121.86	512.93	2270	L. Pied.	Hamlet	7.0	70
CH-AZ-162	2122.16	511.80	2295	L. Pied.	Sm. Village	17.9	360
CH-AZ-164	2122.83	511.97	2260	Lksh. Pl.	Sm. Hamlet	0.2	10
CH-AZ-166	2123.11	511.32	2260	Lksh. Pl.	Sm. Hamlet	0.5	10
CH-AZ-167	2124.85	516.02	2310	L. Pied.	Hamlet	1.5	15
CH-AZ-170	2128.43	512.45	2245	Lksh. Pl.	Sm. Village	13.2	150
CH-AZ-172	2129.15	510.43	2245	Lksh. Pl.	Loc. Center	249.5	12500
CH-AZ-174	2127.60	511.65	2245	Lksh. Pl.	Hamlet	7.7	80
CH-AZ-185	2124.36	505.75	2240	Lakebed	Sm. Hamlet	1.6	20
CH-AZ-186	2126.58	508.72	2243	Lksh. Pl.	Small Village	25.4	500
CH-AZ-187	2126.85	508.50	2245	Lksh. Pl.	Cer. Center	4.7	100
CH-AZ-188	2127.16	506.97	2240	Lakebed	Hamlet	0.1	50
CH-AZ-190	2128.63	508.10	2240	Lakebed	Sm. Village	7.7	160
CH-AZ-192	2129.82	507.55	2245	Lakebed	Lg. Village	62.1	2500
CH-AZ-194	2128.03	507.22	2240	Lakebed	Hamlet	4.1	100
CH-AZ-195	2127.95	506.60	2240	Lakebed	Hamlet	4.4	90
CH-AZ-202	2123.94	504.68	2240	Lakebed	Hamlet	2.3	30
CH-AZ-204	2123.69	501.85	2280	L. Pied.	Hamlet	3.8	50
CH-AZ-205	2126.48	504.60	2240	Lakebed	Hamlet	5.8	100
CH-AZ-207	2127.19	504.68	2240	Lakebed	Sm. Hamlet	0.1	10
CH-AZ-209	2127.76	505.15	2240	Lakebed	Sm. Hamlet	0.5	10

Table I.1
Valley of Mexico Survey Sites Included in Study (continued)

Site Number	Site Location[a] North UTM	East UTM	Elev. (m)	Environmental Zone[b]	Site Type[c]	Area (ha)	Pop.
CH-AZ-213	2128.69	504.72	2240	Lakebed	Hamlet	1.5	30
CH-AZ-218	2129.88	504.53	2240	Lakebed	Sm. Hamlet	0.1	10
CH-AZ-229	2133.54	502.50	2240	Lakebed	Hamlet	3.6	40
CH-AZ-230	2132.44	500.60	2240	Lakebed	Sm. Hamlet	0.9	10
CH-AZ-231	2131.66	501.50	2240	Lakebed	Hamlet	9.6	100
CH-AZ-233	2130.63	501.05	2240	Lakebed	Sm. Hamlet	0.9	10
CH-AZ-236	2129.94	502.35	2240	Lakebed	Sm. Hamlet	0.1	10
CH-AZ-238	2129.11	502.80	2240	Lakebed	Sm. Hamlet	0.4	10
CH-AZ-241	2127.71	504.00	2240	Lakebed	Sm. Hamlet	0.1	10
CH-AZ-248	2127.01	503.22	2240	Lakebed	Sm. Hamlet	1.7	20
CH-AZ-249	2127.51	503.13	2240	Lakebed	Sm. Village	7.0	160
CH-AZ-250	2128.01	503.60	2240	Lakebed	Sm. Hamlet	0.4	10
CH-AZ-252	2128.36	503.13	2240	Lakebed	Hamlet	0.1	15
CH-AZ-253	2127.88	502.43	2240	Lakebed	Sm. Hamlet	0.1	10
CH-AZ-256	2129.23	501.95	2240	Lakebed	Sm. Hamlet	0.8	20
CH-AZ-257	2129.16	501.72	2240	Lakebed	Sm. Hamlet	1.5	20
CH-AZ-263	2128.26	501.53	2240	Lakebed	Sm. Village	12.1	250
CH-AZ-267	2126.66	502.10	2240	Lakebed	Hamlet	2.5	50
CH-AZ-273	2129.41	500.38	2240	Lakebed	Sm. Hamlet	1.5	15
CH-AZ-275	2129.95	499.78	2240	Lakebed	Loc. Center	90.0	4500
CH-AZ-278	2128.58	499.53	2245	Lksh. Pl.	Hamlet	2.4	50
CH-AZ-282	2125.16	499.61	2345	L. Pied.	Lg. Village	99.0	2000
XO-AZ-1	2132.03	497.81	2240	Lakebed	Sm. Hamlet	0.6	10
XO-AZ-5	2130.00	498.44	2240	Lakebed	Sm. Village	7.0	150
XO-AZ-8	2131.95	496.23	2240	Lakebed	Sm. Hamlet	0.3	15
XO-AZ-11	2131.88	496.71	2240	Lakebed	Sm. Hamlet	0.3	10
XO-AZ-14	2130.35	495.06	2240	Lakebed	Sm. Hamlet	1.5	20
XO-AZ-22	2125.06	498.46	2490	L. Pied.	Hamlet	1.6	30

Table I.1
Valley of Mexico Survey Sites Included in Study (continued)

Site Number	Site Location[a]			Environmental Zone[b]	Site Type[c]	Area (ha)	Pop.
	North UTM	East UTM	Elev. (m)				
XO-AZ-28	2123.50	494.46	2520	U. Pied.	Sm. Hamlet	1.7	20
XO-AZ-29	2124.41	492.16	2570	U. Pied.	Cer. Center	0.1	0
XO-AZ-32	2127.58	491.06	2245	Lksh. Pl.	Sm. Hamlet	0.7	10
XO-AZ-33	2127.41	490.53	2270	L. Pied.	Hamlet	5.4	50
XO-AZ-34	2127.31	489.53	2280	L. Pied.	Sm. Village	6.6	130
XO-AZ-35	2126.88	489.28	2320	L. Pied.	Sm. Hamlet	0.8	10
XO-AZ-37	2128.03	491.16	2245	Lksh. Pl.	Hamlet	4.0	50
XO-AZ-46	2131.70	492.78	2240	Lakebed	Hamlet	2.8	40
XO-AZ-51	2132.16	491.28	2240	Lakebed	Sm. Hamlet	0.1	10
XO-AZ-54	2132.66	489.78	2240	Lakebed	Hamlet	5.0	80
XO-AZ-58	2133.88	491.71	2240	Lakebed	Sm. Hamlet	1.0	20
XO-AZ-62	2133.98	489.53	2240	Lakebed	Sm. Hamlet	0.6	10
XO-AZ-66	2136.03	489.86	2245	Lksh. Pl.	Sm. Hamlet	0.6	10
XO-AZ-67	2136.06	489.21	2245	Lksh. Pl.	Sm. Hamlet	1.5	15
XO-AZ-68	2136.68	488.48	2245	Lksh. Pl.	Hamlet	1.5	30
XO-AZ-69	2136.98	488.21	2245	Lksh. Pl.	Sm. Village	7.7	160
XO-AZ-70	2138.06	486.57	2245	Lksh. Pl.	Hamlet	1.2	10
XO-AZ-71	2136.68	487.03	2240	Lakebed	Hamlet	3.8	50
XO-AZ-75	2131.81	488.38	2240	Lakebed	Hamlet	3.6	30
XO-AZ-77	2131.06	487.48	2240	Lakebed	Hamlet	1.8	40
XO-AZ-78	2129.06	486.19	2270	L. Pied.	Sm. Hamlet	0.8	10
XO-AZ-79	2131.68	484.84	2270	L. Pied.	Hamlet	2.7	30
XO-AZ-80	2131.31	484.04	2270	L. Pied.	Hamlet	1.6	30
XO-AZ-86	2127.83	483.97	2460	L. Pied.	Hamlet	3.1	30
XO-AZ-87	2128.31	488.23	2245	Lksh. Pl.	Hamlet	1.9	40
XO-AZ-90	2123.75	485.67	2650	U. Pied.	Sm. Hamlet	0.3	10
XO-AZ-91	2134.50	479.32	2360	L. Pied.	Cer. Center	2.7	0

Table I.1
Valley of Mexico Survey Sites Included in Study (continued)

[a]Locational data from Parsons *et al.* 1983.

[b]Environmental zones (from Parsons *et al.* 1983):
Island = Island in lakebed
Lksh. Pl. = Lakeshore plain
L. Pied. = Lower piedmont
U. Pied. = Upper piedmont
Ameca. = Amecameca subvalley.

[c]Site classification (from Parsons *et al.* (1983) with modifications based on ethnohistorical data):
Reg. Center = Regional political center
Loc. Center = Local political center
Lg. Village = Large village
Sm. Village = Small village
Hamlet = Hamlet
Sm. Hamlet = Small hamlet
Cer. Center = Ceremonial center.

Table I.2
Concordance of Sites and Collections Included in Study

Site Number	Surveyor & Year[a]	Temporary Site No.	Collection Areas Included in Study[b]
		TEXCOCO SURVEY REGION	
TX-A-3	MHP 1967	TX-A-3	Tls. 2, 3, 4
TX-A-6	MHP 1967	TX-A-16	Tls. 78, 79, 81
TX-A-9	MHP 1967	TX-A-7	Tls. 15B-W, 15C, 15-E
TX-A-10	MHP 1967	TX-A-8	Tls. 6-E, 6-W, 7B, 10
TX-A-14	MHP 1967	TX-A-10	Tls. 22, 22B
TX-A-16	MHP 1967	TX-A-21	Tl. 19
TX-A-17	MHP 1967	TX-A-18	Tls. 28, 30, 35, 37
TX-A-18	MHP 1967	TX-A-11	Loc. 4
TX-A-21	MHP 1967	TX-A-20	Tls. 43, 54, 66, 88
TX-A-22	MHP 1967	TX-A-26	Tls. 85, 87
TX-A-23	MHP 1967	TX-A-28	Tl. 97
TX-A-24	MHP 1967	TX-A-22	Areas A, E; Locs. 6, 8; Tls. 92, 132, 157, 161, 163, 176, 196, 215, 271, 303, 305, 339, 345-346, 412, 445, 452, 461
TX-A-25	MHP 1967	TX-A-32	Loc. 11; Tls. 375, 476
TX-A-26	MHP 1967	TX-A-29	Tl. 613

Table I.2
Concordance of Sites and Collections Included in Study (continued)

Site Number	Surveyor & Year[a]	Temporary Site No.	Collection Areas Included in Study[b]
TX-A-27	MHP 1967	TX-A-30	Tls. 554, 567, 569, 575
TX-A-28	MHP 1967	TX-A-31	Loc. 14; Tls. 590, 806, 808, 845, 852
TX-A-30	MHP 1967	TX-A-37	Tls. 695, 712, 727, 752, 754, 760, 791
TX-A-31	MHP 1967	TX-A-36	Tls. 632, 635, 665, 670
TX-A-34	MHP 1967	TX-A-38	Tl. 771
TX-A-36	MHP 1967	TX-A-34	Loc. 13
TX-A-38	MHP 1967	TX-A-33	Tl. 511, 515
TX-A-40	MHP 1967	TX-A-24	Loc. 9; Tls. 103, 105, 111, 115, 369, 370, 378
TX-A-42	JRP 1967	TX-A-54	Tl. 2
TX-A-43	JRP 1967	TX-A-55	Tl. 1
TX-A-44	JRP 1967	TX-A-1	1 collection without location #
TX-A-46	JRP 1967	TX-A-3	Loc. 7; Tl. 4
TX-A-47	JRP 1967	TX-A-51	Tl. 6
TX-A-49	JRP 1967	TX-A-52	Tl. 1A
TX-A-52	JRP 1967	TX-A-4	Tl. 8

Table I.2
Concordance of Sites and Collections Included in Study (continued)

Site Number	Surveyor & Year[a]	Temporary Site No.	Collection Areas Included in Study[b]
TX-A-53	JRP 1967	TX-A-9	Tl. 12
TX-A-56	JRP 1967	TX-A-11	Locs. A, I, J; Tls. 17, 18, 57, 59, 92
TX-A-57	JRP 1967	TX-A-17	Loc. F; Tls. 66, 69, 70
TX-A-58	JRP 1967	TX-A-23	Tl. 1
TX-A-59	JRP 1967	TX-A-22	Tls. 4, 8, 9, 25
TX-A-60	JRP 1967	TX-A-21	Tl. 42
TX-A-61	JRP 1967	TX-A-16	Loc. AA
TX-A-64	JRP 1967	TX-A-13	Tls. 76, 80-82, 96
TX-A-65	JRP 1967	TX-A-14	Loc. P; Tls. 100, 109
TX-A-66	JRP 1967	TX-A-15	Loc. T
TX-A-69	JRP 1967	TX-A-39	Tls. 247, 257
TX-A-70	JRP 1967	TX-A-40	Tls. 235-236
TX-A-72	JRP 1967	TX-A-42	Locs. EE, KK; Tls. 189, 207, 212, 222, 225, 226-229, 241, 270, 279, 284, 301, 313, 333, 345
TX-A-75	JRP 1967	TX-A-38	Loc. DD

Table I.2
Concordance of Sites and Collections Included in Study (continued)

Site Number	Surveyor & Year[a]	Temporary Site No.	Collection Areas Included in Study[b]
TX-A-76	JRP 1967	TX-A-32	Tl. 136
TX-A-77	JRP 1967	TX-A-35	Tl. 130
TX-A-78	JRP 1967	TX-A-33	Loc. CC; Tls. 119, 151, 154, 160, 165, 170, 174, 177, 187; 1 collection without location #
TX-A-79	JRP 1967	TX-A-28	Loc. M; Tls. 69, 73
TX-A-80	JRP 1967	TX-A-25	Locs. H, I, K, L; Tls. 9, 63, 67; 1 collection without location #
TX-A-81	JRP 1967	TX-A-36	Locs. BB, Tl. 115
TX-A-84	JRP 1967	TX-A-27	Loc. F
TX-A-85	JRP 1967	TX-A-26	Loc. G
TX-A-86	JRP 1967	TX-A-20	Locs. D, E; Tl. 47
TX-A-87	JRP 1967	TX-A-10	Locs. A, B, C, D, E, H, K, O; Tls. 24, 28, 29, 30, 31, 32, 34, 37, 39, 41, 43, 49, 51, 53, 84
TX-A-99	RH 1967	TX-A-11	Locs. 48, 51; Tl. 171
TX-A-100	RH 1967	TX-A-10	Loc. 40, 44, 45, 46
TX-A-101	RH 1967	TX-A-9	Loc. 42
TX-A-106	RH 1967	TX-A-7	Loc. 22

Table I.2
Concordance of Sites and Collections Included in Study (continued)

Site Number	Surveyor & Year[a]	Temporary Site No.	Collection Areas Included in Study[b]
TX-A-107	RH 1967	TX-A-6	Tls. 89, 91, 97
TX-A-108	RH 1967	TX-A-4	Loc. 16
TX-A-109	RH 1967	TX-A-3	Areas A, C; Locs. 1, 4A, 4B, 5, 9, 10A, 10B, 11, 12, 13, 17; Tls. 1, 2, 7, 8, 8A, 9, 9B, 10, 11, 12, 16, 18, 19, 20, 21, 22, 22-E, 23, 32, 34, 39, 46, 47, 49, 53, 57, 58, 62, 66, 76, 77; 1 collection without location #
TX-A-110	RH 1967	TX-A-1	Tls. 3, 6
		IXTAPALAPA SURVEY REGION	
IX-A-2	REB 1969	IX-A-2	Tls. 6, 7
IX-A-7	REB 1969	IX-A-7	Tl. 109
IX-A-9	REB 1969	IX-A-9	Tl. 112
IX-A-11	REB 1969	IX-A-13	Areas 2, 18
IX-A-15	REB 1969	IX-A-17	Area 20
IX-A-26	REB 1969	IX-A-28	Areas 103, 104; Tls. 116, 117, 129, 133, 158, 170, 172
		IX-A-29	Tls. 114, 198, 215, 233
IX-A-34	REB 1969	IX-A-36	Area 38
IX-A-35	REB 1969	IX-A-37	Tl. 21
IX-A-37	REB 1969	IX-A-39	Area 34

Table I.2
Concordance of Sites and Collections Included in Study (continued)

Site Number	Surveyor & Year[a]	Temporary Site No.	Collection Areas Included in Study[b]
IX-A-38	REB 1969	IX-A-40	Area 45
IX-A-41	REB 1969	IX-A-43	Areas 54, 55, 57
IX-A-42	REB 1969	IX-A-45	Tls. 26, 27
IX-A-43	REB 1969	IX-A-46	Area 58
IX-A-44	REB 1969	IX-A-47	Area 73
IX-A-47	REB 1969	IX-A-50	Area 133
IX-A-49	REB 1969	IX-A-52	Area 128
IX-A-53	REB 1969	IX-A-56	Area 135; Tls. 280A, 280B
IX-A-57	REB 1969	IX-A-61	Area 140
IX-A-59	REB 1969	IX-A-64	Tl. 303
IX-A-63	REB 1969	IX-A-68	Area 161
IX-A-67	REB 1969	IX-A-73	Area 170
IX-A-69	REB 1969	IX-A-75 IX-A-77	Area 169 Tl. 307
IX-A-70	REB 1969	IX-A-76	Area 171
IX-A-72	REB 1969	IX-A-80	Area 174

Table I.2
Concordance of Sites and Collections Included in Study (continued)

Site Number	Surveyor & Year[a]	Temporary Site No.	Collection Areas Included in Study[b]
CHALCO SURVEY REGION			
CH-AZ-2	JRP 1969	CH-A-25	Loc. TTT
CH-AZ-3	JRP 1969	CH-A-45	Locs. SSS, VVV
CH-AZ-4	JRP 1969	CH-F-15	Loc. III
CH-AZ-6	JRP 1972	CH-AZ-33	Loc. 103
CH-AZ-10	JRP 1969	CH-A-26	Loc. 1
CH-AZ-11	JRP 1969	CH-A-29	Loc. ZZZ
CH-AZ-12	JRP 1969	CH-A-21	Loc. WWW
CH-AZ-14	JRP 1969	CH-A-20	Loc. JJ
CH-AZ-15	MHP 1969	CH-A-30	Locs. 216, 217
CH-AZ-17	MHP 1969	CH-A-31	Loc. 211
CH-AZ-20	JRP 1969	CH-A-23	Loc. AAA, Tl. 85
CH-AZ-21	JRP 1969	CH-F-13	Loc. UU
CH-AZ-22	JRP 1969	CH-A-22	Loc. BBB
CH-AZ-23	JRP 1969	CH-A-43	Loc. 9

Table I.2
Concordance of Sites and Collections Included in Study (continued)

Site Number	Surveyor & Year[a]	Temporary Site No.	Collection Areas Included in Study[b]
CH-AZ-25	JRP 1969	CH-A-34	Loc. 15
CH-AZ-26	JRP 1969	CH-A-35 CH-A-36	Loc. 17 Loc. 16
CH-AZ-29	JRP 1969	CH-A-37	Loc. 18
CH-AZ-30	EP 1972	AM-AZ-3	Loc. 23
CH-AZ-31	EP 1972	AM-AZ-6	Loc. 24
CH-AZ-32	EP 1972	AM-AZ-7	Loc. 38
CH-AZ-35	EP 1972	AM-AZ-1	Locs. 29, 30
CH-AZ-36	EP 1972	AM-AZ-5	Locs. 20, 21
CH-AZ-39	EP 1972	AM-AZ-4	Loc. 36
CH-AZ-40	EP 1972	AM-AZ-8	Loc. 42
CH-AZ-41	EP 1972	AM-AZ-9	Locs. 44, 45, 46, 48, 49, 50
CH-AZ-42	EP 1972	AM-AZ-	Loc. 52
CH-AZ-44	EP 1972	AM-AZ-	Loc. 67
CH-AZ-48	EP 1972	AM-AZ-	Loc. 73
CH-AZ-50	EP 1972	AM-AZ-	Loc. 74

Table I.2
Concordance of Sites and Collections Included in Study (continued)

Site Number	Surveyor & Year[a]	Temporary Site No.	Collection Areas Included in Study[b]
CH-AZ-51	EP 1972	AM-AZ-11	Locs. 62, 63, 65, 69
CH-AZ-57	EP 1972	AM-LF-8	Locs. 70, 72
CH-AZ-59	EP 1972	AM-AZ-13	Loc. 85
CH-AZ-63	RW 1972	AM-AZ-4(W)	Fea. AAM(W)
CH-AZ-65	RW 1972	AM-AZ-3(W)	Fea. AAL(W)
CH-AZ-66	RW 1972	AM-AZ-2(W)	Loc. 31(W)
CH-AZ-67	EP 1972	AM-AZ-10	Locs. 57A, 57B
CH-AZ-70	EP 1972	AM-AZ-2	Loc. 17
CH-AZ-72	MHP 1972	AM-F-16	Locs. 45, 49
CH-AZ-74	MHP 1972	AM-AZ-23	Loc. 41
CH-AZ-75	MHP 1972	AM-AZ-16	Loc. 38
CH-AZ-76	MHP 1972	AM-AZ-62	Loc. 39
CH-AZ-79	MHP 1972	AM-AZ-21	Loc. 61
CH-AZ-82	MHP 1972	AM-LT-3	Loc. 60
CH-AZ-86	MHP 1972	AM-AZ-25	Loc. 40

Table I.2
Concordance of Sites and Collections Included in Study (continued)

Site Number	Surveyor & Year[a]	Temporary Site No.	Collection Areas Included in Study[b]
CH-AZ-87	MHP 1972	AM-CL-5	Loc. 32
CH-AZ-88	MHP 1972	AM-CL-10	Loc. 63
CH-AZ-90	MHP 1972	AM-AZ-7	Locs. 3, 66, 67
CH-AZ-93	MHP 1972	AM-AZ-6	Loc. 6
CH-AZ-94	MHP 1972	AM-AZ-8	Locs. 4, 5
CH-AZ-96	MHP 1972	AM-AZ-2	Loc. 1
CH-AZ-97	MHP 1972	AM-AZ-4	Loc. 2
CH-AZ-100	MHP 1972	AM-F-3	Locs. 16, 18
CH-AZ-102	MHP 1972	AM-AZ-15	Locs. 20, 22
CH-AZ-103	MHP 1972	AM-AZ-14	Locs. 21, 23
CH-AZ-106	MHP 1972	AM-AZ-24	Loc. 31
CH-AZ-107	MHP 1972	AM-AZ-12	Locs. 24, 26
CH-AZ-108	MHP 1972	AM-AZ-10 AM-AZ-20	Locs. 12, 17 Loc. 42
CH-AZ-111	MHP 1972	AM-AZ-26	Locs. 28, 79, 80, 81, 82

Table I.2
Concordance of Sites and Collections Included in Study (continued)

Site Number	Surveyor & Year[a]	Temporary Site No.	Collection Areas Included in Study[b]
CH-AZ-112	MHP 1972	AM-AZ-80	Loc. 71
CH-AZ-119	MHP 1972	AM-AZ-35	Loc. 78
CH-AZ-120	MHP 1972	AM-AZ-40	Fea. R
CH-AZ-126	MHP 1972	AM-AZ-41	Fea. FF
CH-AZ-127	MHP 1972	AM-AZ-39	Fea. L, T, HH, II, KK
CH-AZ-128	MHP 1972	AM-AZ-43	Fea. U, W, Z
CH-AZ-130	MHP 1972	AM-AZ-46	Fea. K, RR, XX; Loc. 92
CH-AZ-131	MHP 1972	AM-AZ-37	Fea. O, Loc. 83
CH-AZ-132	MHP 1972	AM-AZ-44	Fea. I, Loc. 84
CH-AZ-136	MHP 1972	AM-AZ-9	Loc. 13
CH-AZ-137	MHP 1972	AM-AZ-9	Loc. 11
CH-AZ-138	MHP 1972	AM-AZ-45	Locs. 14, 15
CH-AZ-139	MHP 1972	AM-AZ-1	Locs. 8, 9, 10
CH-AZ-140	MHP 1972	AM-AZ-88	Fea. P
CH-AZ-141	MHP 1972	AM-AZ-47	Loc. 90

Table I.2
Concordance of Sites and Collections Included in Study (continued)

Site Number	Surveyor & Year[a]	Temporary Site No.	Collection Areas Included in Study[b]
CH-AZ-144	MHP 1972	AM-AZ-53	Loc. AB
CH-AZ-148	MHP 1972	AM-AZ-54	Loc. 93
CH-AZ-152	MHP 1972	AM-AZ-52	Fea. UU, VV
CH-AZ-154	MHP 1969	CH-T-40	Loc. 228
CH-AZ-157	MHP 1969	CH-A-41	Loc. 219
CH-AZ-158	MHP 1969	CH-T-38	Loc. 227
CH-AZ-160	MHP 1969	CH-A-32	Loc. 229
CH-AZ-161	MHP 1972	AM-AZ-48	Fea. PP
CH-AZ-162	MHP 1972	AM-AZ-49	Fea. NN, OO, SS; Locs. 86, 87
CH-AZ-164	MHP 1972	AM-AZ-63	Loc. 100
CH-AZ-166	MHP 1972	AM-AZ-57	Loc. 94
CH-AZ-167	JRP 1969	CH-C-6	Tl. 82
CH-AZ-170	JRP 1969	CH-A-18	Loc. U
CH-AZ-172	JRP 1969	CH-A-14 CH-A-16	Tl. 66 Locs. Q, S; Tls. 65, 77, 79
CH-AZ-174	JRP 1969	CH-A-17	Loc. T

Table I.2
Concordance of Sites and Collections Included in Study (continued)

Site Number	Surveyor & Year[a]	Temporary Site No.	Collection Areas Included in Study[b]
CH-AZ-185	JRP 1972	CH-AZ-16	Fea. N
CH-AZ-186	JRP 1972	CH-AZ-25	Locs. 44, 45, 46
CH-AZ-187	JRP 1969	CH-A-14	Loc. R
CH-AZ-188	JRP 1972	CH-AZ-24	Fea. U
CH-AZ-190	JRP 1969	CH-A-5	Tls. 52, 53, 60
CH-AZ-192	JRP 1969	CH-A-1 CH-A-3	Locs. A, B, C, H, I, J, M, N, O, P; Tls. 3, 21, 30, 35 Loc. F
CH-AZ-194	JRP 1969	CH-A-12	Tl. 67
CH-AZ-195	JRP 1969	CH-A-11	Tl. 71
CH-AZ-202	JRP 1972	CH-AZ-13	Loc. 32
CH-AZ-204	JRP 1972	CH-AZ-11	Loc. 26
CH-AZ-205	JRP 1972	CH-AZ-14	Loc. 33
CH-AZ-207	RW 1972	CH-AZ-6(W)	Fea. B(W)
CH-AZ-209	RW 1972	CH-AZ-3(W)	Loc. 1(W)
CH-AZ-213	RW 1972	CH-AZ-1(W)	Fea. C(W)

Table I.2
Concordance of Sites and Collections Included in Study (continued)

Site Number	Surveyor & Year[a]	Temporary Site No.	Collection Areas Included in Study[b]
CH-AZ-218	RW 1972	CH-AZ-59(W)	Fea. AQ(W)
CH-AZ-229	RW 1972	CH-AZ-50(W)	Loc. 16(W)
CH-AZ-230	RW 1972	CH-AZ-48(W)	Loc. 15(W)
CH-AZ-231	RW 1972	CH-AZ-45(W)	Loc. 14(W)
CH-AZ-233	RW 1972	CH-AZ-38(W)	Loc. 13(W)
CH-AZ-236	RW 1972	CH-AZ-34(W)	Fea. AB(W)
CH-AZ-238	RW 1972	CH-AZ-18(W)	Loc. 6(W)
CH-AZ-241	RW 1972	CH-AZ-10(W)	Fea. D(W)
CH-AZ-248	JRP 1972	CH-AZ-17	Fea. P
CH-AZ-249	RW 1972	CH-AZ-16(W)	Fea. I(W), K(W); Loc. 5(W)
CH-AZ-250	RW 1972	CH-AZ-8(W)	Loc. 4(W)
CH-AZ-252	RW 1972	CH-AZ-14(W)	Fea. H(W)
CH-AZ-253	RW 1972	CH-AZ-21(W)	Fea. N(W)
CH-AZ-256	RW 1972	CH-AZ-24(W)	Fea. P(W)
CH-AZ-257	RW 1972	CH-AZ-25(W)	Fea. R(W)

Table I.2
Concordance of Sites and Collections Included in Study (continued)

Site Number	Surveyor & Year[a]	Temporary Site No.	Collection Areas Included in Study[b]
CH-AZ-263	RW 1972	CH-AZ-30(W)	Fea. W(W); Locs. 7(W), 8(W), 9(W), 10(W), 11(W)
CH-AZ-267	JRP 1972	CH-AZ-10	Loc. 11
CH-AZ-273	RW 1972	CH-AZ-43(W)	Loc. 12(W)
CH-AZ-275	RW 1972	CH-AZ-68(W)	Fea. AAF(W), AAG(W)
CH-AZ-278	JRP 1972	CH-AZ-29	Loc. 61
CH-AZ-282	JRP 1972	CH-AZ-1	Locs. 12, 13, 14, 16, 17
XOCHIMILCO SURVEY REGION			
XO-AZ-1	MHP 1972	XE-LF-1	Loc. 136
XO-AZ-5	MHP 1972	XE-AZ-1	Loc. 132
XO-AZ-8	MHP 1972	XE-AZ-2	Fea. AT
XO-AZ-11	MHP 1972	XE-AZ-4	Fea. AV
XO-AZ-14	MHP 1972	XE-AZ-8	Fea. BA
XO-AZ-22	JRP 1972	CH-AZ-2	Loc. 15
XO-AZ-28	MHP 1972	XE-AZ-37	Loc. 156
XO-AZ-29	MHP 1972	XE-AZ-36	Fea. CT

Table I.2
Concordance of Sites and Collections Included in Study (continued)

Site Number	Surveyor & Year[a]	Temporary Site No.	Collection Areas Included in Study[b]
XO-AZ-32	JRP 1972	XW-AZ-36	Fea. AG
XO-AZ-33	JRP 1972	XW-AZ-35	Locs. 86, 87, 88, 89
XO-AZ-34	JRP 1972	XW-AZ-42	Locs. 97, 98, 99
XO-AZ-35	JRP 1972	XW-AZ-38	Loc. 100
XO-AZ-37	MHP 1972	XE-AZ-33	Fea. CM
XO-AZ-46	MHP 1972	XE-AZ-23	Fea. BL
XO-AZ-51	MHP 1972	XE-AZ-17	Fea. BO
XO-AZ-54	MHP 1972	XE-AZ-13	Fea. CD
XO-AZ-58	JRP 1972	XW-AZ-27	Fea. YY
XO-AZ-62	JRP 1972	XW-AZ-22	Fea. RR
XO-AZ-66	JRP 1972	XW-AZ-18	Loc. 78
XO-AZ-67	JRP 1972	XW-AZ-17	Fea. NN
XO-AZ-68	JRP 1972	XW-AZ-14	Loc. 73
XO-AZ-69	JRP 1972	XW-AZ-16	Loc. 75
XO-AZ-70	JRP 1972	XW-AZ-13	Loc. 72

Table I.2
Concordance of Sites and Collections Included in Study (continued)

Site Number	Surveyor & Year[a]	Temporary Site No.	Collection Areas Included in Study[b]
XO-AZ-71	JRP 1972	XW-AZ-15	Loc. 74
XO-AZ-75	JRP 1972	XW-AZ-2	Fea. FF
XO-AZ-77	JRP 1972	XW-AZ-6	Loc. 62
XO-AZ-78	JRP 1972	XW-AZ-32	Loc. 81
XO-AZ-79	JRP 1972	XW-AZ-9	Loc. 68
XO-AZ-80	JRP 1972	XW-AZ-11	Loc. 69
XO-AZ-86	JRP 1972	XW-AZ-29	Loc. 79
XO-AZ-87	JRP 1972	XW-AZ-34	Loc. 82
XO-AZ-90	JRP 1972	XW-AZ-39	Loc. 90
XO-AZ-91	JRP 1972	XW-AZ-12	Loc. 91

1Supervisors: **JRP** = Jeffrey R. Parsons, **MHP** = Mary H. Parsons, **RH** = Robert Hirning, **REB** = Richard E. Blanton, **EP** = Earl Prahl, and **RW** = Robert Wenke.

[b]**Fea.** = Feature, **Loc.** = Location, **Tl.** = Tlatel.

Table I.3
Assignment of Archaeological Sites to Political Confederations and Late Aztec City-States Based on Documentary Sources and Archaeological Settlement Maps[a]

Site Number	Political Confederation[b]	Polity (City-State) Affiliation[c]
TEXCOCO SURVEY REGION		
TX-A-1	Acolhua	Texcoco
TX-A-2	Acolhua	Texcoco
TX-A-3	Acolhua	Texcoco
TX-A-6	Acolhua	Texcoco
TX-A-9	Acolhua	Texcoco
TX-A-10	Acolhua	Chiautla
TX-A-14	Acolhua	Chiautla
TX-A-16	Acolhua	Chiautla
TX-A-17	Acolhua	Chiautla
TX-A-18	Acolhua	Chiautla
TX-A-21	Acolhua	Tepetlaoztoc
TX-A-22	Acolhua	Tepetlaoztoc
TX-A-23	Acolhua	Tepetlaoztoc
TX-A-24	Acolhua	Tepetlaoztoc
TX-A-25	Acolhua	Tepetlaoztoc
TX-A-26	Acolhua	Tepetlaoztoc
TX-A-27	Acolhua	Tepetlaoztoc
TX-A-28	Acolhua	Tepetlaoztoc
TX-A-30	Acolhua	Tepetlaoztoc
TX-A-31	Acolhua	Tepetlaoztoc
TX-A-34	Acolhua	Tepetlaoztoc
TX-A-36	Acolhua	Tepetlaoztoc
TX-A-38	Acolhua	Tepetlaoztoc
TX-A-40	Acolhua	Tepetlaoztoc
TX-A-42	Acolhua	Texcoco
TX-A-43	Acolhua	Texcoco
TX-A-44	Acolhua	Texcoco
TX-A-46	Acolhua	Texcoco
TX-A-47	Acolhua	Texcoco
TX-A-49	Acolhua	Texcoco
TX-A-52	Acolhua	Huexotla
TX-A-53	Acolhua	Huexotla
TX-A-56	Acolhua	Texcoco
TX-A-57	Acolhua	Texcoco
TX-A-58	Acolhua	Texcoco
TX-A-59	Acolhua	Texcoco
TX-A-60	Acolhua	Texcoco
TX-A-61	Acolhua	Texcoco
TX-A-64	Acolhua	Texcoco
TX-A-65	Acolhua	Texcoco
TX-A-66	Acolhua	Texcoco

Table I.3
Political Affiliations of Sites Included in Study[a] (continued)

Site Number	Political Confederation[b]	Polity (City-State) Affiliation[c]
TX-A-69	Acolhua	Texcoco
TX-A-70	Acolhua	Texcoco
TX-A-72	Acolhua	Texcoco
TX-A-75	Acolhua	Texcoco
TX-A-76	Acolhua	Texcoco
TX-A-77	Acolhua	Texcoco
TX-A-78	Acolhua	Texcoco
TX-A-79	Acolhua	Texcoco
TX-A-80	Acolhua	Texcoco
TX-A-81	Acolhua	Texcoco
TX-A-84	Acolhua	Huexotla
TX-A-85	Acolhua	Huexotla
TX-A-86	Acolhua	Huexotla
TX-A-87	Acolhua	Huexotla
TX-A-99	Acolhua	Coatepec
TX-A-100	Acolhua	Coatepec
TX-A-101	Acolhua	Coatepec
TX-A-106	Acolhua	Chimalhuacan
TX-A-107	Acolhua	Chimalhuacan
TX-A-108	Acolhua	Chimalhuacan
TX-A-109	Acolhua	Chimalhuacan
TX-A-110	Acolhua	Coatlinchan
IXTAPALAPA SURVEY REGION		
IX-A-2	Acolhua	Coatepec
IX-A-7	Acolhua	Coatepec
IX-A-9	Acolhua	Coatepec
IX-A-11	Acolhua	Ixtapaluca
IX-A-15	Acolhua	Ixtapaluca
IX-A-26	Acolhua	Ixtapaluca
IX-A-34	Acolhua	Ixtapaluca
IX-A-35	Acolhua	Ixtapaluca
IX-A-37	Culhua	Ixtapalapa
IX-A-38	Culhua	Ixtapalapa
IX-A-41	Culhua	Ixtapalapa
IX-A-42	Culhua	Ixtapalapa
IX-A-43	Culhua	Ixtapalapa
IX-A-44	Culhua	Ixtapalapa
IX-A-47	Cuitlahuaca	Cuitlahuac
IX-A-49	Cuitlahuaca	Cuitlahuac
IX-A-53	Cuitlahuaca	Cuitlahuac
IX-A-57	Cuitlahuaca	Cuitlahuac
IX-A-59	Culhua	Ixtapalapa
IX-A-63	Culhua	Ixtapalapa

Table I.3
Political Affiliations of Sites Included in Study[a] (continued)

Site Number	Political Confederation[b]	Polity (City-State) Affiliation[c]
IX-A-67	Culhua	Ixtapalapa
IX-A-69	Culhua	Ixtapalapa
IX-A-70	Culhua	Mexicaltzingo
IX-A-72	Culhua	Culhuacan
CHALCO SURVEY REGION		
CH-AZ-2	Chalca	Tlalmanalco
CH-AZ-3	Chalca	Tlalmanalco
CH-AZ-4	Chalca	Tlalmanalco
CH-AZ-6	Chalca	Tlalmanalco
CH-AZ-10	Chalca	Tlalmanalco
CH-AZ-11	Chalca	Tlalmanalco
CH-AZ-12	Chalca	Tlalmanalco
CH-AZ-14	Chalca	Tlalmanalco
CH-AZ-15	Chalca	Tlalmanalco
CH-AZ-17	Chalca	Tlalmanalco
CH-AZ-20	Chalca	Tlalmanalco
CH-AZ-21	Chalca	Tlalmanalco
CH-AZ-22	Chalca	Tlalmanalco
CH-AZ-23	Chalca	Tlalmanalco
CH-AZ-25	Chalca	Tlalmanalco
CH-AZ-26	Chalca	Tlalmanalco
CH-AZ-29	Chalca	Tlalmanalco
CH-AZ-30	Chalca	Tlalmanalco
CH-AZ-31	Chalca	Tlalmanalco
CH-AZ-32	Chalca	Tlalmanalco
CH-AZ-35	Chalca	Amecameca
CH-AZ-36	Chalca	Amecameca
CH-AZ-39	Chalca	Amecameca
CH-AZ-40	Chalca	Amecameca
CH-AZ-41	Chalca	Amecameca
CH-AZ-42	Chalca	Amecameca
CH-AZ-44	Chalca	Amecameca
CH-AZ-48	Chalca	Amecameca
CH-AZ-50	Chalca	Amecameca
CH-AZ-51	Chalca	Amecameca
CH-AZ-57	Chalca	Amecameca
CH-AZ-59	Chalca	Amecameca
CH-AZ-63	Chalca	Amecameca
CH-AZ-65	Chalca	Amecameca
CH-AZ-66	Chalca	Tenango
CH-AZ-67	Chalca	Tenango
CH-AZ-70	Chalca	Tenango
CH-AZ-72	Chalca	Tenango

Table I.3
Political Affiliations of Sites Included in Study[a] (continued)

Site Number	Political Confederation[b]	Polity (City-State) Affiliation[c]
CH-AZ-74	Chalca	Tenango
CH-AZ-75	Chalca	Tenango
CH-AZ-76	Chalca	Tenango
CH-AZ-79	Chalca	Tenango
CH-AZ-82	Chalca	Tenango
CH-AZ-86	Chalca	Tenango
CH-AZ-87	Chalca	Tenango
CH-AZ-88	Chalca	Tenango
CH-AZ-90	Chalca	Tenango
CH-AZ-93	Chalca	Tenango
CH-AZ-94	Chalca	Tenango
CH-AZ-96	Chalca	Tenango
CH-AZ-97	Chalca	Tenango
CH-AZ-100	Chalca	Tenango
CH-AZ-102	Chalca	Tenango
CH-AZ-103	Chalca	Tenango
CH-AZ-106	Chalca	Tenango
CH-AZ-107	Chalca	Tenango
CH-AZ-108	Chalca	Tenango
CH-AZ-111	Chalca	Tenango
CH-AZ-112	Chalca	Tenango
CH-AZ-119	Chalca	Tenango
CH-AZ-120	Chalca	Tenango
CH-AZ-126	Chalca	Tenango
CH-AZ-127	Chalca	Tenango
CH-AZ-128	Chalca	Tenango
CH-AZ-130	Chalca	Tenango
CH-AZ-131	Chalca	Tenango
CH-AZ-132	Chalca	Tenango
CH-AZ-136	Chalca	Tenango
CH-AZ-137	Chalca	Tenango
CH-AZ-138	Chalca	Tenango
CH-AZ-139	Chalca	Tenango
CH-AZ-140	Chalca	Tenango
CH-AZ-141	Chalca	Tenango
CH-AZ-144	Chalca	Tenango
CH-AZ-148	Chalca	Tenango
CH-AZ-152	Chalca	Chalco
CH-AZ-154	Chalca	Chalco
CH-AZ-157	Chalca	Chalco
CH-AZ-158	Chalca	Chalco
CH-AZ-160	Chalca	Chalco
CH-AZ-161	Chalca	Tenango
CH-AZ-162	Chalca	Tenango

Table I.3
Political Affiliations of Sites Included in Study[a] (continued)

Site Number	Political Confederation[b]	Polity (City-State) Affiliation[c]
CH-AZ-164	Chalca	Chalco
CH-AZ-166	Chalca	Chalco
CH-AZ-167	Chalca	Chalco
CH-AZ-170	Chalca	Chalco
CH-AZ-172	Chalca	Chalco
CH-AZ-174	Chalca	Chalco
CH-AZ-185	Chalca	Chalco
CH-AZ-186	Chalca	Chalco
CH-AZ-187	Chalca	Chalco
CH-AZ-188	Chalca	Chalco
CH-AZ-190	Chalca	Chalco
CH-AZ-192	Cuitlahuaca	Cuitlahuac
CH-AZ-194	Cuitlahuaca	Cuitlahuac
CH-AZ-195	Cuitlahuaca	Cuitlahuac
CH-AZ-202	Mixquica	Mixquic
CH-AZ-204	Mixquica	Mixquic
CH-AZ-205	Mixquica	Mixquic
CH-AZ-207	Mixquica	Mixquic
CH-AZ-209	Mixquica	Mixquic
CH-AZ-213	Cuitlahuaca	Cuitlahuac
CH-AZ-218	Cuitlahuaca	Cuitlahuac
CH-AZ-229	Cuitlahuaca	Cuitlahuac
CH-AZ-230	Cuitlahuaca	Cuitlahuac
CH-AZ-231	Cuitlahuaca	Cuitlahuac
CH-AZ-233	Cuitlahuaca	Cuitlahuac
CH-AZ-236	Cuitlahuaca	Cuitlahuac
CH-AZ-238	Cuitlahuaca	Cuitlahuac
CH-AZ-241	Cuitlahuaca	Cuitlahuac
CH-AZ-248	Cuitlahuaca	Cuitlahuac
CH-AZ-249	Mixquica	Mixquic
CH-AZ-250	Cuitlahuaca	Cuitlahuac
CH-AZ-252	Cuitlahuaca	Cuitlahuac
CH-AZ-253	Cuitlahuaca	Cuitlahuac
CH-AZ-256	Cuitlahuaca	Cuitlahuac
CH-AZ-257	Cuitlahuaca	Cuitlahuac
CH-AZ-263	Cuitlahuaca	Cuitlahuac
CH-AZ-267	Mixquica	Mixquic
CH-AZ-273	Cuitlahuaca	Cuitlahuac
CH-AZ-275	Cuitlahuaca	Cuitlahuac
CH-AZ-278	Cuitlahuaca	Cuitlahuac
CH-AZ-282	Xochimilca	Xochimilco
XOCHIMILCO SURVEY REGION		
XO-AZ-1	Cuitlahuaca	Cuitlahuac

Table I.3
Political Affiliations of Sites Included in Study[a] (continued)

Site Number	Political Confederation[b]	Polity (City-State) Affiliation[c]
XO-AZ-5	Cuitlahuaca	Cuitlahuac
XO-AZ-8	Cuitlahuaca	Cuitlahuac
XO-AZ-11	Cuitlahuaca	Cuitlahuac
XO-AZ-14	Xochimilca	Xochimilco
XO-AZ-22	Xochimilca	Xochimilco
XO-AZ-28	Xochimilca	Xochimilco
XO-AZ-29	Xochimilca	Xochimilco
XO-AZ-32	Xochimilca	Xochimilco
XO-AZ-33	Xochimilca	Xochimilco
XO-AZ-34	Xochimilca	Xochimilco
XO-AZ-35	Xochimilca	Xochimilco
XO-AZ-37	Xochimilca	Xochimilco
XO-AZ-46	Xochimilca	Xochimilco
XO-AZ-51	Xochimilca	Xochimilco
XO-AZ-54	Xochimilca	Xochimilco
XO-AZ-58	Culhua	Ixtapalapa
XO-AZ-62	Culhua	Ixtapalapa
XO-AZ-66	Culhua	Ixtapalapa
XO-AZ-67	Culhua	Ixtapalapa
XO-AZ-68	Culhua	Ixtapalapa
XO-AZ-69	Culhua	Ixtapalapa
XO-AZ-70	Culhua	Ixtapalapa
XO-AZ-71	Culhua	Ixtapalapa
XO-AZ-75	Xochimilca	Xochimilco
XO-AZ-77	Xochimilca	Xochimilco
XO-AZ-78	Xochimilca	Xochimilco
XO-AZ-79	Xochimilca	Xochimilco
XO-AZ-80	Xochimilca	Xochimilco
XO-AZ-86	Xochimilca	Xochimilco
XO-AZ-87	Xochimilca	Xochimilco
XO-AZ-90	Xochimilca	Xochimilco
XO-AZ-91	Xochimilca	Xochimilco

[a]Political territories have been reconstructed based on the spatial distribution of sites with known political affiliations at the time of Spanish Conquest. See Hodge and Minc (1990) for details of this historical analysis and for the list of sources utilized.

[b]Applies to both the Early Aztec and Late Aztec periods.

[c]Applicable for the Late Aztec period only.

APPENDIX II

AZTEC I BLACK/ORANGE TYPE DESCRIPTIONS

The Aztec Black/Orange I ceramic complex was first defined in detail by Griffin and Espejo (1947, 1950), who named the characteristic material of this phase Culhuacan Black/Orange after the type site of Culhuacan. Griffin and Espejo (1950:15) described this type as characterized by:

> "poor firing; reddish-orange color, extraordinary thickness, and multiplicity in the form of supports; extended plates with cylindrical supports; heavy, crude lines in the painted decoration; representation of cross-sections of flowers and stems (in the painted decoration); motifs similar to the day hieroglyphics used later, and of the symbol of Quetzalcoatl; pictorial representation of natural forms; great ability in the arrangement of dissimilar motifs in asymmetrical zones, within a balanced composition; and contrast between the complexity of the design and the lack of skill in the manufacture of the vessels" (translated in Parsons 1966:76).

Although Griffin and Espejo noted that Culhuacan-phase material seemed to be largely confined to the area immediately around the site of Culhuacan, the term "Culhuacan Black/Orange" has been broadly applied to all Early Aztec Black/Orange ceramics that have relatively wide-line painted decoration. This broad usage resulted in part from the relatively few published illustrations accompanying this type's definition (Griffin and Espejo 1950). It was not until Séjourné's (1970) publication of the Culhuacan material and her later (1983) well-illustrated presentation of Early Aztec ceramics from a number of sites in the southern Valley area (including Chalco, Mixquic, Xico, Cuitlahuac, and Tlalmanalco) that the broad range of variability in these ceramics became apparent. The development of the following subdivision of Aztec I Black/Orange ceramics owes much to Séjourné's extensive coverage and illustration of this material.

During the re-analysis of the regional survey collections, considerable variability was encountered within the sphere of Aztec I Black/Orange ceramics. It rapidly became apparent that the southern Valley includes a number of distinct Early Aztec Black/Orange types that are quite different from "classic" Culhuacan as first defined from that type site (cf. Brenner 1931; Griffin and Espejo 1950; Peterson 1957). Two new Black/Orange types have been defined, which are provisionally named Chalco Black/Orange and Mixquic Black/Orange, after two major sites in the southern lake basin where they are found in abundance. The term Culhuacan Black/Orange has been reserved for the material originally defined at that type site.

Chalco, Mixquic, and Culhuacan Black/Orange represent distinctive stylistic traditions with distinct geographic distributions within the southern Valley. Chalco Black/Orange occurs from the site of Chalco on the lakeshore up through the Tenango and Amecameca subvalleys; occasional finds of this type come from the Texcoco region as well. Mixquic Black/Orange has a distribution narrowly restricted to sites of the Chalco lake basin. Culhuacan Black/Orange is concentrated around the type site of that name at the western end of the Ixtapalapa peninsula. Trace-element analyses

(Minc et al. 1989, 1994; see also Appendix V) have confirmed that these visually distinct types have different clay sources as well.

It should be stressed at the onset, however, that these three types do not encompass all the variability in Aztec I Black/Orange ceramics within the southern Valley. There is a substantial minority of ceramics that do not fit into these categories. Some of these may well represent extremely localized production systems. For example, at the sites of CH-AZ-263 and CH-AZ-249, two small village sites in western Lake Chalco, ceramic vessels display a limited subset of Culhuacan Black/Orange stylistic elements, and may represent local copies of Culhuacan-made vessels. On-going analyses at the attribute level will help clarify some of these distinctions.

Because the Chalco, Mixquic, and Culhuacan types seldom co-occur in sites, their relative chronological relationships remain somewhat uncertain. At Chalco, O'Neill's (1962) encountered Mixquic Black/Orange stratigraphically below (but mixed with) our Chalco Black/Orange. At nearby CH-AZ-195, J. Parsons' (Parsons, Brumfiel, Parsons, Popper, and Taft 1982) excavations encountered Mixquic Black/Orange in a sequence that produced very early radiocarbon dates. Both of these contexts suggest that the Mixquic type may be earlier. However, to the south of the Chalco-Mixquic region, excavations of an Early Aztec structure at Tetla, Morelos (Norr 1987a, 1987b) yielded both apparent Chalco Black/Orange ceramics and types very similar to Mixquic Black/Orange. This single component Early Aztec occupation argues for some degree of temporal overlap in the Chalco and Mixquic types. Further, radiocarbon dates from the Tetla house (Norr 1987a:406-407) place both types firmly within the Early Aztec period for the Basin of Mexico.

The relative placement of Culhuacan Black/Orange is equally difficult to determine, again owing to the discrete distribution of this type. No sherds of either the Chalco or Mixquic type have been illustrated from excavations at the type site of Culhuacan (Séjourné 1970), nor were these other types encountered in extensive surface collections from Culhuacan (the UMMA Griffin Collection). All three types, however, display similar attributes of paste, wide-line designs, and some shared motifs, and accordingly are interpreted as representing broadly contemporaneous but discrete stylistic traditions.

It is hoped that the identification of these distinctive styles of Aztec I Black/Orange will pave the way to a better understanding of their chronological and spatial relationships. Descriptions and illustrations of these types and their vessel forms follow.

WARE: **Orange**

TYPE: **Chalco Black/Orange**

VESSEL FORMS: **Chunky Grater Bowls, Hemispherical Bowls, Shouldered or Upright-Rim Bowls**

I. Chalco Chunky Grater Bowls

Vessel form: Fairly hefty round-sided vessels with very thick walls, stamped bases, and solid cylindrical or tapered supports. Rim diameters measure from 18 to 30 cm. Vessels range from shallow to fairly deep; vessel walls are outcurving in profile with simple, rounded lips. Almost all vessels show extreme wear from grinding or abrasion on the interior, indicating that their stamped bases functioned as molcajetes. Painted decoration has been abraded off most of the interior wall except right below the lip and in many cases the abrasion has actually ground into the vessel wall, modifying the profile (Fig. II.1, f-g). A number of vessels show evidence of a spout (Fig. II.1, n-q).

Paste and firing: Paste is a dull orange to brownish-orange in color with medium- to coarse-textured temper and many large voids. Sherds are incompletely oxidized and have a buff or gray core. Fire clouding is common.

Surface treatment: Surfaces are moderately well smoothed on the exterior but show obvious burnishing facets. Interior surfaces are extremely worn, but appear to have been generally well smoothed.

Decoration: Decoration is interior and is executed in black or maroon paint. The painted design consists of a painted rim band above a panel of decoration delimited by one to several horizontal lines. Commonly, the upper-most line of the panel is loopy or wavy. The panel itself forms a continuous band containing the characteristic Chalco "undulating comb" motif in one of its several forms. In the most commonly occurring form, one to three diagonal lines (straight or wavy) zig-zag around the vessel wall dividing the panel into triangular areas (Figs. II.1-II.2). The triangular areas are filled with vertical lines (straight or wavy) that extend from the panel borders to approach or interset the diagonal line(s). Rarely, the triangular areas are filled with stacks of short horizontal lines. Alternatively, a single undulating line runs continuously around the vessel wall and forms squared loops. Groups of vertical lines (straight or wavy) extend from the panel borders to fill in U-shapes created by the undulating line (cf. Fig. II.5, a). A third form of panel decoration, one more commonly found on bowls than on Chalco Chunky, consists of groups of vertical straight lines alternating with a unit bounded on either side by a diagonal wavy line and containing two to several straight diagonal lines (cf. Fig. II.4). For an excellent presentation of typical Chalco designs, see Séjourné (1983, Figs. 79-81). Chalco designs are also illustrated for the site of Tetla, Morelos (Norr 1987b, Fig. I.3, b", n', and p").

Panel decoration is usually poorly preserved due to abrasion. All vessels presumably had stamped designs on their bases, but little can be said about its organization, other than that concentric circles encircle and outline the base.

II. Bowls

Vessel form: Hemispherical or outcurving bowls with fairly thick walls, direct rims and simple, rounded lips (Figs. II.3, II.4, and II.5, a). Bases are flat or have a pronounced dimple (Figs. II.4 and II.5, a).

Paste and firing: Paste is a dull orange in color, with medium temper and many small voids. Sherds are generally oxidized throughout but may have a gray medial core. Chalco bowls frequently show fire clouding on basal portions.

Surface treatment: Sherds are well smoothed on the interior and somewhat less so on the exterior. Burnishing facets are obvious on the exterior.

Decoration: Decoration is interior and consists of a horizontal panel placed several cm below a black rim band and topped with a loopy or wavy line. The panel is delimited by two to three horizontal straight lines and contains the characteristic continuous Chalco comb motif formed by an undulating line which alternates with sets of short vertical lines (Figs. II.3 and II.5, a). An alternative and less frequent motif consists of groups of vertical lines interset with diagonal wavy and straight lines (Fig. II.4).

III. Shouldered and Upright-Rim Bowls

Vessel form: Small shouldered or upright rim bowls with a well-defined shoulder angle in the vessel profile. The upper portion (3-5 cm in height) is vertical to slightly insloping and may be slightly thickened. The lower portion of the vessel is rounded to hemispherical in profile. The lip form is simple/direct to slightly everted. Basal form is largely unknown, but is probably flat with rounded basal angles. There is no indication of supports.

Paste and firing: As above.

Surface treatment: As above.

Decoration: Decoration is exterior and consists of a continuous panel set below a black rim band (Fig. II.6). Frequently the upper-most line of the panel is wavy or loopy. Panel motifs include the undulating Chalco comb (Fig. II.6, a and b), or more frequently, sets of vertical straight lines alternating with a unit bounded on either side by a diagonal wavy line and containing two to several straight diagonal lines (Fig. II.6, d-g). Elements resembling the Culhuacan serpent jaw motif (Brenner 1931; Peterson 1957) also occur (Fig. II.6, f-g).

IV. Miniature Vessels

Miniature vessels bearing the characteristic Chalco motifs occur in two shape classes: miniature Chalco Chunky (Figs. II.5, b, and II.7, a-c) and miniature dishes with outsloping walls and flat bases (Fig. II.7, d-f). Both forms have stamped bases but do not show the extreme wear associated with full-size vessels.

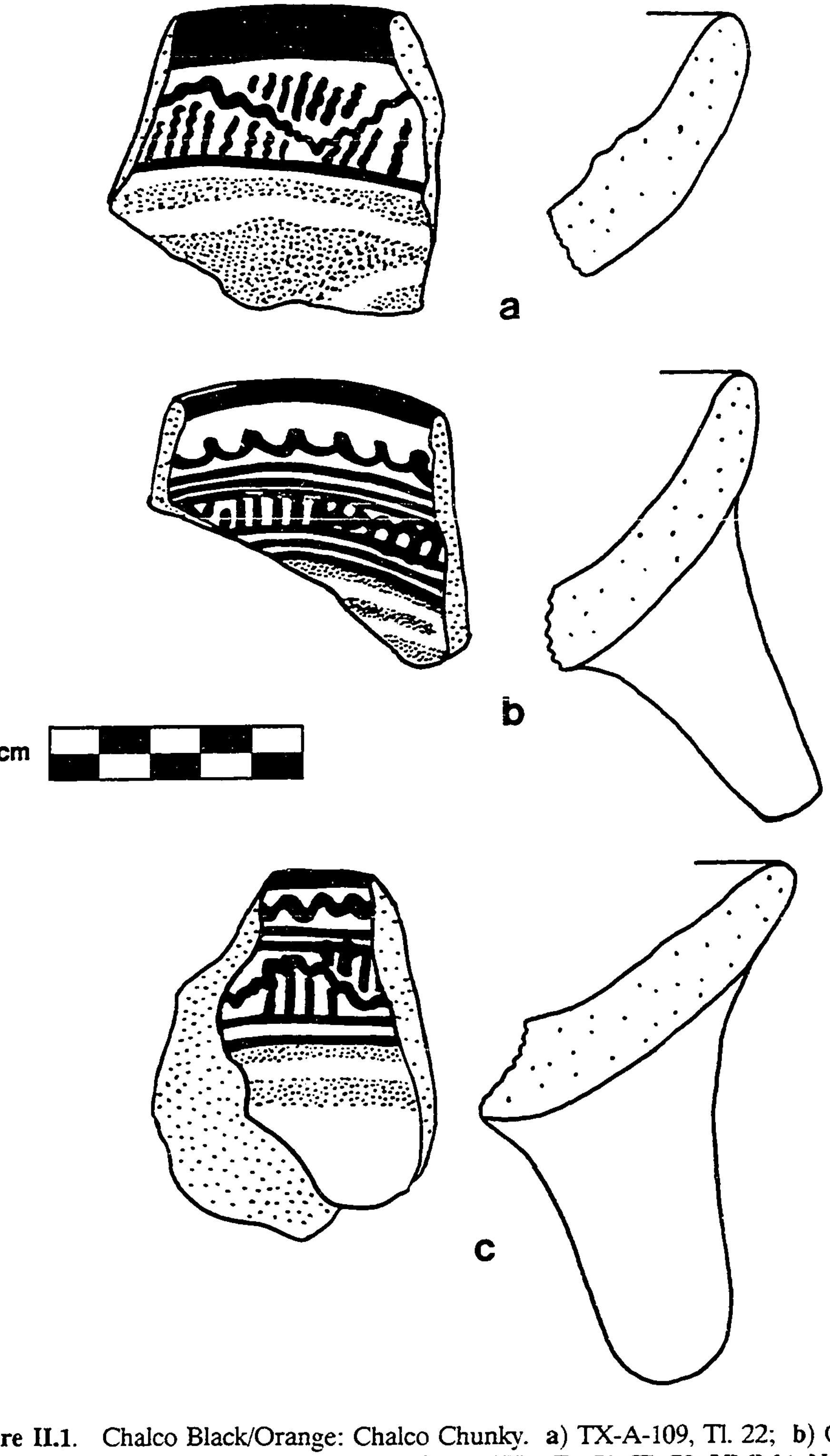


Figure II.1. Chalco Black/Orange: Chalco Chunky. **a)** TX-A-109, Tl. 22; **b)** Chalco, UMMA No. 30646 [NAA 14]; **c)** CH-AZ-172, Tl. 79, UMMA No. 82099 [NAA 13].

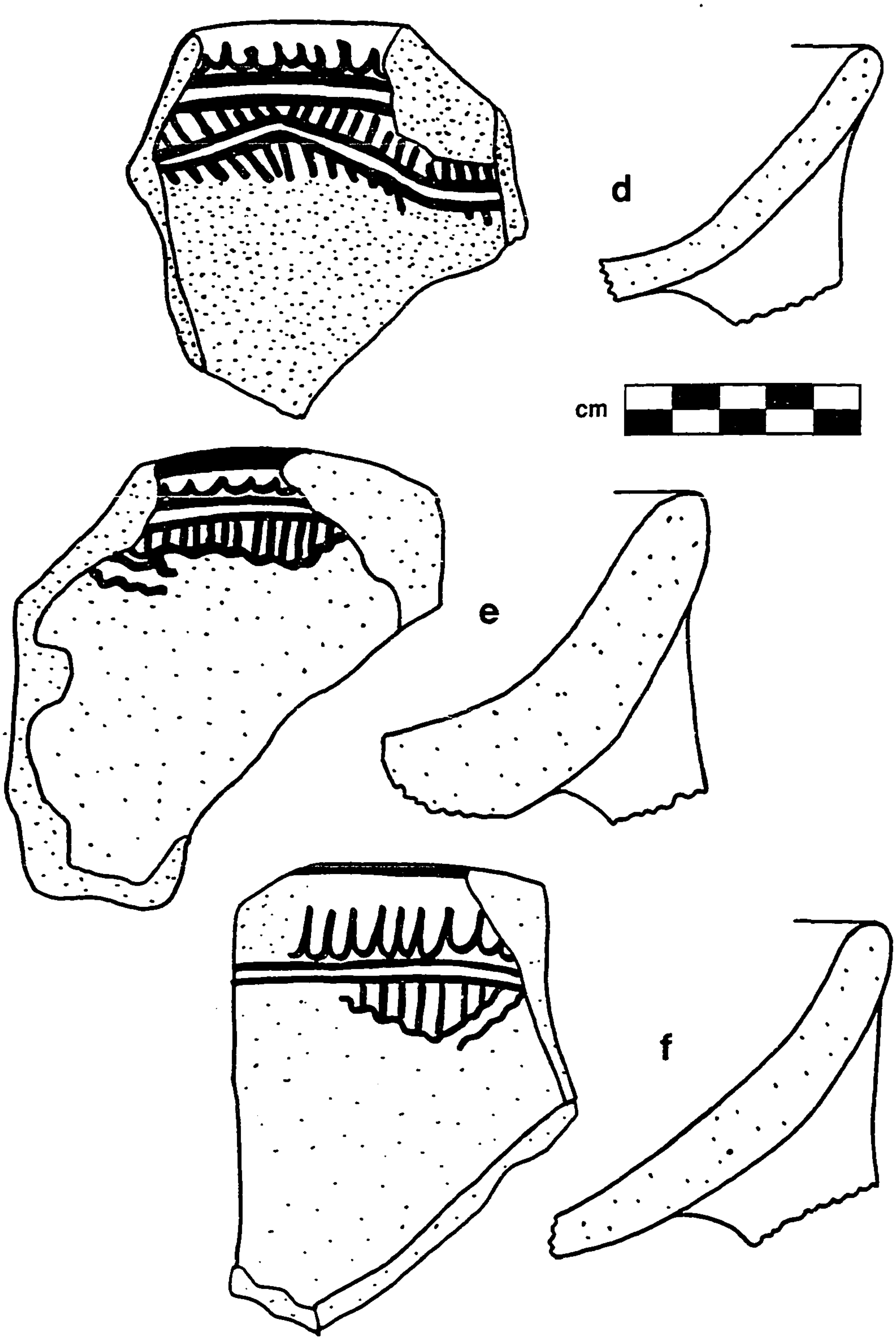


Figure II.1 (continued). Chalco Black/Orange: Chalco Chunky. **d)** TX-A-79, Loc. M; **e)** CH-AZ-30, Loc. 23; **f)** CH-AZ-111, Loc. 79.

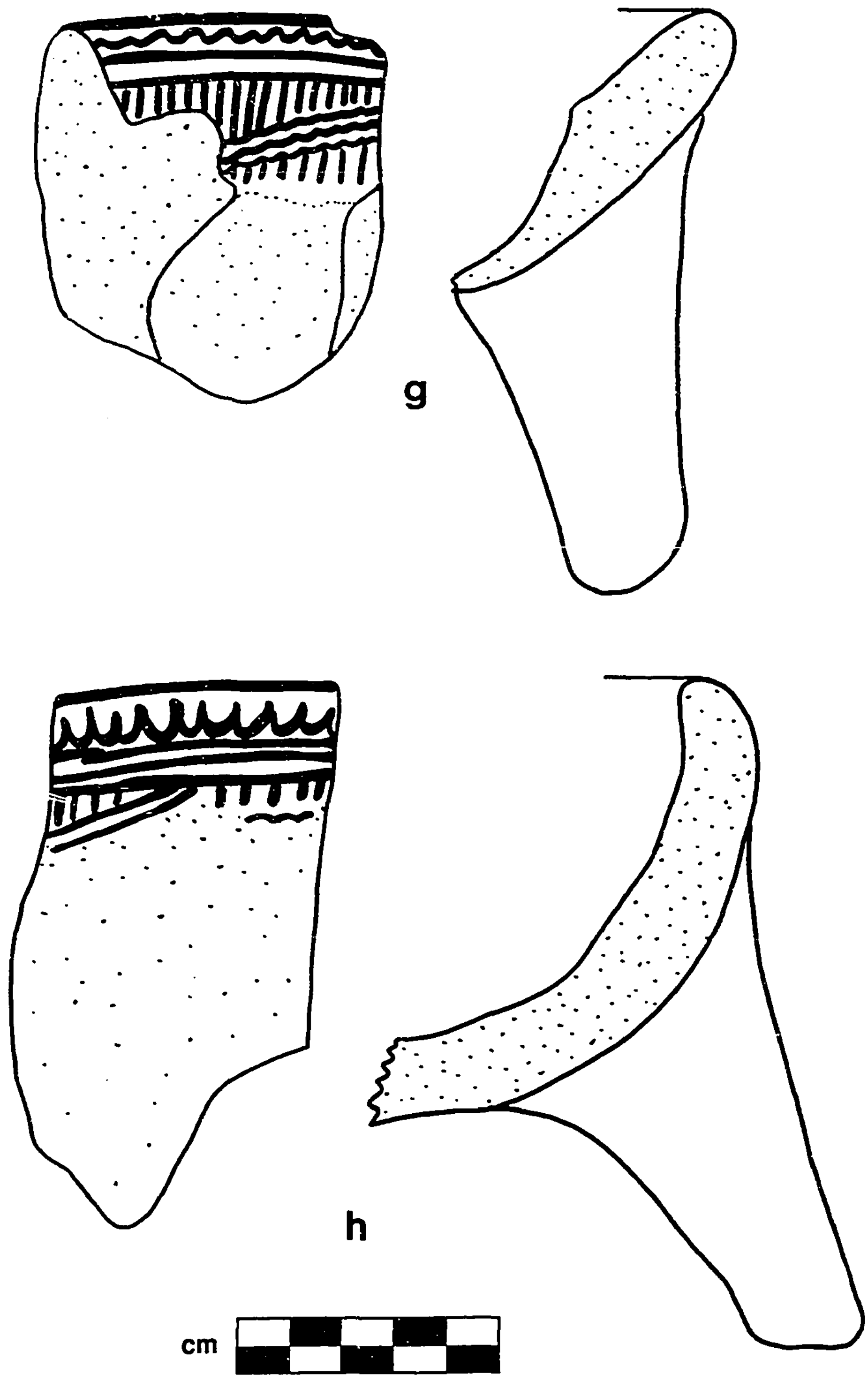


Figure II.1 (continued). Chalco Black/Orange: Chalco Chunky. **g**) CH-AZ-93, Loc. 6; **h**) Chalco survey region, provenience unknown.

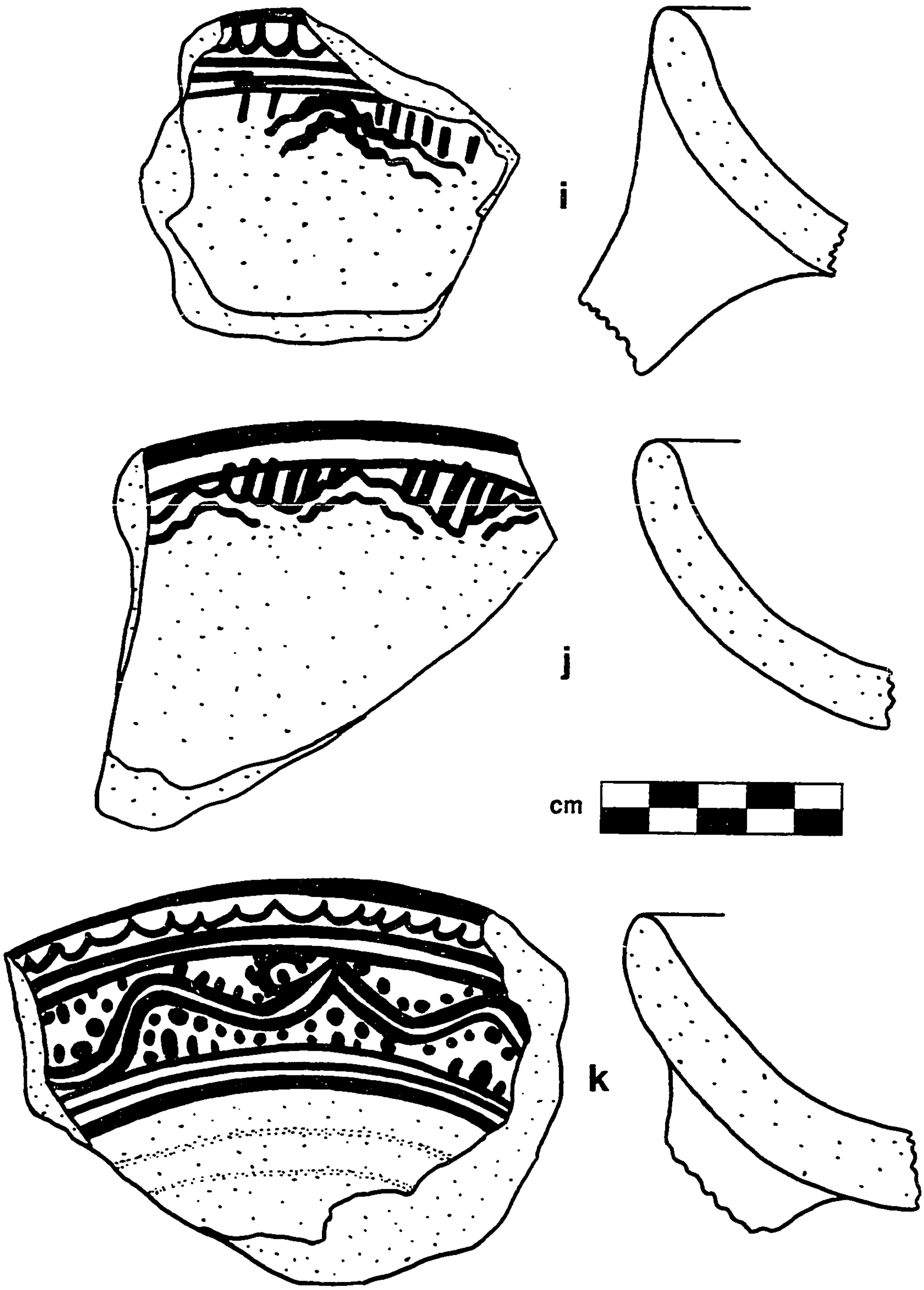


Figure II.1 (continued). Chalco Black/Orange: Chalco Chunky. **i**) Chalco survey region, provenience unknown; **j**) CH-AZ-30, Loc. 23; **k**) CH-AZ-100, Loc. 18.

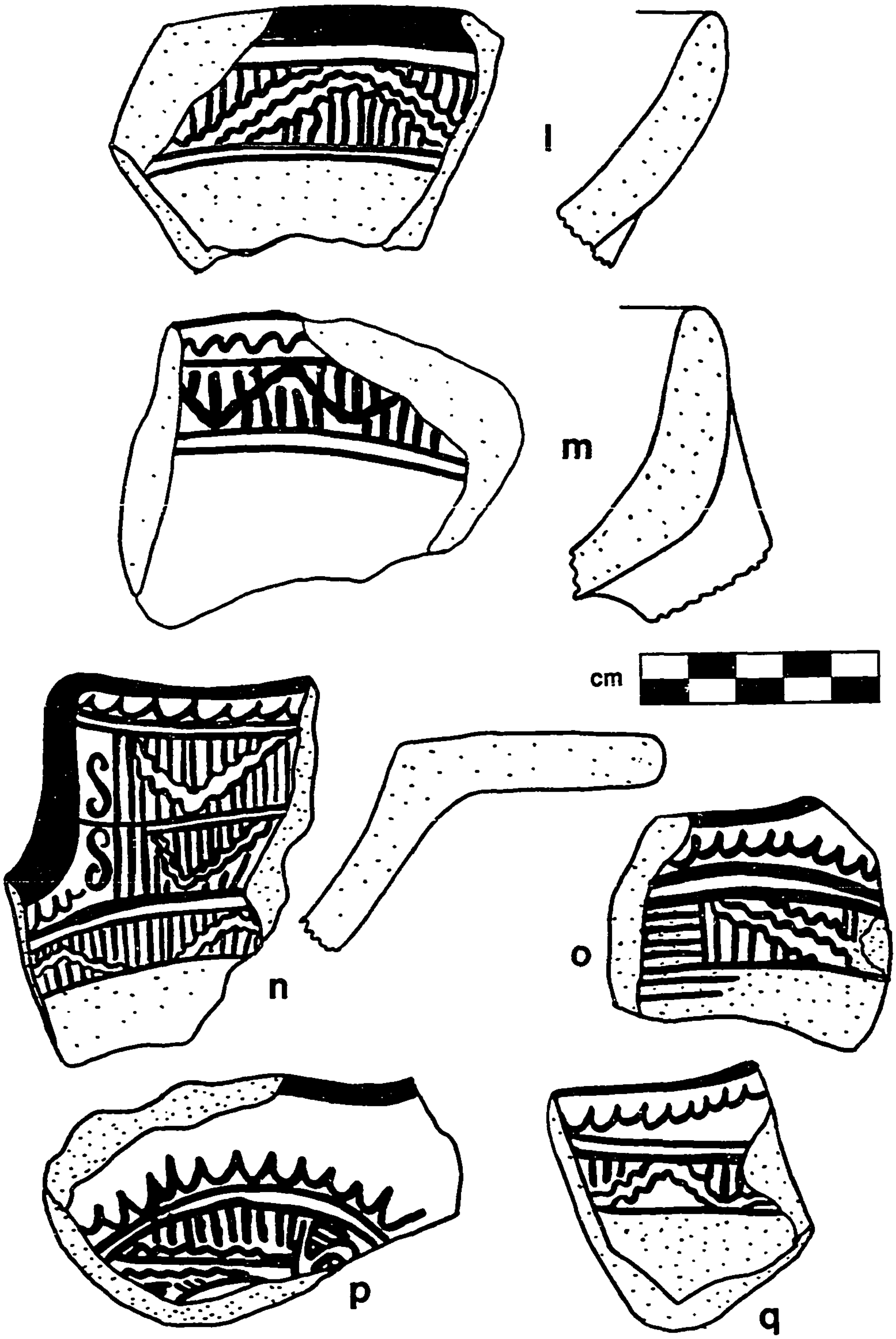


Figure II.1 (continued). Chalco Black/Orange: Chalco Chunky. **l**) CH-AZ-57, Loc. 70; **m**) CH-AZ-164, Loc. 100; **n**) CH-AZ-72, Loc. 49; **o**) CH-AZ-136, Loc. 13; **p**) CH-AZ-166, Loc. 94; **q**) CH-AZ-107, Loc. 24.

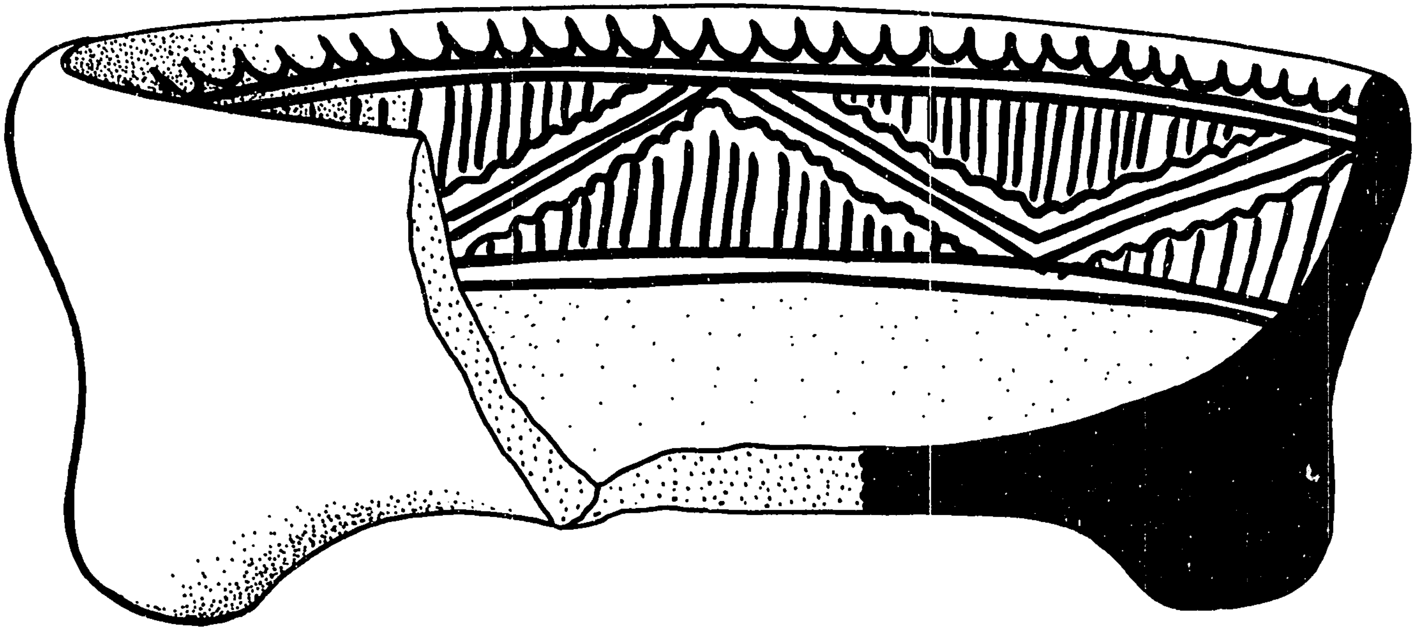


Figure II.2. Chalco Black/Orange grater bowl from the site of Chalco. (Redrawn from Séjourné 1983, Fig. 79).

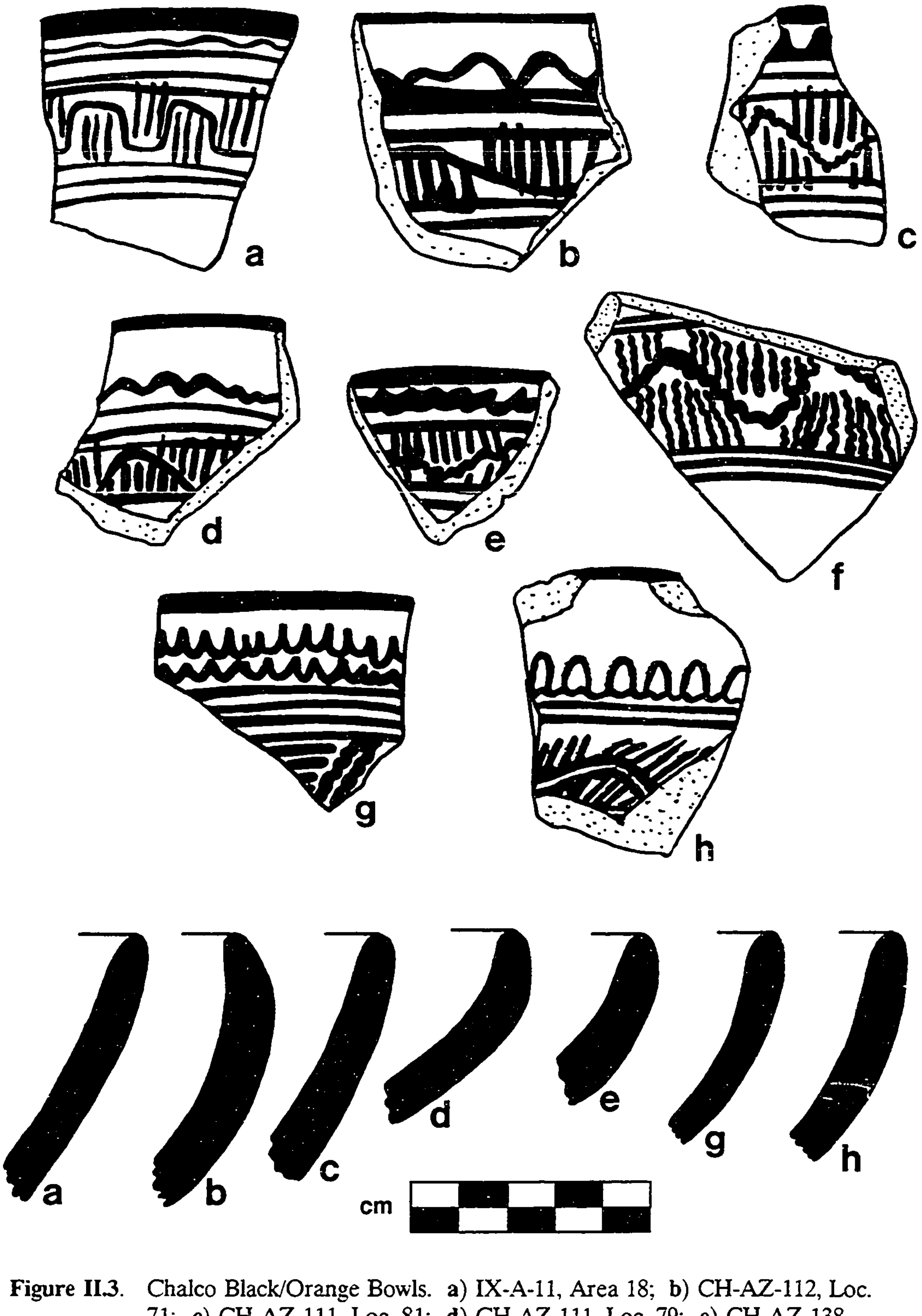


Figure II.3. Chalco Black/Orange Bowls. **a**) IX-A-11, Area 18; **b**) CH-AZ-112, Loc. 71; **c**) CH-AZ-111, Loc. 81; **d**) CH-AZ-111, Loc. 79; **e**) CH-AZ-138, Loc. 14; **f**) CH-AZ-102, Loc. 22; **g**) CH-AZ-166, Loc. 94; **h**) CH-AZ-111, Loc. 80.

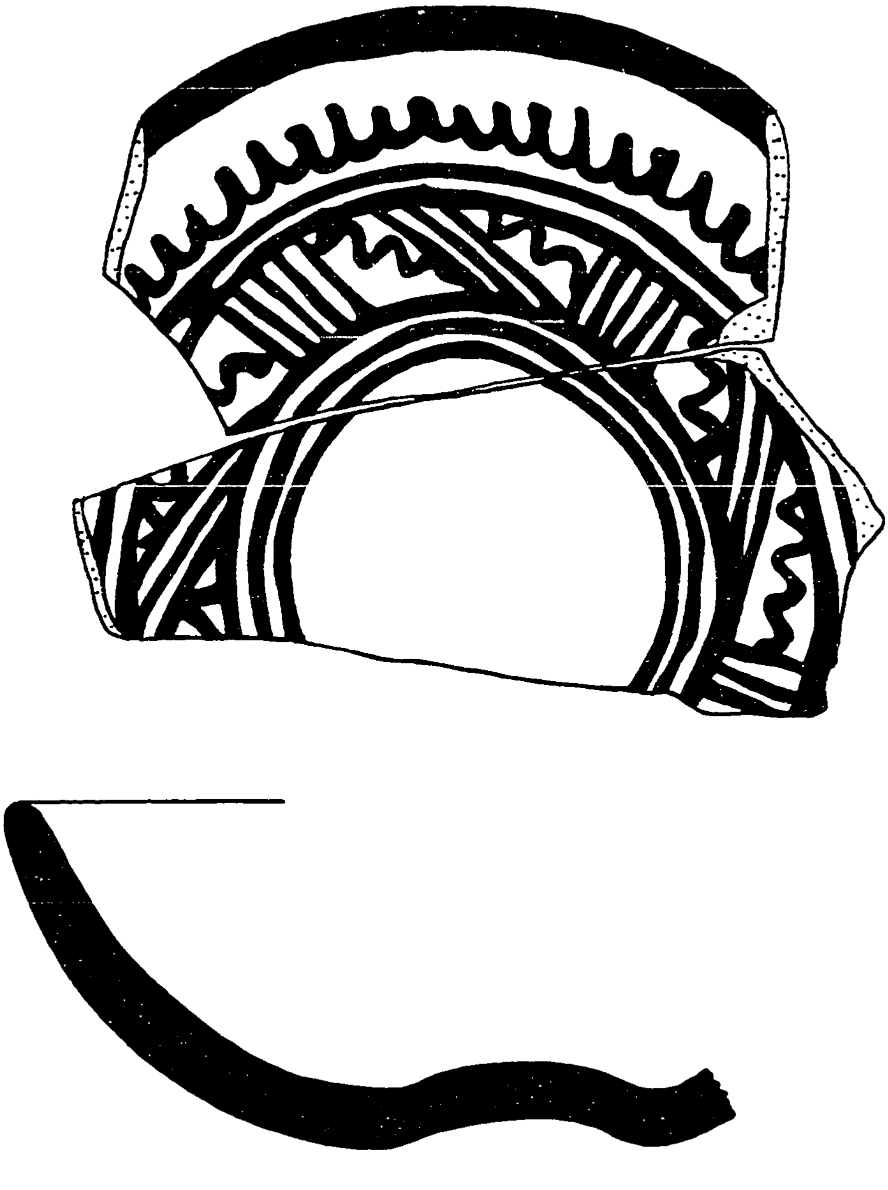
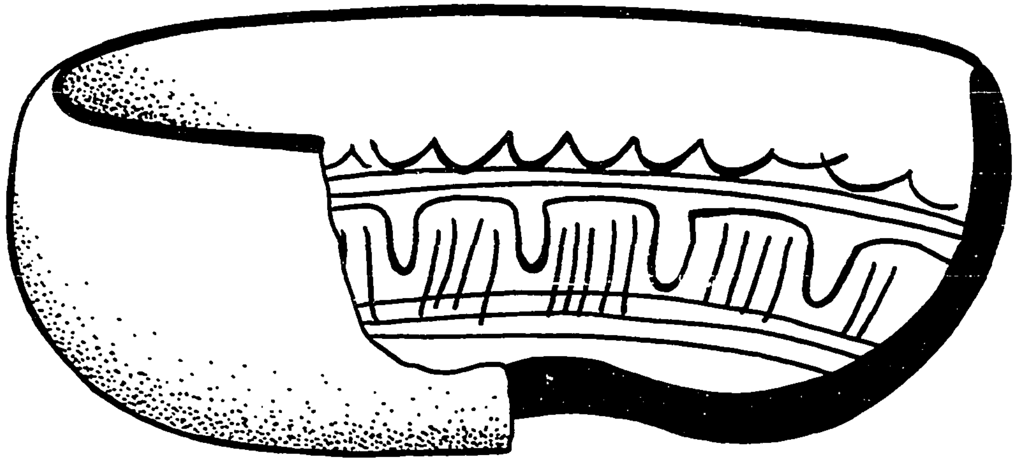
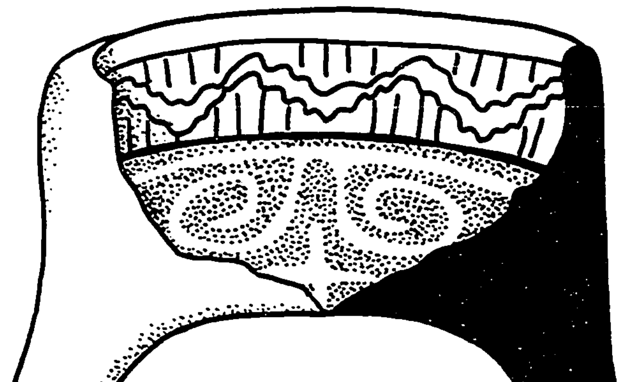


Figure II.4. Chalco Black/Orange Bowl. (Chalco [O'Neill Collection, A.M.N.H. 30.3/1623, Level 17]).



a



b

Figure II.5. Chalco Black/Orange Bowl (a) and Miniature *Molcajete* (b) (not to scale). **a**) Chalco (redrawn from Séjourné 1983, Fig. 79); **b**) Chalco (redrawn from Séjourné 1983, Fig. 82).

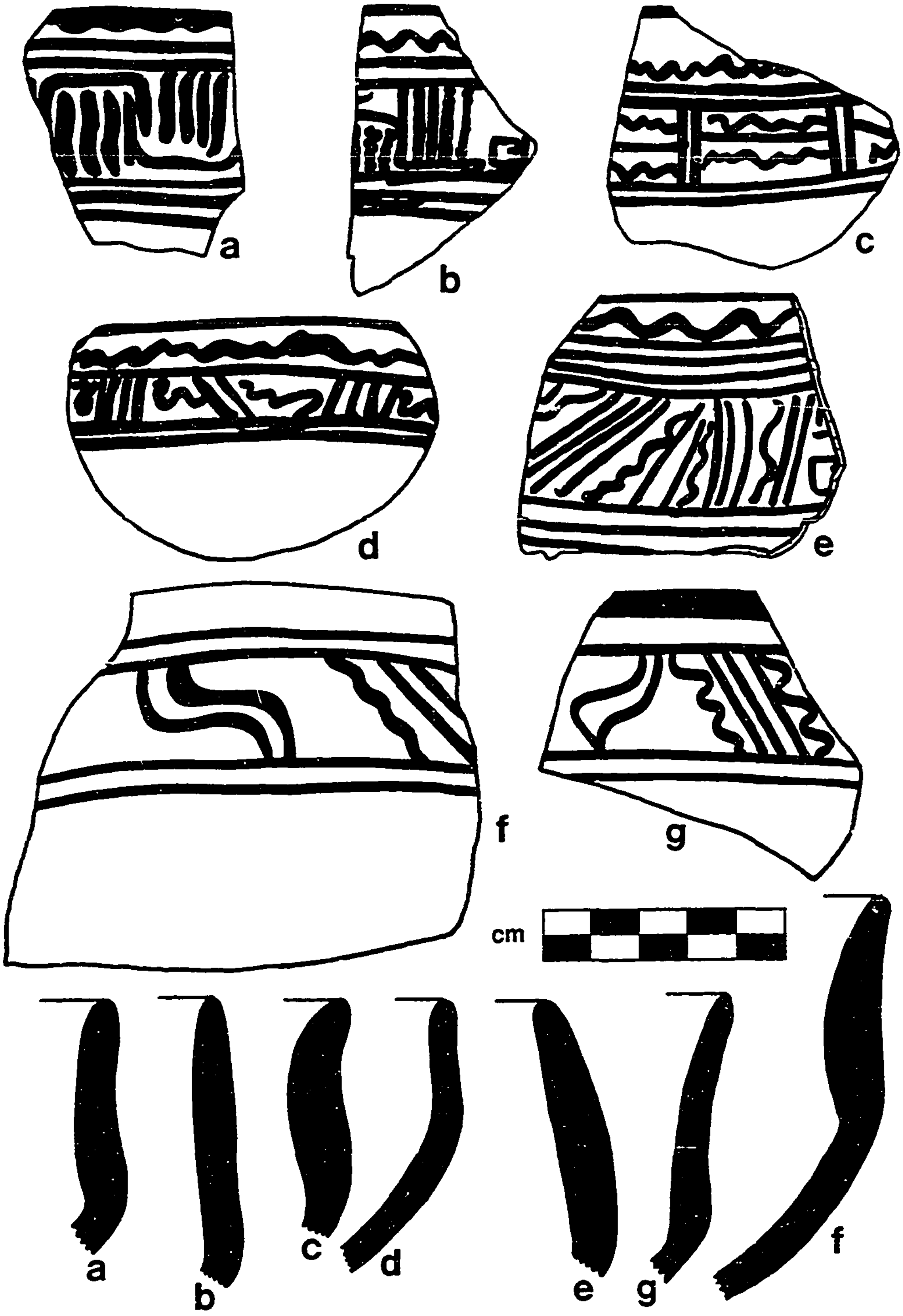


Figure II.6. Chalco Black/Orange: Upright-Rim Bowls with Exterior Decoration. **a**) Chalco, UMMA No. 30645 [NAA 361]; **b**) CH-AZ-88, Loc. 63; **c**) CH-AZ-111, Loc. 81; **d**) CH-AZ-172, Loc. Q; **e**) CH-AZ-111, Loc. 28; **f**) Chalco (O'Neill Collection, A.M.N.H. 30.3/1619, Level 22); g) Chalco (O'Neill Collection, A.M.N.H. 30.3/1623, Level 17.

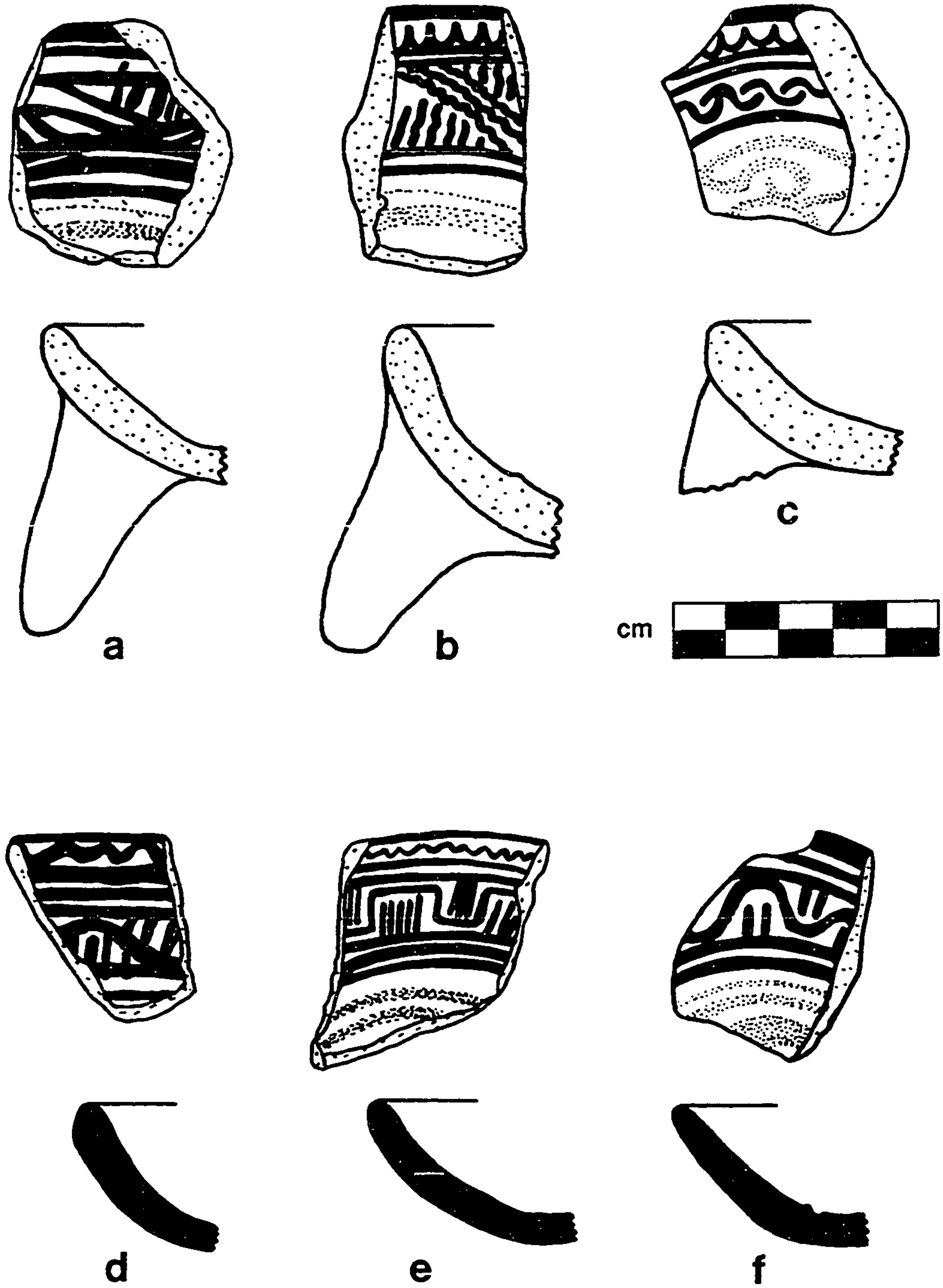


Figure II.7. Chalco Black/Orange Miniature Vessels: Miniature Chalco Chunky (a-c) and Miniature Bowls/Dishes (d-f). **a**) CH-AZ-186, Loc. 45; **b**) CH-AZ-166, Loc. 94; **c**) CH-AZ-190, Loc. 3; **d**) CH-AZ-138, Loc. 14; **e**) CH-AZ-139, Loc. 8; **f**) CH-AZ-139, Loc. 8.

WARE: Orange Ware

TYPE: **Mixquic Black-on-Orange (Mixquic Black/Orange)**

VESSEL SHAPE CLASSES: **Dishes, Shouldered/Upright-Rim Bowls**

The Mixquic Black/Orange type is distinctive in that vessels have glossy surfaces and are hard and well fired. Sherd breaks are angular and the sherds make a distinct chinking sound when struck against one another. In contrast, other southern Early Aztec Black/Orange types have smooth or well-polished surfaces, but lack the surface gloss associated with Mixquic. Sherds of Chalco Black/Orange and Culhuacan Black/Orange have crumbly or rounded edges and appear to have been fired at lower temperatures (Griffin and Espejo 1950:3; O'Neill 1962).

The glossy surfaces of the Mixquic types appear to result from the application of a well-burnished, thin self-slip or wash, which occasionally shows some crazing. Other Early Aztec Black/Orange types are smoothed or polished, but show no surface crazing. An examination of thin sections from Mixquic sherds was unable to confirm the presence of a slip, or to find obvious cross-sectional differences between the glossy Mixquic sherds and later Black/Orange types without glossy surfaces (Alison Rautman, personal communication). However, the brittle surface edges of the Mixquic sherds did not survive the thin-sectioning process well and thus the presence of a very thin slip would be difficult to see (Alison Rautman, personal communication).

Mixquic Black/Orange occurs in three major shape classes: (1) **Mixquic Bolstered**, shallow dishes with an exterior triangular rim bolster and cylindrical tripod supports; (2) **Mixquic Grooved**, outcurving dishes with an exterior groove below the lip; and (3) **Mixquic Shouldered**, deep shouldered bowls typically with an exterior groove below the lip as well. A fourth category, consisting of shallow, open dishes or -molcajetes with stamped bases and tripod supports, may also belong to this complex.

The Mixquic Black/Orange type apparently occurs in abundance at the site of Mixquic, as illustrated by Séjourné (1983, Figs. 69-71, 75). Thus, the type has been named after this site. Its distribution is narrowly restricted to the Lake Chalco lake basin and adjacent lakeshore sites.

The Mixquic type has not been previously identified as a distinct entity in the literature. O'Neill (1962) illustrates examples of this type from his excavations at Chalco and includes it in his "Early Culhuacan" complex. Similarly, this type is illustrated by Séjourné (1983, Figs. 69, 70, 71) from the site of Mixquic. Parsons' excavations at the site of CH-AZ-195 (Parsons, Brumfiel, Parsons, Popper, and Taft 1982) produced Mixquic Black/Orange in conjunction with an excellent sequence of Early Aztec undecorated ceramics that will be described more fully at a later date.

Outside of the Valley of Mexico, Norr (1987b) illustrates Early Aztec material from Tetla, Morelos exhibiting motifs remarkably similar to those found on Mixquic Black/Orange. Although strong similarities in vessel form are also evident at that site, the vessel forms appear to be distinct in the two areas (cf. Mixquic Shouldered with Norr's [1987b, Fig. I.1] recurved rim bowls, and Mixquic Bolstered dishes with the flaring wall bowls [1987b, Fig. I.2]). Similarities to Mixquic Black/Orange in vessel form and motifs are also apparent in material excavated at Cholula, with strong resemblances to Mixquic Bolstered (Noguera 1954:107) and key supports (Noguera 1954:117, 145) being the most noteworthy.

I. Mixquic Bolstered-Rim Dishes

Vessel form: Shallow open dishes with gently outcurving to outsloping walls and a distinct triangular bolster applied to the exterior of the lip. The bolster is elongated in some cases so that the lip appears either hooked or flanged. This distinctive lip form is the diagnostic feature of this shape class. Rim diameters range from 14 to 30 cm, with most measuring between 24 and 28 cm. Bases are relatively flat with tripod supports; the interior basal angle break is well defined while the exterior basal angle is more gradually curved. Although many sherds showed attachment scars from hollow supports, whole supports were rare in our sample. Séjourné (1983, Fig. 69) illustrates one complete vessel of this type with cylindrical tripod supports. Effigy and key supports (see below) also occur commonly in association with this type.

Paste and firing: This type is characteristically hard and well fired. The sherds tend to have angular breaks and make a distinctive chinking sound when clinked together. Paste is of medium texture and platey in composition with many small voids. Temper consists of fine to medium-fine black inclusions. Gray firing cores are generally present.

Surface treatment: Interior surfaces have a very smooth and glossy finish; exterior surfaces are less well smoothed and somewhat irregular, especially on the base. Paste color is variable, with surface color generally in the range of a clear, bright orange (5YR5/6) to a darker orange (5YR5/8) with black linear painted decoration. Many sherds appear overfired, however, with a yellowish-brown surface color and gray-white linear decoration.

Decoration: Decoration is interior and consists of black painted designs. The interior design space consists of (a) a black rim band above (b) one or more horizontal lines delineating (c) a decorative panel on the interior vessel wall, terminated by (d) one or more horizontal lines. In contrast to the continuous designs of Chalco Black/Orange, the panel design contains discrete elements. The decorative band is subdivided by sets of two to many vertical or diagonal lines, which may be straight or obviously wavy. Motifs interset between these sets of lines include concentric chevrons or loops pendant from the top of the panel (Fig. II.8), or the squared scroll or *xicalcoliuhqui* (Fig. II.9). Variations in panel decoration include curvilinear motifs (Fig. II.10). Several examples bear painted decoration on the interior base (Fig. II.9, d); in general, however, sherd size is too small to adequately characterize basal decoration beyond saying that it appears curvilinear. One sherd additionally exhibited incised exterior decoration (Fig. II.9, a).

II. Mixquic Grooved-Rim Dishes

Vessel form: Shallow dishes or bowls with outcurving to nearly outsloping walls, direct rims, and simple rounded lips. The vessel exterior bears a characteristic horizontal groove at the rim 0.5-1.0 cm below the lip. The groove can be quite sloppy and the vessel wall is generally thicker below the groove. Vessel bases are flat to gently rounded; one vessel had a stamped base. Several vessels show attachment scars from hollow supports at the wall/base juncture (Fig. II.11, e and k). Rim diameters range from 18 to 28 cm.

Paste and firing: As above.

Surface treatment: As above.

Decoration: Decoration is interior and consists of a panel of black painted decoration running around the vessel wall below a black rim band (Fig. II.11). Panel motifs include sets of vertical or diagonal lines, which may be straight or wavy, horizontal lines, concentric pendant chevrons, and squared scrolls.

III. Mixquic Shouldered or Upright-Rim Bowls

Vessel form: Deep upright-rim or shouldered bowls, with a distinct angle in the vessel wall. The upper portion (4-5 cm in height) above the angle is vertical to slightly in-sloping; the lower portion is rounded to hemispherical in profile. The lip form is simple/direct to slightly everted, frequently with a slight groove encircling the exterior wall just below the lip. Basal form is largely unknown, but is most likely flat with rounded basal angles. There is no indication of supports. Rim diameters fall in the range of 14-24 cm.

Paste and firing: As above.

Surface treatment: As above.

Decoration: Decoration is exterior and consists of linear black painted designs, forming a panel of decoration restricted to the vertical portion of the rim, above the shoulder angle (Fig. II.12). The panel consists of a black rim band on the lip above two parallel lines containing an inner band of designs. Most typically, the inner band is divided up by sets of vertical or diagonal lines which are frequently wavy. Motifs placed between the sets of lines include concentric loops and chevrons, and the squared scroll or *xicalcoliuhqui*. Alternatively, simple horizontal or diagonal banding of the panel area occurs.

IV. Supports Associated with Mixquic Black/Orange

In addition to the vessel forms described above, several types of hollow supports co-occur with Mixquic Black/Orange. The most distinctive of these is the stepped or key support in which the sides of the support have been notched to look like steps (Fig. II.13, a-c); incised grooves parallel the notching on the front of the support. Fairly well-made effigy supports are also common (Fig. II.13, d-f; also see Séjourné 1983, Figs. 67 and 73). While effigy supports definitely occur on painted ceramics, the notched key support appears restricted to plain orange vessels with stamped bases. Judging from the wear on these latter vessels, the stamped bases most likely served as grater bowls or molcajetes. See Séjourné (1983, Figs. 68 and 74) for designs occurring on stamped bases.

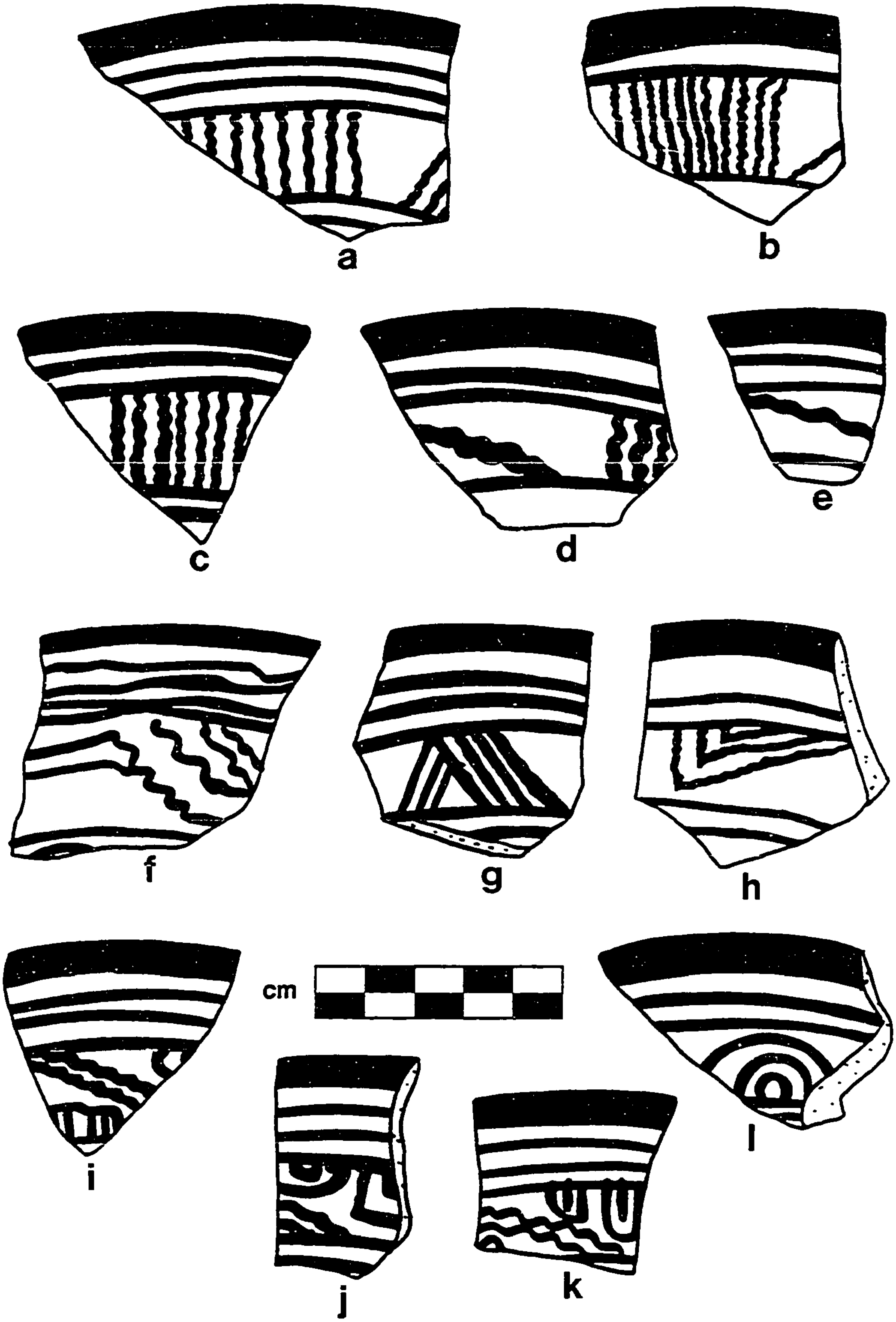


Figure II.8. Mixquic Black/Orange: Bolstered-Rim Dishes.

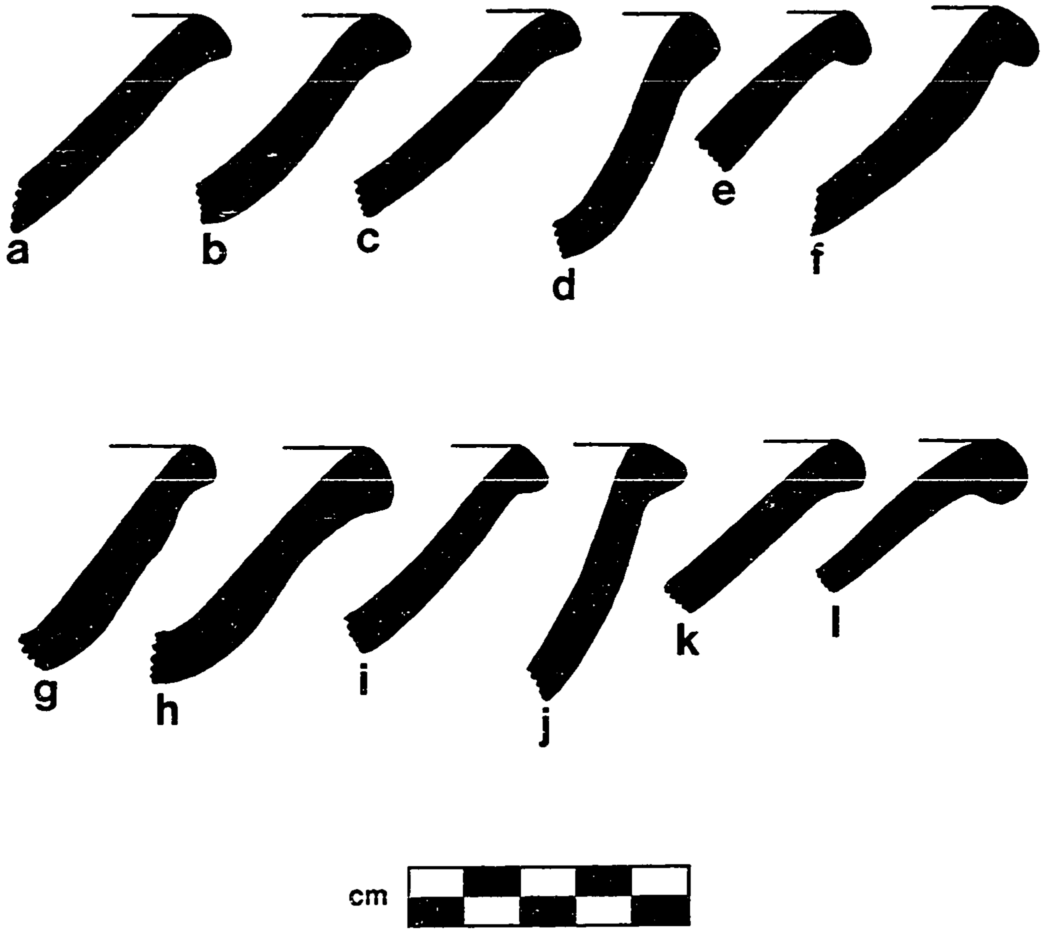


Figure II.8 (continued). Mixquic Black/Orange: Bolstered-Rim Dishes.
a) CH-AZ-192, Loc. N; **b**) CH-AZ-249, Fea. I; **c**) CH-AZ-195, Tl. 71; **d**) CH-AZ-248, Fea. P; **e**) CH-AZ-192, Loc. H; **f**) CH-AZ-192, Loc. F; **g**) CH-AZ-195, Tl. 71; **h**) CH-AZ-192, Loc. F; **i**) CH-AZ-249, Fea. K; **j**) CH-AZ-249, Fea. K; **k**) CH-AZ-192, Loc. H; **l**) CH-AZ-192, Loc. H.

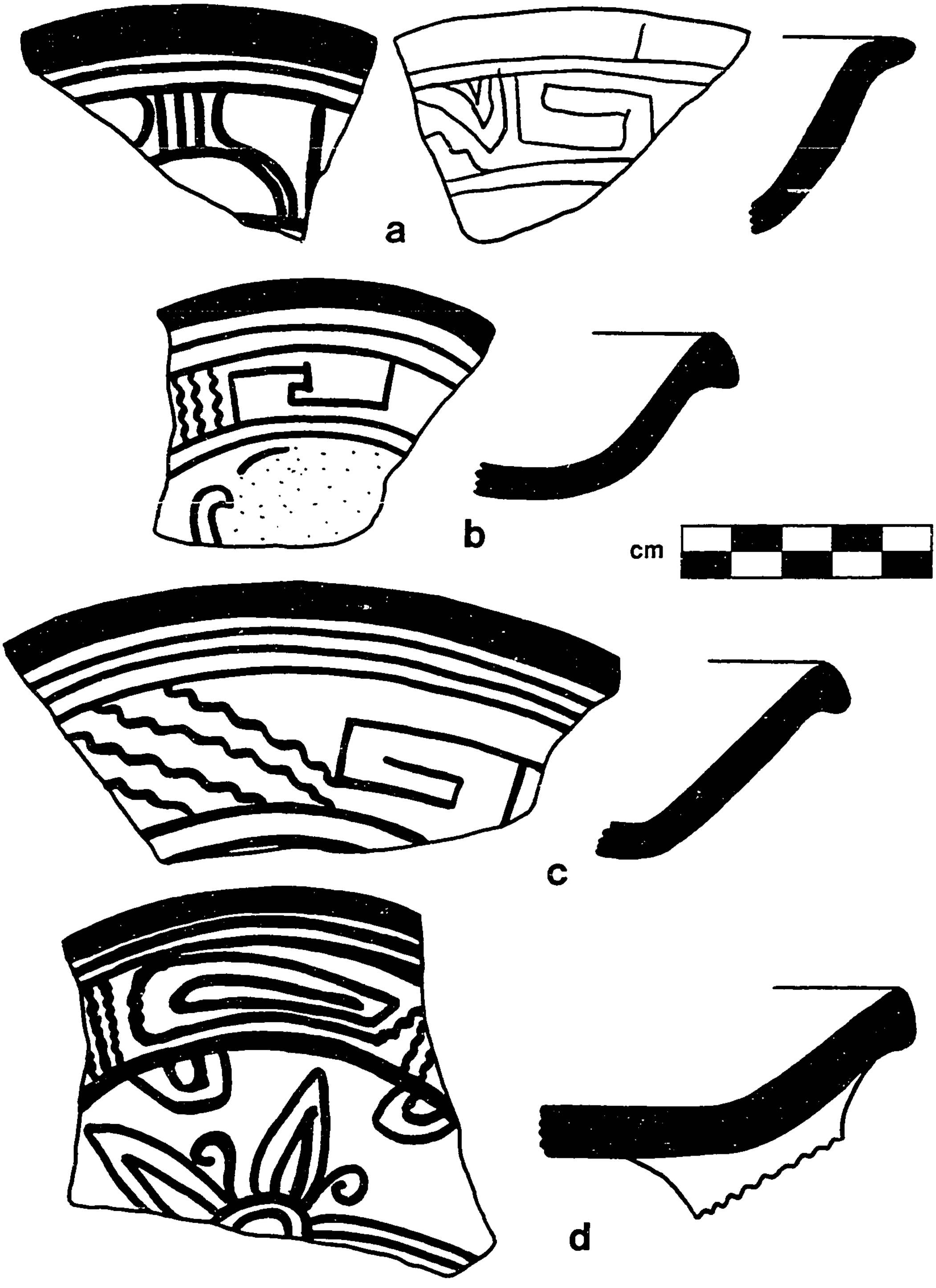


Figure II.9. Mixquic Black/Orange: Bolstered-Rim Dishes. **a**) CH-AZ-192, Loc. N; **b**) CH-AZ-252, Fea. H; **c**) CH-AZ-252, Fea. H; **d**) CH-AZ-192, Loc. O.

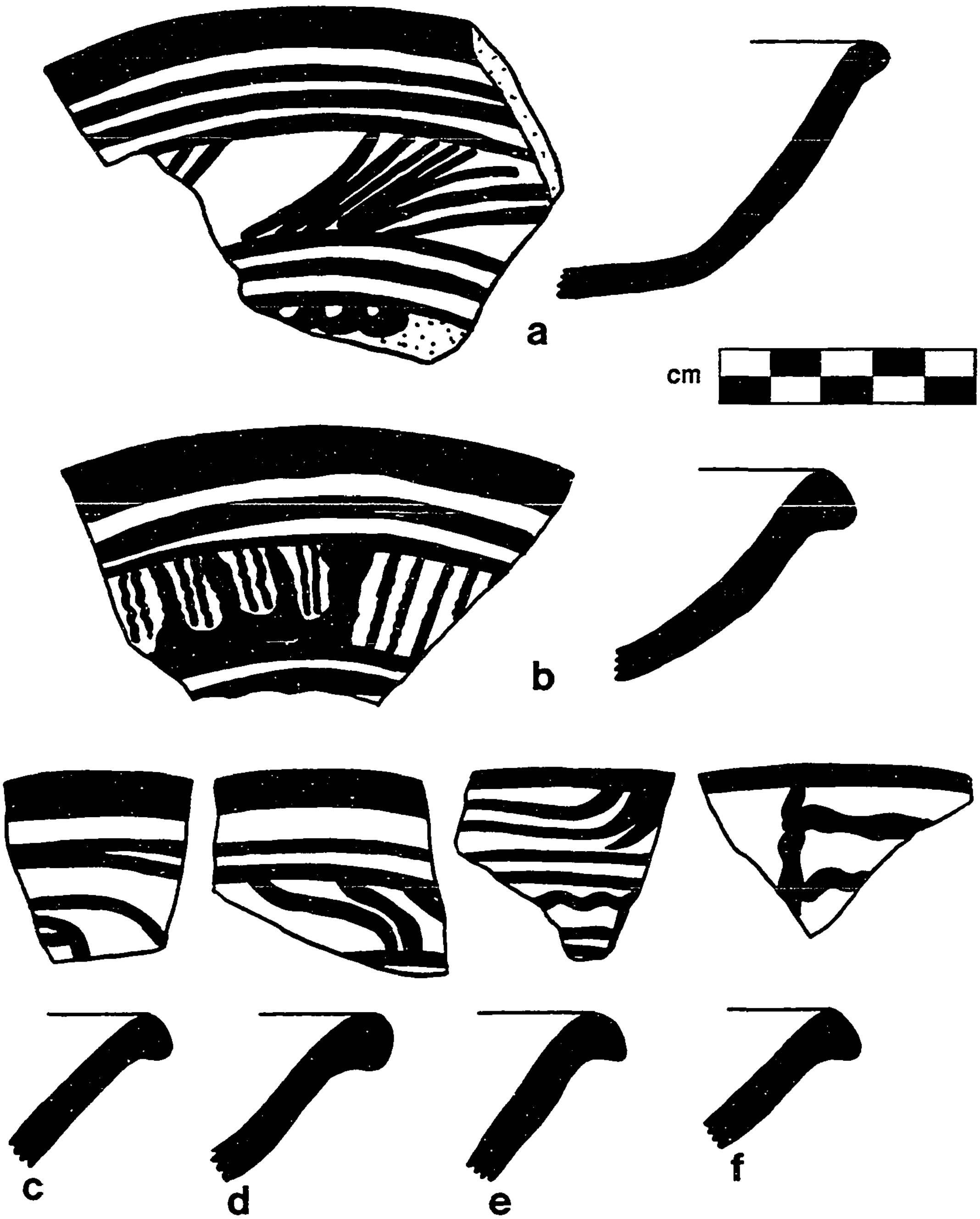


Figure II.10. Mixquic Black/Orange: Bolstered-Rim Dishes. **a)** CH-AZ-195, Tl. 71; **b)** CH-AZ-190, Tl. 52; **c)** CH-AZ-192, Loc. F; **d)** CH-AZ-190, Tl. 52; **e)** CH-AZ-249, Loc. 5; **f)** CH-AZ-249, Loc. 5.

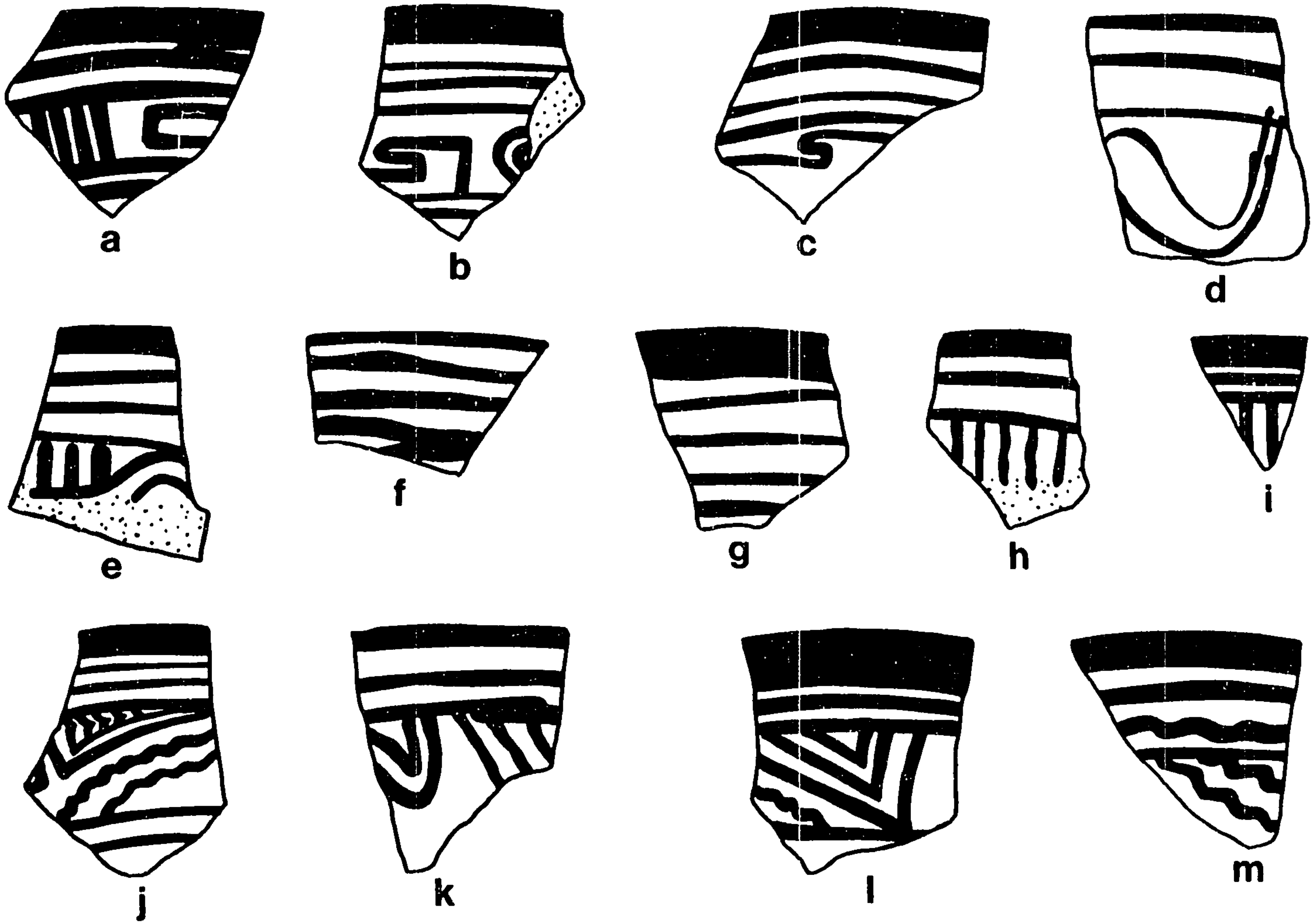


Figure II.11. Mixquic Black/Orange: Grooved-Rim Dishes.

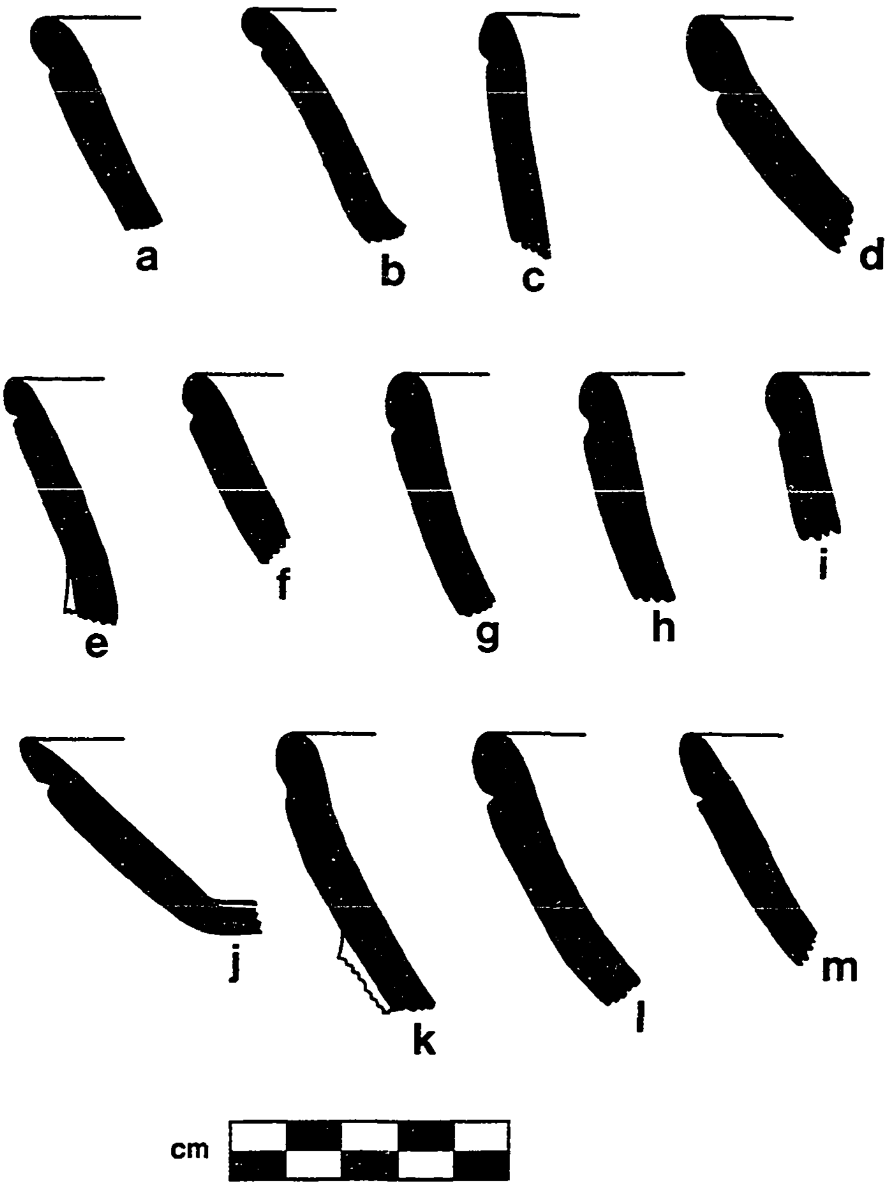


Figure II.11 (continued). Mixquic Black/Orange: Grooved-Rim Dishes.
a) CH-AZ-192, Loc. N; **b**) CH-AZ-192, Loc. N; **c**) CH-AZ-190, Tl. 52; **d**) Chalco (O'Neill Collection, A.M.N.H. 30.3/1626c, Level 25); **e**) CH-AZ-192, Loc. H; **f**) CH-AZ-192, Loc. H; **g**) CH-AZ-192, Loc. N; **h**) CH-AZ-192, Loc. O; **i**) CH-AZ-190, Tl. 52; **j**) CH-AZ-192, Loc. N; **k**) CH-AZ-192, Loc. N; **l**) CH-AZ-190, Loc. O; **m**) CH-AZ-190, Tl. 60.

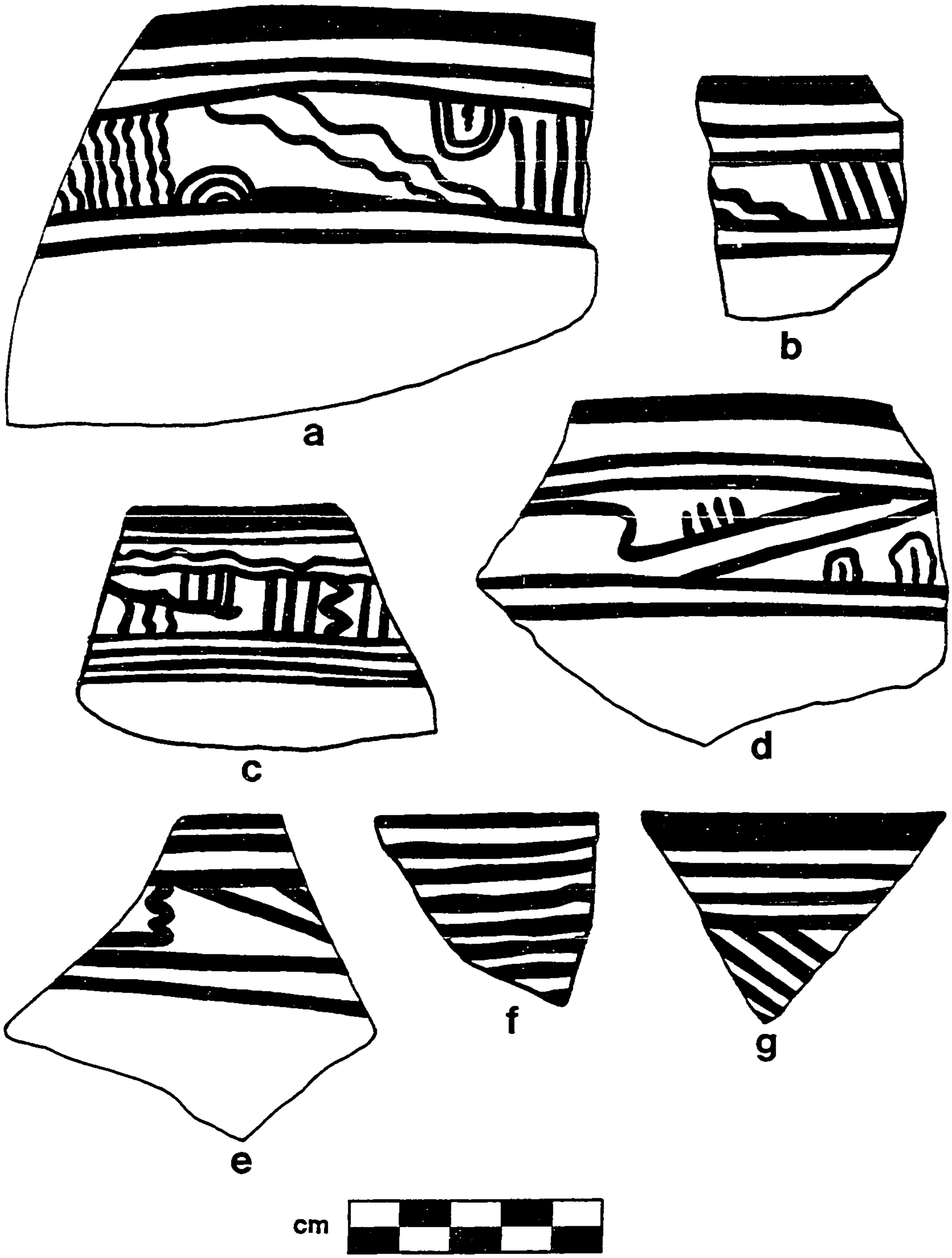


Figure II.12. Mixquic Black/Orange: Shouldered or Upright-Rim Bowls.

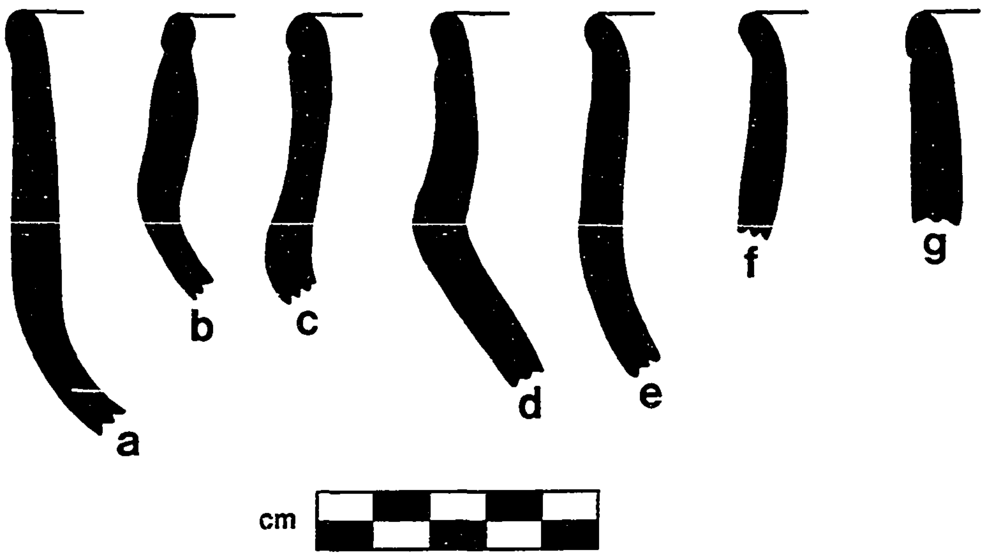


Figure II.12 (continued). Mixquic Black/Orange: Shouldered or Upright-Rim Bowls. a) CH-AZ-195B, Level 10 (from Parsons' excavations [Parsons et al. 1982b]; b) CH-AZ-192, Loc. F; c) CH-AZ-195, Tl. 71; d) CH-AZ-195B, Level 16 (from Parsons' excavations [Parsons et al. 1982b]; e) CH-AZ-195B, Level 32 (from J. Parsons' excavations [Parsons et al. 1982b]; f) CH-AZ-192, Loc. O; g) CH-AZ-195B, Level 26 (from J. Parsons' excavations [Parsons et al. 1982b].

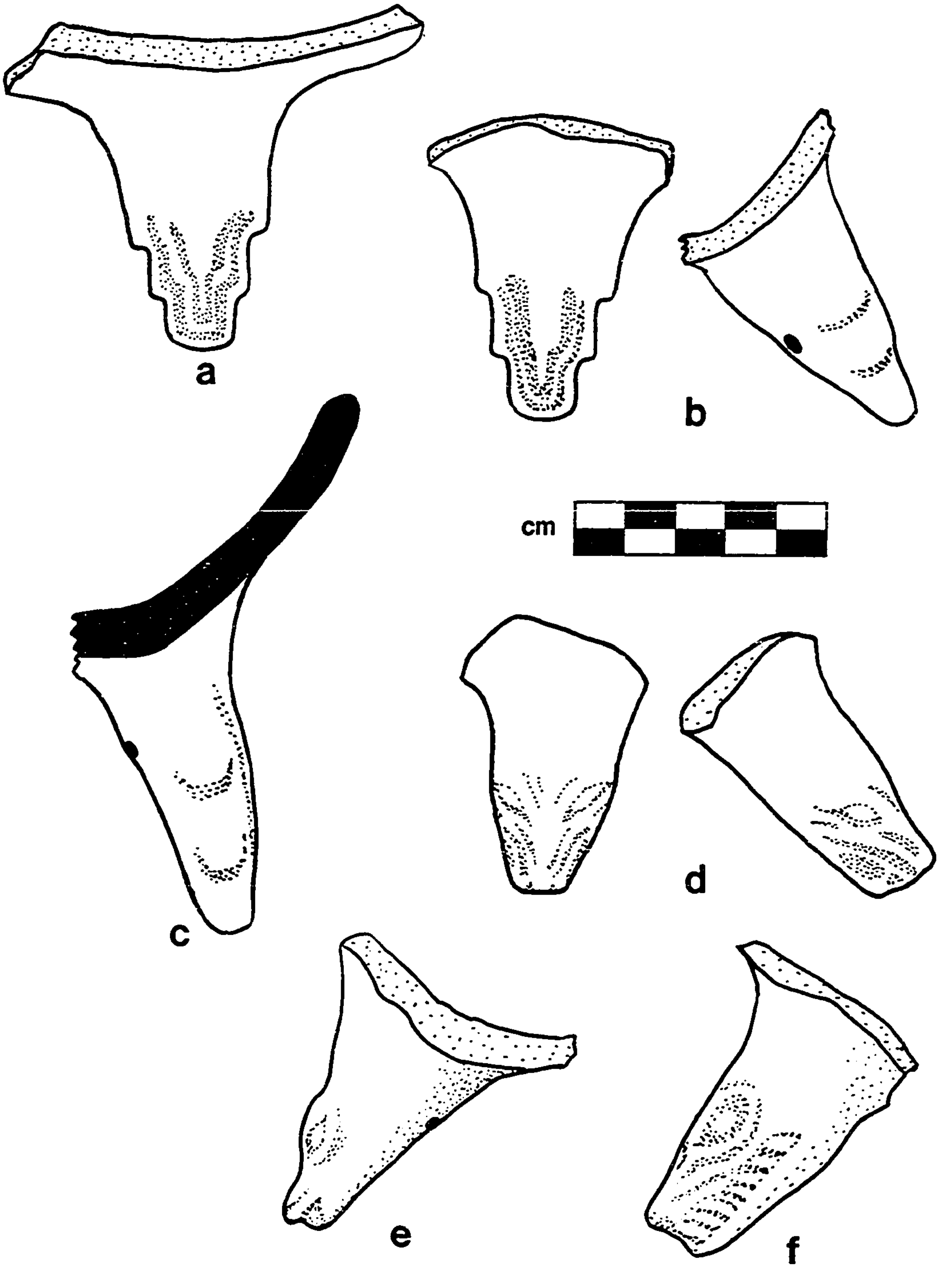


Figure II.13. Supports Associated with Mixquic Black/Orange: Stepped or Key Supports (a-c) and Effigy Supports (d-f). **a**) CH-AZ-190, Tl. 52; **b**) CH-AZ-190, Tl. 52; **c**) CH-AZ-192, Loc. F; **d**) CH-AZ-248, Fea. P; **e**) CH-AZ-233, Loc. 13; **f**) CH-AZ-263, Fea. W.

WARE: **Orange**

TYPE: **Culhuacan Black/Orange**

VESSEL FORMS: **Dishes, Hemispherical Bowls, Upright-Rim Bowls**

I. Dishes

Vessel form: Dishes are by far the most common vessel form in the Culhuacan Black/Orange type and there is substantial variability within this form class. Dishes range from quite shallow to fairly deep, with outsloping to slightly flaring vessel walls. Rims are usually direct, with simple rounded lips but may be slightly everted. Bases are generally flat but occasionally show a slight upward curvature. Hollow tripod supports are attached at the wall/base juncture; supports are typically roughly cylindrical or slightly tapered in form but bulbous and effigy supports are also found. Dishes also occur in miniature.

Paste and firing: Paste is brownish-orange to clear orange in color, with medium to fine temper and many small voids. Some vessels show signs of lamination in cross-section. Most vessels are incompletely oxidized in firing and have a gray medial core; fire clouding is common.

Surface treatment: Vessel surfaces are fairly well smoothed on the interior and less so on the exterior, especially on the base and around supports. Both surfaces bear burnishing facets.

Decoration: Decoration is interior and is usually organized in a horizontal panel running around the vessel wall set several cm below a wide black rim band. The upper boundary of the panel is delimited by two to three lines, the upper-most of which may be wavy or more rarely loopy, while the lower panel boundary consists of 2-3 straight lines. Occasionally the decorative panel may begin directly below the black rim. Decoration within the panel consists of a series of discrete elements, which contrasts with the continuous band of decoration found on Chalco Black/Orange.

Many of the elements found on the wall panel appear to have symbolic content. Commonly recurring motifs include spirals (Fig. II.14, a-c) and concentric loops (Fig. II.14, d-h), referred to by Séjourné (1970) as "*plumones u ojos estelares.*" Variations on the serpent jaw motif (cf. Brenner 1931; Peterson 1957) are also common (Fig. II.15). Geometric motifs include the *xicalcoliuhqui* and associated elements such as squared scrolls and diagonal stepped lines (Fig. II.16). A minority of dishes have simple linear wall decoration, commonly associated with floral elements (Fig. II.17). For an extensive presentation of Culhuacan Black/Orange motifs see Séjourné (1970).

The bases of dishes may be plain or may have black painted or stamped decoration. Painted basal decoration can be quite complex, including stylized representations of plants, animals, and mythological creatures. For designs occurring on stamped bases, see Séjourné (1970, Figs. 64-66).

II. Hemispherical Bowls

Vessel form: Hemispherical or simple rounded bowls with outcurving walls, direct rims, and simple rounded lips. Bases may be flat or dimpled. There is no evidence of supports.

Paste and firing: As above.

Surface treatment: As above.

Decoration: Decoration is interior. The most commonly occurring style is a simple linear one, consisting of a series of horizontal lines, wavy and/or straight, that run around the interior vessel wall below a black rim band (Fig. II.18, a-f; also see Séjourné 1970, Figs. 54-55). Alternatively, a single or double line may create large loops around the upper vessel wall (Fig. II.18, g-j). Bases may be plain or painted with complex curvilinear motifs.

III. Upright-Rim Bowls

Vessel form: Small, upright-rim bowls with either a continuous curved profile or a pronounced angle between rim and body. Most rims show a slight interior thickening at the lip. Rim diameters range from 12 to 22 cm.

Paste and firing: As above.

Surface treatment: As above.

Decoration: Decoration is exterior and is restricted to a horizontal panel placed around the upper vessel wall immediately below a black rim band. There is some cross-over in motifs from Culhuacan dishes (including *plumones* [Fig. II.19, a-d] and serpent jaws [Fig. II.19, j-n]), but greater emphasis is placed on geometric designs. Execution ranges from very neat to quite sloppy.

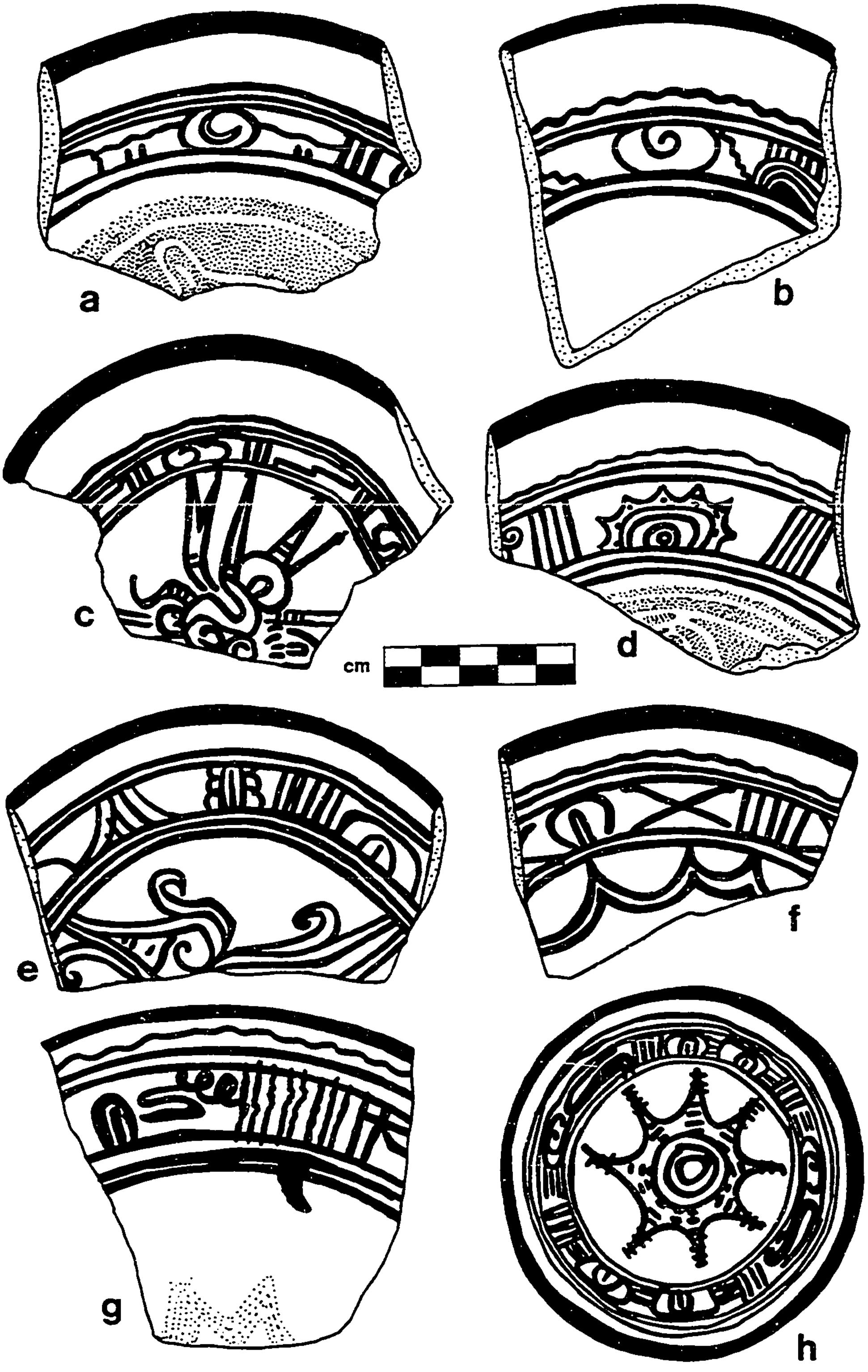


Figure II.14. Culhuacan Black/Orange Dishes.

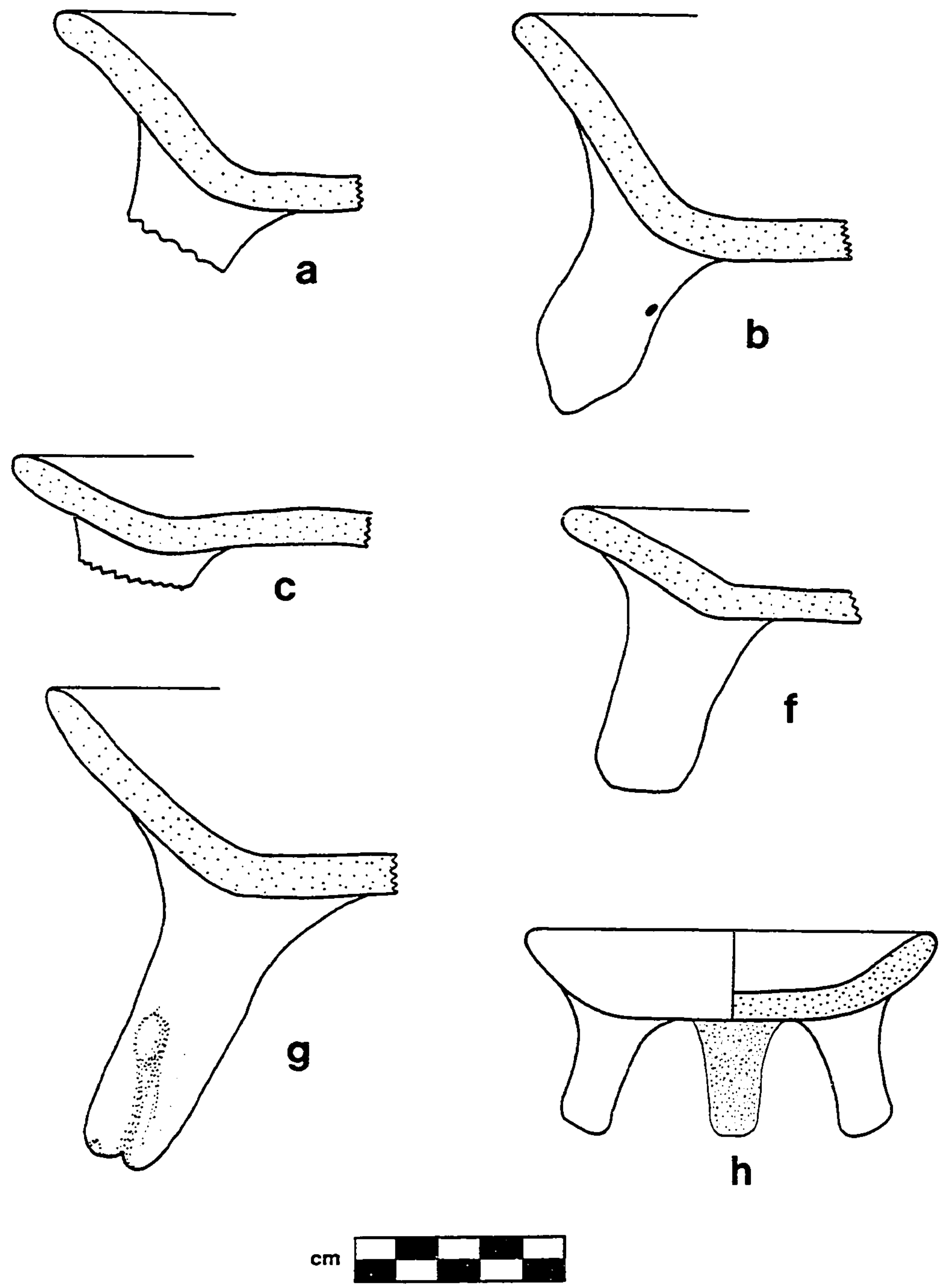


Figure II.14 (continued). Culhuacan Black/Orange Dishes: Spiral and Feather Motifs. **a-f**) Culhuacan (Griffin Collection, UMMA No. 30858); **g**) CH-AZ-263, Loc. 11; **h**) Culhuacan (Griffin Collection, UMMA No. 30872).

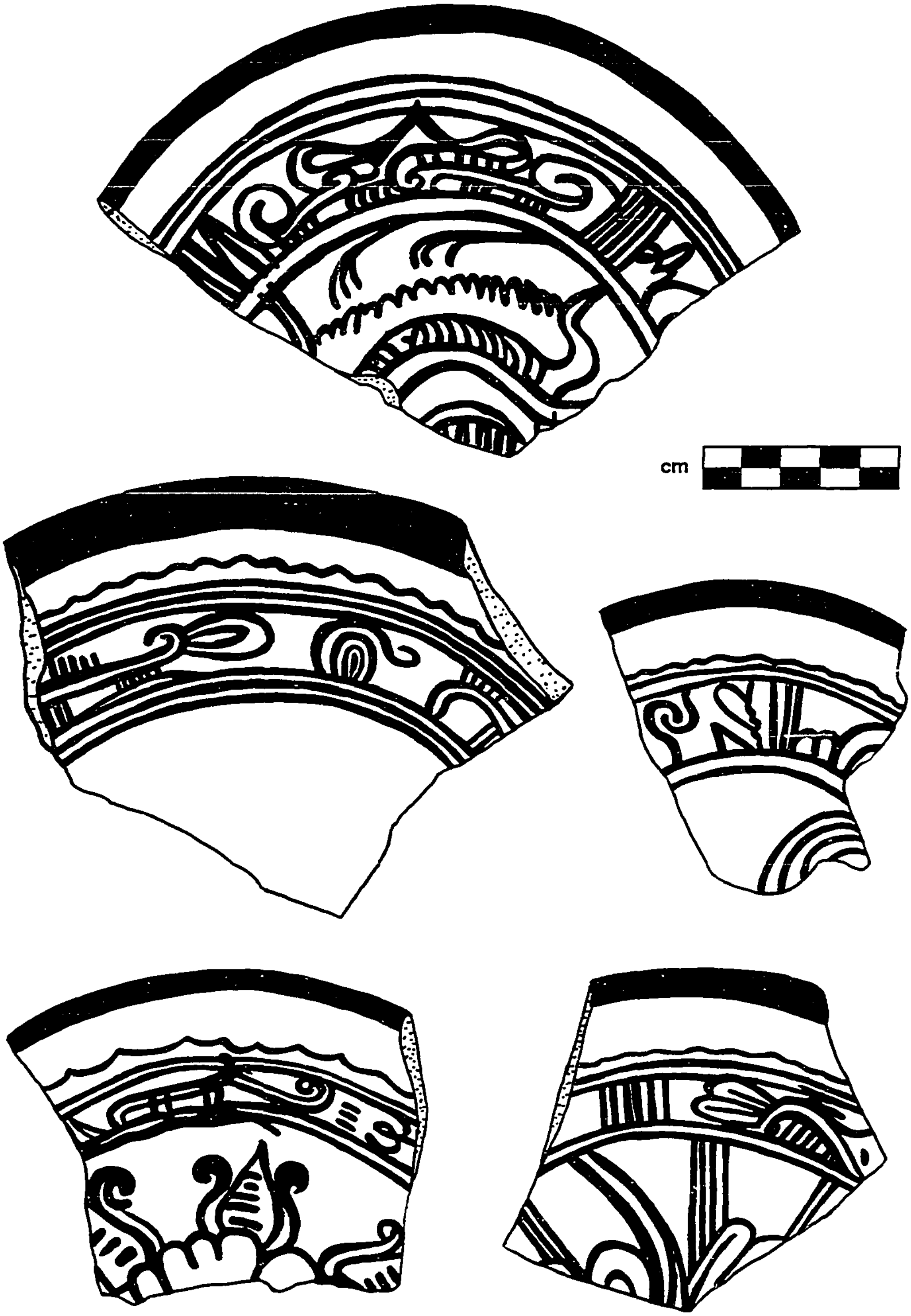


Figure II.15. Culhuacan Black/Orange Dishes: Serpent Jaw Motifs. (Culhuacan [Griffin Collection, UMMA No. 30858]).

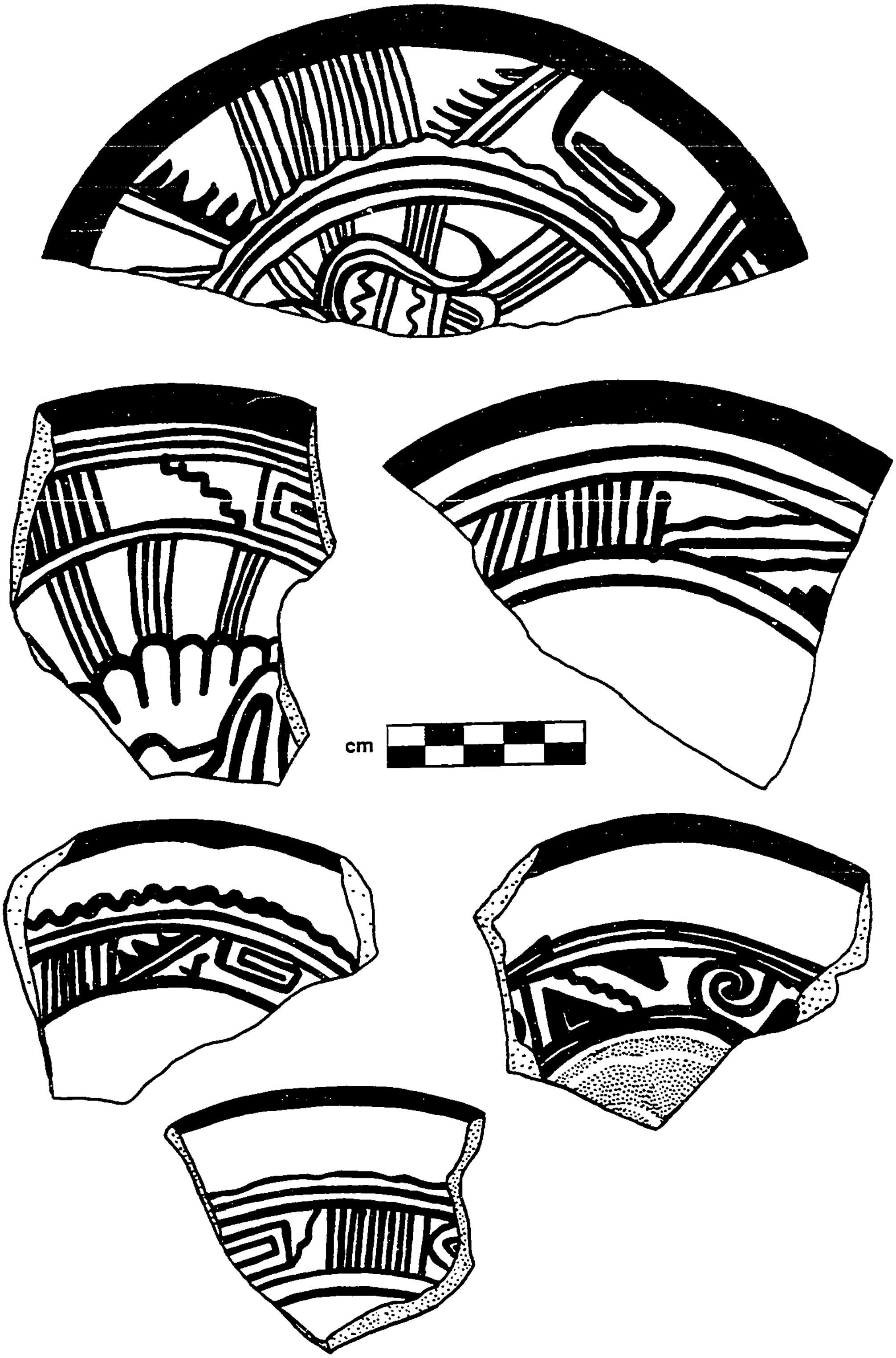


Figure II.16. Culhuacan Black/Orange Dishes: Geometric Motifs. (Culhuacan [Griffin Collection, UMMA No. 30858]).

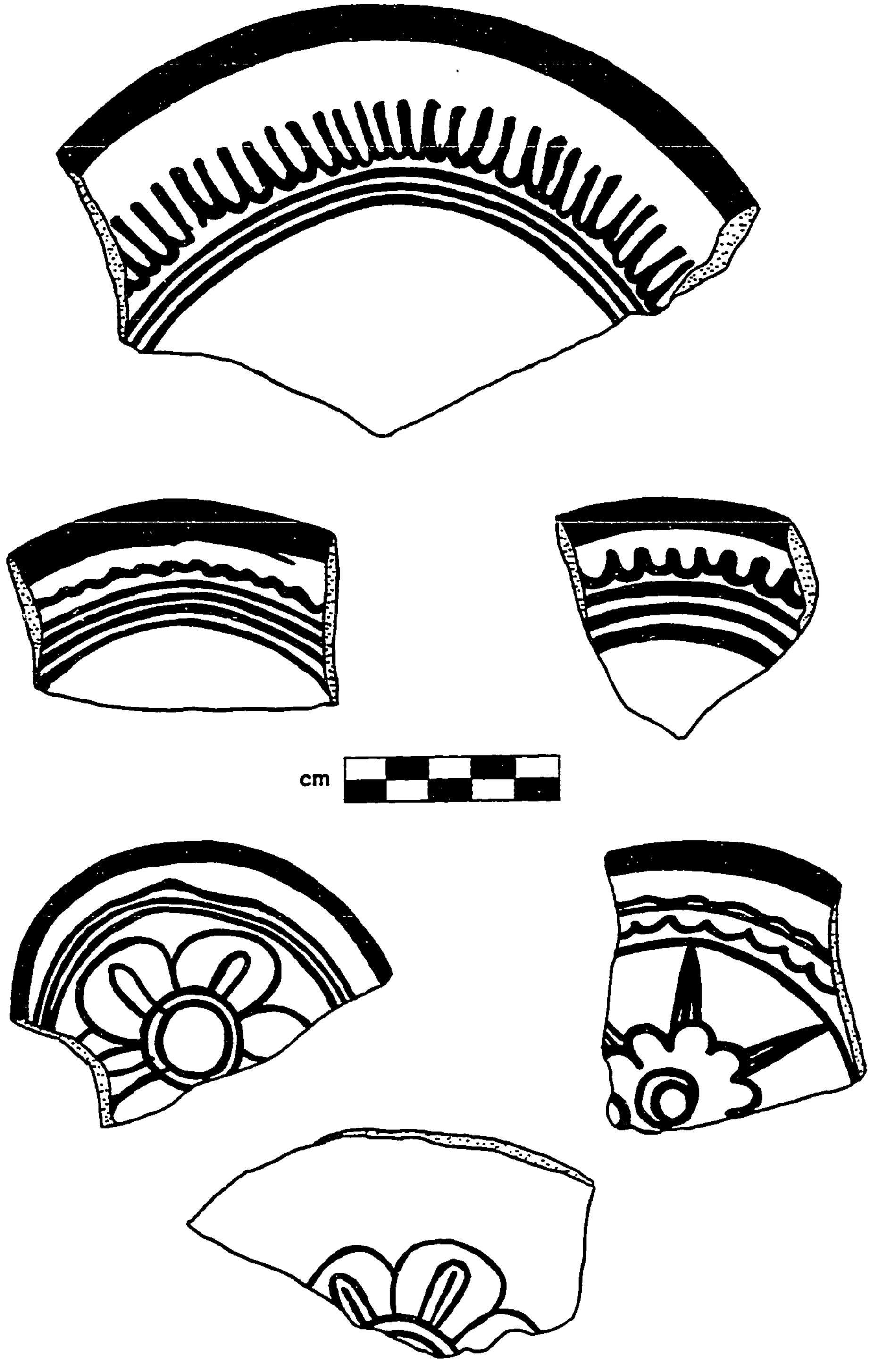


Figure II.17. Culhuacan Black/Orange Dishes: Linear and Floral Motifs. (Culhuacan [Griffin Collection, UMMA No. 30858]).

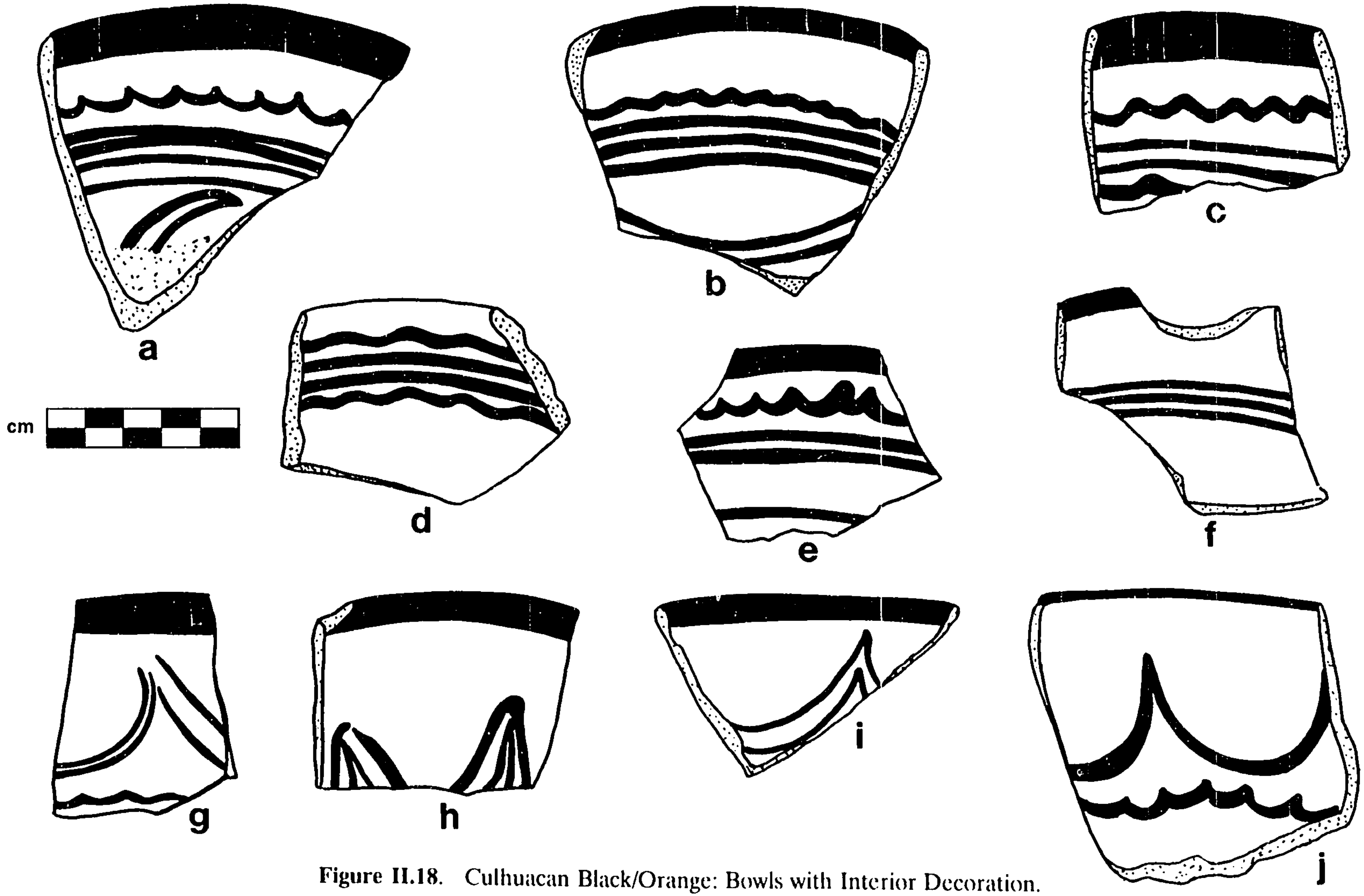


Figure II.18. Culhuacan Black/Orange: Bowls with Interior Decoration.

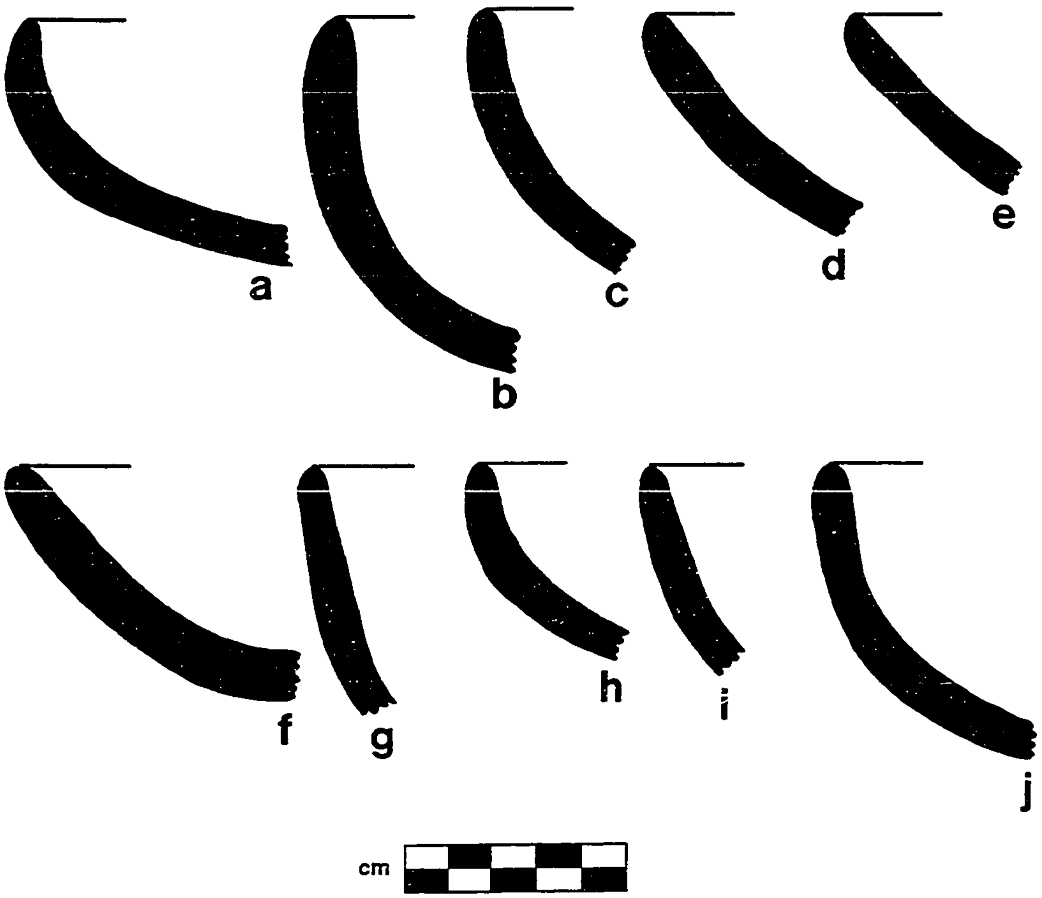


Figure II.18 (continued). Culhuacan Black/Orange: Bowls with Interior Decoration. **a**) CH-AZ-263, Loc. 10; **b**) Culhuacan (Griffin Collection, UMMA No. 30858); **c**) Culhuacan (Griffin Collection, UMMA No. 30858); **d**) Culhuacan (Griffin Collection, UMMA No. 30858); **e**) XO-AZ-5, Loc. 132; **f**) Culhuacan (Griffin Collection, UMMA No. 30858); **g**) Culhuacan (Griffin Collection, UMMA No. 30858); **h**) Culhuacan (Griffin Collection, UMMA No. 30858); **i**) Chalco-Xochimilco survey region, unknown provenience; **j**) XO-AZ-5, Loc. 132.

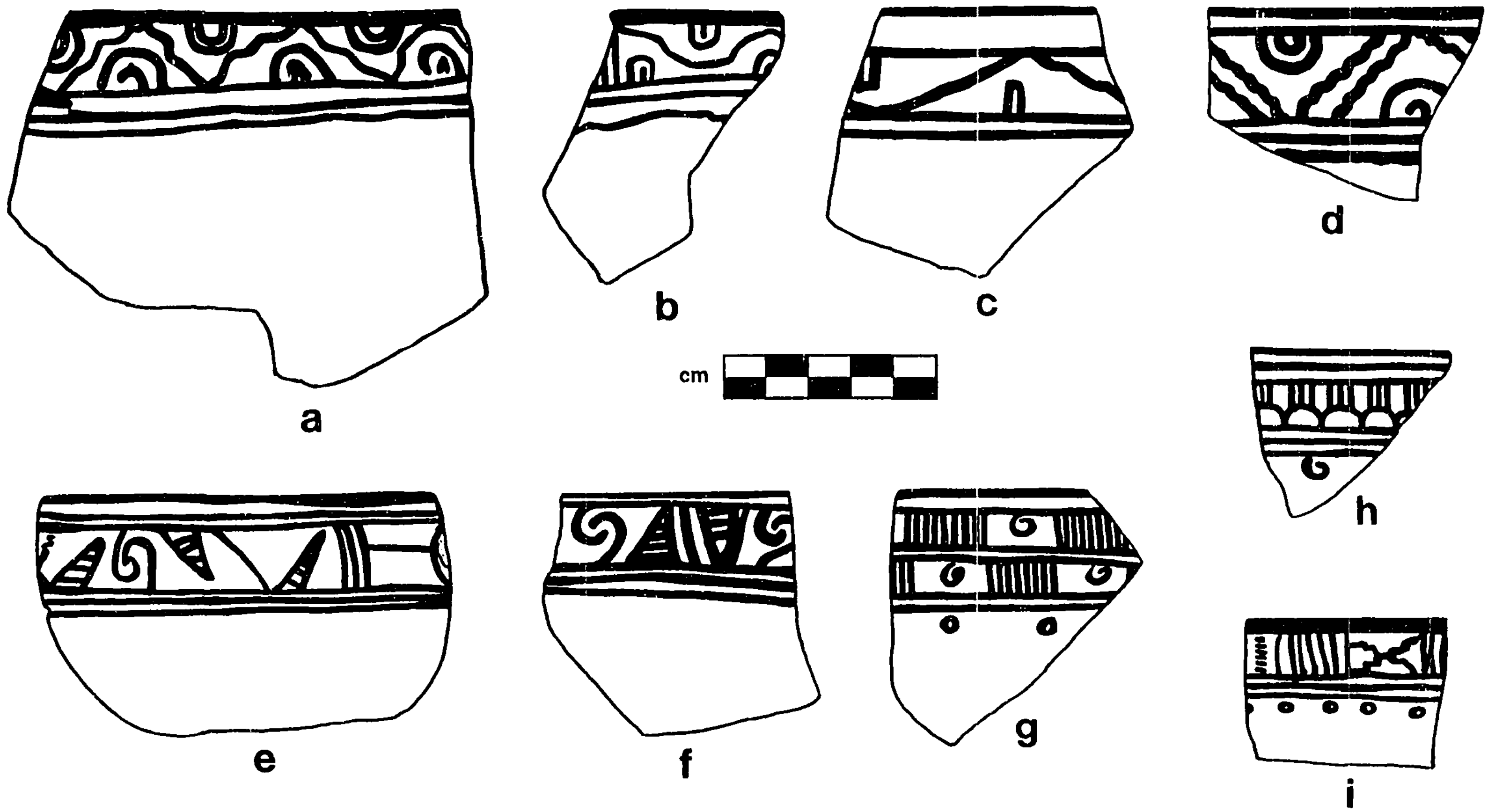


Figure II.19. Culhuacan Black/Orange: Upright-Rim Bowls with Exterior Decoration.

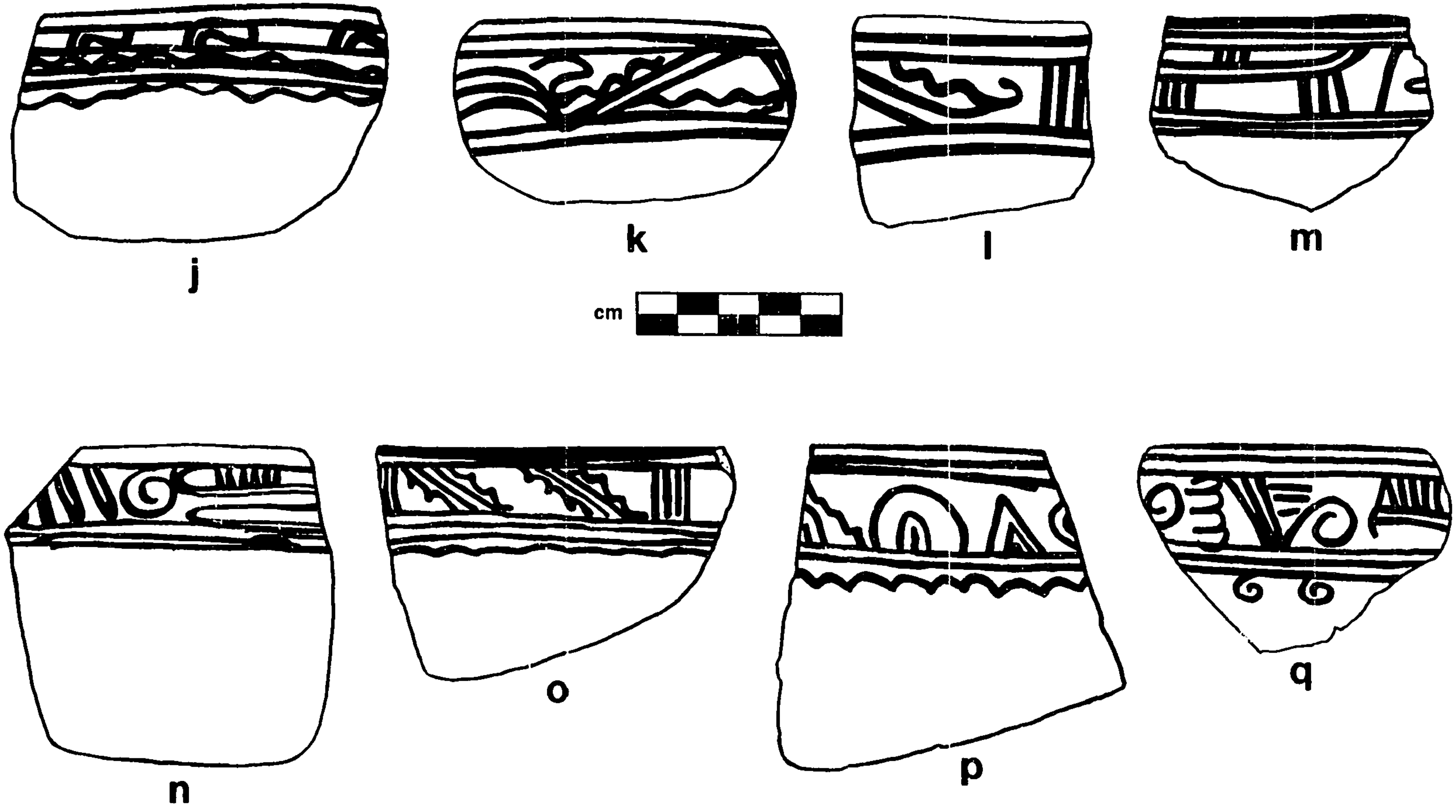


Figure II.19 (continued). Culhuacan Black/Orange: Upright-Rim Bowls with Exterior Decoration.

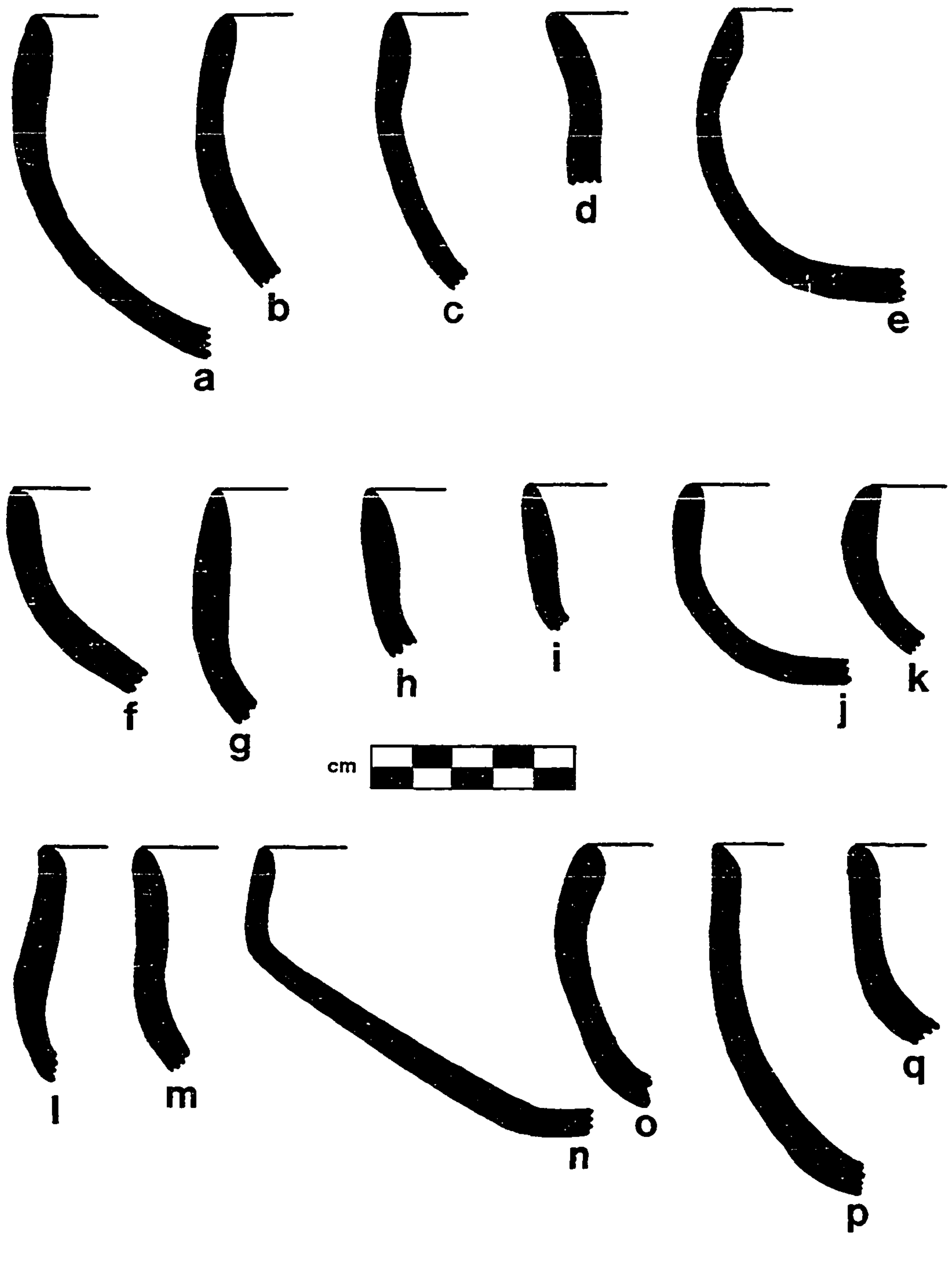


Figure II.19 (continued). Culhuacan Black/Orange: Upright-Rim Bowls with Exterior Decoration. **a-d, f-j, m-p**) Culhuacan (Griffin Collection, UMMA No. 31121); **e**) Chalco-Xochimilco survey region, provenience unknown; **k**) CH-AZ-263, Loc. 7; **l**) CH-AZ-263, Loc. 11; **q**) CH-AZ-275, Loc. 12.

APPENDIX III

AZTEC RED WARE CERAMIC DESCRIPTIONS

Black/Red Type Descriptions

WARE: **Red Ware**

TYPE: **Black-on-Red** or **Black/Red**

VESSEL SHAPE CLASSES: **Bowls, Basins, and *Copas***

The Black/Red ware typology presented below is a direct out-growth of that developed by J. Parsons (1966) for the Teotihuacan Valley. Using Parsons' earlier work as a guideline, I have attempted to subdivide and refine his variants. In addition, this typology presents several new variants. These new variants have spatial distributions restricted to the south of our study area and therefore were probably not found in Parsons' sample. Correspondences between this typology and that of Parsons are expressly noted where possible. Finally, several Black/Red variants defined by Parsons could not be substantiated within our study area; these likely represent more northern or western decorative styles.

The refined typology presented here may error in making typological distinctions that are too narrow, as in, for example, noting the presence or absence of a black rim-band at the subvariant level. However, until the importance of this level of design variability can be determined, this information has been recorded as having potential significance for mapping geographic patterns of production and exchange.

My chronological placement of the Black/Red variants differs significantly from Parsons (1966:224-226). According to that typology, only my Black/Red Variant A (Subvariants A-1 through A-4) dates securely to the Early Aztec period. My analyses show, however, that most Black/Red variants occurring on simple bowls with recurved, interior thickened, or direct rim forms date to the Early Aztec period, while significant changes in vessel profile distinguish Late Aztec bowls. The major exception is Black/Red Variant C which occurs on an early bowl form even though it has strong associations with the Late Aztec period. Most conical-cup *copas* belong to the Late Aztec period as well; basins are probably late as well. For details on chronological placement, see Appendix IV.

I. Bowls

Vessel form: Simple rounded bowls with curved walls ranging from slightly incurving to outcurving, with a gentle basal angle, and flat or slightly dimpled base. Occasionally the vessel walls are more outsloping than outcurving, in which case the basal angle is more pronounced. Wall thickness is fairly even from lip to base. Rim form occurs in three main variations: (1) simple with a rounded, direct lip (**direct**); (2) slightly thickened on the interior wall just below simple, rounded lip (**interior thickened**); or

(3) slightly recurved (**recurved**). Vessels with **exterior thickened** rims are discussed separately under the heading "Late Profile Bowls".

Paste and firing: Paste ranges from buff to red-brown in color, and frequently contains a gray-to-black medial core. Texture is compact. Temper is generally fine; Parsons (1966:213) reports temper in the range of 5% to 20%.

Surface treatment: Both exterior and interior surfaces generally appear well smoothed, but may show horizontal polishing facets or burnishing streaks. In most variants, vessels have been slipped a deep red over all or most of the exterior surfaces. (The exceptions to this are Variants H and I, in which slip is usually limited to the upper portion of the vessel wall). Interior surfaces generally are left the natural paste color or bear a red slip similar to the exterior. A minority of vessels have interior surfaces that bear a black slip or have been smudged a dark gray or brown color.

Decoration: Decoration consists of black mineral (rarely graphite) paint, applied in linear geometric and/or curvilinear designs. (Variants that occur only with graphite paint are treated under "Low Frequency Red Ware Types".) Decoration is usually exterior, although some vessels may have interior decoration as well. Vessels with only interior decoration are rare, and almost exclusively belong to the plate form class.

Decorative Variants: Nine decorative variants have been defined for Black/Red bowls, A through I, based on differences in the organization (layout and composition) of the painted designs and on associated variability in vessel and rim morphology. Subvariants reflect minor variations in design structure.

<u>Variant A</u>. The four subvariants defined here all represent the wide-line Black/Red variant recognized by J. Parsons (1966:216), but not separated by him from his more general Variant A, marked by vertical black lines around the vessel exterior. Grove (1964:44) included these as part of his Texcoco Black/Red I characterized by heavy-line decoration, in contrast to his Texcoco Black/Red II, bearing finer-liner decoration. Brumfiel (1976:234) included these in her Variant A.

The wide-line A subvariants have somewhat thicker walls than other bowl variants, as well as a high proportion of black interiors and recurved rims - three attributes associated with Early Aztec Red Ware. Parsons (1966:225) considered the wide-line Black/Red variant to be of Early Aztec date by its association with Aztec I Black/Orange. Brumfiel's MDS seriation supports this placement (1976:74, Fig. 2a). Norr (1987a, 1987b), who excavated in a pure Early Aztec context, illustrates sherds that are similar, but not strictly comparable, to Subvariant A4 (1987b, Fig. I-5). In contrast, O'Neill (1962:49, Table 2) found no Black/Red in his pure Early Aztec strata nor does he illustrate anything comparable to the wide-line variants in his figures of red ware types.

<u>Subvariant A-1</u>. Decoration consists of black (rarely graphite) lines including a wide black rim band (ca. 0.5-1.5 cm), below which a series of wide (ca. 0.4-0.8 cm) vertical lines are widely spaced around the vessel wall (Fig. III.1). The vertical lines are distinctly wider at their top and narrow downward in an inverted tear-drop shape.

These vertical lines rarely intersect the black rim band. Rims of this variant are frequently interior thickened.

Subvariant A-2. Decoration consists of vertical black painted lines widely spaced around the vessel exterior (Fig. III.2, a). Lines begin at or near the lip and decrease in width downward, representing a brushstroke grading from heavy to light. This subvariant is distinguished from A-1 by the absence of a black rim band.

Subvariant A-3. Decoration consists of a broad horizontal band encircling the exterior vessel wall below a red rim. The characteristic tear-drop vertical lines occur below, but do not touch, the horizontal band, and are widely spaced around the vessel exterior (Fig. III.2, b-c).

Subvariant A-4. Decoration is exterior only and is distinguished by large, solid black circles (ca. 2 cm in diameter) spaced widely around the vessel wall. This subvariant usually, but not always, has a wide black rim band as well (Fig. III.2, d-f).

Variant B. Vessels are small, rounded bowls with outcurving to nearly outsloping walls (rare). Rims are direct, slightly interior thickened, or slightly recurved. Bases are flat and basal angles curved. Surfaces are generally well-smoothed, although they may show horizontal polishing facets. Exterior surfaces have been slipped red from lip to basal angle. Interior surfaces are also slipped red when they bear interior black painted decoration. Usually, however, interior surfaces are the natural paste color or have been smudged to a dark gray-brown color.

Subvariant B-1. Decoration is generally exterior and consists of a narrow black rim band (< 0.5 cm wide) above a series of single vertical to slightly oblique lines evenly spaced around the vessel wall (Fig. III.3, a-f). The vertical lines approach but seldom intersect the black rim band and continue down to the basal angle. Vertical line widths range from 0.15 to 0.3 cm, while intervening spaces are 3 to 5 times as wide. This ratio of spacing to line width is much greater than that between lines within a group of the so-called "comb" variants (see Variant C, below), and potentially allows the analyst to determine from even a small sherd whether the vertical lines are continuous or clumped in their distribution around the vessel. Interior decoration is rarely present. This subvariant was included in Parsons' fine-line Variant A (1966:215) and Brumfiel's Variant B (1976:234).

Subvariant B-2. Decoration consists of a continuous panel of single vertical to slightly oblique black lines evenly spaced around the vessel wall (Fig. III.3, g-h; also cf. Séjourné 1980, Figs. 154-155). The vertical lines extend from near the lip to the basal angle. This subvariant differs from B-1 in the absence of a black rim band. Subvariant B-2 was included with Parsons' Variant B (1966:217).

Variant C. Vessels are simple, rounded bowls with outcurving walls of fairly even thickness. Rim forms are direct or slightly interior thickened; recurved rims are rare.

Vessel walls are fairly well smoothed, although most show polishing facets. In some cases, polishing appears to have been done after application of black paint, so that the decoration is blurred or smeared. Exterior surfaces have been slipped a deep red over all or most of the vessel wall; the red slip may continue somewhat over the lip into the interior. Interior surfaces are generally polished and/or self-slipped the natural paste color. Smudging of the interior is rare. Red-slipped interiors co-occur with interior black decoration. Frequently the exterior red slip is mis-fired and is muddy or brownish in color.

Subvariant C-1. Exterior decoration consists of a narrow (generally < 0.5 cm) black rim band above groups or clusters of vertical to oblique black lines (Figs. 4.4 and 4.5). Parsons termed the groups of lines the "comb" motif [1966:215]. The vertical lines approach or intersect the black rim band and continue roughly two-thirds of the way down the vessel wall; they rarely reach the basal angle. The number of lines in the comb motif ranges from two to ten (Parsons 1966:215); vessels bearing units of two lines (Fig. III.5, c) are similar in appearance and spatial distribution to Black/Red basins (cf. Fig. III.15). Subvariant C-1 was included in Parsons' Variant A (1966:215).

Subvariant C-2. Exterior decoration consists of groups of vertical to slightly oblique lines (i.e. the comb motif) spaced around the vessel wall (Fig. III.6). The lines extend from the lip at least half way down the vessel wall. The lines range from fairly straight to slightly wavy; the later apparently results from polishing or burnishing after the black painted decoration had been applied. Interior decoration usually consists of triangles composed of stacked horizontal lines of increasing length; the wide end of the triangle is topped with a row of small, solid triangles, zacate, or loops (Fig. III.6, e). This motif appears to have been applied randomly around the interior of the vessel wall and base. Subvariant C-2 is distinguished from C-1 by the absence of a black rim band and by a greater proportion of decorated interiors. Subvariant C-2 was included in Parsons' Variant B (1966:217).

Variant D. Small, round-sided bowls with outcurving to nearly outsloping walls, flat bases, and simple direct or slightly recurved rims. Vessels are generally well smoothed and do not show polishing facets or burnishing streaks. Both interior and exterior surfaces appear to have been slipped with a low- to semi-gloss red slip.

Subvariant D-1. Decoration is primarily exterior and consists of a black horizontal line encircling the vessel approximately 0.4-1.0 cm below the lip. Below this horizontal line, a series of vertical lines are placed around the vessel wall (Fig. III.7, a-c). These vertical lines are usually single and evenly spaced, but may more rarely occur in groups of two to several (i.e. the comb motif). The vertical lines may intersect or only approach the horizontal line, and continue roughly half-way down the vessel wall. Interior decoration is highly variable, usually consisting of a triangle of stacked lines, topped with a row of petals or loops. Subvariant D-1 is equivalent to Parsons' Variant C (1966:217).

Subvariant D-2. Decoration is similar to that of Subvariant D-1, except that two horizontal lines encircle the exterior vessel wall just below the lip. Below the double horizontal lines, a series of vertical to slightly oblique lines, evenly spaced or grouped, are placed around the vessel wall. The vertical lines approach or may intersect the lower horizontal line, and they continue approximately two-thirds of the way down the exterior vessel wall (Fig. III.7, d-f). Many sherds bear interior decoration as well. Common interior motifs include (1) the triangular stack of lines and (2) chevrons surrounded by petals or loops, but the decoration may be considerably more complex (Fig. III.7, e). This subvariant is equivalent to Parsons' Variant D (1966:217-218).

Subvariant D-3. Exterior decoration consists of three horizontal lines encircling the rim a short distance below the lip. Below these horizontal lines a continuous series of vertical lines runs around the vessel, extending from the lowest horizontal line two-thirds of the way down the vessel wall (Fig. III.7, g-i). Interior decoration is generally similar to that of the other D subvariants. Subvariant D-3 is equivalent to Parsons' Variant E (1966:218).

Variant E. Thin-walled bowls, with outcurving to nearly outsloping walls. Vessels have direct rims with simple, rounded lips that may show some thickening on the interior. Basal angles appear fairly sharp, and bases are flat.

Vessel surfaces are well smoothed, and both interior and exterior surfaces bear a slip of a distinctive red-orange shade. Vessel interiors are slipped over the entire surface; exterior surfaces may be slipped entirely red as well, or the red may cover only a broad rim band.

Variant E appears to have a southerly distribution within the Valley of Mexico, concentrated around the sites of Ixtapaluca and Chalco. Parsons (1966) recorded nothing similar to Variant E.

Subvariant E-1. Decoration is exterior, and consists of a bounded "grill" motif (Fig. III.8, a-d). This grill is formed by two horizontal lines encircling the vessel wall, the uppermost well down from the rim and the second approximately 1 cm above the basal angle. Between these horizontal lines, a series of vertical lines run continuously around the vessel wall. The vertical lines clearly intersect both the upper and lower horizontal lines and are distinctly wider than the horizontal lines.

Subvariant E-2. Decoration is exterior and consists of a variation on the bounded grill motif (Fig. III.8, e-i). Two horizontal lines encircle the rim well below the lip; the lower line forms the upper boundary of the bounded grill. Broad vertical lines extend downward from this second horizontal line to intersect the lower boundary, formed by a horizontal line running around the lower vessel wall. These vertical lines are distinctly wider than the horizontal.

Variant F. A low-frequency decorative variant found on a range of bowl forms, including simple, rounded bowls with incurving walls as well as vessels having outcurving or outsloping walls. Rims are direct with simple, rounded lips. Vessels are well smoothed and are slipped red on the interior. Vessel exterior may be entirely red as well, or the red may extend down only over a broad rim band several centimeters in width. The red slip has a distinctive orangish cast to it.

Exterior decoration is characterized by the presence of the "anchored scrolls" motif (Fig. III.9), usually occurring as a panel set between multiple horizontal lines encircling the rim and the lower bounded grill motif of Variant E (Fig. III.9, a-c). However, the anchored scroll motif can occur in other contexts as well (Fig. III.9, e).

With a larger sample, this variant could be further subdivided into those vessels that appear to be an elaboration of Variant E and those that have decoration organized in a manner distinct from Variant E.

Like Variant E, this variant appears to have a largely southerly distribution within the Valley.

Variant G. Simple rounded bowls with outcurving to slightly incurving walls, direct rims, and rounded lips. Surfaces are well smoothed and slipped red over the entire exterior and (generally) interior surfaces.

Exterior decoration is characterized by the presence of the lazy-S (sideways S), scroll, or squared lazy-S motif running around the vessel in a panel delimited by horizontal black lines. This panel may occur just below the rim above a continuous series of vertical black lines (Fig. III.10, a-d), in which case the application of the lazy-S motif appears to be an elaboration of a Variant D design. Alternatively, the panel of lazy-S motifs may occur lower down the vessel wall, above vertical black lines but below other panel motifs (Fig. III.10, e-f). One example (Fig. III.10, d) shows close affinities to Black/Red Basin Variant B. Parsons included sherds of this group in his Variant G (1966:218-219 and Plate 71, m-aa).

Variant H. Small bowls with outcurving to nearly outsloping walls, direct rims, and simple rounded or interiorally thickened lips. Surfaces are fairly well smoothed near the rim, but show obvious burnishing facets on lower vessel walls. The vessel exterior generally bears a band of red slip 2-3 cm wide at the rim, although the entire exterior may be slipped red. Interior surfaces are frequently red and may bear simple black decorative motifs.

Exterior decoration is simple, consisting of horizontal lines encircling the vessel below the vessel rim. Four subvariants have been defined based on the number of horizontal lines decorating the exterior. Interior decoration consists of free motifs, generally the petalled scroll or *ilhuitl* motif applied near the rim. Variant H differs from Variant I (see below) in that the horizontal lines are placed below (rather that at) the rim.

Variant H has a spatial distribution restricted almost entirely to the Chalco survey region, with a concentration in the Tenango subvalley. Parsons (1966) and Brumfiel (1976), both of whom worked to the north of this area, recorded nothing similar to Variant H.

Subvariant H-1. Exterior decoration consists of a single horizontal line encircling the vessel wall 1-2 cm below the rim (cf. Séjourné 1983, Lám. XX).

Subvariant H-2. Exterior decoration consists of two parallel horizontal lines encircling the vessel wall at the approximate base of the red slip band, i.e. ca. 2 cm below the lip (Fig. III.11, a-d). Interior decoration consists of the petalled *ilhuitl* motif (Fig. III.11, d).

Subvariant H-3. Exterior decoration consists of three parallel horizontal lines encircling the rim at the approximate base of the red band of slip or approximately 2-3 cm. below the lip (Fig. III.11, e-g). Interior decoration includes the *ilhuitl* motif and a horizontal line near the base of the vessel wall.

Subvariant H-4. Exterior decoration consists of two parallel horizontal black lines encircling the vessel roughly 2-3 cm below the lip, similar to Subvariant H-2. Above these lines on the red band, the petalled scroll or *ilhuitl* occurs as a free motif (Fig. III.11, h-i). This subvariant represents a further elaboration of Subvariant H-2 and could well be included with that subvariant.

Variant I. Generally very shallow outcurving bowls with direct rims and simple direct or slightly interiorally thickened lips. Occasional deep bowls are found as well (Fig. III.12, d), as are vessels with nearly outsloping walls (Fig. III.12, h-i), but the latter are rare.

Paste and firing is typical of early Red wares. Paste is orange in color and generally oxidized throughout. Vessel surfaces are smoothed but show burnishing facets, especially on the lower vessel wall. Vessel exteriors generally bear a band of red slip only on the upper vessel wall that extends from the lip down several centimeters. Below the red band, vessel color is orangish, as is the interior. Occasionally, the entire exterior surface has been slipped red.

Decoration is exterior and is limited to parallel horizontal lines encircling the vessel rim. In contrast to Variant H, the horizontal lines begin at (rather than below) the rim. Like Variant H, Variant I shows its greatest spatial concentration in the south. Parsons (1966) defines no variant similar to Variant I.

Subvariant I-1. Other than the irregular band of red slip, the only decoration consists of a single black band at the lip, generally 0.5-1.0 cm thick (Fig. III.12, a-c). Small sherds bearing this decoration were classed as BRO (black rim-band only), since it was unclear whether they belonged to this subvariant or were actually sherds of Subvariant C-1 on which the comb motif was not visible. The restricted band of red slip at the rim could potentially distinguish the two subvariants, since the C-1 sherds are generally slipped over most or all of the exterior surface.

Subvariant I-2. A band of red slip 1.5-4 cm wide has been applied to the upper vessel wall below the rim. This red band is roughly banded by two horizontal black lines, one at the lip and the other at the approximate base of the red-slipped band (Fig. III.12, d-g).

Subvariant I-3. Decoration consists of three parallel horizontal lines of black encircling the vessel wall, the uppermost of which runs at the lip, while the lower ones run at the base of the red-slipped band or at a distance of 3-4 cm below the lip (Fig. III.12, h).

Subvariant I-4. Decoration consists of two or three horizontal lines with additional free motifs placed between the lines on the red band (Fig. III.12, i).

II. Late Profile Bowls

Vessel form: "Late Profile" bowls were separated out from other Black/Red variants because of their distinctive profile, even though in decoration some of them are equivalent to previously defined Black/Red variants. Vessels are bowls with outsloping walls, flat bases and a sharp basal angle. Vessel walls are thin relative to other Red wares and bear a characteristic bulge or exterior thickening at the rim. Above this thickening, vessel lips are frequently thinned, rather than simple and rounded.

Paste and firing: Paste is fine and sherds are hard and well-fired. In cross-section, these vessels have a dark gray or black "core" that comprises almost the entire thickness of the sherd. This dark medial core has been associated with Texcoco polished red wares and has assumed to be of Late Aztec date.

Surface treatment: Surfaces are extremely well polished and are generally quite glossy. Both interior and exterior surfaces have been slipped. Slips range in color from a deep, almost maroon to pinkish (cream-of-tomato-soup) red.

Decoration: Decoration is exterior and consists of fine-line black designs. Frequently these vessels appear to have been mis-fired, in that the "black" painted decoration appears grayish or even white in color. Many earlier publications have classed these sherds as "White-on-Red", a classification that I feel is inappropriate. True White/Red has a paint more in character with that found on Black-and-White/Red, that is, chalky in appearance, easily abraded, and often fugitive.

Decorative Variants: Three main decorative variants were defined (A, B, and E). Of these, A and B are similar in layout to Black/Red Variants B and C, respectively, while E represents an entirely new decorative variant.

Late Profile Variant A. Decoration is exterior and consists of thin vertical black lines evenly spaced around the vessel wall (Fig. III.13, a-b). Decoration is similar to that of Black/Red Variant B.

Late Profile Variant B. Decoration is exterior and consists of groups of vertical lines (the comb motif) spaced around the vessel wall (Fig. III.13, c). This variant is similar in decoration to Black/Red Variant C.

Late Profile Variant E. Decoration is exterior and consists of a black rim band above curvilinear wing-like motifs outlined in black and bounded by groups of fine parallel oblique lines or fine-line hatchure (Fig. III.14). More complete examples of this variant are illustrated by Séjourné (1983, Figs. 143 and 145). The decoration on this variant is usually executed in black mineral paint, but may be graphite (Fig. III.14, a and d). Parsons included sherds of this group in his Variant F (1966:218 and Plate 71, a-l); Brumfiel (1976:234) included it as her Variant C.

III. Basins

Black/Red basins have not been previously defined in the literature, although Brumfiel (1976:234) and García (1987) record their presence at Huexotla. In fact, our spatial data indicate that these vessels have a very narrow distribution in our study area, concentrated in the piedmont between Huexotla and Coatepec.

Vessel form: Large, thick-walled vessels with rim diameters exceeding 30 cm. Profiles range from slightly incurving (barrel-shaped) to near vertical to outsloping. Lips are generally direct and rounded but may be slightly thinned. Small lug handles were commonly encountered (Fig. III.17, d).

Paste and firing: Paste appears similar to most other red wares, except that it appears laminated and voids are larger. Paste is buff-orange in color with a gray medial core.

Surface treatment: Vessel surfaces are roughly smoothed and show horizontal burnishing facets. Both interior and exterior surfaces have been slipped a deep (maroon), matt red.

Decoration: Decoration is exterior and consists of fairly sloppy, wide-line black painted decoration.

Decorative Variants: Two decorative variants have been defined.

Variant A. Decoration is exterior and consists of several (two to four) horizontal black lines encircling the vessel below the lip. Above these horizontal lines, short vertical lines or tick-marks extend up to the lip. Beginning below the horizontal lines, long vertical lines (organized in groups of two) extend down the vessel wall to the base (Figs. 4.15 and 4.16, a).

Variant B. Decoration is similar to that of Variant A with the exception that the horizontal lines encircling the rim define an open panel in which the lazy-S or side-lying scroll motif is found (Fig. III.17).

IV. *Copas*

Vessel form: Goblets having conical bases and conical-to-flaring cups. At the neck of the vessel, where the cup and pedestal join, the interior bases of both portions are flat with well-defined basal/wall angles. Vessel walls are thin. The cups have simple rounded to slightly thickened lips, while the lip of the base is frequently squared-off or beveled.

Paste and firing: Well-fired vessels with a fine paste. Unslipped surfaces are pinkish-buff to tan; most vessels show a dark gray medial core.

Surface treatment: Vessels are well smoothed or polished, with a moderate to very high luster. As Parsons notes (1966:212), these vessels characteristically have vertical as opposed to horizontal burnishing facets over much of the vessel wall. Horizontal facets may occur at the rim. *Copas* appear to have been slipped over the entire exterior surface. Interior surfaces of the cup may be unslipped or bear a slip only on the upper portion (2-5 cm) of the wall; interiors of the base or pedestal are unslipped and poorly finished.

Decoration: Decoration is exterior and consists of black lines of varying width, giving the appearance of rather sloppy application.

Decorative Variants: Three decorative variants have been defined based on the most consistent design categories found on the *copa* cup.

Variant A. Decoration consists of a number of vertical lines (grouped or evenly spaced) that extend from the neck to the rim; the neck is encircled with a series of straight or slightly wavy horizontal lines (Fig. III.18, c).

Variant B. Decoration consists of a number of parallel horizontal lines encircling the *copa* cup below the rim (Fig. III.18, a-b). A single broad black band runs around the *copa* neck.

Variant C. Decoration is characterized by the "*espumoso*" or foamy motif, formed by several large concentric loops or inverted U's stemming from the neck and surrounded by a row of radiant tick-marks. (See Graphite/Red *Copas* (Fig. III.40) for examples of this motif.) Parsons also reports Black/Red copas in this design category (1966:215; Plate 64, z-oo).

Variant D. Decoration consists of the bounded grill motif similar to that of Black/Red Variant E bowls (Fig. III.18, e).

Miscellaneous *Copas*. Miscellaneous designs found on *copas* include the *xicalcoliuhqui* motif interset between horizontal lines (Fig. III.18, d and f).

Key to Figures III.1 - III.18: Black painted areas are represented in black, while red slipped areas are indicated with a shading film. Areas left white on the sherd drawings indicate unslipped portions of the vessel. NAA numbers refer to sherd identification numbers used in instrumental neutron activation (INA) analyses.

Black Paint

Red Slip

Unslipped Areas

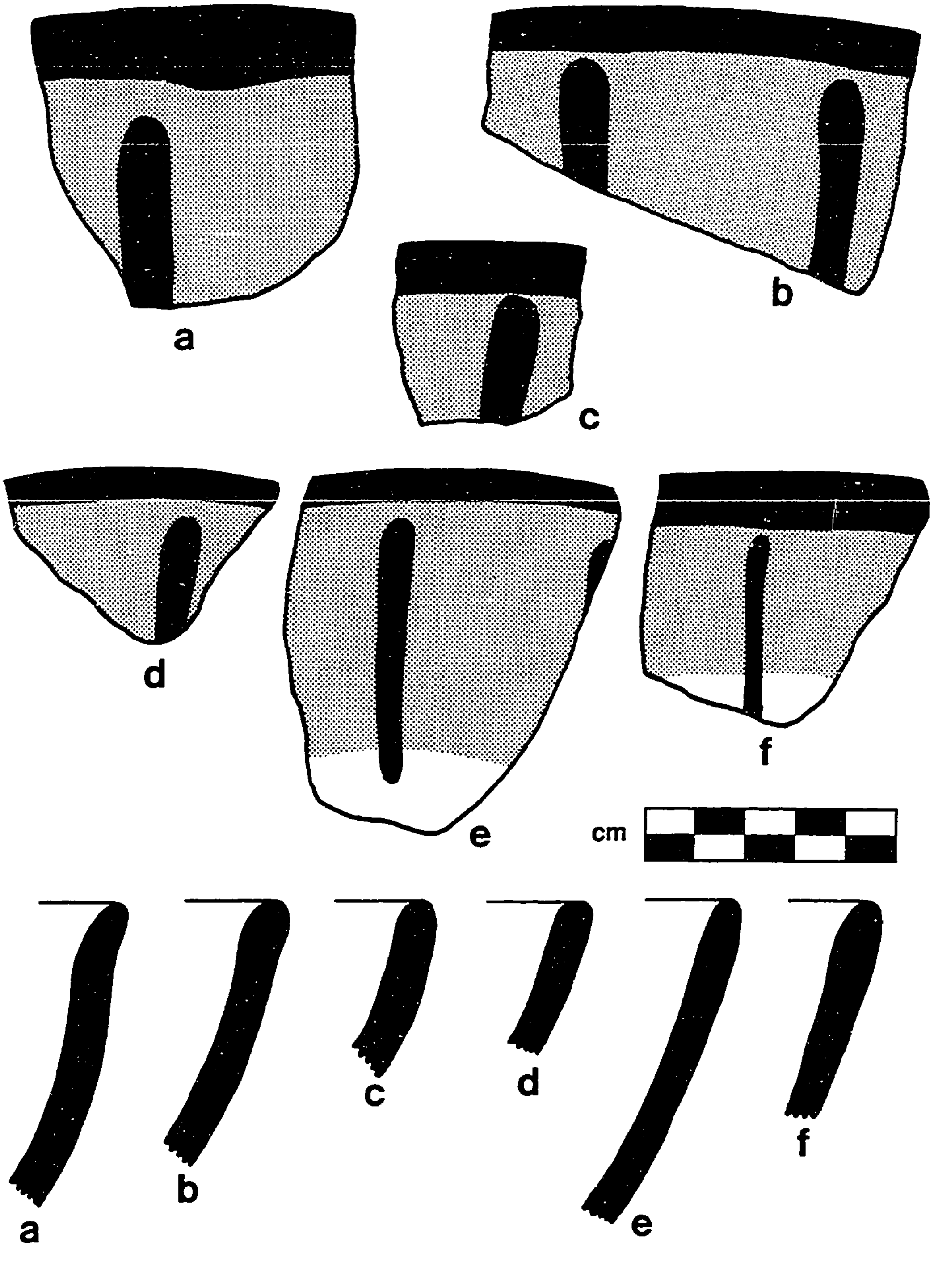


Figure III.1. Black/Red Bowl Variant A: Subvariant A-1. **a**) Chalco, UMMA No. 30633 [NAA 351]; **b**) Chalco, UMMA No. 30633 [NAA 352]; c) Huexotla, UMMA No. 31058 [NAA 369]; **d**) Chalco, UMMA No. 30633 [NAA 354]; e) Chalco, UMMA No. 30633 [NAA 353]; f) Huexotla, UMMA No. 31058 [NAA 370].

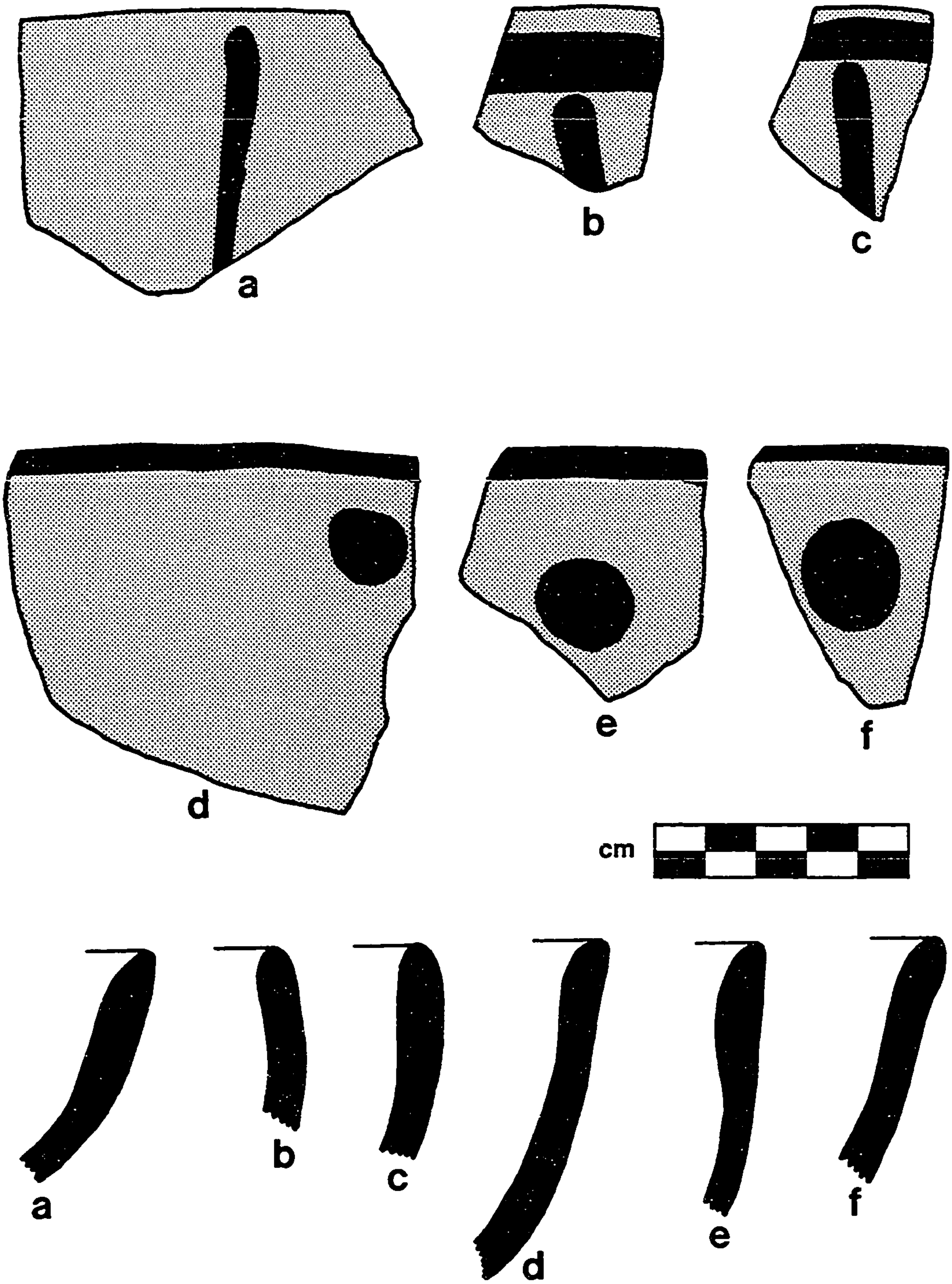


Figure III.2. Black/Red Bowl Variant A: Subvariant A-2 (a), Subvariant A-3 (b-c), and Subvariant A-4 (d-f). **a**) IX-A-26, Area 104; **b**) TX-A-87, Tl. 51; **c**) Chalco, UMMA No. 30634; **d**) Huexotla, UMMA No. 31058 [NAA 345]; **e**) CH-AZ-111, Loc. 80; **f**) CH-AZ-111, Loc. 81. White represents unslipped areas.

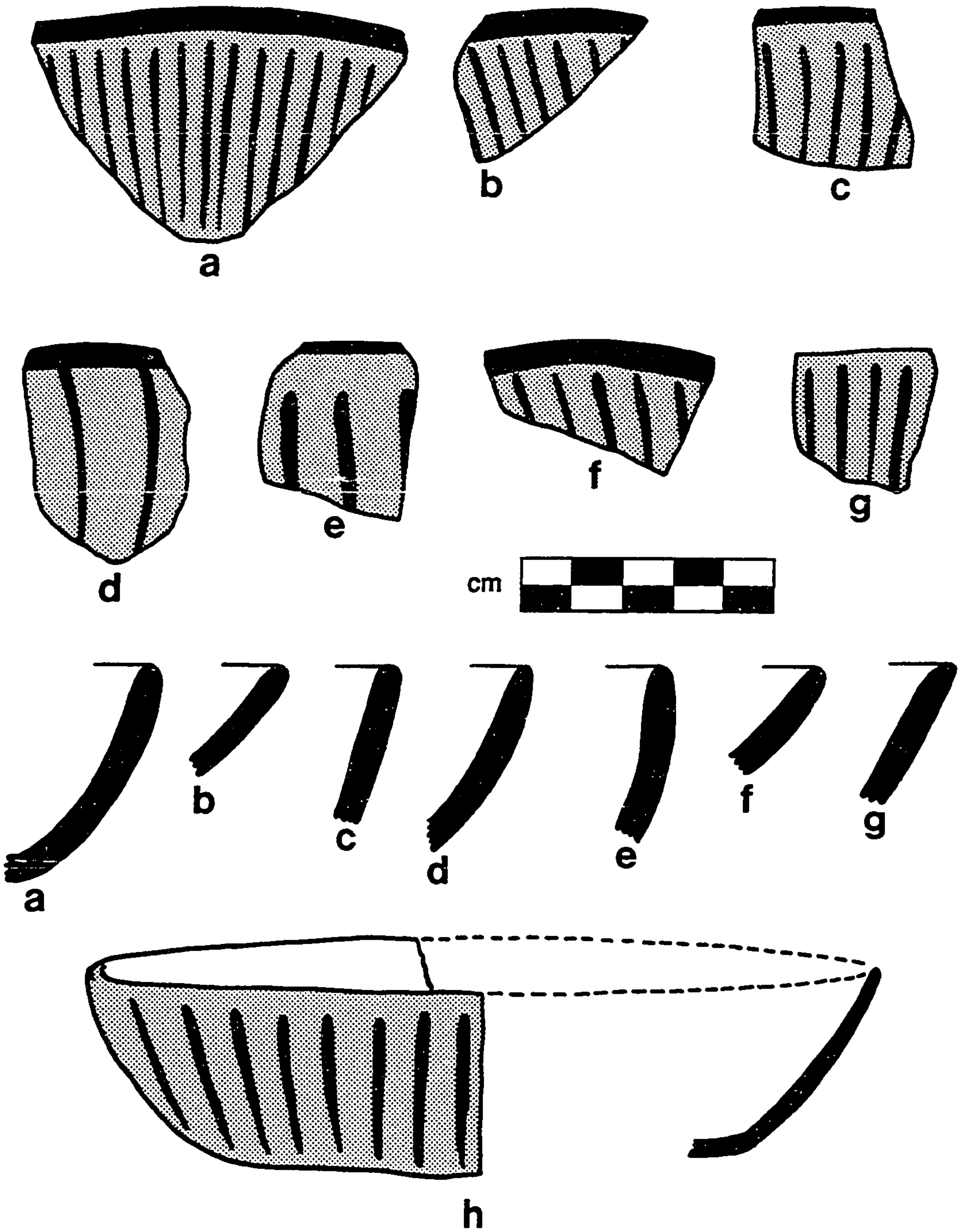


Figure III.3. Black/Red Bowl Variant B: Subvariant B-1 (a-g), and Subvariant B-2 (h). **a**) CH-AZ-172, Tl. 79, UMMA No. 82099; **b**) Huexotla, UMMA No. 31112; **c**) Chalco, UMMA No. 30633 [NAA 356]; **d**) Chalco, UMMA No. 30633 [NAA 355]; **e**) Huexotla, UMMA No. 31112 [NAA 372]; **f**) Huexotla, UMMA No. 31112; **g**) CH-AZ-172, Loc. Q; **h**) Mixquic, redrawn from Séjourné 1983, Fig. 154 (not to scale).

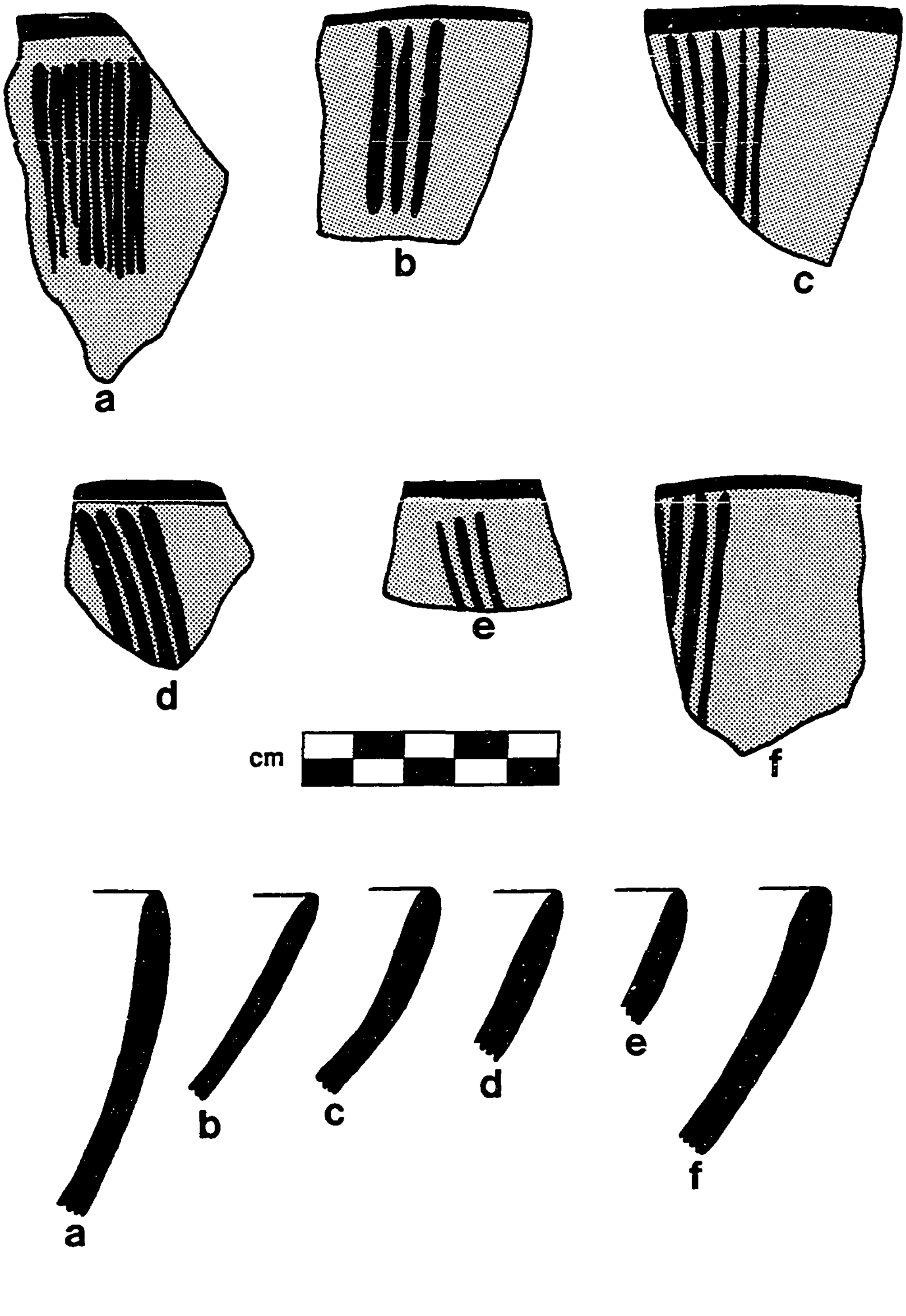


Figure III.4. Black/Red Bowl Variant C: Subvariant C-1. **a**) TX-A-109, Loc. 5; **b**) TX-A-24, Tl. 305; **c**) TX-A-24, Tl. 305; **d**) TX-A-87, Tl. 24; **e**) Huexotla, UMMA No. 31175 [NAA 374]; **f**) Huexotla, UMMA No. 31058 [NAA 377].

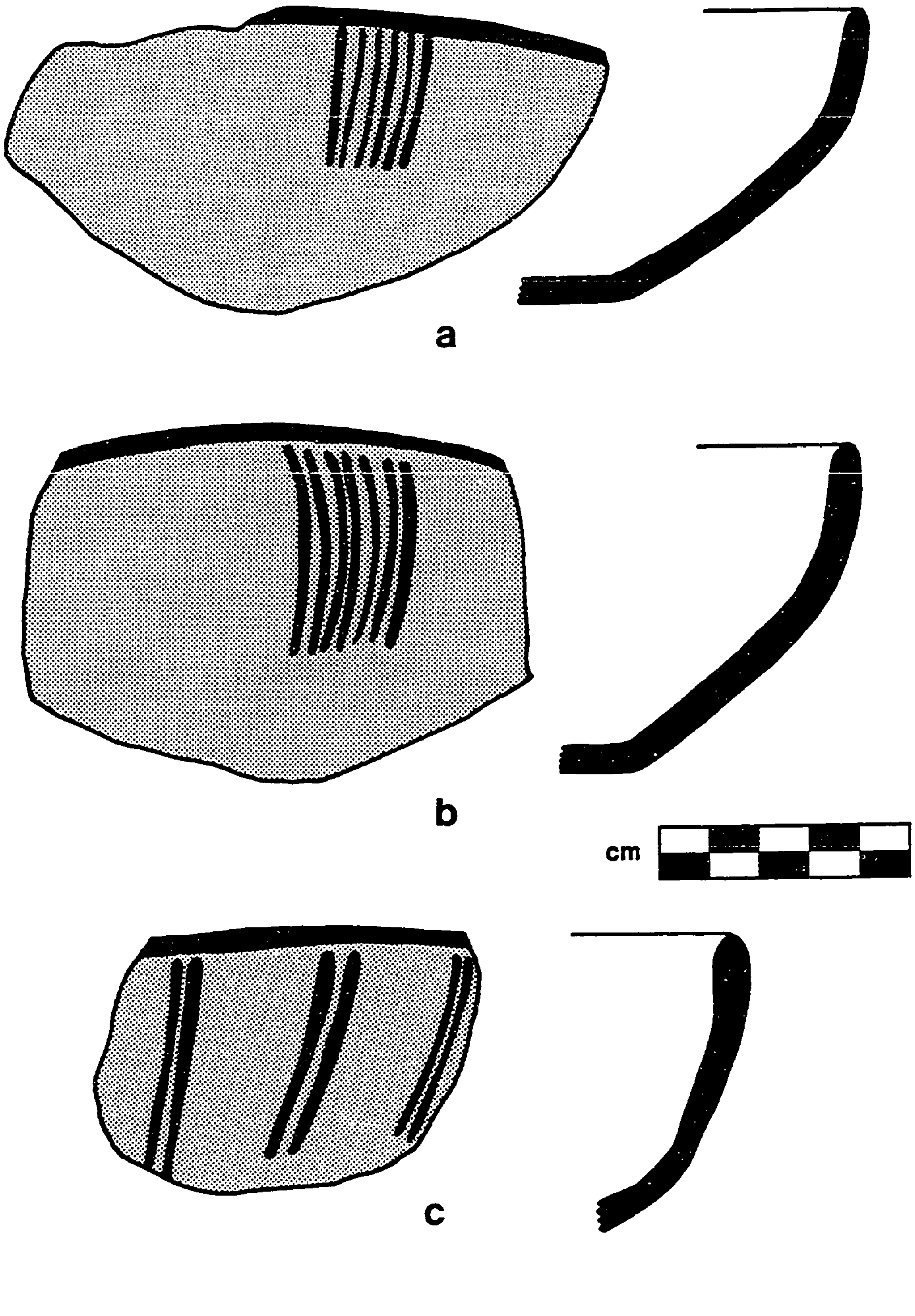


Figure III.5. Black/Red Bowl Variant C: Subvariant C-1. **a)** TX-A-109, Tl. 22; **b)** TX-A-109, Tl. 47; **c)** TX-A-80, Loc. I.

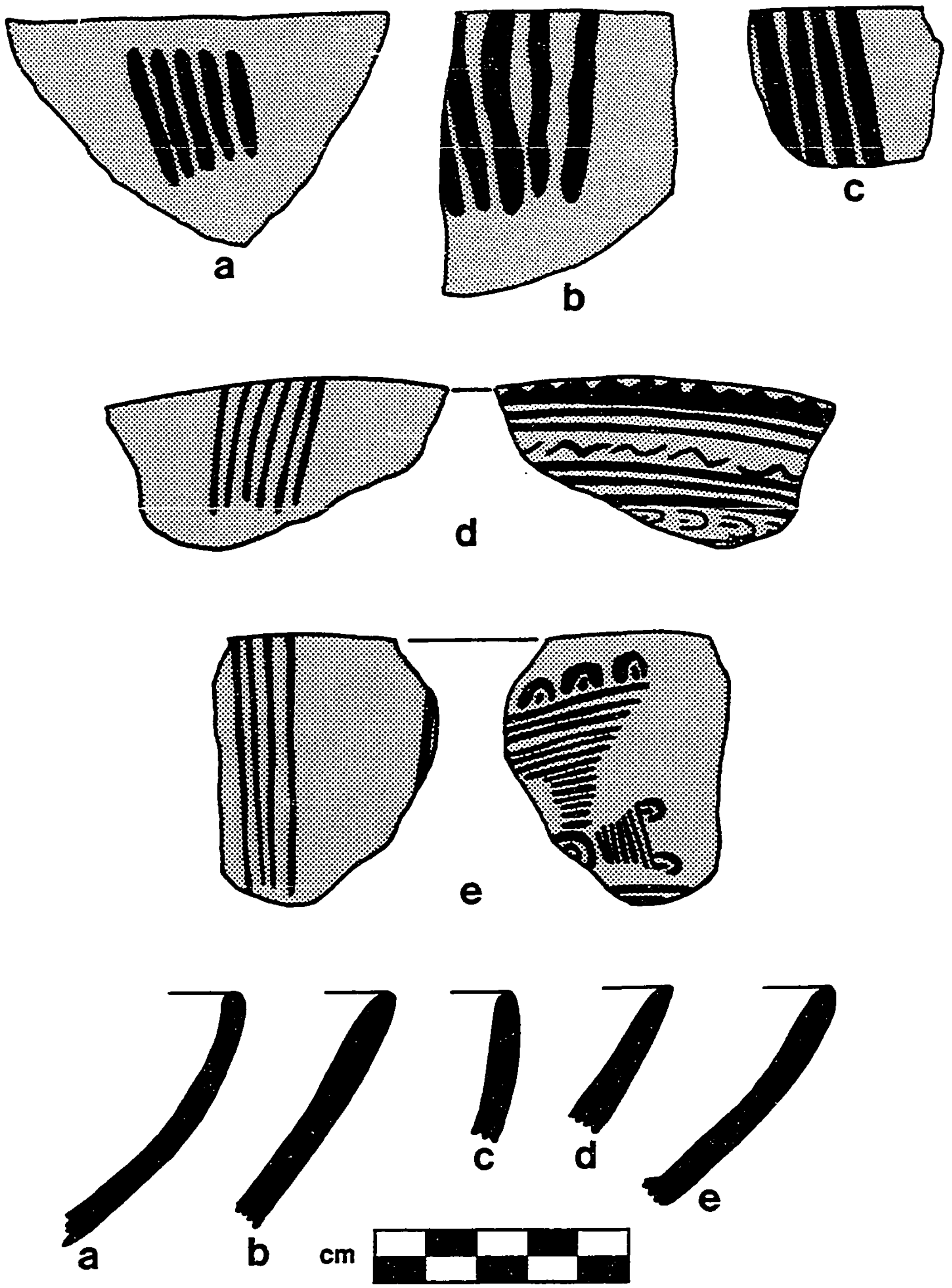


Figure III.6. Black/Red Bowl Variant C: Subvariant C-2. **a**) Mixquic, redrawn from Séjourné 1983, Fig. 154 (scale approximate); **b**) TX-A-24, Tl. 271; **c**) TX-A-24, Tl. 271; **d**) TX-A-72, Tl. 345; **e**) Huexotla, UMMA No. 31079.

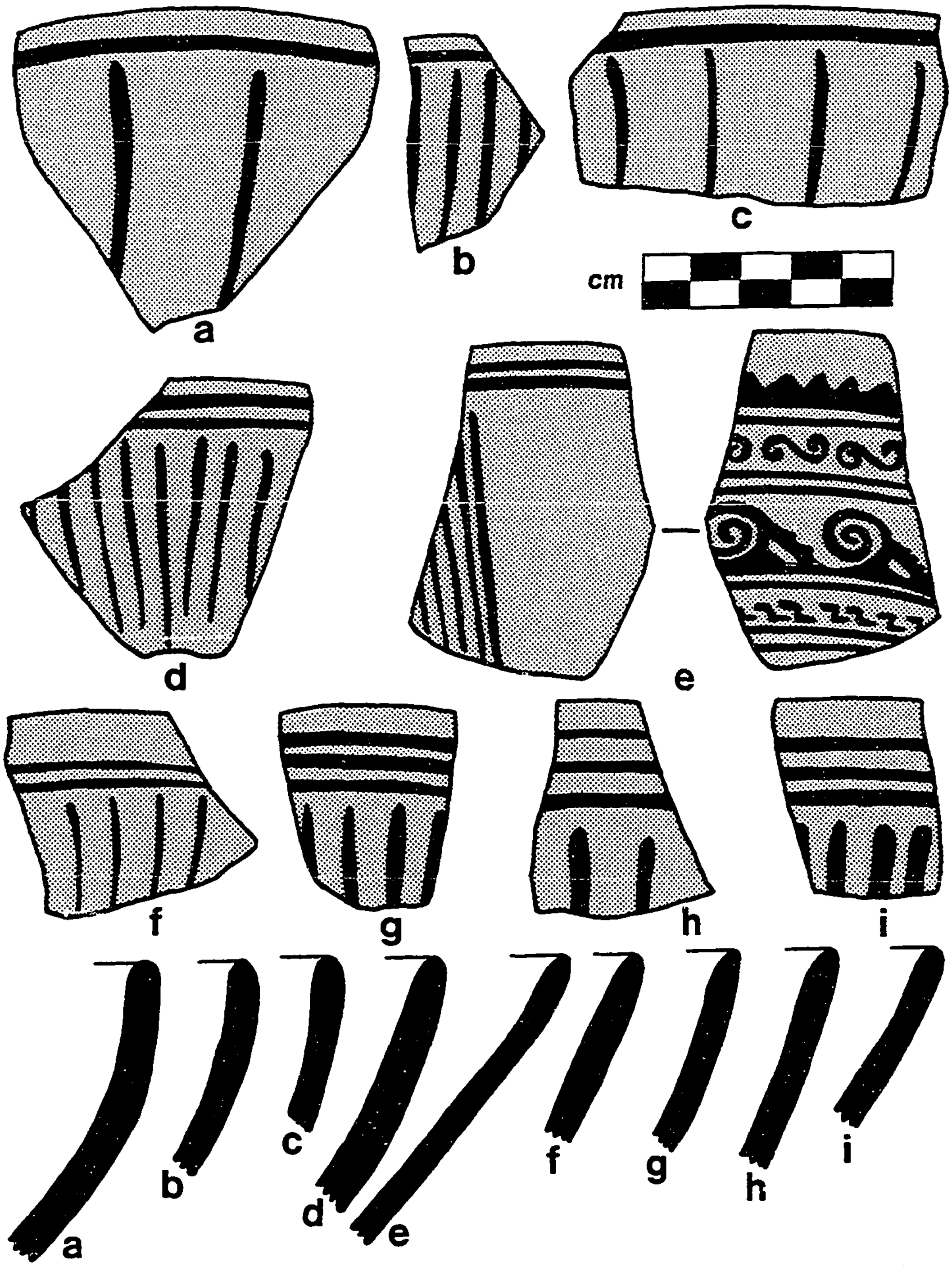


Figure III.7. Black/Red Bowl Variant D: Subvariant D-1 (a-c), Subvariant D-2 (d-f), and Subvariant D-3 (g-i). **a)** Xaltocan, UMMA No. 60030; **b)** Huexotla, UMMA No. 31058; **c)** Xaltocan, UMMA No. 60030; **d)** IX-A-26, Tl. 116; **e)** TX-A-56, Loc. J; **f)** IX-A-26, Tl. 215; **g)** Huexotla, UMMA No. 31079; **h)** Huexotla, UMMA No. 31058; **i)** Huexotla, UMMA No. 31112.

Figure III.8. Black/Red Bowl Variant E: Subvariant E-1 (a-d) and Subvariant E-2 (e-i). **a**) IX-A-26, Tl. 215 [NAA 220]; **b**) CH-AZ-29, Loc. 18 [NAA 218]; **c**) Xaltocan, UMMA No. 60030; **d**) CH-AZ-29, Loc. 18 [NAA 219]; **e**) IX-A-26, Area 104 [NAA 240]; **f**) CH-AZ-66, Loc. 31 [NAA 242]; **g**) IX-A-26, Tl. 116 [NAA 241]; **h**) CH-AZ-132, Fea. I [NAA 244]; **i**) CH-AZ-132, Fea. I [NAA 243].

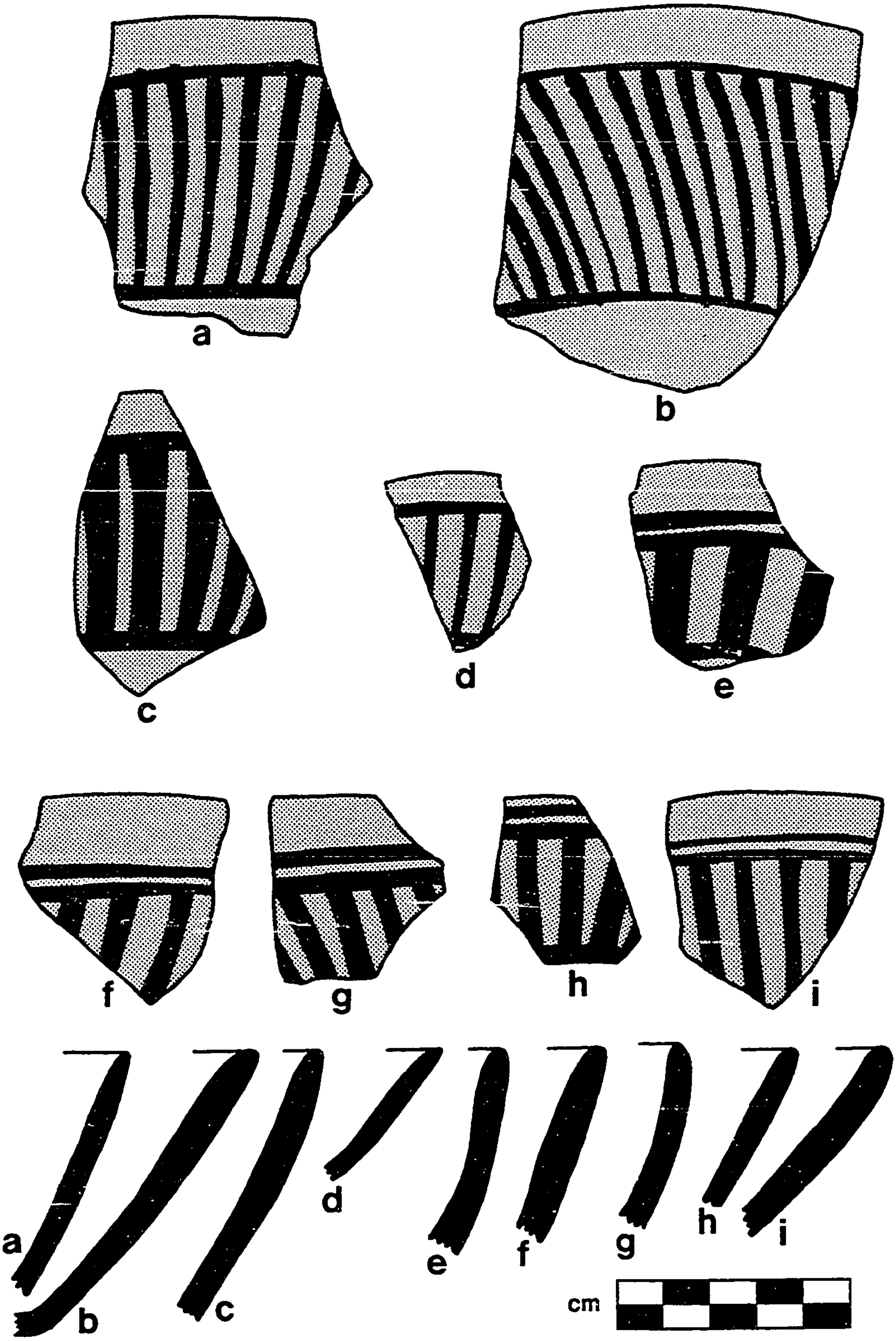


Figure III.8. Black/Red Bowl Variant E.

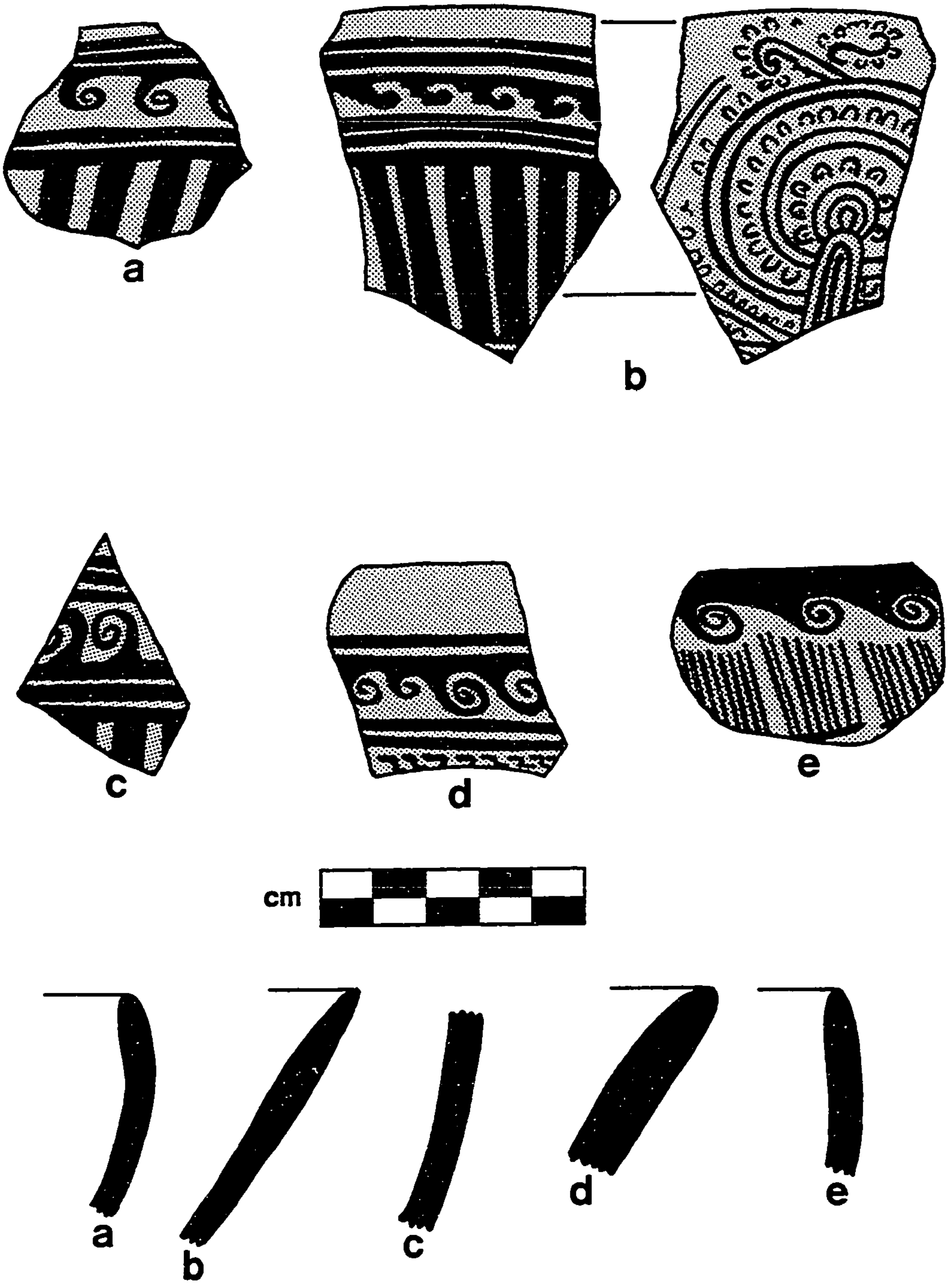


Figure III.9. Black/Red Bowl Variant F. **a)** IX-A-26, Area 103 [NAA 217]; **b)** CH-AZ-31, Loc. 24; **c)** IX-A-26, Tl. 170; **d)** Ch-AZ-41, Loc. 50; **e)** TX-A-109, Loc. 10B.

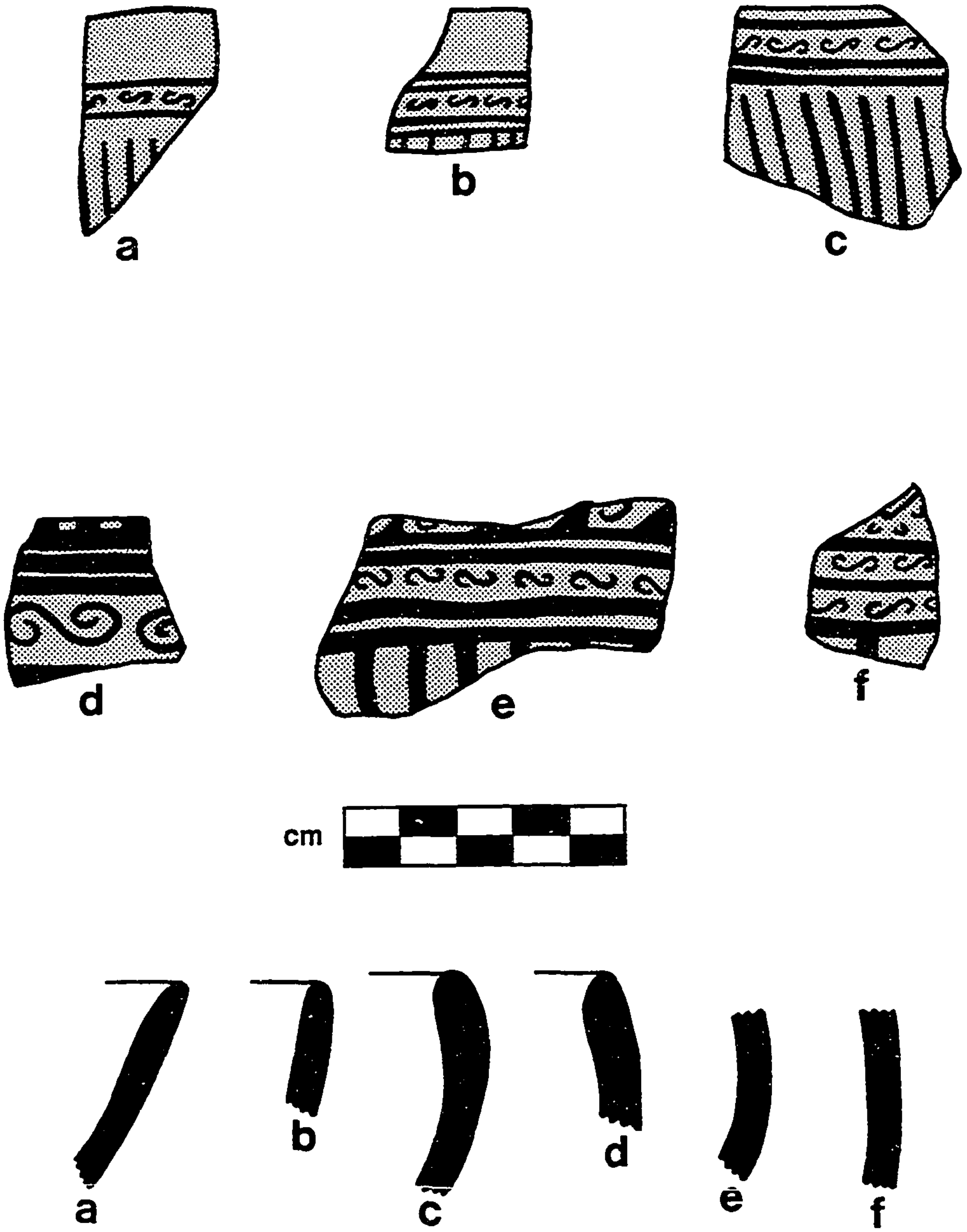


Figure III.10. Black/Red Bowl Variant G. a) Chalco, UMMA No. 30633; b) Chalco, UMMA No. 30633; c) IX-A-26, Area 103; d) TX-A-87, Tl. 51; e) CH-AZ-6, Loc. 103; f) CH-AZ-164, Loc. 100.

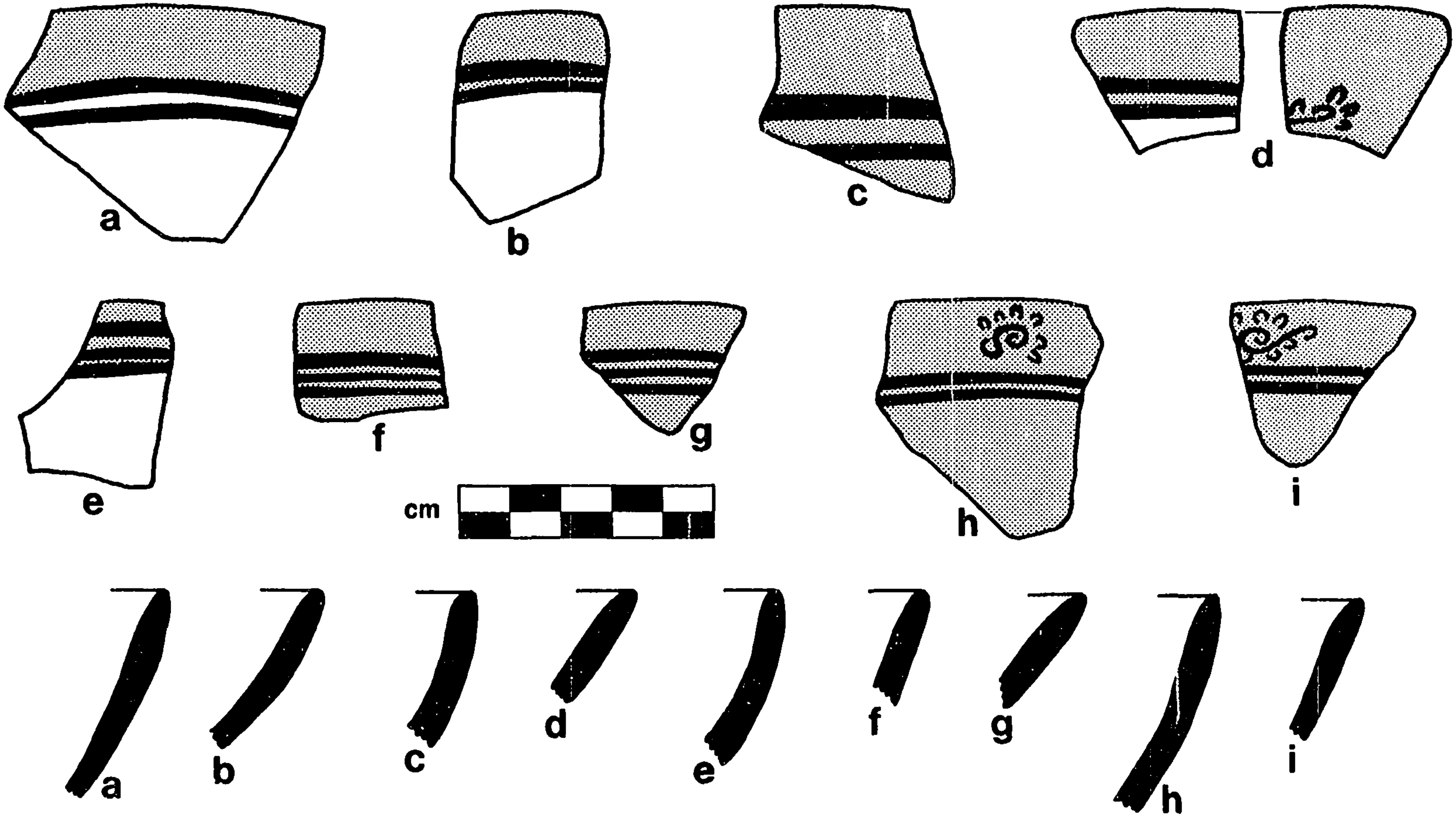


Figure III.11. Black/Red Bowl Variant H: Subvariant H-2 (a-d), Subvariant H-3 (e-g), and Subvariant H-4 (h-i). **a)** CH-AZ-139, Loc. 8 [NAA 256]; **b)** Ch-AZ-41, Loc. 49 [NAA 254]; **c)** CH-AZ-41, Loc. 48 [NAA 255]; **d)** Ch-AZ-41, Loc. 48; **e)** TX-A-87, Loc. C; **f)** CH-AZ-48, Loc. 48; **g)** Chalco, UMMA 30633 [NAA 476]; **h)** Ch-AZ-139, Loc. 8 [NAA 260]; **i)** Ch-AZ-41, Loc. 50 [NAA 259]. White represents unslipped areas.

Figure III.12. Black/Red Bowl Variant I: Subvariant I-1 (a-c), Subvariant I-2 (d-g), Subvariant I-3 (h), and Subvariant I-4 (i). **a**) Ch-AZ-148, Loc. 93 [NAA 245]; **b**) CH-AZ-152, Fea. VV [NAA 246]; **c**) CH-AZ-51, Loc. 65 [NAA 247]; **d**) CH-AZ-51, Loc. 69 [NAA 249]; **e**) CH-AZ-66, Loc. 31 [NAA 248]; **f**) CH-AZ-87, Loc. 32 [NAA 250]; **g**) Ch-AZ-41, Loc. 50 [NAA 251]; **h**) Ch-AZ-67, Loc. 57 [NAA 253]; **i**) TX-A-24, Tl. 303. White represents unslipped areas.

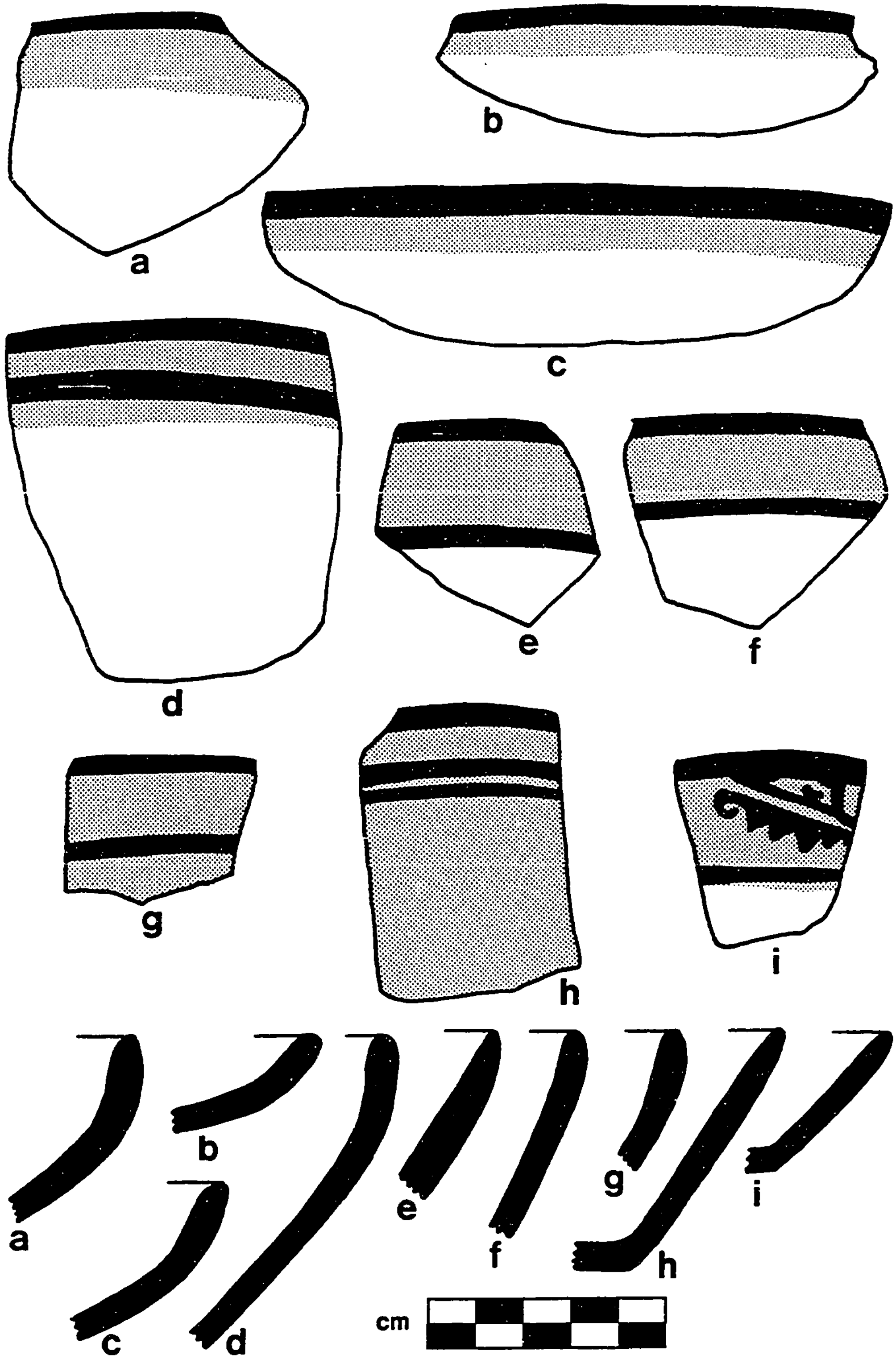


Figure III.12. Black/Red Bowl Variant I.

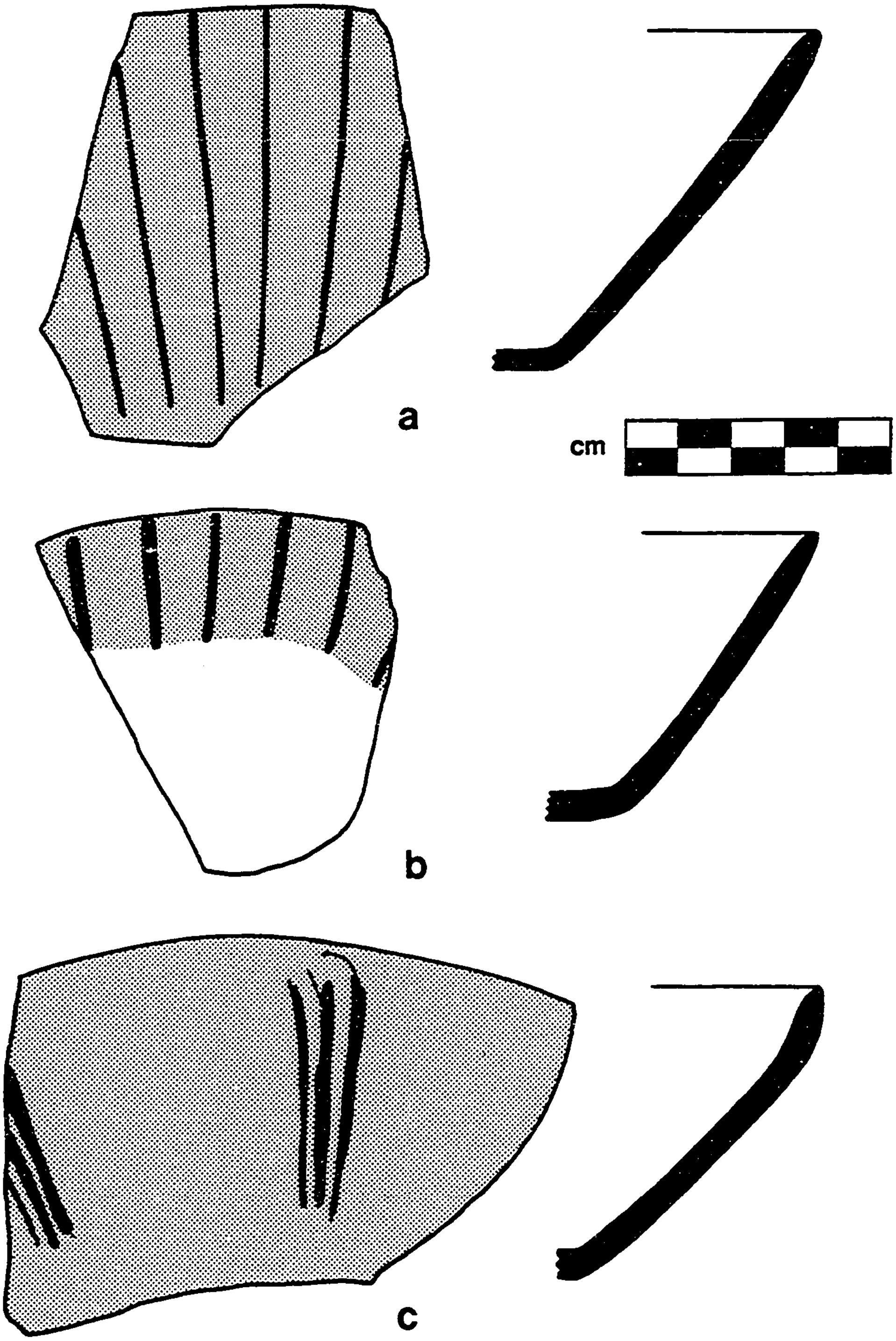


Figure III.13. Black/Red Late Profile Bowl Variant A (a-b) and Variant B (c). **a**) CH-AZ-192, Loc. H; **b**) TX-A-109, TL. 53; **c**) IX-A-26, UMMA No. 82048. White represents unslipped areas.

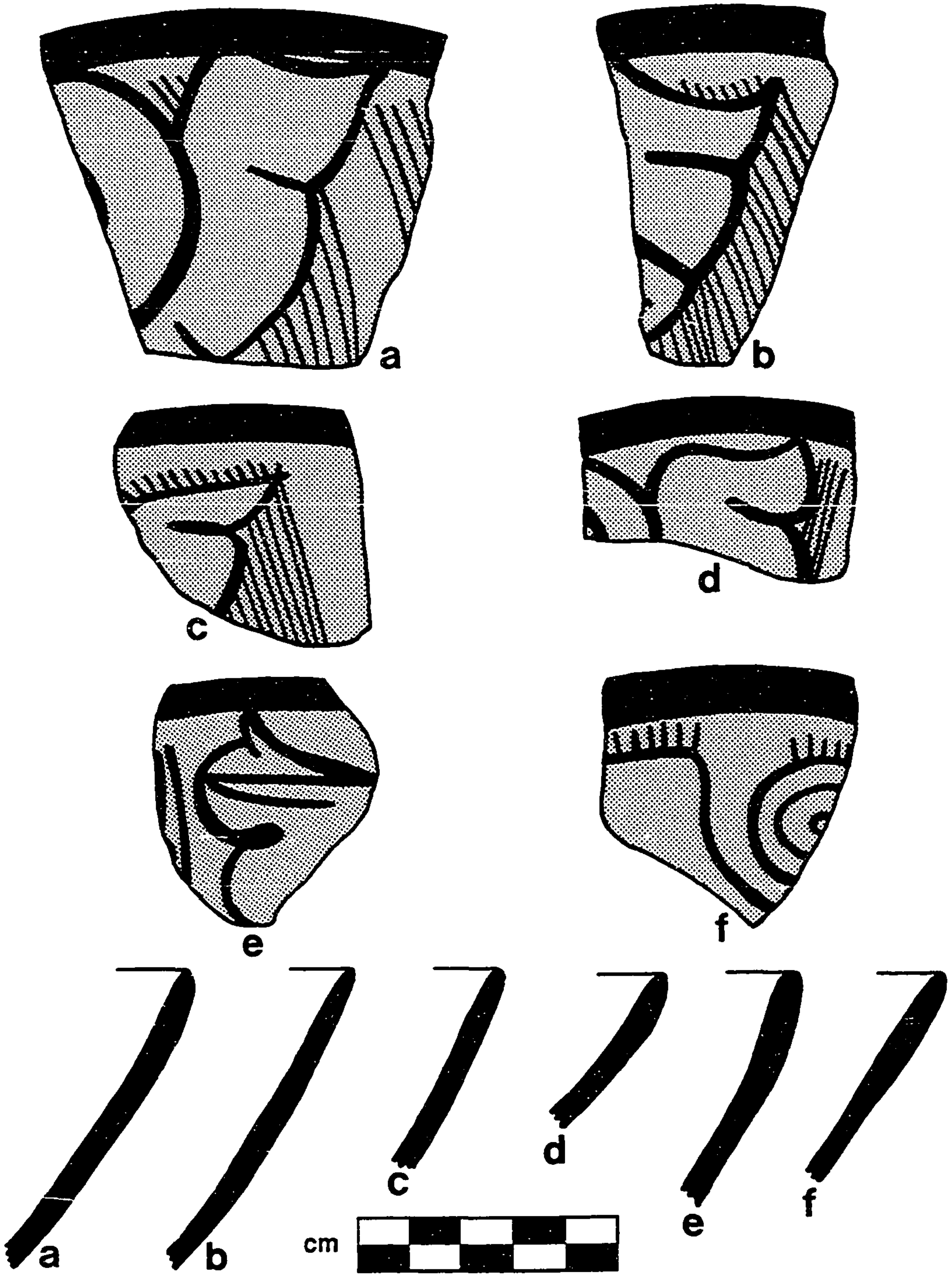


Figure III.14. Black/Red Late Profile Bowl Variant E. **a**) Culhuacan, UMMA 30868 [NAA 382]; **b**) CH-AZ-257, Fea. R [NAA 288]; **c**) CH-AZ-249, Fea. K [NAA 292]; **d**) Culhuacan, UMMA No. 30868 [NAA 383]; **e**) TX-A-56, Tl. 18 [NAA 287]; **f**) CH-AZ-190, Tl. 60 [NAA 286]. The black paint on **a** and **d** is graphite.

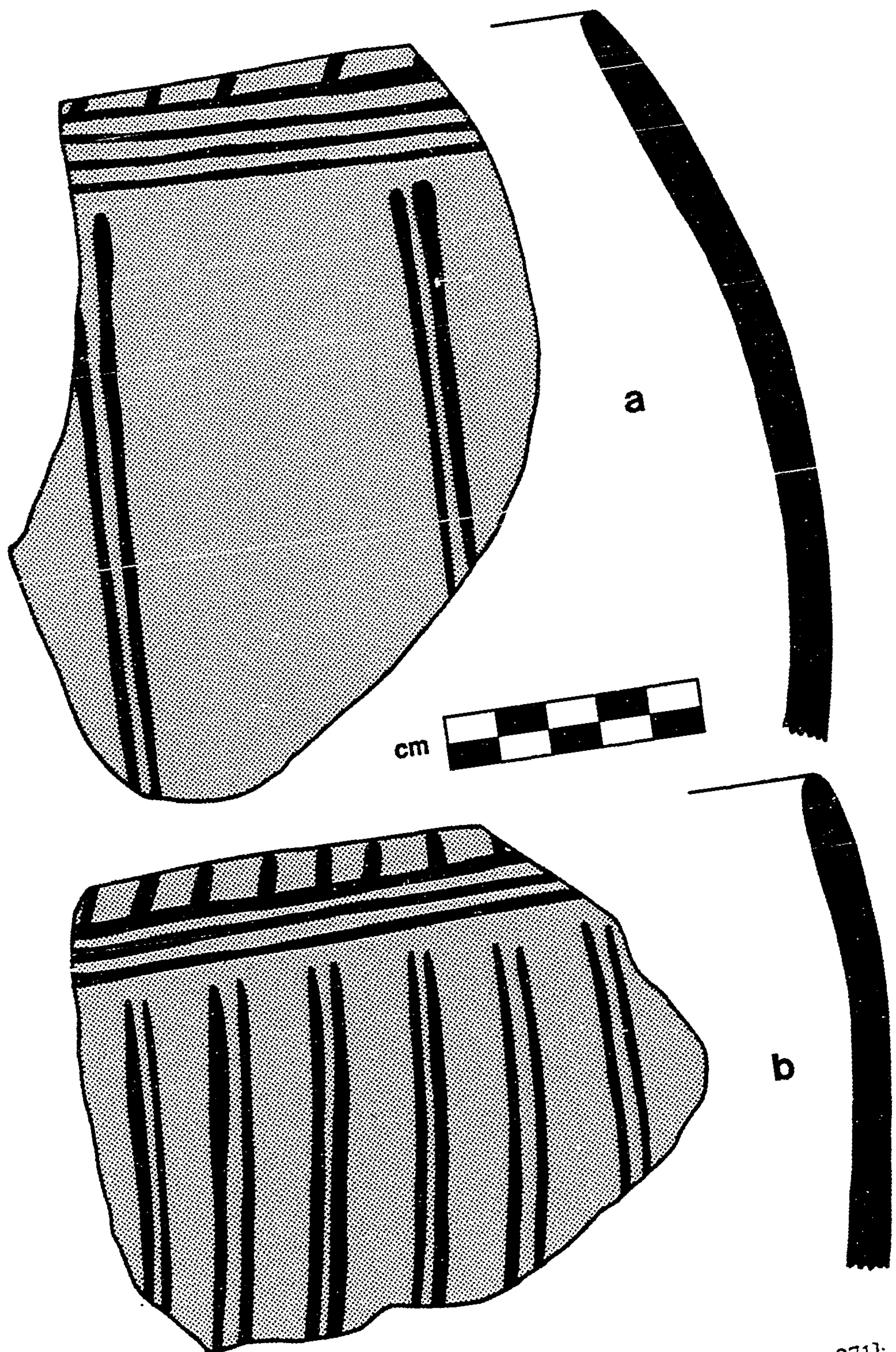


Figure III.15. Black/Red Basin Variant A. a) TX-A-80, Tl. 24 [NAA 271]; b) TX-A-87, Tl. 34 [NAA 270].

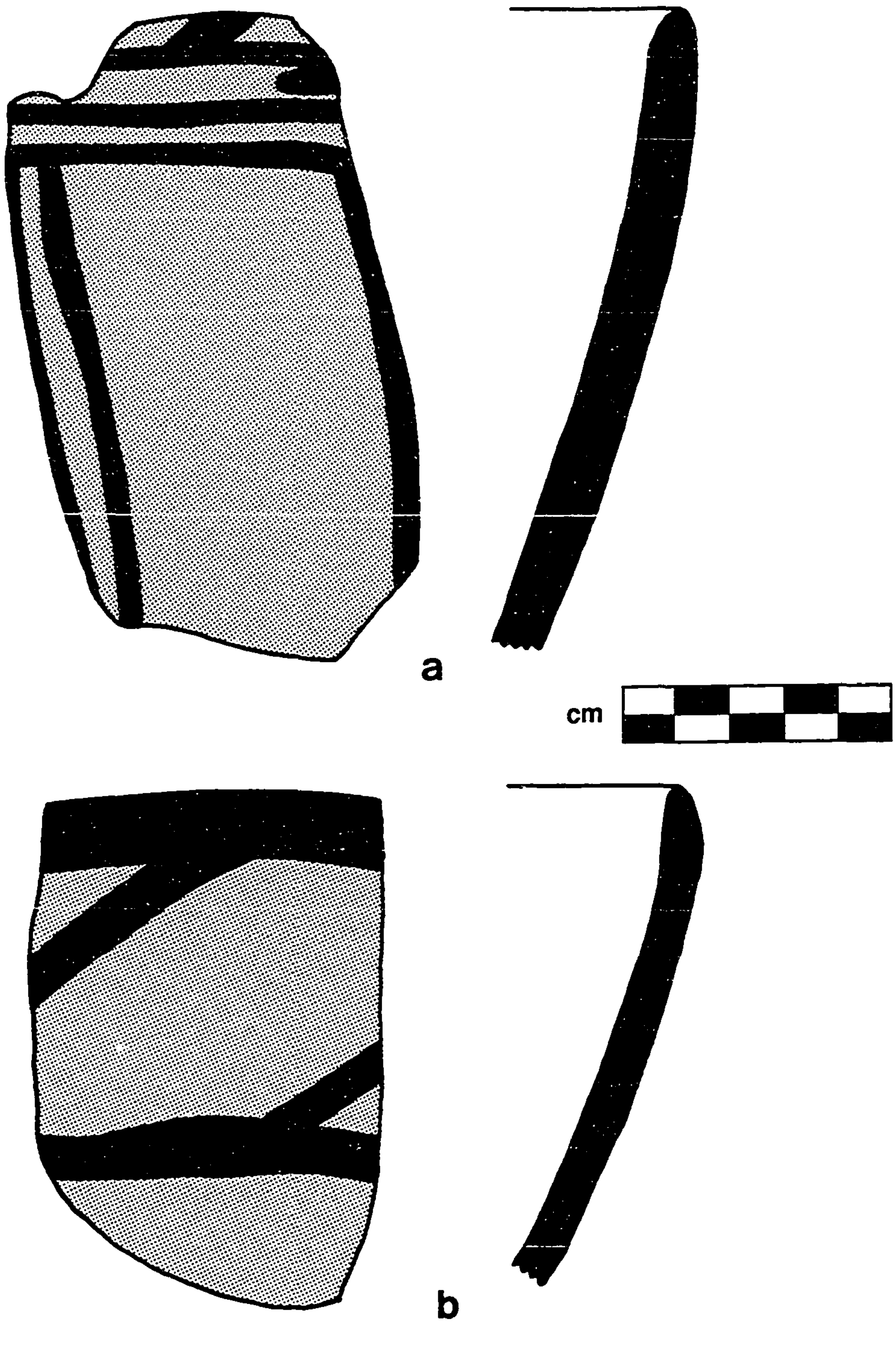


Figure III.16. Black/Red Basin Variant A (a) and Miscellaneous Basin (b).
a) TX-A-87, Tl. 51; b) TX-A-24, Tl. 305.

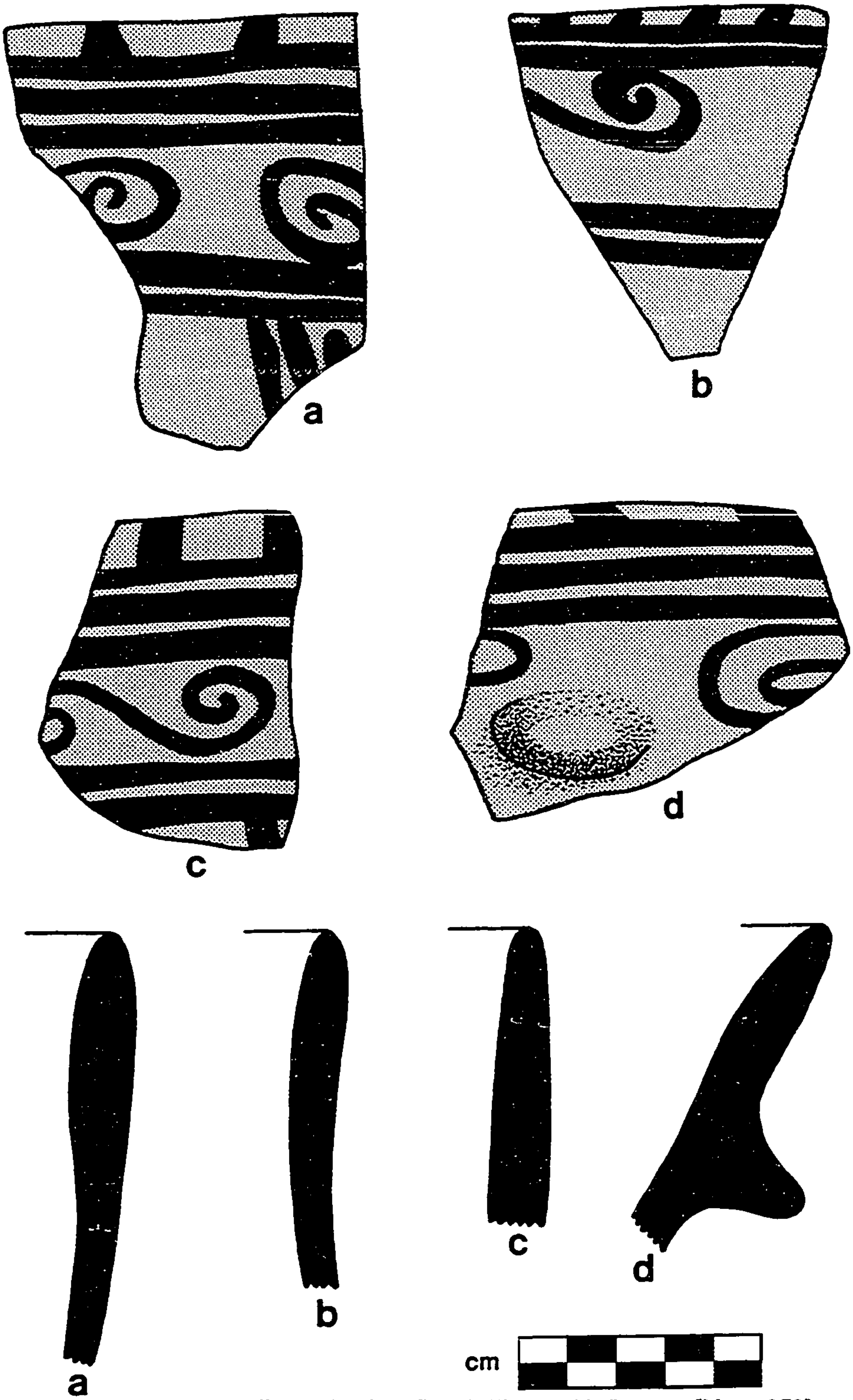


Figure III.17. Black/Red Basin Variant B. **a**) TX-A-100, Loc. 44 [NAA 273]; **b**) TX-A-87, Tl. 53; **c**) TX-A-87, Tl. 49 [NAA 272]; **d**) TX-A-86, Tl. 47.

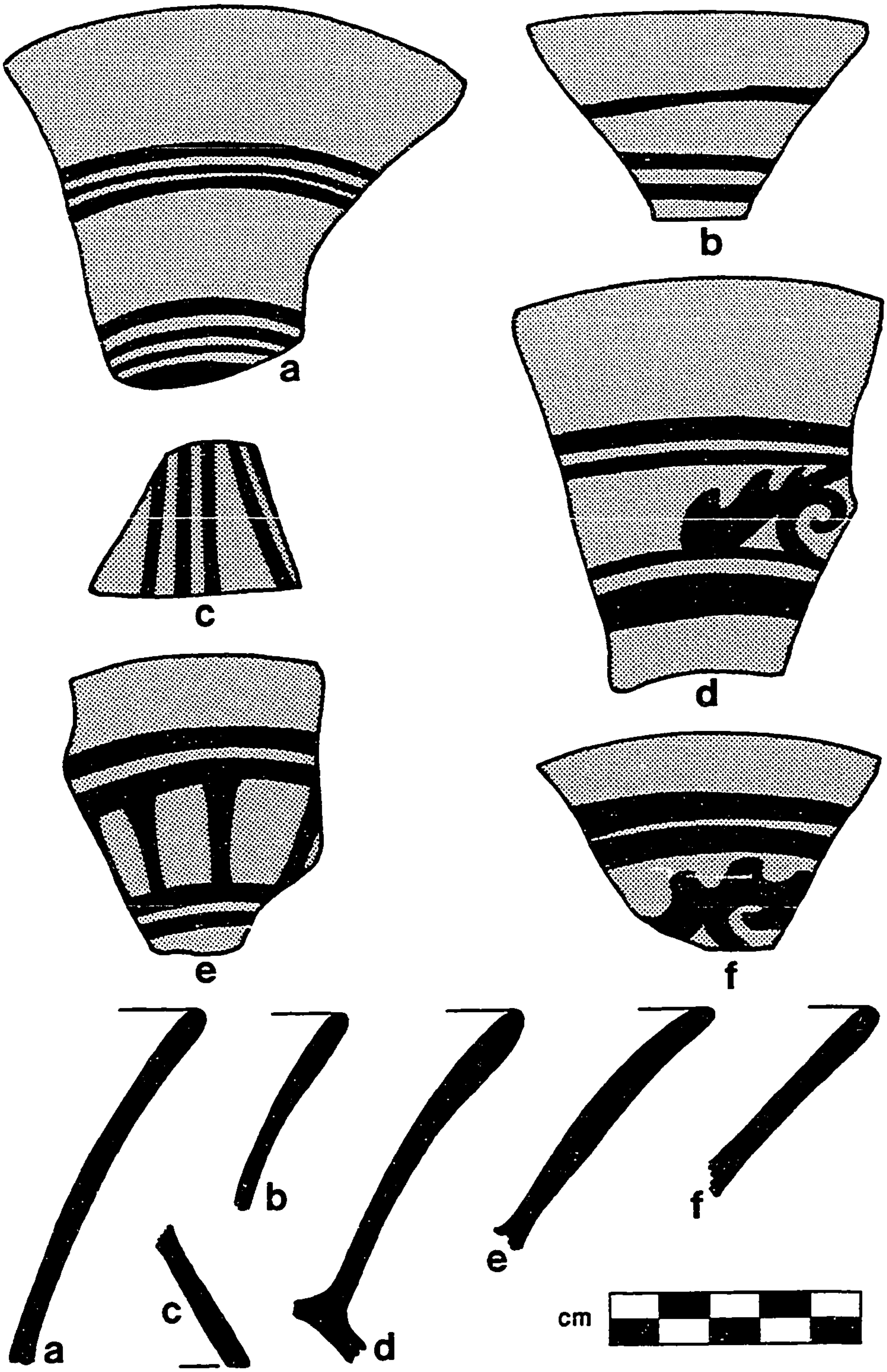


Figure III.18. Black/Red *Copas*. **a**) TX-A-87, Tl. 49; **b**) IX-A-26, UMMA No. 82047; **c**) Huexotla, UMMA No. 31079; **d**) Culhuacan, UMMA No. 30869; **e**) CH-AZ-76, Loc. 39; **f**) Culhuacan, UMMA No. 30869.

Black/Red-Incised Type Descriptions

WARE: **Red Ware**

TYPE: **Black-on-Red Incised or Black/Red-Incised**

VESSEL SHAPE CLASSES: **Bowls and *Copas***

The Black/Red-Incised type combines black painted decoration with fine line incision. The painted designs may be applied in either graphite or black mineral paint. Several authors have argued for distinct Incised Graphite/Red and Incised Black/Red types (O'Neill 1962; M. Smith 1983; Norr 1987b), while suggesting that the use of these pigments may have chronological significance. In the Valley of Mexico sample, however, both graphite and black mineral paint are found on the full range of incised Red ware variants and both pigments continue in use in early colonial times, suggesting that some other factor (such as availability or proximity to source) may have determined the choice of one over the other. As a result, this typology focuses on the organization of the painted and incised designs as the major dimension of variability, and combines both pigments under the rubric of "Black/Red-Incised".

Two major styles of Black/Red-Incised are recognized here: (1) those in which the decoration is exterior and limited to a panel around the upper vessel wall, and (2) those in which a series of repeated incised motifs (canes or scrolls) cover much of the exterior vessel wall and that may bear interior incised and/or painted motifs as well.

Black/Red-Incised as a type belongs to the Early Aztec period (Tolstoy 1958:63-64; O'Neill 1962; Parsons 1966:224). In type collections resulting from O'Neill's stratigraphic excavations at Chalco, Black/Red-Incised with repeated incised motifs (canes or scrolls) occurred in lower levels of the excavation in association with Aztec I Black/Orange. In contrast, Black/Red-Incised with paneled decoration was found only in his upper-most strata associated with a mix of Early Aztec and Late Aztec Black/Orange types. This sequence was supported by quantitative seriations (see Appendix 4, this volume) and suggests that within the Early Aztec period, Black/Red-Incised with canes or scrolls are somewhat earlier than that with panelled decoration. It is interesting to note in this regard that the cane and scroll decorative variants have a higher proportion of recurved rims -- an attribute associated with Early Aztec placement (Parsons 1966:225).

I. Bowls

Vessel form: Simple rounded bowls that range in profile from incurving to outcurving. This type shows a high proportion of slightly recurved rims as well as rims that have a slight interior thickening below the lip.

Paste and firing: Paste is fine- to very fine-textured with many small voids. Paste color ranges from orange to buff and may have a grayish medial core.

Surface treatment: There is great variability in the application of red slip in this type. Vessel exteriors may be slipped entirely red or may bear a band of red slip only around the upper vessel wall. Vessel interiors may be slipped red, left the natural paste color (buff, orange, brown, or gray), or be polished black. This type has a high proportion of black interiors, especially in the decorative variants bearing panelled designs. Exteriors of vessels are generally well polished in the areas to which red slip was applied, while unslipped exterior portions bear obvious burnishing facets. Interiors are usually well smoothed even if unslipped.

Decoration: Decoration consists of a combination of black painted and incised (engraved) designs. The engraving generally appears to have been done after the slip was applied. In most cases, the paint is black mineral paint, but graphite paint also occurs. There is no obvious correlation between design type and the use of mineral vs. graphite paint.

Decorative Variants: Four decorative variants have been defined, two with panelled decoration and two with free motifs.

Variant A. Decoration is exterior and consists of a panel delineated by two horizontal black painted lines encircling the upper vessel wall. An incised line runs around the vessel at the base of the upper black line while the lower black line is outlined by two parallel incised lines. These horizontal lines delineate a red panel several cm wide that contains incised motifs. The characteristic incised motif of this variant consists of several vertical lines bounded by opposed scrolls (Fig. III.19, a). Occasionally the scrolls may stem from the same boundary (upper or lower) as in Fig. III.19, b. The central element of several vertical lines may be modified to contain one or more vertical zigzag lines (Fig. III.19, c).

Variant B. Decoration is exterior and consists of a panel delineated by painted and incised black lines as described above for Variant A. Within the panel and pendant from the upper boundary, the characteristic *xicalcoliuhqui* motif is found, painted in black and outlined by incision (Fig. III.19, d-f). This motif consists of a zigzag diagonal line ending in an upward curl.

Occasionally, the elements characteristic of both Variants A and B may be found on the same vessel (cf. Séjourné 1983, Figs. 157 and 160).

Variant C. Exterior decoration consists of a series of incised canes repeated around the vessel wall. These vessels may have a black painted rim band as well (Fig. III.20, a-c) or the rim may be left red (Fig. III.20, d-h). In the latter case, exterior red slip is frequently limited to a band around the upper vessel wall (e.g. Fig. III.20, d-e). Interior decoration consists of curvilinear black painted motifs roughly outlined with incision (Fig. III.20, d and g). See Séjourné (1983, Fig. 160) for a more complete illustration of interior motifs.

Variant D. Exterior decoration consists of a series of incised long-tailed scrolls or scrolled canes repeated around the vessel wall (Fig. III.21). As in the preceding variant, these vessels may have a black painted rim band (Fig. III.21, a-c) or the rim may be left red (Fig. III.21, d-f). Interior decoration consists of curvilinear black painted motifs roughly outlined with incision (Fig. III.21, f).

II. ***Copas***

Vessel form: Small goblets with a rounded cup and conical pedestal. Cup rim is direct and shows some thickening on the interior.

Paste and firing: Fine textured paste, buff in color.

Surface treatment: Exterior surface is well smoothed and slipped a deep red. Interior surfaces of both the cup and the pedestal are unfinished and unslipped.

Decoration: Decoration is exterior and consists of a narrow black painted rim band above curvilinear or geometric motifs painted in black and outlined with incised lines (Fig. III.21, g and h).

Decorative Variants: Our sample of Black/Red-Incised *copas* was too small to define decorative variants.

Key to Figures III.19 - III.21: Black painted areas are represented with a dark shading film, while red slipped areas are indicated with a lighter shading film. Areas left white on the sherd drawings indicate unslipped portions of the vessel. Incised or engraved lines are indicated in black. NAA numbers refer to sherd identification numbers for instrumental neutron activation (INA) analyses.

Black Paint

Red Slip

Unslipped Areas

Incised Lines

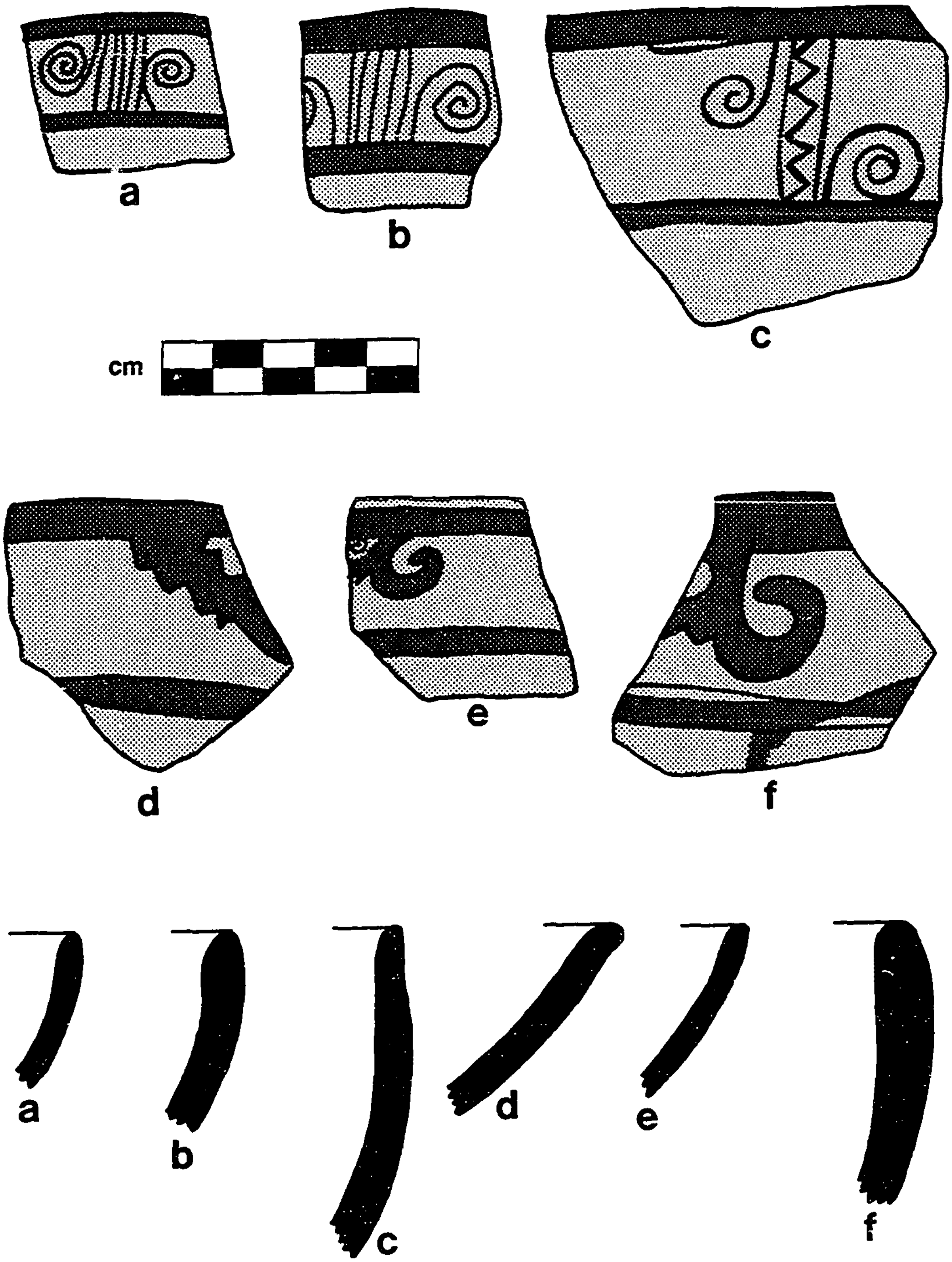


Figure III.19. Black/Red-Incised Bowl Variant A (a-c) and Variant B (d-f). **a**) IX-A-26, UMMA No. 82042; **b**) IX-A-26, UMMA No. 82042 [NAA 201R]; **c**) Huexotla, UMMA No. 31055 [NAA 200R]; **d**) TX-A-87, Tl. 32 [NAA 213]; **e**) IX-A-26, Tl. 170 [NAA 214]; **f**) Huexotla, UMMA No. 31055 [NAA 346].

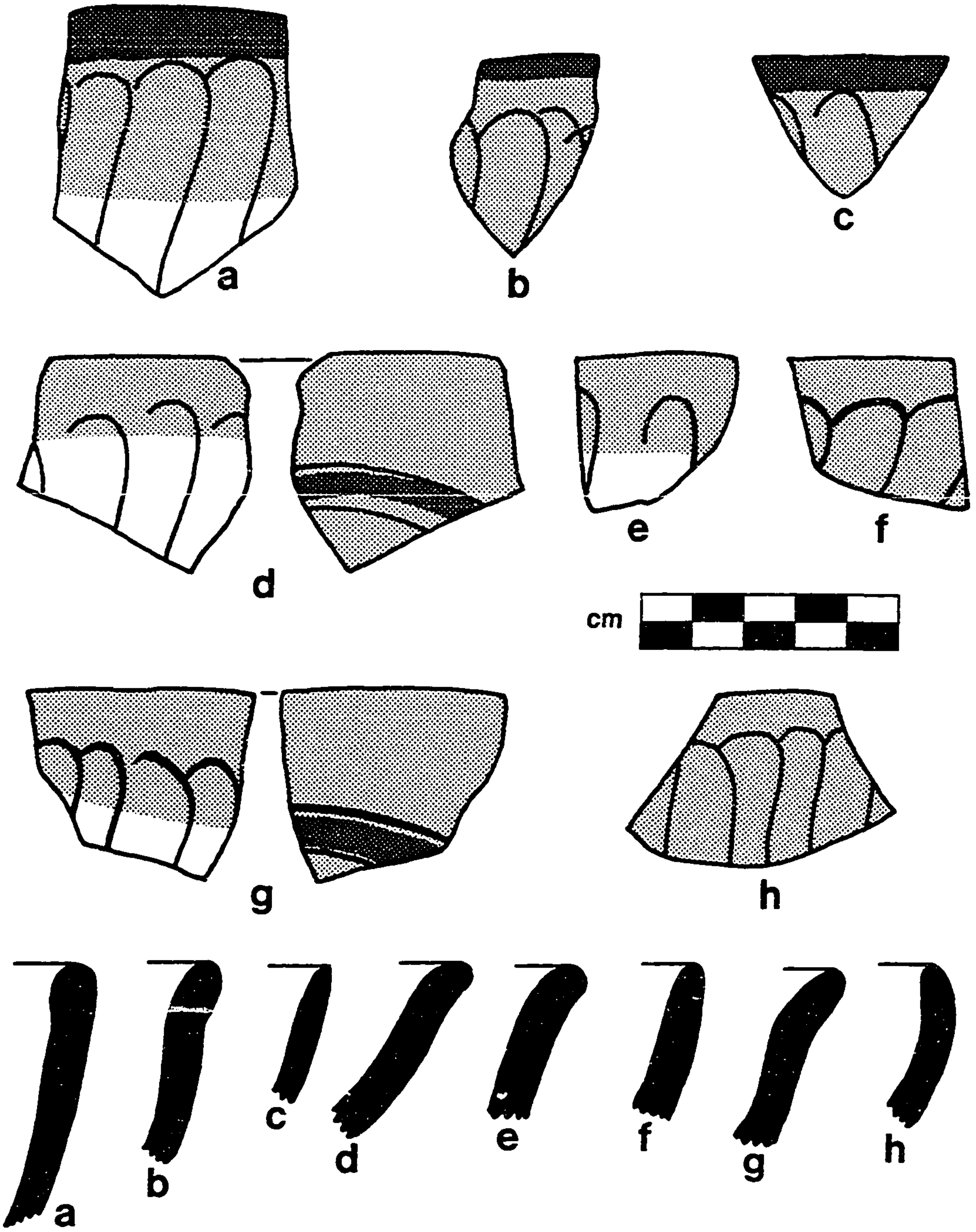


Figure III.20. Black/Red-Incised Bowl Variant C. **a**) Chalco, UMMA No. 30636 [NAA 348], black paint is graphite; **b**) IX-A-11, UMMA No. 82041 [NAA 350]; **c**) CH-AZ-172, Tl. 65; **d**) CH-AZ-172, Loc. Q; **e**) Chalco, UMMA No. 30636; **f**) Chalco, UMMA No. 30636; **g**) Huexotla, UMMA No. 31109 [NAA 349]; **h**) Xaltocan, UMMA No. 60030. White represents unslipped areas.

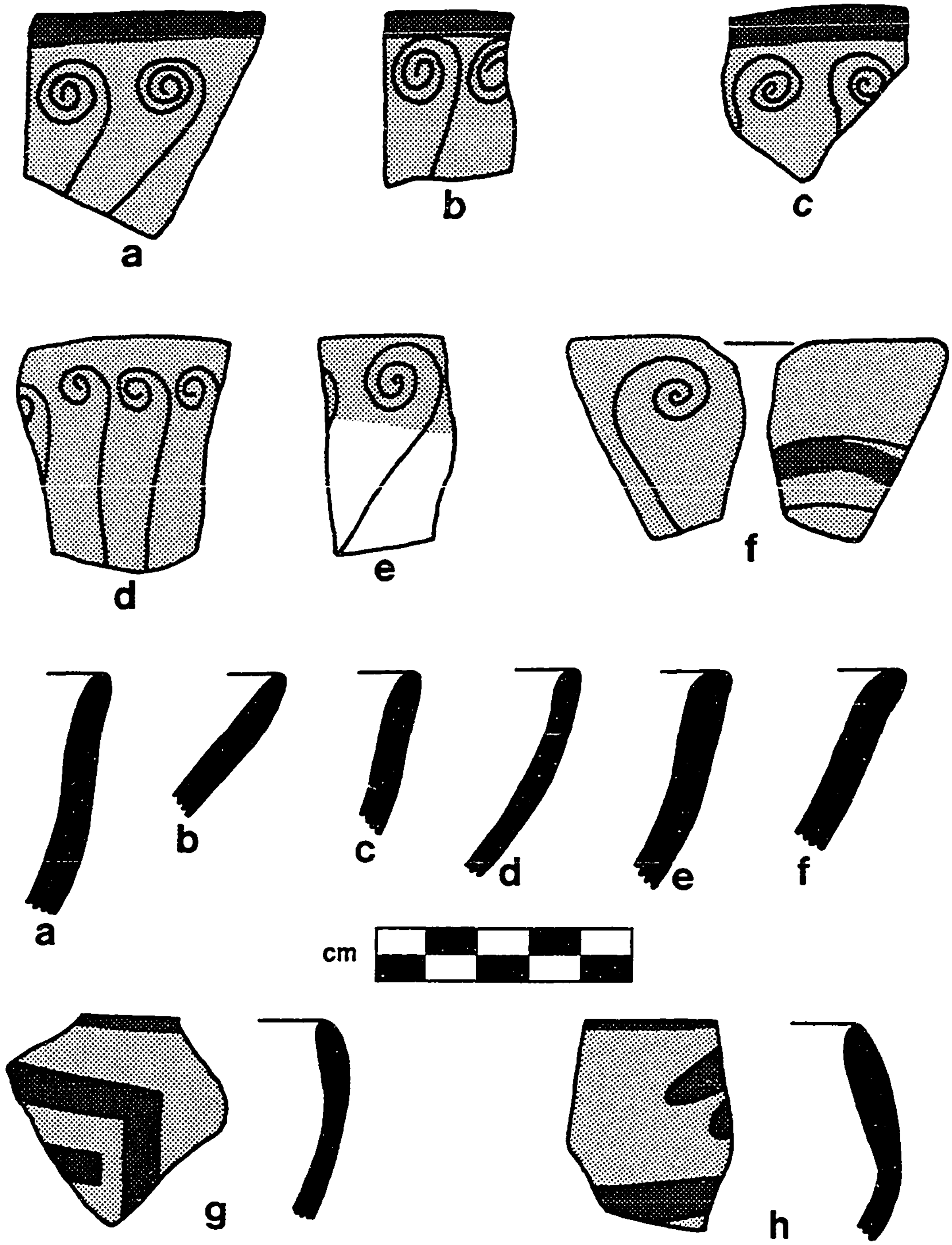


Figure III.21. Black/Red-Incised Bowl Variant D (a-f) and Black/Red-Incised *Copas* (g, h). **a**) Culhuacán, UMMA No. 30865 [NAA 347]; **b**) TX-A-87, Tl. 24; **c**) Huexotla, UMMA No. 31055; **d**) Xaltocan, UMMA No. 60030; **e**) Chalco, UMMA No. 30636; **f**) CH-AZ-111, Loc. 79; **g**) TX-A-87, Loc. D; **h**) TX-A-87, Loc. D. White represents unslipped areas.

Black-&-White/Red Type Descriptions

WARE: **Red Ware**

TYPE: **Black-and-White-on Red or Black-&-White/Red**

VESSEL SHAPE CLASSES: **Bowls and *Copas***

The typology for Black-&-White/Red bowls is based on the work of J. Parsons (1966) for the Teotihuacan Valley. In this typology, like that of Parsons, the definition of variants is based on the organization of design as laid out by black painted designs and motifs. The white motifs in this type generally occur as filler or embellishments, applied after the design structure has been established by the red and black spaces. Less attention has been paid to white motifs, since the white paint abrades easily and these motifs are often fugitive or entirely eroded away.

In refining the basic categories set out by Parsons (1966), I have focused on three areas. First, I have attempted to subdivide his types where possible based on finer distinctions in the organization of black painted design. For example, I have distinguished between vertical and oblique black and red panels (combined by Parsons into Variant B and separated here into Variants B and C) and I have consistently considered the placement of the design relative to the rim, i.e. whether the black design begins at the rim (black rim) or below the rim (red rim). Second, I have taken into consideration variability in vessel profile and rim form (see below) and have cross-tabulated all sherds by both design variant and vessel form. Third, I have recorded white motifs where preserved, in order to relate this finer level of design variability to both overall design structure and vessel form.

Finally, I have attempted to present the typology as a logical subdivision of overall design structure, where the variants represent distinct organizational frameworks (e.g. vertical vs. horizontal) and the subvariants represent modifications of that basic plan. While this approach may seem somewhat mechanical, I hope that the logic of the typological units will lead to improved consistency and reproducibility in ceramic classification.

Tolstoy (1958:63) originally assigned the Black-&-White/Red type as a whole to the Early Aztec period, based on his seriation of surface collections. Parsons (1966:239-240) identified few temporal trends in this type, but also concluded that most of his variants belonged to the Early Aztec period. Brumfiel's (1976:75, Fig. 2a) multidimensional scaling seriation of decorated types at Huexotla similarly concluded that all Black-&-White/Red types included in her analysis belonged to the Early Aztec period.

Chronological subdivisions of this type are possible, however, through a consideration of vessel form, as discussed below. The Black-&-White/Red type includes a range of simple rounded bowls dating to the Early Aztec period but also has an abundance of "Late Profile" bowls as well. It is disturbing to note that design variants completely cross-cut these differences in vessel form, i.e. a design can occur on a range of distinct vessel forms. The distribution of decorative variations vis-a-vis vessel morphology is not uniform; where preferences exist between design variants and vessel forms they have been noted.

I. Bowls

Vessel form: There is considerable variety in bowl forms within the Black-&-White/Red type that cross-cuts design variants. Most vessels are simple rounded bowls with walls ranging from slightly incurving to outcurving, with a gentle basal angle, and flat or slightly dimpled base. Occasionally the vessel walls are more outsloping than outcurving, in which case the basal angle is more pronounced. Wall thickness is fairly even from lip to base. On these vessels with rounded profiles, the rim may take one of three forms: (1) simple with a rounded, direct lip (**direct**); (2) slightly thickened on the interior wall just below simple, rounded lip (**interior thickened**); or (3) slightly recurved (**recurved**). These three bowl forms are associated with the Early Aztec period (see Appendix IV).

In addition to the above form categories, **Late Profile** bowls are found as well and in higher proportions than in the Black/Red type. These vessels have thin, outsloping walls and **exterior thickened** rims that show a slight exterior bulge below the rim above which the lip is thinned. Vessels of this form are definitely late (judging by association with Black/Orange types), as are the extremely thin-walled bowls associated with Variant G.

Paste and firing: In the simple rounded bowls, paste ranges from buff to red-brown in color, and frequently contains a gray-to-black medial core. Parsons (1966:228) reports that, in texture and temper, these vessels are nearly identical to the Black/Red type. Temper is fine to very fine, and the paste shows numerous small voids. Late profile bowls have buff surface colors but a dark gray or black medial core that may comprise most of the thickness of the sherd, leaving only a thin veneer of buff paste at the surface.

Surface treatment: On simple rounded bowls, both exterior and interior surfaces generally appear well smoothed, but most show horizontal polishing facets or burnishing streaks. These vessels have been slipped red over all or only part of the exterior surfaces. Areas that were later painted white were frequently not covered with a red slip first. Interior surfaces generally are left the natural paste color or bear a red slip similar to the exterior. A minority of vessels have interior surfaces that appear black or have been smudged a dark gray or brown color.

Late Profile bowls seem generally better smoothed, but burnishing facets are still visible, especially on the interior. Both exterior and interior surfaces have been slipped red. Slip color and texture is highly variable on the Late Profile bowls, ranging from a clear, glossy red to a low gloss or matt maroon. In the later case, the black paint has a purplish or brownish cast to it or may actually appear gray, giving the vessel the appearance of having been poorly fired or misfired.

Decoration: Decoration is exterior and consists of designs laid out over the basal red slip in black mineral paint to create geometric spaces of alternating red and black.

Linear motifs have been applied over both the black and white with chalky, white paint that is often quite fugitive.

Decorative Variants: Eight decorative variants have been defined for Black-&-White/Red bowls, based on differences in the organization (layout and composition) of the painted designs and on associated variability in vessel and rim morphology. Subvariants reflect minor variations in design structure.

Variant AW. Decoration is exterior and consists of two wide black bands that encircle the vessel near the rim and at the base of the vessel wall. Within the panel so defined, wide diagonal black lines divide the space into triangles (Figs. III.22 and III.23). Triangular spaces have been filled with a red slip or with a soft white paint; white fine-line motifs overlie both the black and red areas. Petals (or loops) and/or circles are especially common white motifs over the superior horizontal and diagonal black bands; diagonal combs are also common. The panel of decoration may begin below the lip, leaving a red rim (Subvariant AW-1; Fig. III.22, a-d and Fig. III.23, b) or at the lip, with a black rim band (Subvariant AW-2; Fig. III.22, e-f and Fig. III.23, a).

Most examples appear to have been self-slipped or slipped with natural clay prior to decoration. In these cases, the surface below the decorated panel is the natural paste color (Fig. III.22, a and e). A few vessels have been slipped red over the entire exterior surfaces, but these are definitely in the minority. This variant was included in Parsons' Variant A-wide line (1966:228-229).

Variant AN. Decoration is exterior and similar in organization to that of Variant AW. Two wide black bands encircle the vessel, one near the rim and one at the base of the vessel wall. Within the panel so defined, two parallel narrow diagonal black lines divide the space into triangles (Figs. III.24 and III.25). The spaces between the parallel diagonal lines are filled with red slip, while the triangular areas are painted white. Fine-line white motifs overlie both red and black areas. Dots, circles, and petal motifs (or loops) are common white motifs. The panel of decoration may begin below the lip, leaving a red rim (Subvariant AN-1; Fig. III.24, a-d), or at the lip, with a black rim band (Subvariant AN-2; Fig. III.24, e-g and Fig. III.25).

Like Variant AW, many examples appear to have been self-slipped or slipped with natural clay prior to decoration; the area below the decorative panel is the natural paste color (Fig. III.24, g; Fig. III.25, b). A few vessels have been slipped red over their entire exterior surface, but these are in the minority and generally co-occur with a late profile (Fig. III.24, a-b). This variant was included in Parsons' Variant A-narrow line (1966:228-229).

Variant B. Decoration is exterior and consists of two broad horizontal black bands encircling the vessel at the rim and at the base of the vessel wall. In the panel so defined, broad black bands extend between the two horizontal bands and divide the space vertically (Figs. III.26 and III.27). The areas between the vertical black bands are frequently outlined with white lines and filled with red slip or white paint. White fine-line motifs overlie both black and red areas. Common white motifs include petals/loops, circles, dotted half circles (Figs. III.26-3.27), and diagonal combs (Fig. III.27, e).

Occasionally, the vertical black bands may be serrated (Fig. III.27, a, b, and e). Vessels with this variation are characteristic of the Huexotla area.

The panel of decoration may begin below the lip, leaving a red rim (Subvariant B-1; Fig. III.26), or it may begin at the lip, forming a black rim band (Subvariant B-2, Fig. III.27). Late profiles are more common in Subvariant B-2 (cf. Fig. III.27, f-h). This variant was included in Parsons' Variant B (1966:230-231).

Variant C. Decoration is exterior and consists of two broad horizontal black bands encircling the vessel at the rim and at the base of the vessel wall. In the panel so defined, broad black bands run obliquely between the two horizontal bands and divide the space diagonally (Figs. III.28 and III.29). The areas between the slanted or oblique black bands are filled with red slip or white paint. Black and red areas are frequently outlined with white, while fine-line white motifs overlie both black and red areas. Common white motifs on the superior horizontal band include petals/loops, inverted V's, and circles (Fig. III.28), and scallops (Fig. III.29)

The panel of decoration may begin below the lip, leaving a red rim (Subvariant C-1; Fig. III.28), or it may begin at the lip, forming a black rim band (Subvariant C-2, Fig. III.29). Late profiles are very common in Subvariant C-2 and co-occur with the white scallop motif at the rim (Fig. III.29). Many of these Late Profile vessels seem poorly fired: the black paint has a brown or purplish cast to it, while the red slip is a matt maroon that appears quite soft. This variant was included in Parsons' Variant B (1966:230-231).

Variant D. This variant is characterized by horizontally banded or paneled decoration that begins below the lip, leaving a red rim band. (Horizontal decoration below a black rim band is included in Variant E, below.) Variant D occurred on very few Late Profile vessels (see, however, Fig. III.30, f); it may therefore be one of the earlier Black-&-White/Red variants. Three subvariants have been defined based on the number and placement of horizontal bands.

Subvariant D-1. Vessels appear to have been slipped red over their entire exterior surface prior to the application of black painted decoration. Decoration is exterior and consists of two or three horizontal black bands encircling the upper vessel wall below a red rim band, forming alternating bands of red and black (Fig. III.30). Horizontal white lines outline or subdivide the black and red horizontal bands or may entirely cover a red band to form a band of white. In addition, fine white line designs have been applied over both red and black bands. Common white motifs include loops, circles, lazy-S's, chevrons, and diagonal combs. This subvariant is closely related in organization to Subvariant E-3, but the fine-line white motifs are generally distinct. This subvariant was included in Parsons' Variant D (1966:231-232).

Subvariant D-2. Vessels appear to have been slipped red over their entire exterior surface prior to the application of black painted decoration. Decoration is exterior and consists of two horizontal black bands encircling the vessel, the upper just below a red rim band and the lower at the base of the vessel wall (Fig. III.31). These horizontal lines define a panel that is filled with complex geometric and curvilinear fine-line white motifs. Panel motifs include paisleys, petalled chevrons, and petalled spirals. In addition, white motifs overlie the upper black band and the red rim band. Common motifs on the rim include spikes or inverted V's. This is a low frequency subvariant.

Subvariant D-3. Vessels appear to have been slipped red over their entire exterior surface prior to the application of black painted decoration. Decoration is exterior and consists of two wide horizontal black bands encircling the vessel wall below a red rim band. These black bands may be closely spaced just below the rim or may define a panel containing curvilinear black motifs (Fig. III.32). Fine-line white motifs overlie the black and red areas. The most common motif on the red rim is a series of loops; the most common motifs overlying the black bands are the diagonal comb and circles. This subvariant contains considerable variability and, with a larger sample, could well be further subdivided.

Variant E. This variant is characterized by horizontally banded or paneled decoration that begins at the lip, forming a black rim band. (Horizontal decoration below a red rim band is included in Variant D, above.) There is a high proportion of rims with interior thickening; conversely, Variant E does not seem to co-occur with late profiles. It may therefore be relatively early in the Black-&-White/Red sequence. Four subvariants have been defined based on the number and placement of horizontal bands.

Subvariant E-0. Vessels appear to have been slipped red over their entire exterior surface prior to the application of black painted decoration. Decoration is exterior and consists of a single black band at the rim (Fig. III.33, a-b). White motifs (usually a row of circles) occur in a band immediately below the black.

Subvariant E-1. Vessels appear to have been slipped red over their entire exterior surface prior to the application of black painted decoration. Decoration is exterior and consists of two black bands encircling the vessel, one at the rim and the other at the base of the vessel wall (Fig. III.33, c-f). The red panel so defined is filled with fine white and black motifs. Common filler motifs include stacked chevrons and petalled chevrons. In addition, white motifs overlie the black rim band; vertical tick marks and dotted half circles are common.

Subvariant E-2. Vessels appear to have been slipped red over their entire exterior surface prior to the application of black painted decoration. Decoration is exterior and consists of two horizontal black bands encircling upper vessel wall, one at the rim and the second just below (Fig. III.34). These black bands define a narrow red band. White decoration is restricted to the black bands and the intervening red band. Common motifs include a row of triangles or circles on the rim band and a wavy line with dots or dotted half circles on the red band. This subvariant has been previously described by Parsons (1966:231) as his Variant C.

Subvariant E-3. Vessels appear to have been slipped red over their entire exterior surface prior to the application of black painted decoration. Decoration is exterior and consists of two or three horizontal black bands encircling the upper vessel wall, forming alternating bands of red and black below a black rim band (Fig. III.35). Horizontal white lines outline or subdivide the black and red horizontal bands or may entirely cover a red band to form a band of white. In addition, fine white line designs have been applied over both red and black bands. Common white motifs on the black rim band include triangles, loops, inverted V's and circles. Motifs below the rim are lines of dots or wavy lines alternating with dots or dotted half-circles. This subvariant is closely related in organization to Subvariant D-1, but there is little overlap in the fine-line white motifs. This subvariant was included in Parsons' Variant D (1966:231-232).

Variant F. Vessels appear to have been slipped red over their entire exterior surface prior to the application of black painted decoration. Decoration is exterior and consists of two black bands encircling the vessel, one at or just below the rim and the second at the base of the vessel wall (Fig. III.36). The panel so defined contains wide-line curvilinear black motifs, including the cable motif (Fig. III.36, b-c; see also Séjourné 1983, Lám. XII and Fig. 148), spirals, and scrolls. The wide-line black motifs are outlined or embellished with white decoration. The panel of decoration may begin below the lip leaving a red rim band (Subvariant F-1), or at the rim, forming a black rim band (Subvariant F-2). White scallops are common on the black rim band of Subvariant F-2.

There is a high proportion of late profile vessels included in this variant (Fig. III.36, a-e). The variant should probably be subdivided based on analyses of those motifs present only on late profile vessels (such as the cable), as opposed to the more general class of curvilinear motifs that occur on both early and later forms. Parsons' included vessels of this variant in his Variant G (1966:233 and Pl. 87, a-v).

Variant G. Small bowls with outsloping walls and flat bases. Lips are simple and rounded or slightly thinned. Vessel walls are very thin and very well smoothed, and show a pronounced black core in cross-section. Vessels appear to have been slipped red over their entire exterior surface prior to the application of painted decoration. Decoration is exterior and consists of complex curvilinear black and white painted designs within a panel formed by a black rim band and a black band encircling the base (Fig. III.37). Panel motifs include the cable or twisted ropes (Fig. III.37, b-c), floral elements (Fig. III.37, a and e), or vertical bands. A characteristic attribute of this variant is the very fine vertical white lines or *zacate* placed over the black rim band. Parsons included sherds of this variant in his variants G and I (1966, Pls. 87 and 88).

II. *Copas*

Vessel form: Goblets with truncated-conical bases and conical cups with outsloping to slighting outflaring walls. Where the cup and pedestal join at the neck of the vessel, the interior bases of both portions are flat with well-defined basal/wall angles. The cups have simple rounded to slightly thickened lips, while the lip of the base is squared-off or beveled.

Paste and firing: Well-fired vessels with a fine paste. Unslipped surfaces are pinkish-buff to tan; most vessels show a dark gray medial core.

Surface treatment: Vessels are well smoothed or polished, with a moderate to high luster. Vertical burnishing facets are characteristic of this vessel form. *Copas* appear to have been slipped red over the entire exterior surface. Interior surfaces of the cup may be unslipped or bear a slip only on the upper portion (2-5 cm) of the wall; interiors of the base or pedestal are unslipped and poorly finished.

Decoration: Decoration is exterior; in our limited sample, it consists of a broad black band and/or horizontal lines encircling the neck, with vertical black bands extending to the rim of both base and cup (Fig. III.38). Narrower white lines run vertically from neck to lip and overlie the red slip.

<u>Key to Figures III.22 - III.38:</u> Black painted areas are represented with black; white painted areas are left white. Red slipped areas are indicated with a dark shading film, while unslipped areas are represented with a slightly lighter and coarser shading film. NAA numbers refer to sherd identification numbers used in instrumental neutron activation (INA) analyses.

Black Paint

White Paint

Red Slip

Unslipped Areas

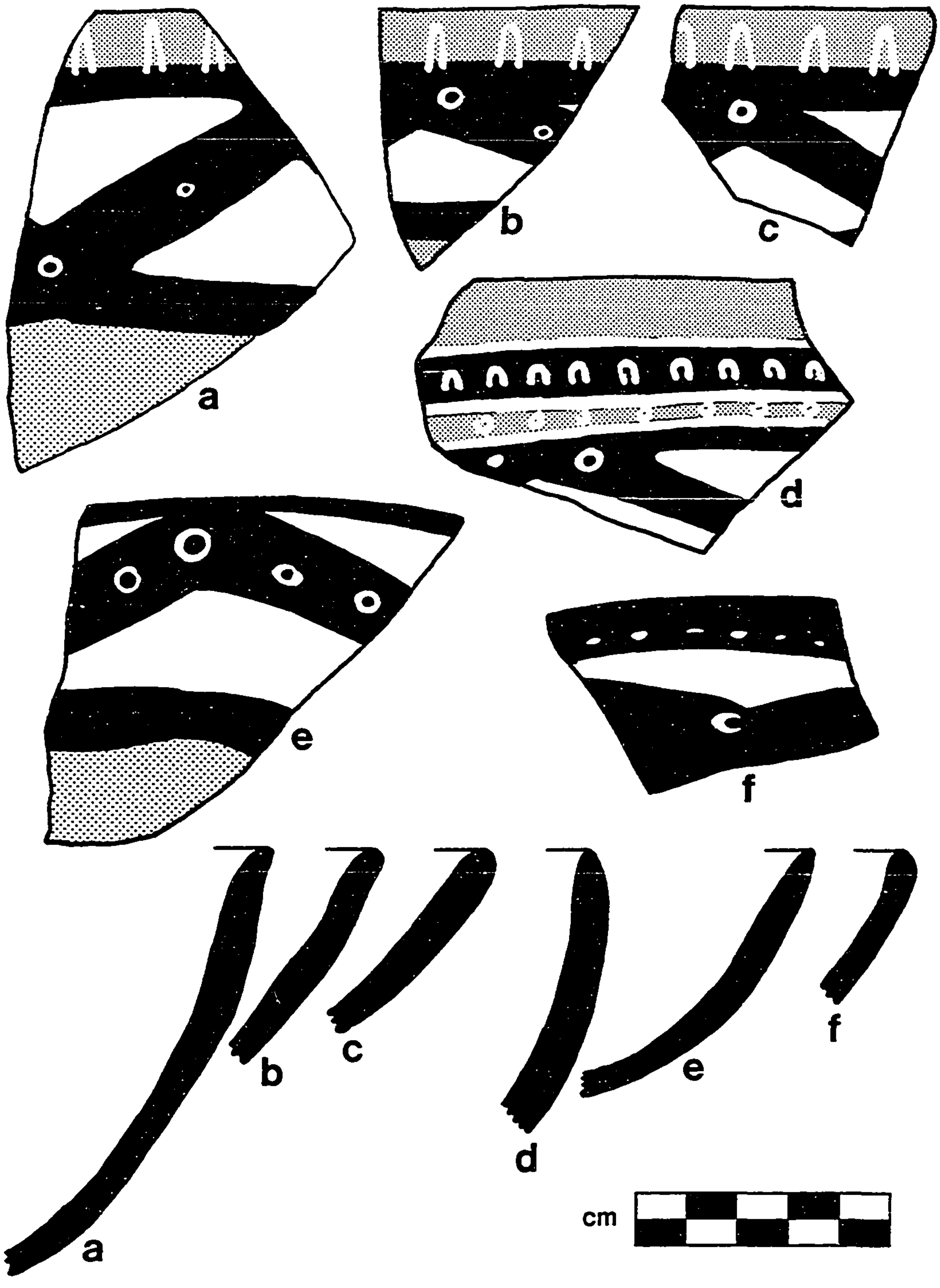


Figure III.22. Black-&-White/Red Bowl Variant AW: Subvariant AW-1 (a-d) and Subvariant AW-2 (e, f). **a**) Huexotla, UMMA No. 31092 [NAA 393]; **b**) Huexotla, UMMA No. 31092; **c**) Huexotla, UMMA No. 31058 [NAA 394]; **d**) Culhuacan, UMMA No. 30866 [NAA 392]; **e**) CH-AZ-172, Loc. Q; **f**) TX-A-87, Tl. 32.

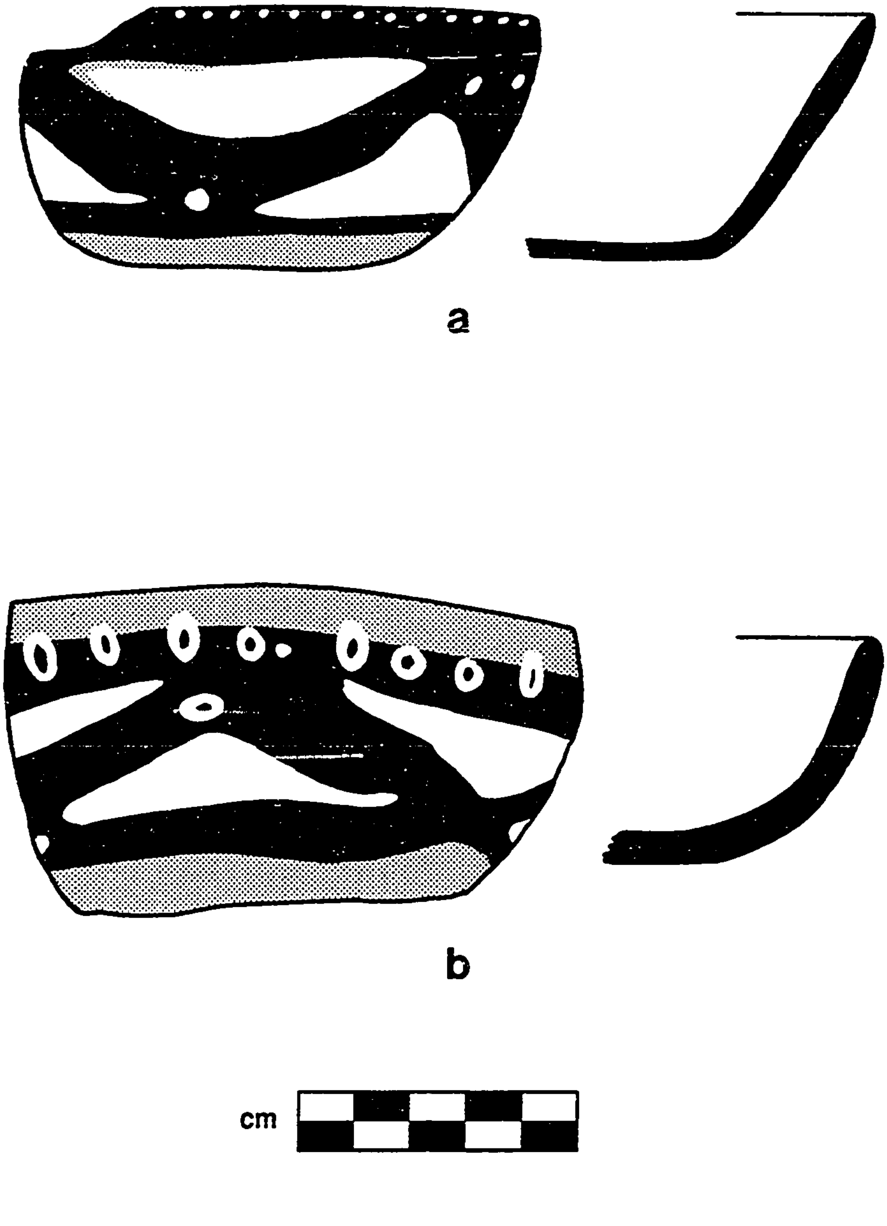


Figure III.23. Black-&-White/Red Variant AW Bowls. **a**) Subvariant AW-2, (Culhuacan, UMMA No. 30869); **b**) Subvariant AW-1 (TX-A-109, Loc. 12).

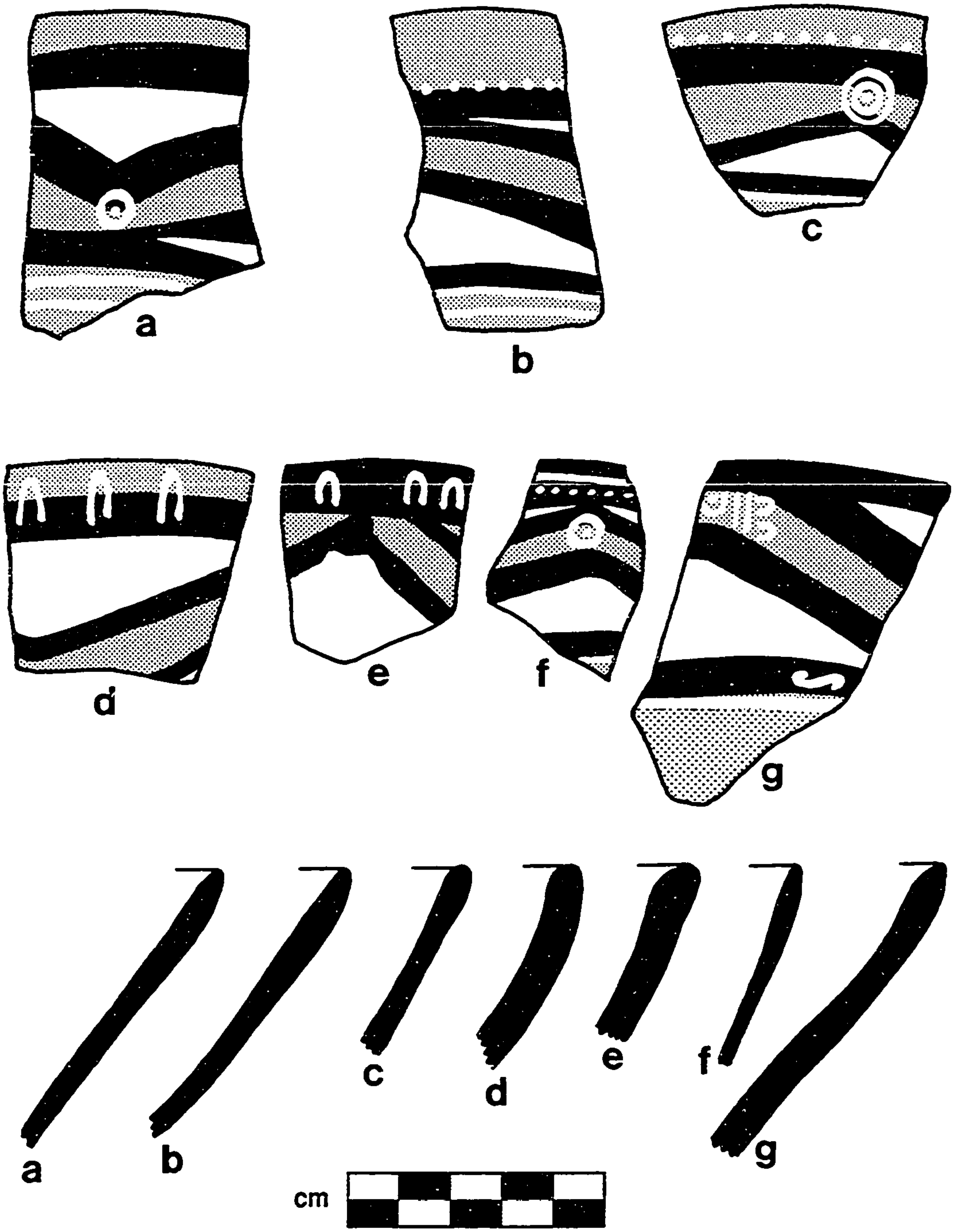


Figure III.24. Black-&-White/Red Bowl Variant AN: Subvariant AN-1 (a-d) and Subvariant AN-2 (e-g). **a)** CH-AZ-192, Loc. B; **b)** Culhuacan, UMMA No. 30866 [NAA 391]; **c)** Culhuacan, UMMA 30870 [NAA 390]; **d)** Huexotla, UMMA No. 31111 [NAA 388]; **e)** Chalco, UMMA No. 30633 [NAA 387]; **f)** Huexotla, UMMA No. 31111 [NAA 389]; **g)** Culhuacan, UMMA No. 30866.

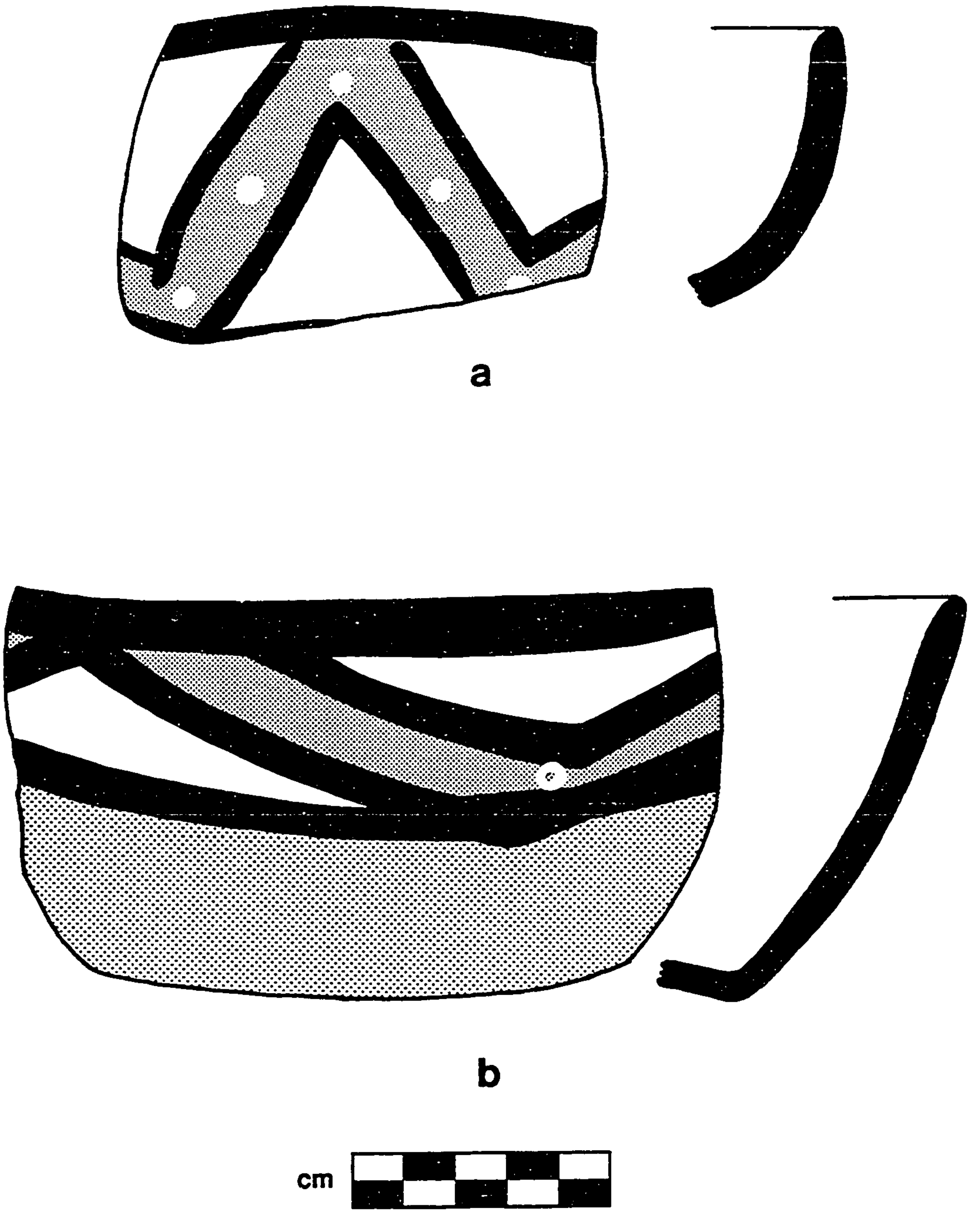


Figure III.25. Black-&-White/Red Bowl Variant AN: Subvariant AN-2. **a**) Huexotla, UMMA No. 31092; **b**) CH-AZ-6, Loc. 103.

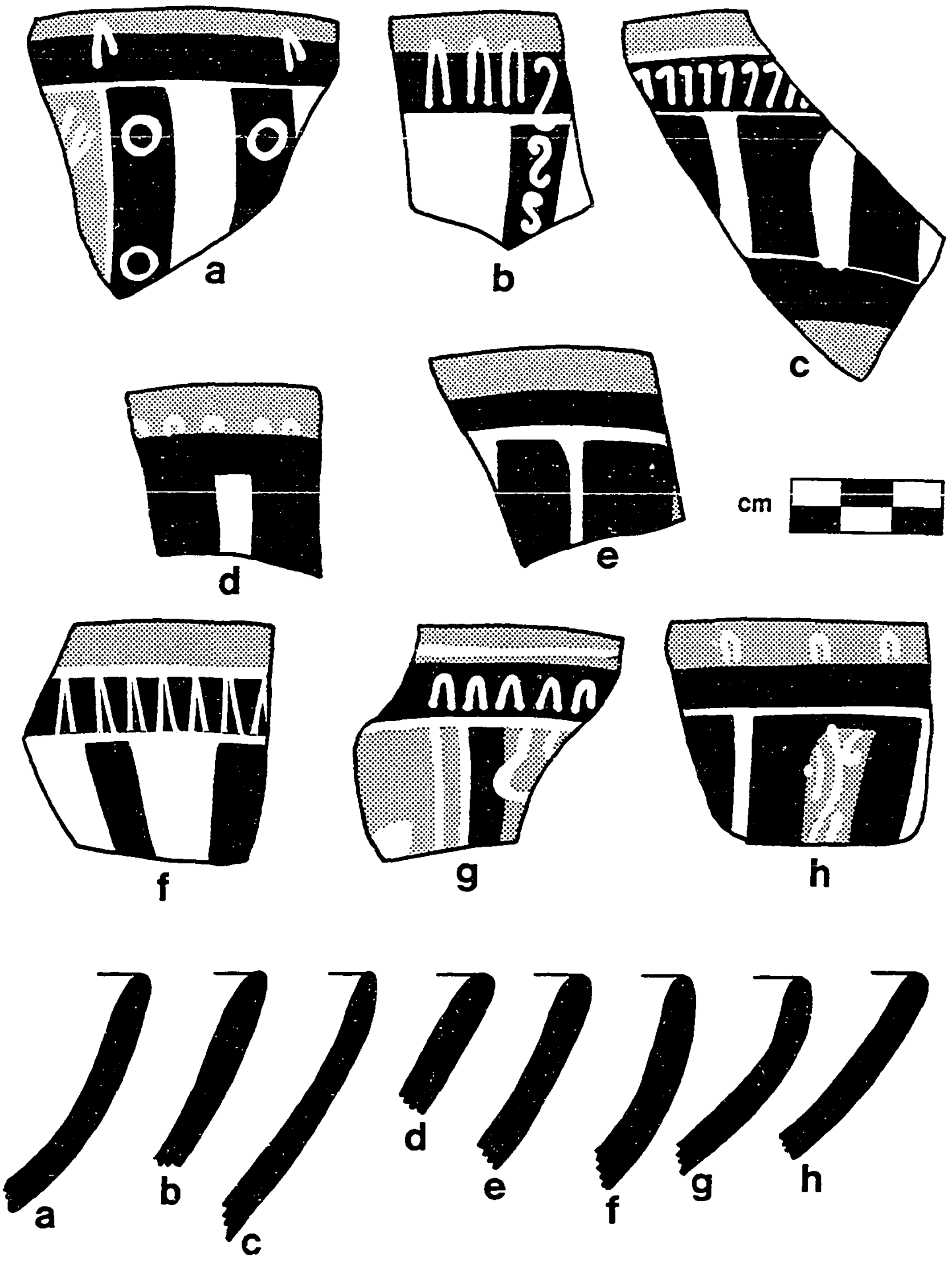


Figure III.26. Black-&-White/Red Bowl Variant B: Subvariant B-1 (a-h).
a) TX-A-87, Tl. 24; **b**) Huexotla, UMMA No. 31058 [NAA 400];
c) TX-A-87, Tl. 32; **d**) TX-A-87, Tl. 32; **e**) TX-A-24, Tl. 305;
f) Huexotla, UMMA No. 31057 [NAA 425]; **g**) TX-A-87, Loc. C;
h) Huexotla, UMMA No. 31057 [NAA 457].

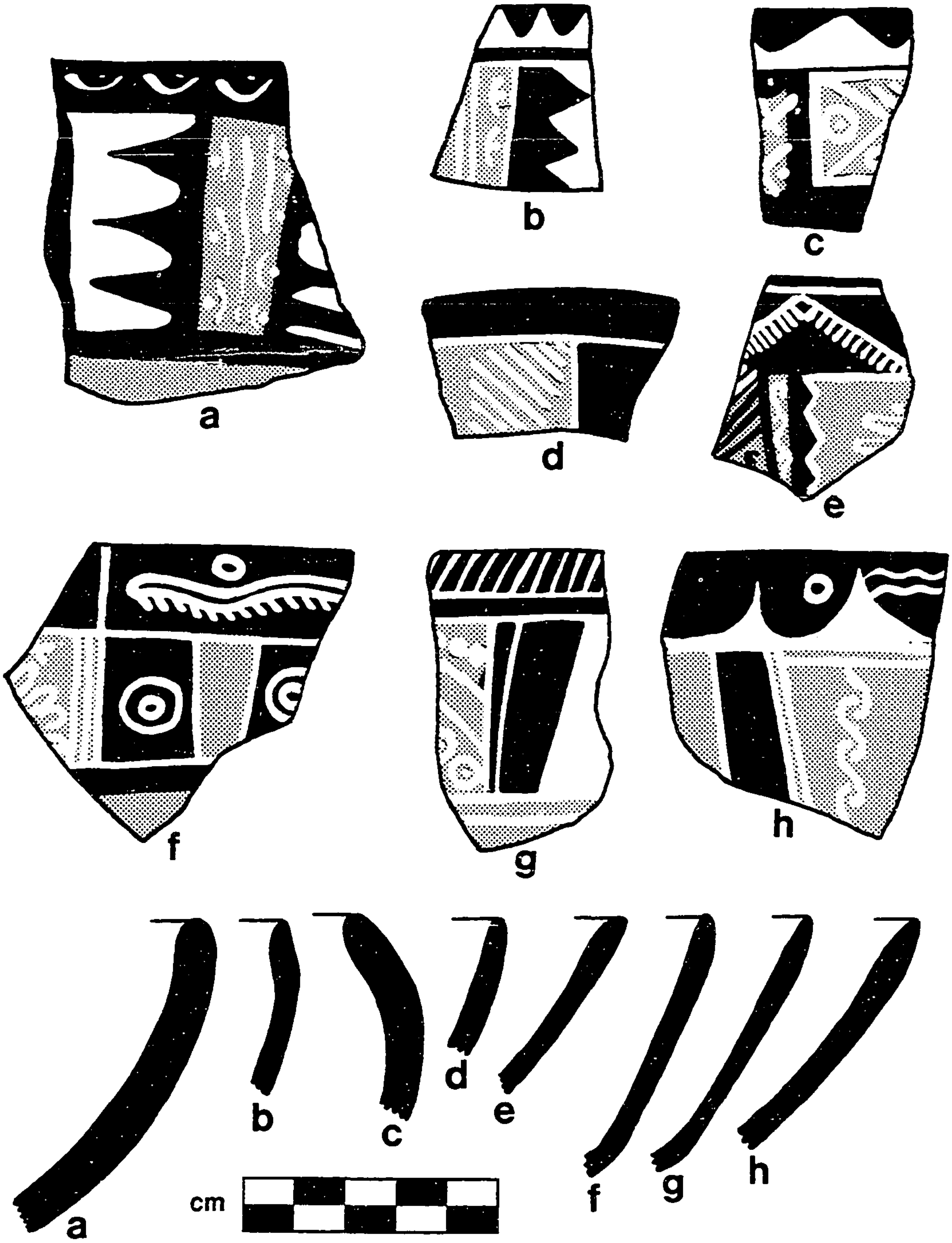


Figure III.27. Black-&-White/Red Bowl Variant B: Subvariant B-2 (a-h). **a**) Huexotla, UMMA 31058 [NAA 399]; **b**) Huexotla, UMMA No. 31092; **c**) Huexotla, UMMA No. 31111 [NAA 398]; **d**) TX-A-87, Tl. 49; **e**) Chalco, UMMA No. 30641 [NAA 397]; **f**) Culhuacan, UMMA No. 30866 [NAA 421]; **g**) Culhuacan, UMMA No. 30869 [NAA 422]; **h**) Culhuacan, UMMA 30869 [NAA 423].

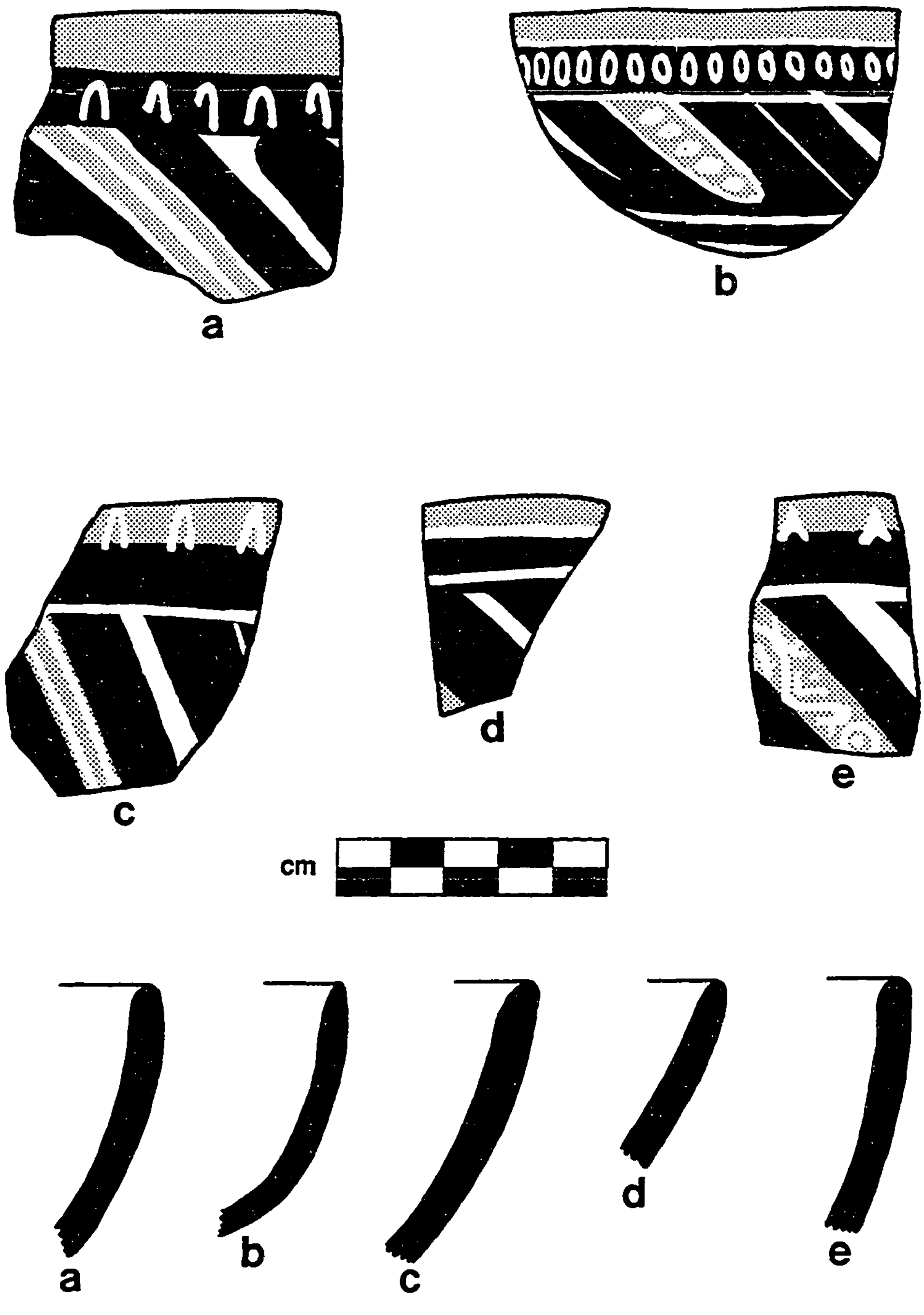


Figure III.28. Black-&-White/Red Bowl Variant C: Subvariant C-1 (a-e).
a) TX-A-40, Tl. 105; **b**) Huexotla, UMMA No. 31096 [NAA 456];
c) Los Melones, UMMA No. 31175 [NAA 455]; **d**) TX-A-87, Tl. 24;
e) IX-A-26, UMMA No. 82047 [NAA 430].

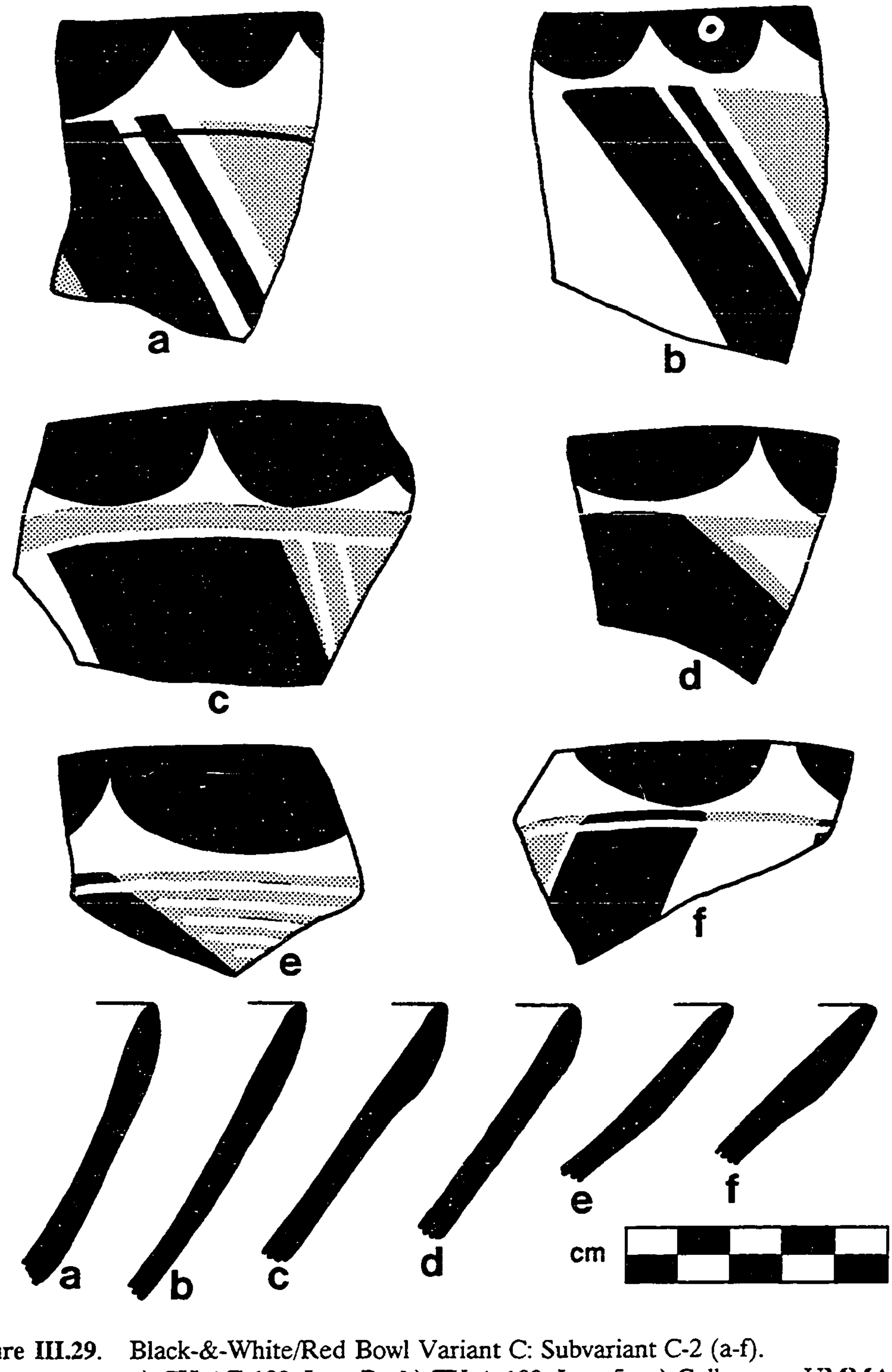


Figure III.29. Black-&-White/Red Bowl Variant C: Subvariant C-2 (a-f). **a**) CH-AZ-192, Loc. B; **b**) TX-A-109, Loc. 5; **c**) Culhuacan, UMMA No. 30869 [NAA 429]; **d**) Culhuacan, UMMA No. 30866 [NAA 427]; **e**) Culhuacan, UMMA No. 30869 [NAA 428]; **f**) Culhuacan, UMMA 30866 [NAA 426].

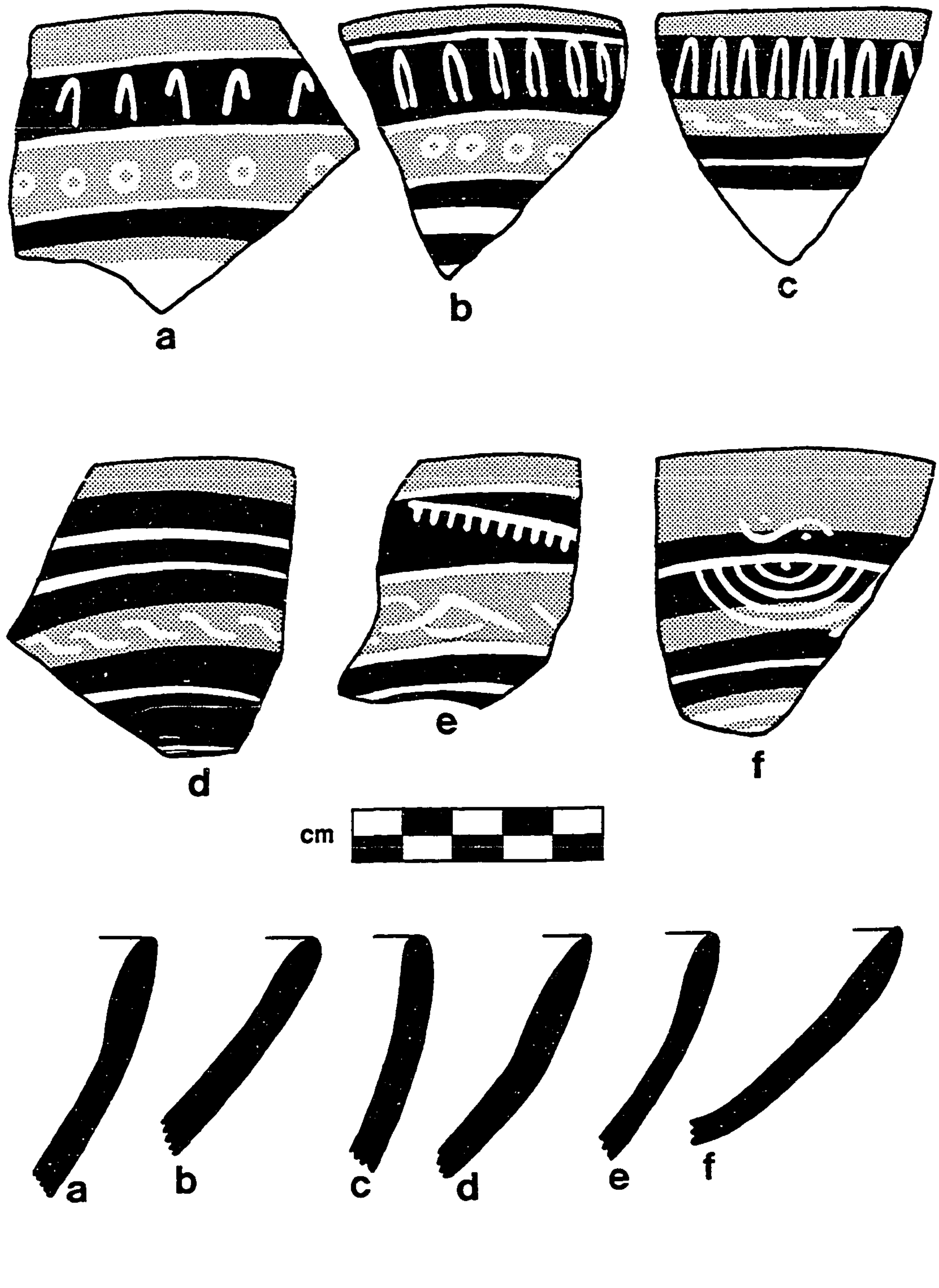


Figure III.30. Black-&-White/Red Bowl Variant D: Subvariant D-1 (a-f). **a)** TX-A-87, Tl. 49; **b)** TX-A-87, Tl. 49; **c)** TX-A-109, Loc. 12; **d)** TX-A-87, Tl. 32; **e)** TX-A-87, Tl. 49; **f)** Culhuacan, UMMA No. 30866 [NAA 450].

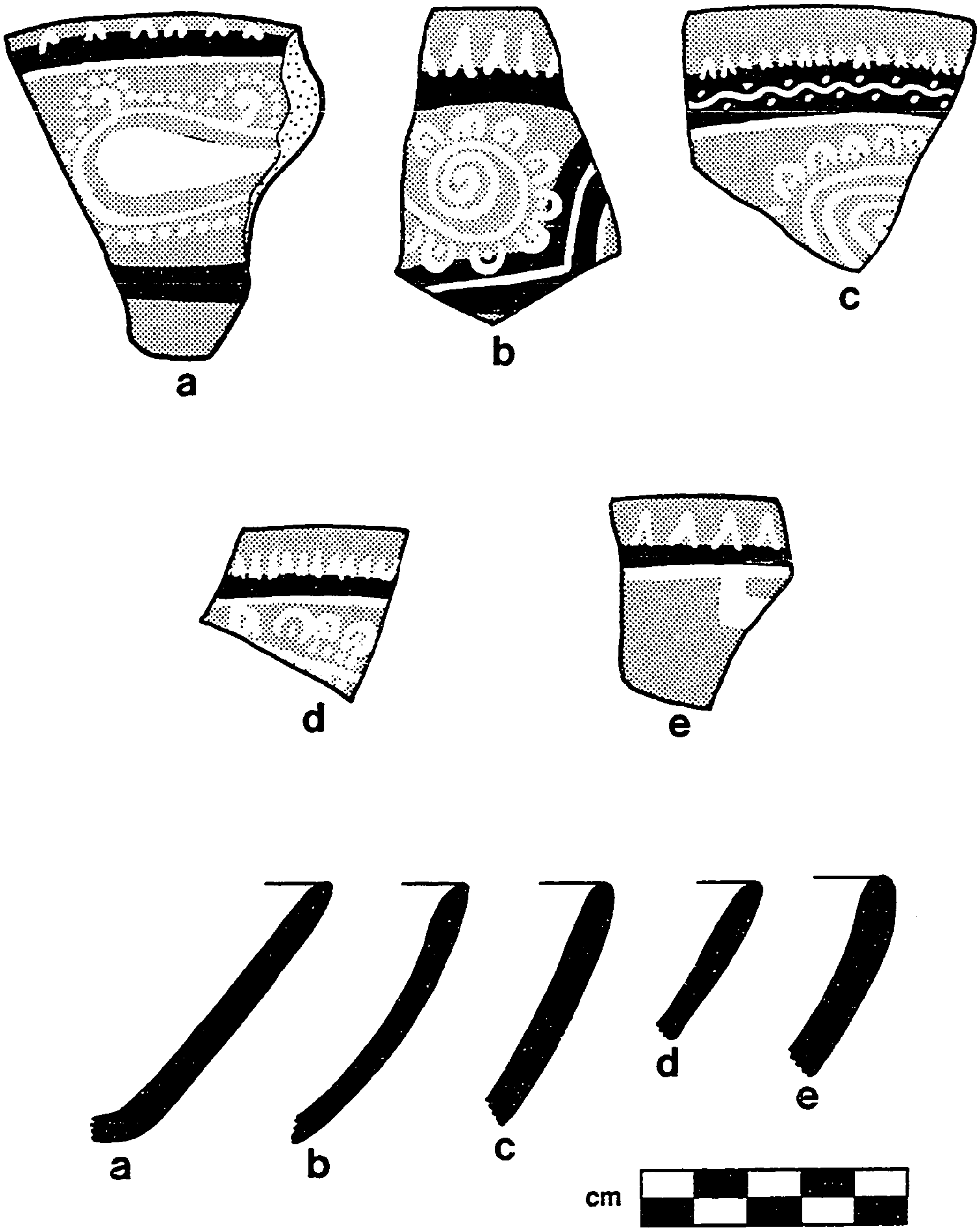


Figure III.31. Black-&-White/Red Bowl Variant D: Subvariant D-2 (a-e). **a**) TX-A-80, unknown location; **b**) CH-AZ-172, Tl. 65; **c**) IX-A-26, Tl. 215; **d**) Chalco, UMMA No. 30641 [NAA 453]; **e**) CH-AZ-172, Loc. Q.

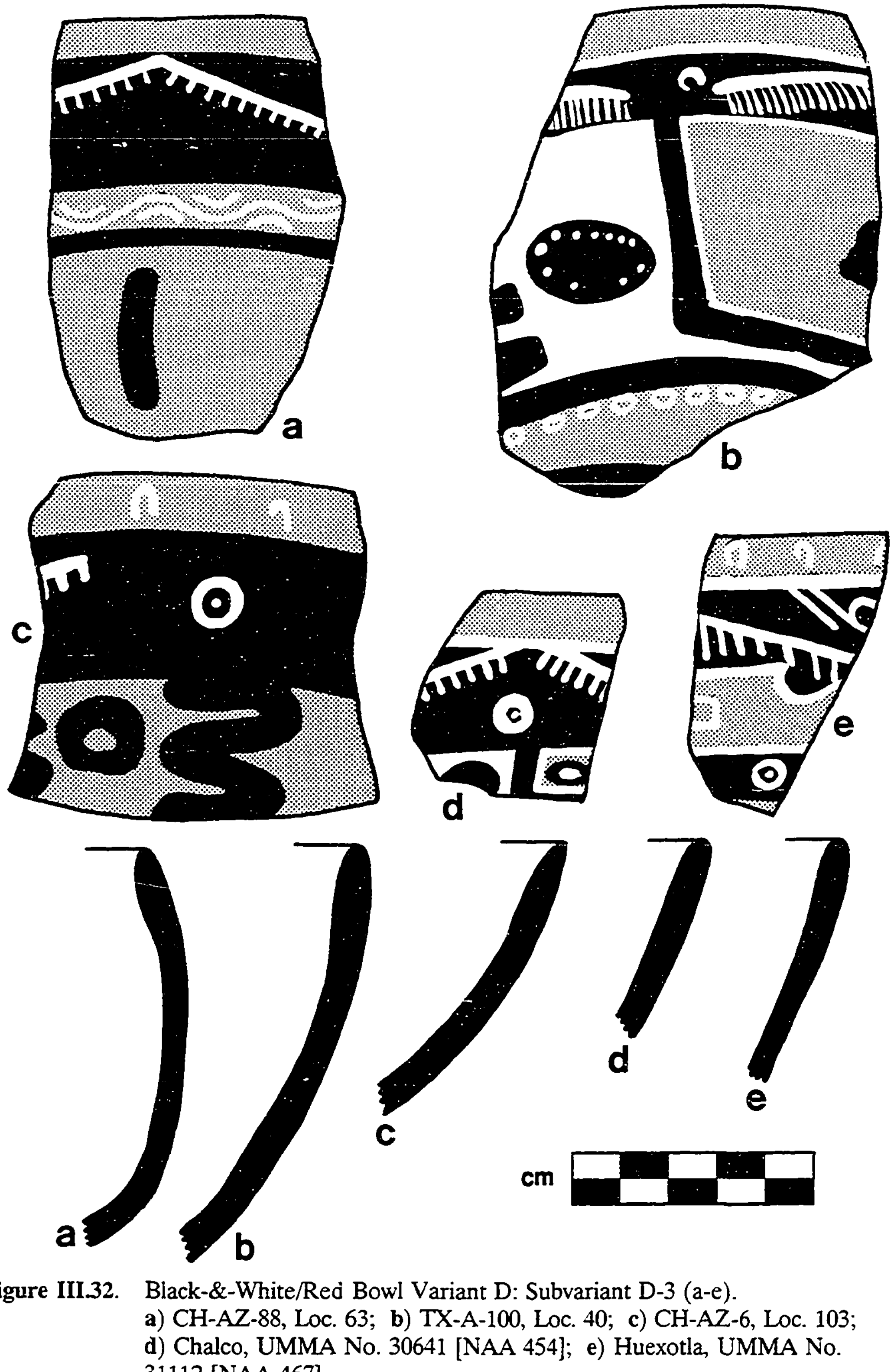


Figure III.32. Black-&-White/Red Bowl Variant D: Subvariant D-3 (a-e).
a) CH-AZ-88, Loc. 63; **b**) TX-A-100, Loc. 40; **c**) CH-AZ-6, Loc. 103; **d**) Chalco, UMMA No. 30641 [NAA 454]; **e**) Huexotla, UMMA No. 31112 [NAA 467].

Figure III.33. Black-&-White/Red Bowl Subvariant E-0 (a, b) and Subvariant E-1 (c-f). **a)** Huexotla, UMMA No. 31092 [NAA 438]; **b)** Culhuacan, UMMA No. 30870 [NAA 437]; **c)** TX-A-87, Loc. C; **d)** TX-A-87, Tl. 32; **e)** CH-AZ-172, Tl. 65; **f)** TX-A-87, Tl. 32.

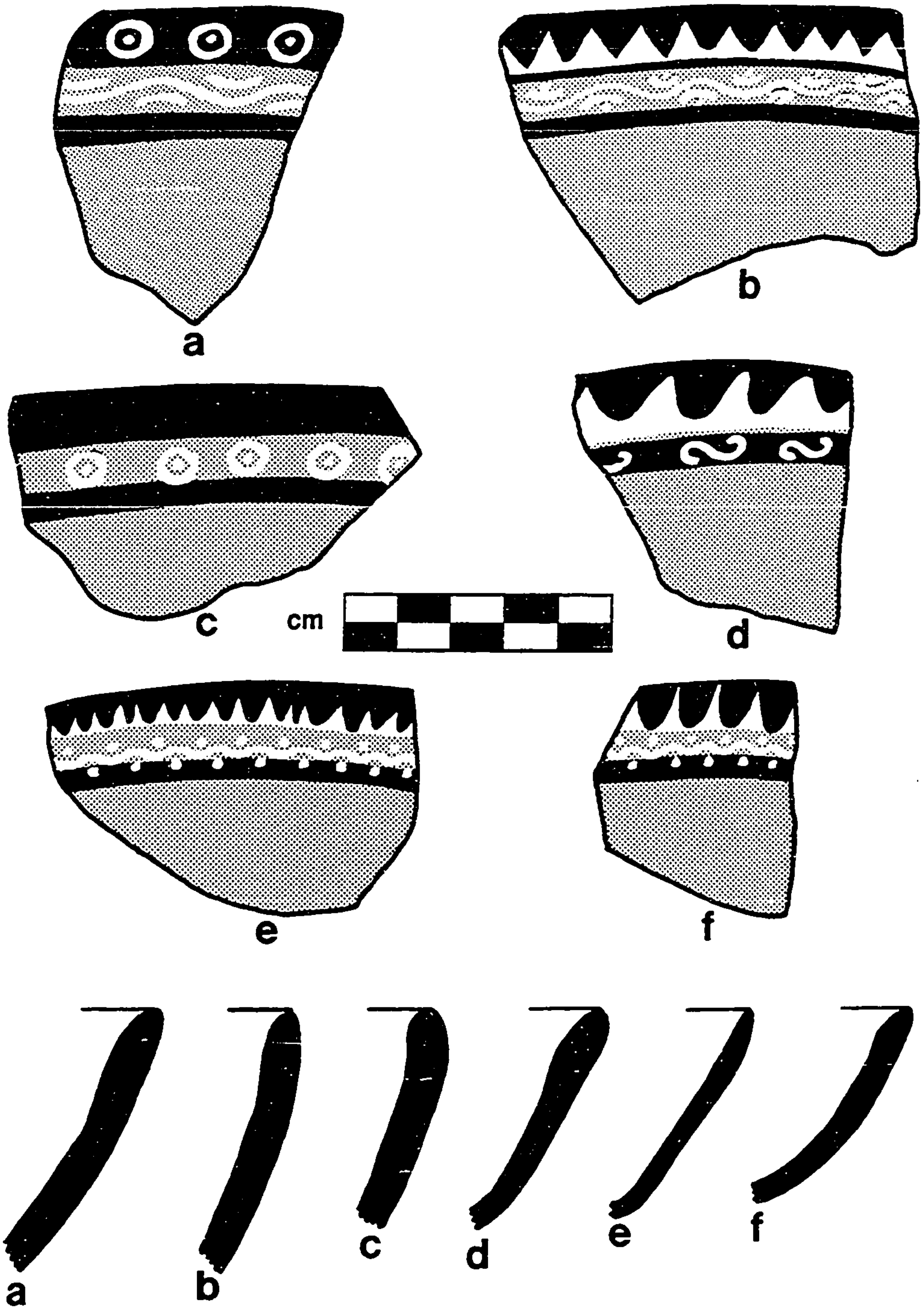


Figure III.34. Black-&-White/Red Bowl Subvariant E-2 (a-f). **a**) TX-A-87, Tl. 24; **b**) TX-A-87, Tl. 32; **c**) TX-A-87, Tl. 24; **d**) TX-A-87, Tl. 24; **e**) CH-AZ-172, UMMA No. 82099 [NAA 439]; **f**) CH-AZ-172, UMMA No. 82099 [NAA 440].

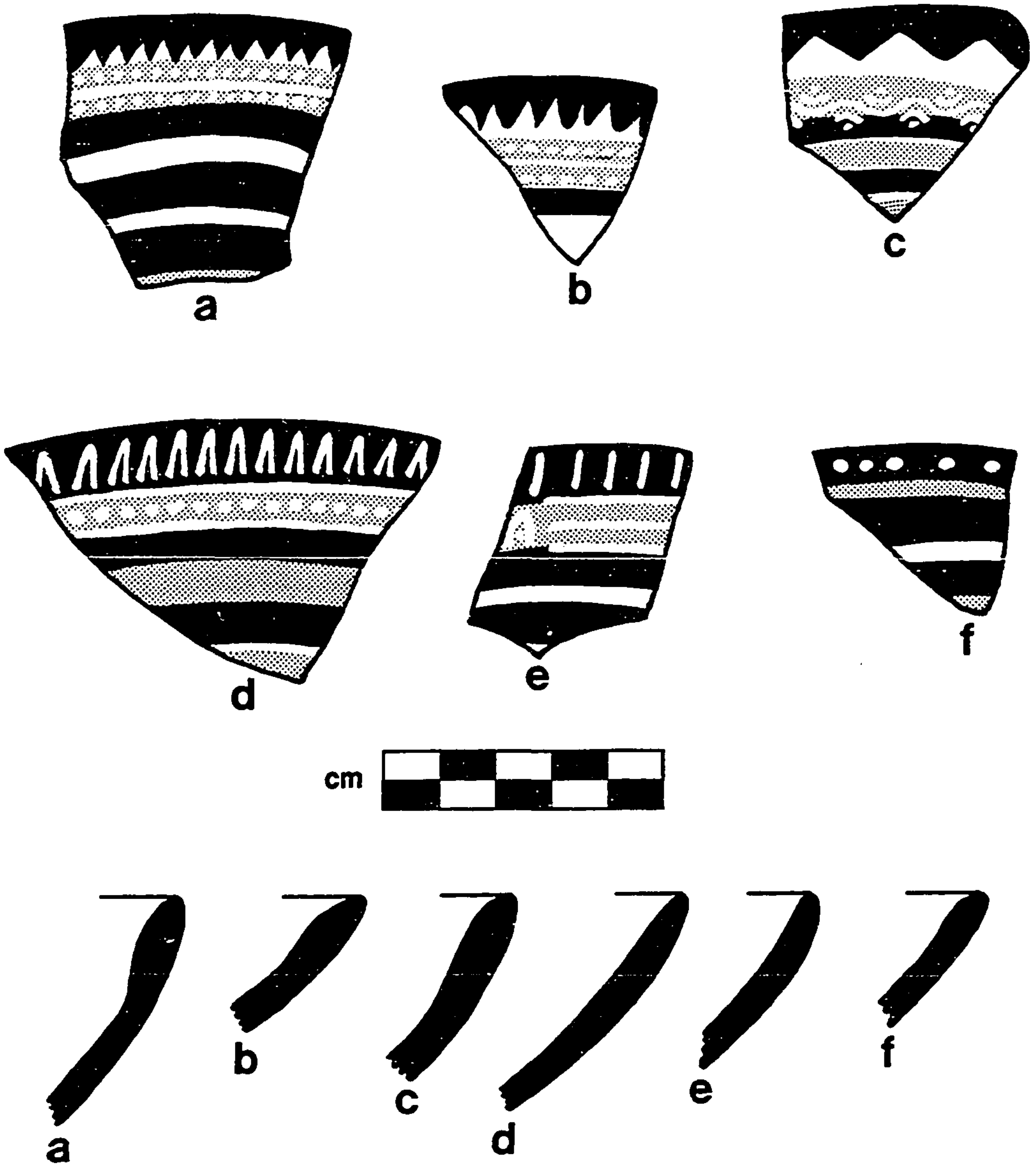


Figure III.35. Black-&-White/Red Bowl Subvariant E-3 (a-f). **a**) CH-AZ-172, Loc. Q; **b**) CH-AZ-172, Loc. Q; **c**) CH-AZ-111, Loc. 82; **d**) Culhuacan, UMMA No. 30866 [NAA 448]; **e**) Huexotla, UMMA No. 31111 [NAA 449]; **f**) TX-A-87, Tl. 32.

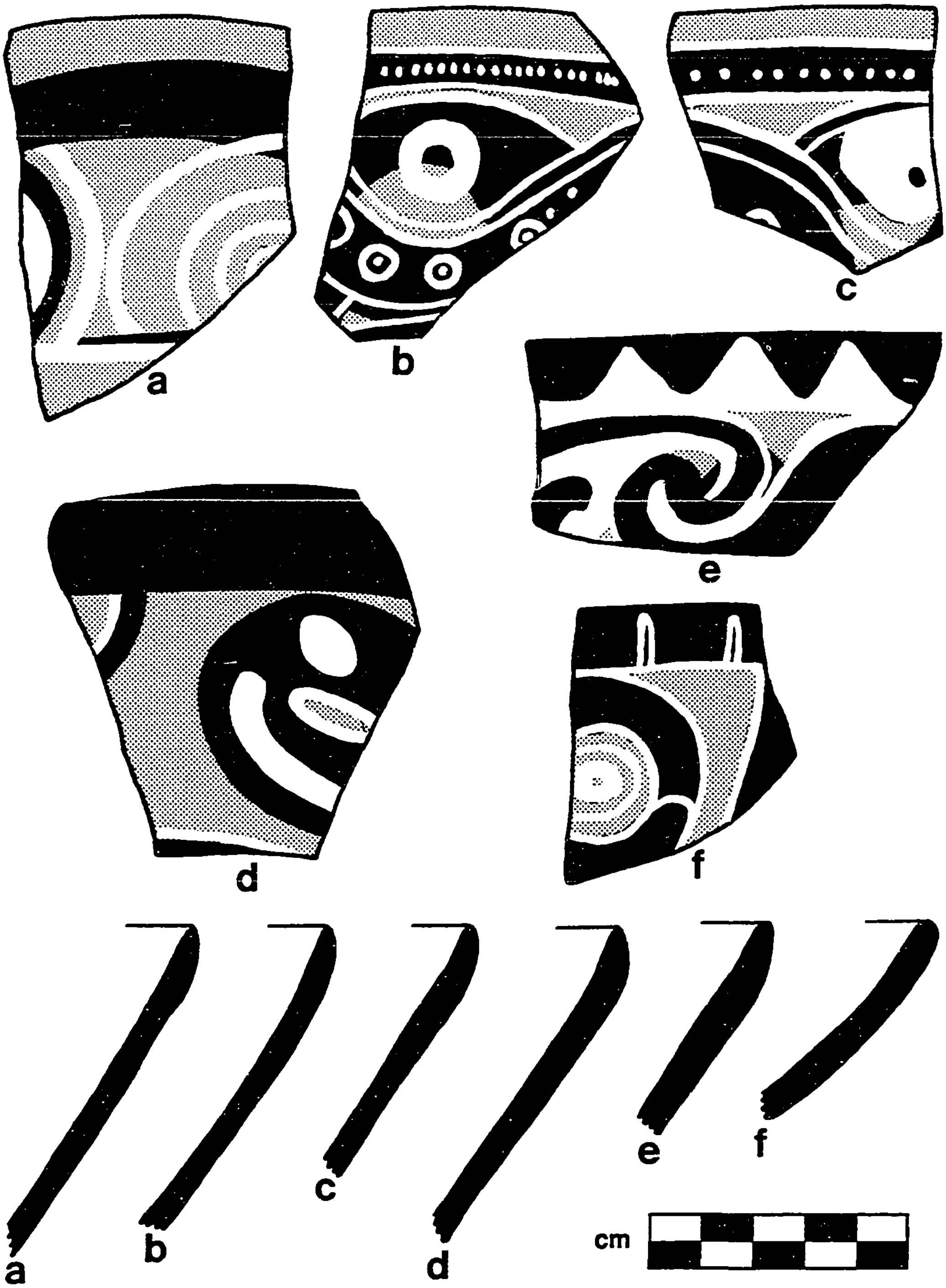


Figure III.36. Black-&-White/Red Bowl Variant F: Subvariant F-1 (a-c) and Subvariant F-2 (d-f). **a**) CH-AZ-192, Loc. H; **b**) Culhuacan, UMMA No. 30870 [NAA 436]; **c**) Culhuacan, UMMA 30866 [NAA 432]; **d**) Ch-AZ-192, Loc. B [NAA 268]; **e**) IX-A-26, UMMA No. 82047 [NAA 470]; **f**) CH-AZ-192, Loc. B.

Figure III.37. Black-&-White/Red Bowl Variant G (a-e). **a**) TX-A-109, Tl. 57 [NAA 281]; **b**) TX-A-87, Loc. C [NAA 283]; **c**) Culhuacan, UMMA No. 30866; **d**) Culhuacan, UMMA No. 30866 [NAA 385]; **e**) Culhuacan, UMMA No. 30866 [NAA 386].

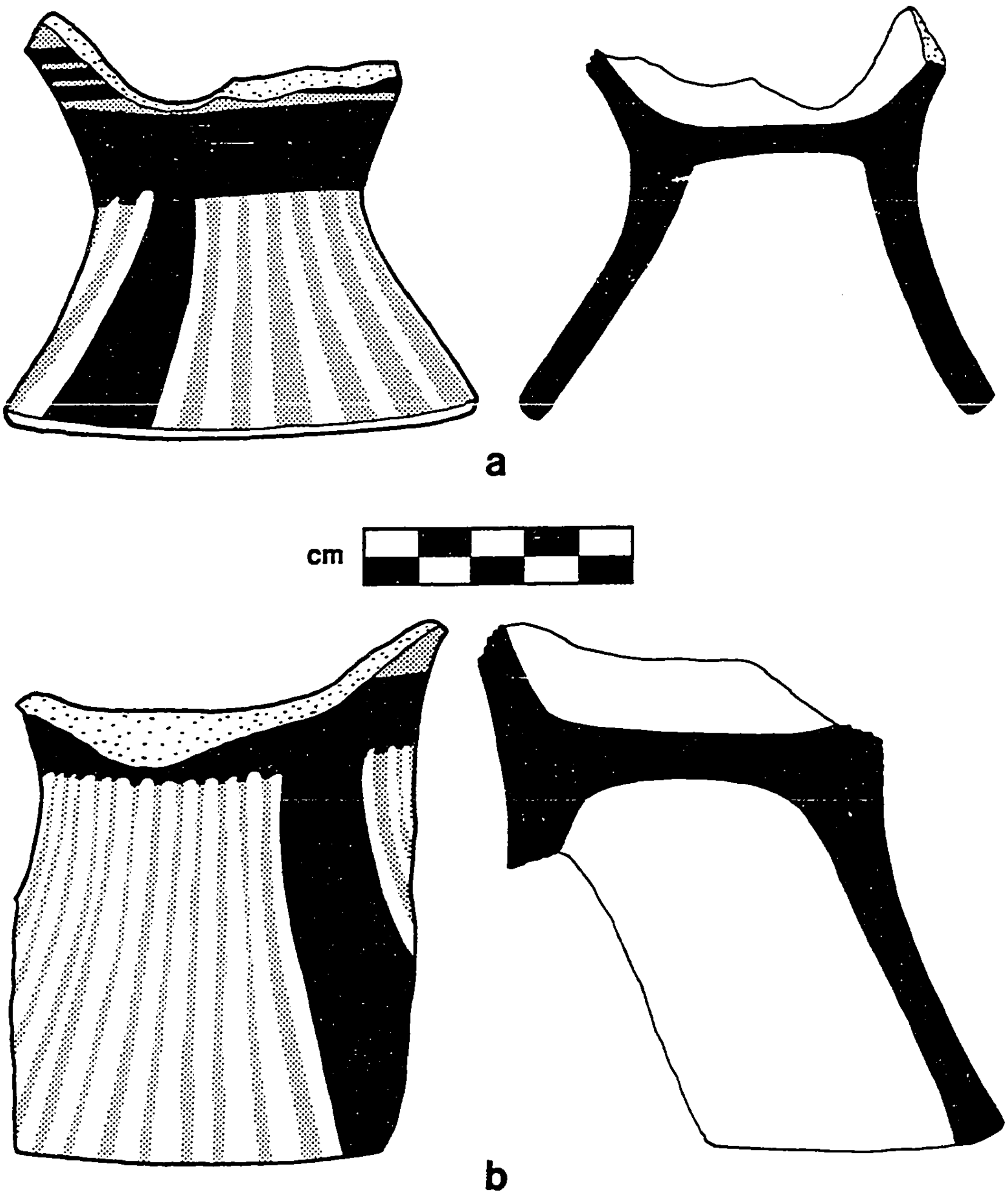


Figure III.38. Black-&-White/Red *Copas*. **a**) Culhuacan, UMMA No. 30867; **b**) Culhuacan, UMMA No. 30867.

Miscellaneous Low Frequency Red Ware Type Descriptions

WARE: **Red Ware**

TYPE: **Graphite-on-Red** or **Graphite/Red**

VESSEL SHAPE CLASSES: **Plates and *Copas***

Graphite paint appears as a silvery sheen; when well preserved it is readily distinguishable from black paint. Graphite easily erodes, however, leaving a dark gray residue that can be mistaken for weathered or misfired black.

In Early Aztec red wares, graphite is a not uncommon substitute for black mineral paint, especially on Black/Red Variant A and Black/Red-Incised Variants C and D. At Chalco, the incised red wares encountered in the lower levels of O'Neill's (1962) excavations are purely Graphite/Red-Incised; true Black/Red appears later in the sequence. Norr (1987b:530), in her pure Early Aztec excavation units, notes that graphite decoration is much the same as that found on Black/Red types; vessel form is also similar. Since the usage of graphite in these contexts does not appear to differ from that of black mineral paint, a distinct Graphite/Red type has not been distinguished in these cases.

In later Aztec red wares, Graphite/Red is a low frequency type throughout much of our study area, and would appear to be restricted to ritual or high status vessels. Graphite occurs occasionally on our Black/Red Late Profile Variant E (Fig. III.14), a variant characterized by complex curvilinear decoration. In addition, Graphite/Red appears in contexts apparently not replicated by black mineral paint. These are discussed in more detail below.

I. Plates

Vessel form: Plates with outsloping or slightly flaring walls and depressed, flat bases. Vessel walls are generally exteriorally thickened at the rim; lips are simple and rounded.

Paste and firing: Fine paste, with surface colors of buff to tan, frequently with a dark gray medial core.

Surface treatment: Surfaces are extremely well smoothed and bear a glossy red slip on both interior and exterior surfaces.

Decoration: Decoration is interior and consists of linear designs carefully executed in graphite paint. The design may consist of simple horizontal lines and/or bands running around the vessel wall (not illustrated), or it may include a panel of curvilinear or floral motifs (Fig. III.39). The interlocking scroll motif (Fig. III.39, a-b) is particularly characteristic of Graphite/Red plates of the Huexotla area.

Date: Thomas Charlton (personal communication, 1991) associates this plate form with early colonial "soup-plates" and suggests that it represents a postconquest development.

II. ***Copas***

Vessel form: Goblets with conical bases and conical cups with flaring walls. At the neck of the vessel, where the cup and pedestal join, the interior bases of both portions are flat with well-defined basal/wall angles. Vessel walls are thin. The cups have simple rounded to slightly thickened lips, while the lip of the base is frequently squared-off or beveled.

Paste and firing: Well-fired vessels with a fine paste. Unslipped surfaces are pinkish-buff to tan; most vessels show a dark gray medial core.

Surface treatment: Vessels are well smoothed or polished, with a moderate to very high luster. As noted above for Black/Red *Copas*, these vessels characteristically have vertical as opposed to horizontal burnishing facets. *Copas* appear to have been slipped over the entire exterior surface. Interior surfaces of the cup may be unslipped or bear a slip only on the upper portion (2-5 cm) of the wall; interiors of the base or pedestal are unslipped and poorly finished.

Decoration: Decoration is exterior only and consists of the "*espumoso*" or foamy motif, formed by several large concentric loops or inverted U's stemming from a band encircling the neck and surrounded by a row of radiant tick-marks (Fig. III.40). Execution appears somewhat sloppy in that line width varies considerably.

Date: Late Aztec.

WARE: **Red Ware**

TYPE: **Yellow-on-Red** or **Yellow/Red**

VESSEL SHAPE CLASSES: **Bowls**

Vessel form: Thin-walled, deep (barrel-shaped) bowls with vertical to slightly incurving walls. Rims are frequently thickened on the interior along the upper-most 2-3 cm of the vessel wall below the lip.

Paste and firing: Vessels have a very fine paste, with surface colors of pale buff to tan. Medial cores are generally absent or only a pale gray in color.

Surface treatment: Vessels are well smoothed and slipped a deep red over their exterior surfaces. Interior surfaces are slipped only at the rim with a band 1-2 cm wide (Fig. III.41, b and d). The remainder of the interior is unslipped and less well finished.

Decoration: Decoration is exterior and consists of linear designs carefully executed in glossy yellow-orange paint. The yellow paint appears to overlie a chalky white under-paint. Both the yellow and white paints erode easily. The primary decorative motif employed is that of a cable or intertwining ropes outlined in yellow (Fig. III.41; see also Séjourné 1983, Lám. XVI and XIX). Yellow dots or X-marks run along the cable.

Date: Late Aztec.

WARE: **Red Ware**

TYPE: **White-on-Red** or **White/Red**

VESSEL SHAPE CLASSES: **Bowls**

Vessel form: Small, deep bowls with thin, outsloping walls and rounded basal angles. Lips are simple and direct.

Paste and firing: Similar to that of other late Red wares. Paste is fine tempered with a tan surface color and pronounced dark gray to black core.

Surface treatment: Surfaces are well burnished and smoothed, with moderate to high luster. Basal exterior color is a deep-to-pinkish red, overlaid by complex white designs. Interior surfaces are slipped red as well.

Decoration: Decoration is exterior and consists of curvilinear and geometric designs painted in white. The white paint tends to be somewhat chalky and easily erodes. True White/Red can be distinguished from misfired Black/Red that appears grayish or whitish in color, from the fact that the former can generally be abraded with the fingernail while the latter cannot. Designs include wing-like motifs and fine-line hatchure (Séjourné 1983:Fig. 144) and concentric circles surrounded by radiant tick marks (Séjourné 1983:Fig. 143).

Decorative Variants: No decorative variants have been designated.

Date: Late Aztec.

WARE: **Red Ware**

TYPE: **Black-and-Yellow-on-Red or Black-&-Yellow/Red** or
Black-and-White-and-Yellow-on Red or Black-&-White-Yellow/Red

VESSEL SHAPE CLASSES: **Bowls**

Vessel form: Small, deep bowls with thin, outsloping walls and rounded basal angles. Lips are simple and direct.

Paste and firing: Similar to that of other late Red wares. Paste is fine tempered with a tan surface color and pronounced dark gray to black core.

Surface treatment: Surfaces are well burnished and smoothed, with moderate to high luster. Basal exterior color is a deep red, overlaid by complex black and yellow or black, white, and yellow designs. Interior surfaces are generally slipped a deep red.

Decoration: Decoration is exterior and consists of curvilinear and geometric designs painted in black and yellow. The black paint tends to be somewhat streaky. The yellow paint appears to overlie a chalky white under-paint, which gives the yellow a translucent, glossy character. Design motifs include *ilhuitl* or side-lying S-scrolls at the rim, circles, and crosses (Fig. III.42; see also Séjourné 1983, XIX).

Decorative Variants: No decorative variants have been designated.

Date: Late Aztec.

WARE: **Red Ware**

TYPE: **Black-and-Red-on-Buff or Black-&-Red/Buff or Black-and-Red-on-Tan or Black-&-Red/Tan**

VESSEL SHAPE CLASSES: **Bowls**

A low frequency type found in our study area only within the Texcoco survey region; Branstetter-Hardesty (1978:97) reports it from the Ixtapaluca region as well. This type has been reported previously by Parsons (1966:216), Brumfiel (1976:237), and Branstetter-Hardesty (1978:97; cf. her "Circular Red and Black/Buff"). Since Parsons encountered only a single sherd of this type, its distribution may not extend as far north as the Teotihuacan Valley.

Vessel form: Small rounded bowls with near-vertical to slightly incurving walls. Rims are generally thickened on the interior; lips are simple and rounded. Rim diameters range from 15-20 cm; wall thicknesses are in the range of 0.5-0.65 cm.

Paste and firing: Paste is buff colored and contains fine to very fine temper. Most sherds show a dark gray core.

Surface treatment: The basal color of the exterior is a tan or buff (10 YR5.4 - 10 YR6/6); interiors are slipped a deep red (10 YR4/4 - 10 YR4/8). Surfaces are smoothed but show obvious burnishing facets; exteriors are less well smoothed than interiors and have smudges or streaks of red in the buff or tan surface.

Decoration: Decoration is exterior and includes a broad black band (0.7 - 1.1 cm wide) at the rim and a second band encircling the base. Between these bands, large solid red and black circles (ca. 5 cm in diameter) are placed around the vessel wall (Fig. III.43). Branstetter-Hardesty (1978:95) suggests that four circles are present, two black and two red, placed on opposites sides of the vessel with colors alternating.

Date: Late Aztec, based on similarities in paste and vessel form to Yellow/Red.

<u>Key to Figures III.39 - III.43</u>: Black mineral and graphite paint are represented with black. Red slipped areas are indicated with shading film. Areas left white on Figures III.41 and III.42 represent yellow paint. On Figure III.43, areas left white represent the natural base color of the paste, i.e. buff or tan. NAA numbers refer to sherd identification numbers used in instrumental neutron activation (INA) analyses.

Black or Graphite Paint

Red Slip

Yellow Paint (Figs. III.41-III.42); Unslipped Areas (Fig. III.43 only)

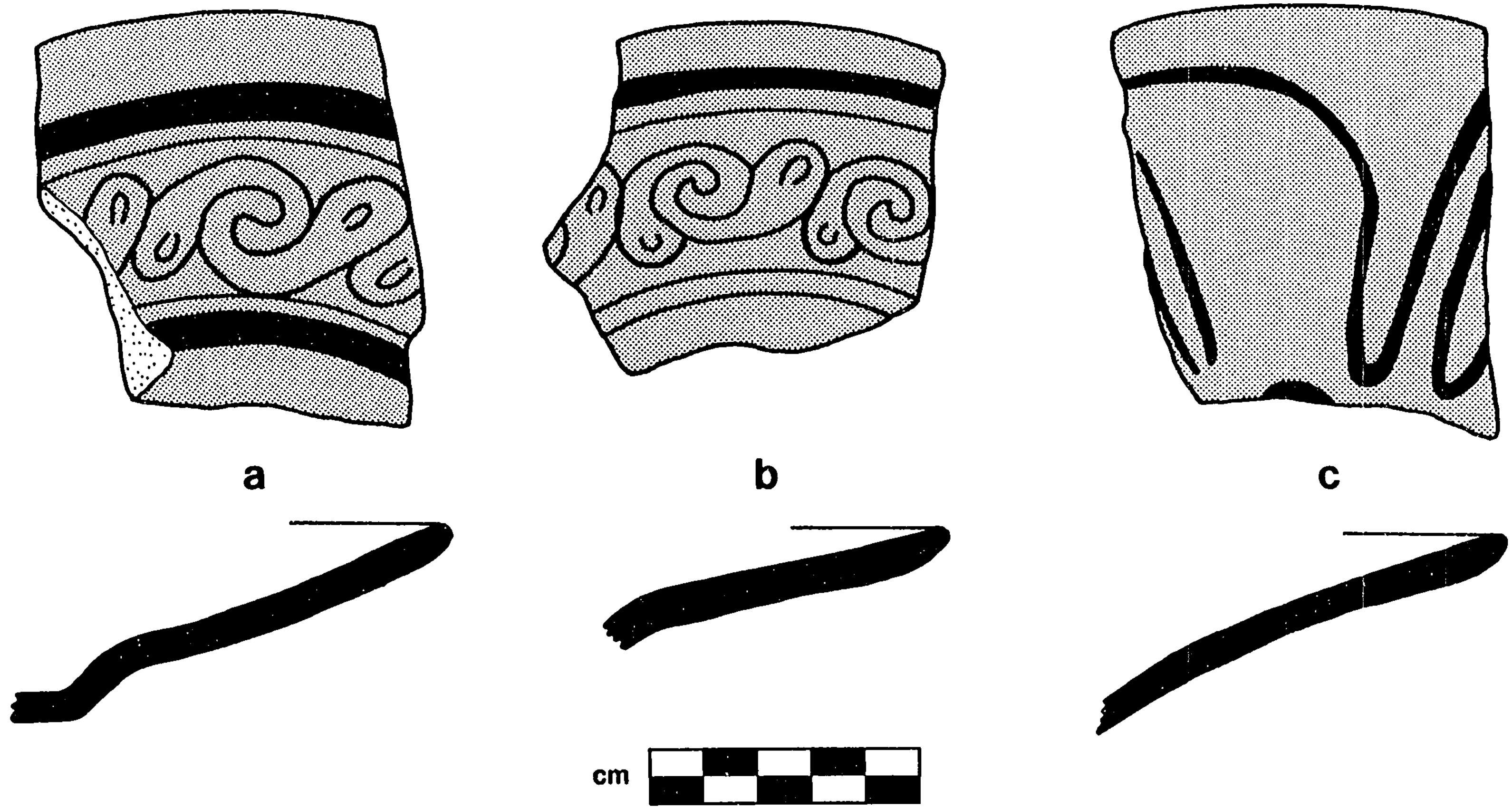


Figure III.39. Graphite/Red Plates. **a)** TX-A-78, Tl. 177; **b)** TX-A-53, Tl. 12; **c)** TX-A-26, Tl. 613.

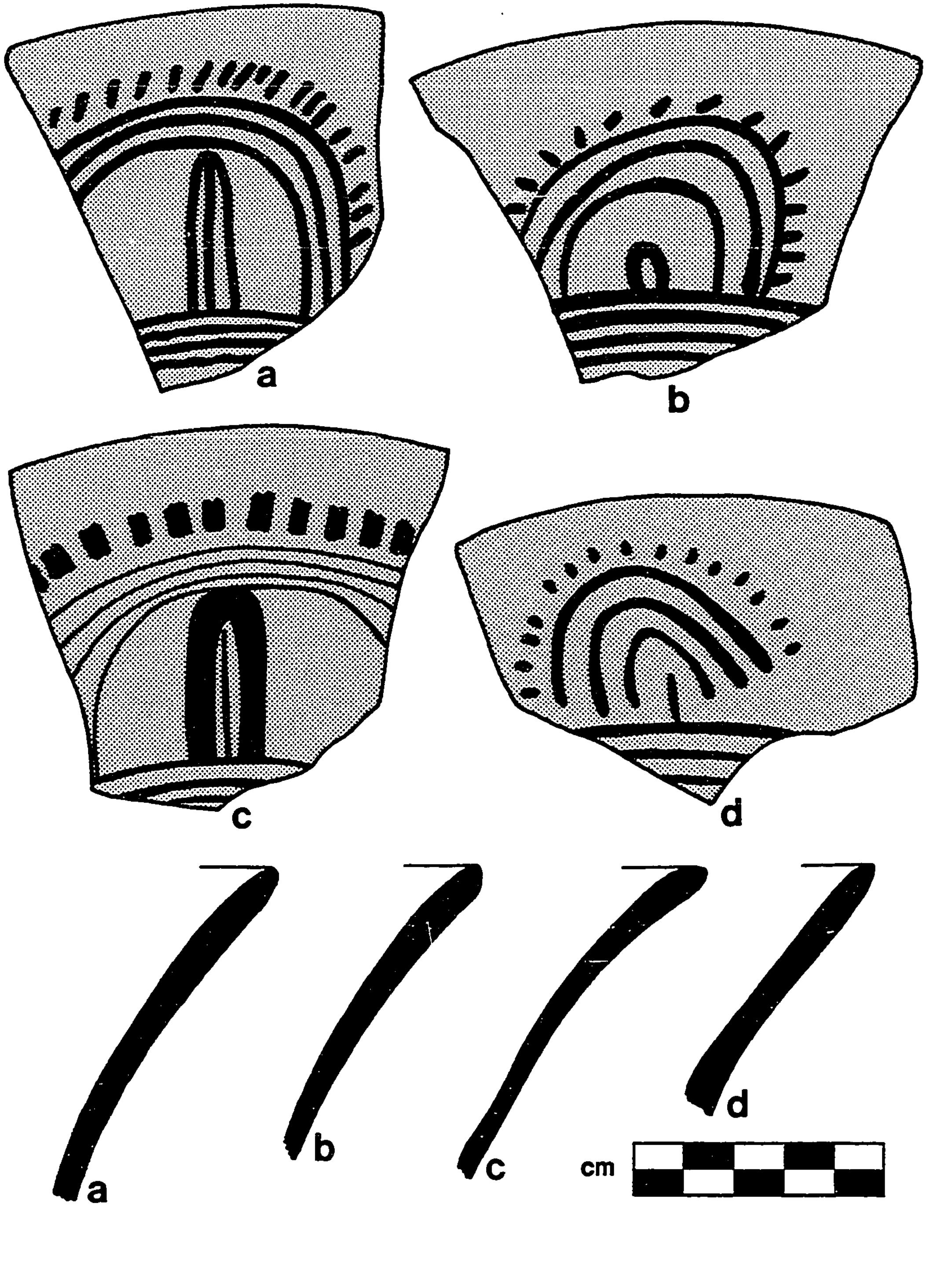


Figure III.40. Graphite/Red *Copas*. (Culhuacan [UMMA No. 30867]).

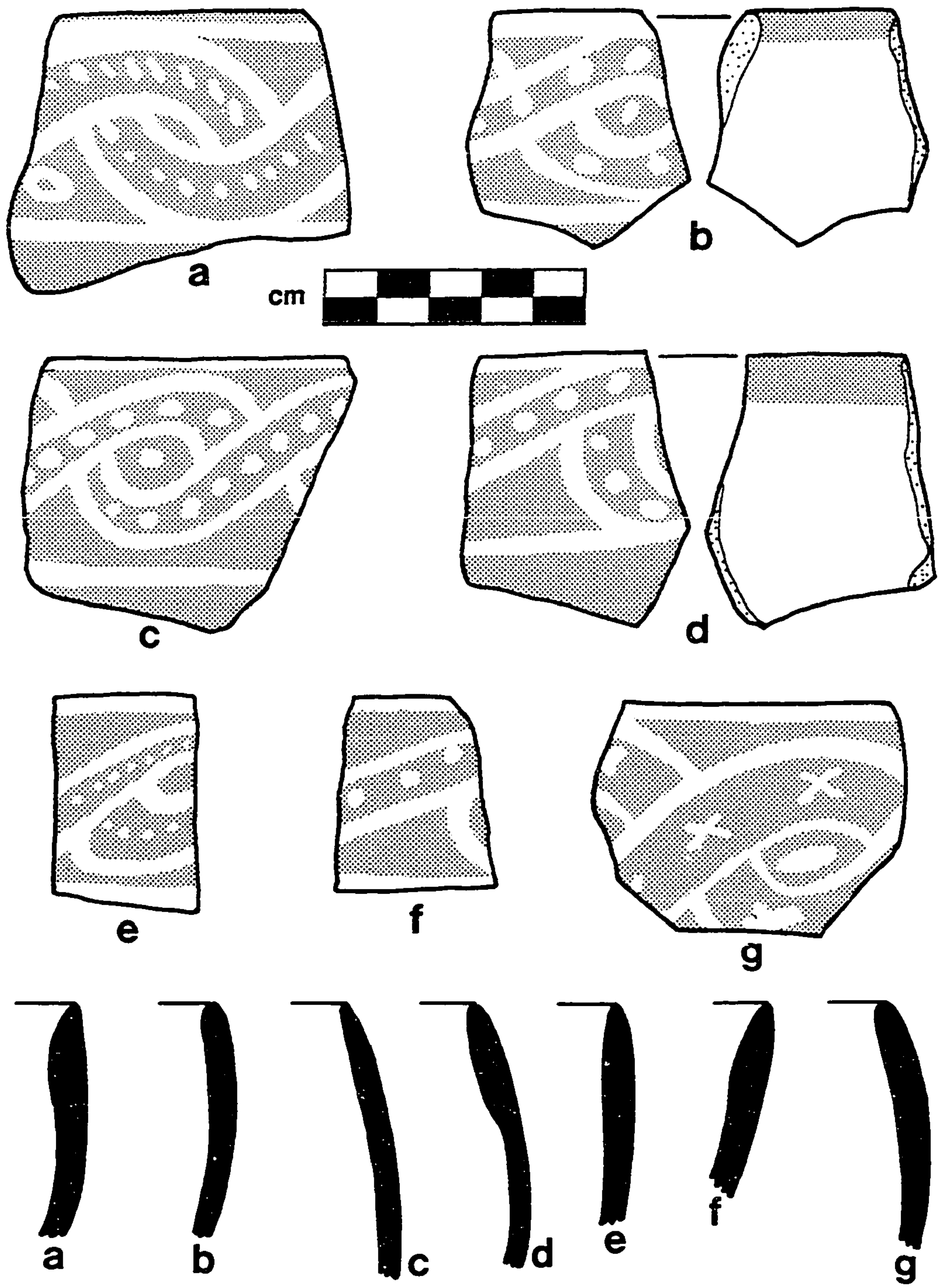


Figure III.41. Yellow/Red Bowls. **a)** TX-A-78, Tl. 165 [NAA 232]; **b)** CH-AZ-190, Tl. 52 [NAA 233]; **c)** Ch-AZ-192, Tl. 35 [NAA 236]; **d)** CH-AZ-190, Tl. 52 [NAA 234]; **e)** IX-A-26, Tl. 215 [NAA 237]; **f)** Ch-AZ-190, Tl. 52 [NAA 235]; **g)** CH-AZ-192, Tl. 21. White areas on sherd exteriors represent areas covered with yellow paint.

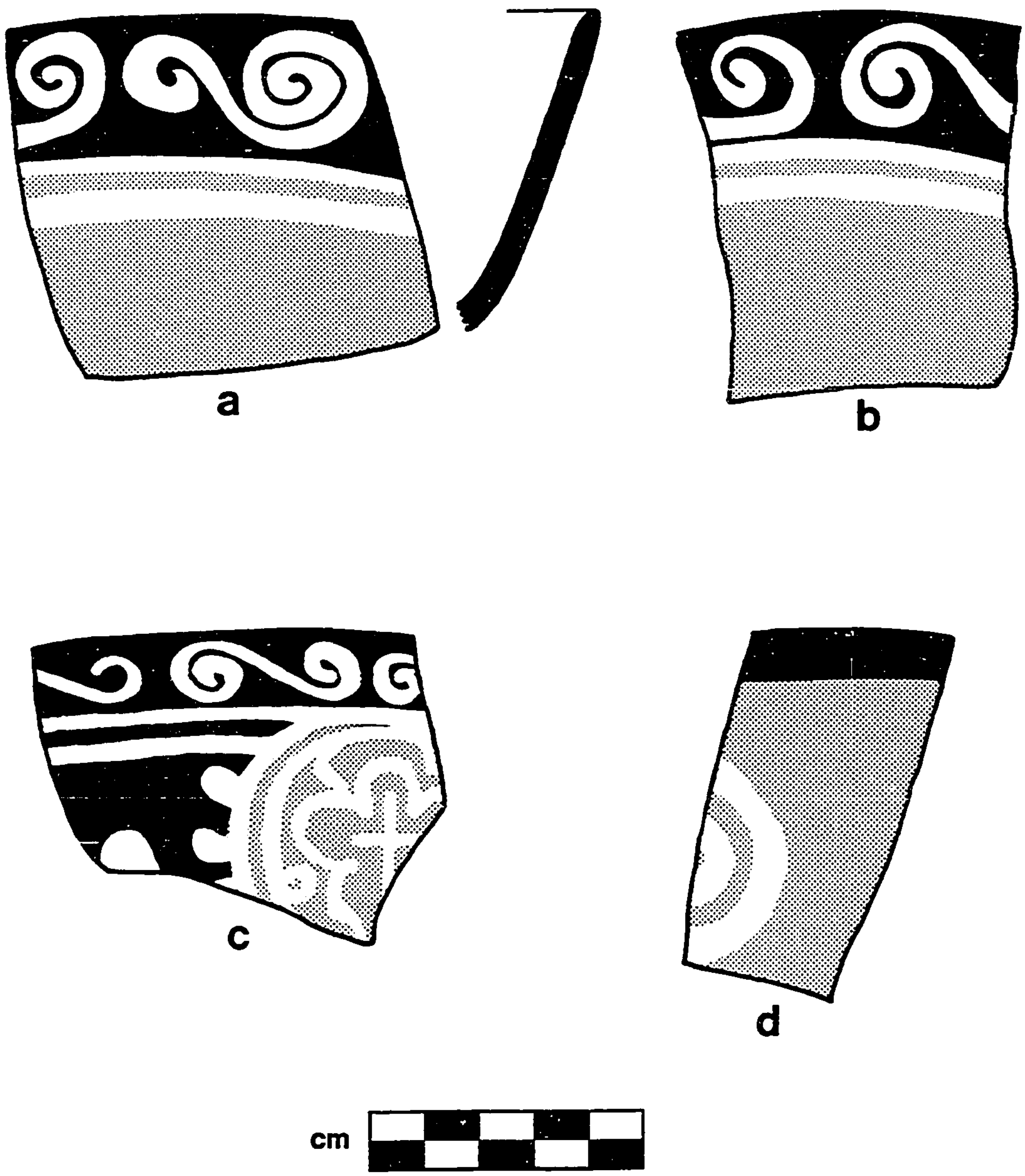


Figure III.42. Black-and-Yellow/Red Bowls. **a**) TX-A-87, Tl. 49; **b**) TX-A-87, Tl. 49; **c**) CH-AZ-41, Loc. 48; **d**) TX-A-16, Tl. 19. White areas on sherds represent areas covered with yellow paint.

Figure III.43. Black-and-Red/Tan Bowls. **a**) TX-A-87, Tl. 28 [NAA 229]; **b**) TX-A-86, Tl. 47; **c**) TX-A-27, Tl. 567 [NAA 226]; **d**) TX-A-109, Tl. 53 [NAA 227]; **e**) TX-A-27, Tl. 567; **f**) TX-A-109, Tl. 66; **g**) portion of base, TX-A-26, Tl. 613 [NAA 228]; **h**) portion of base, TX-A-24, Tl. 461 [NAA 222]. White areas in the illustrations represent unslipped, buff-colored portions of the vessel.

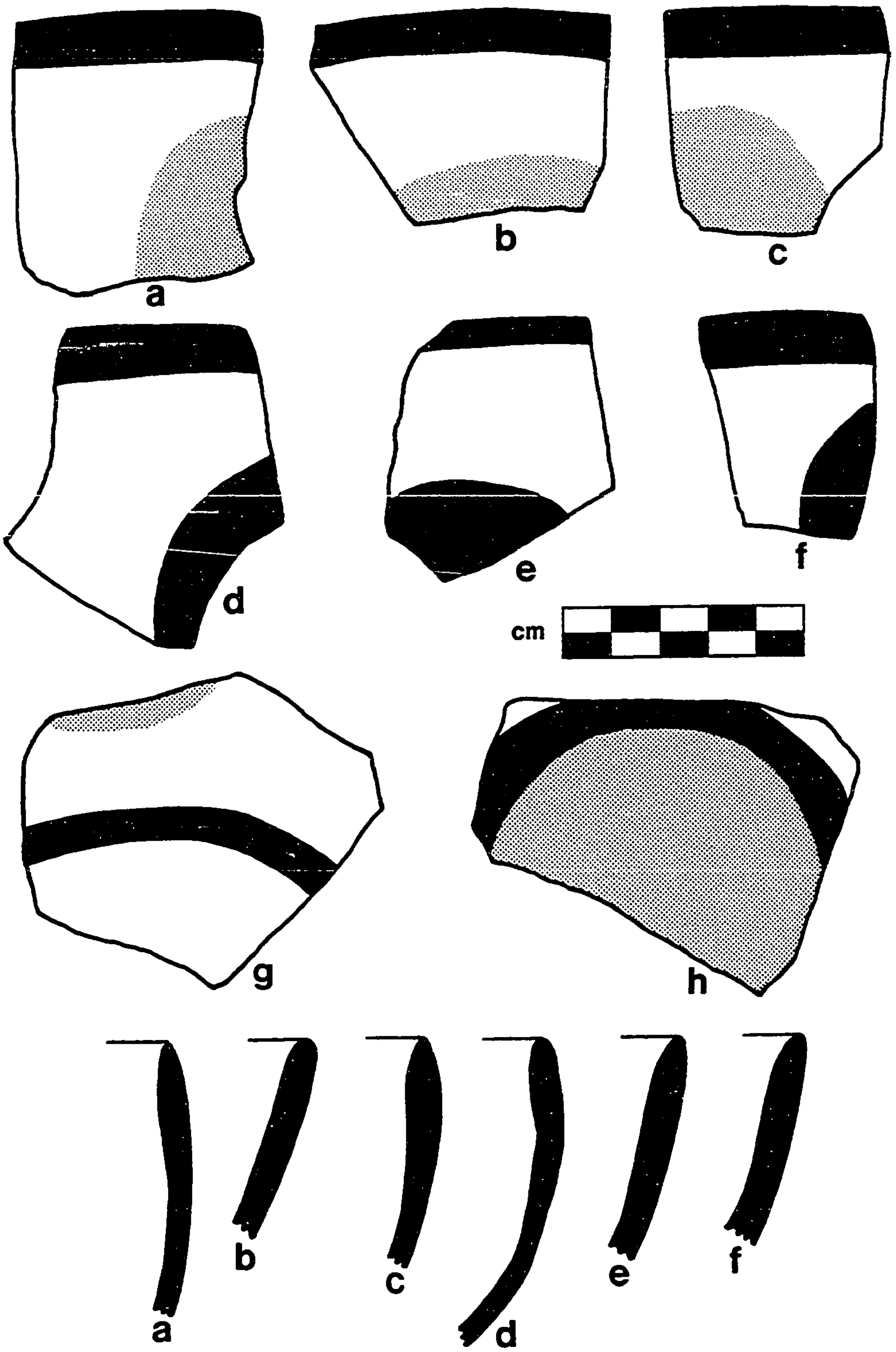


Figure III.43. Black-and-Red/Tan Bowls (alt. Black-and-Red/Buff).

APPENDIX IV
CHRONOLOGY OF AZTEC DECORATED CERAMICS

Introduction

Ceramics are used in this study to gauge changes in economic organization and political policy through time; it is therefore necessary to have a fairly secure and independent means of relating the ceramic chronology to political events. This section is concerned with two fundamental problems in Aztec ceramic chronology: first, the relative temporal order of, and relationships among, Aztec decorated ceramics, and second, their absolute chronology vis-a-vis calendar years and political events in the Valley. The well-established chronologies for Aztec Black/Orange ceramics are reviewed and then utilized to determine, through quantitative seriations, the relative order of the more poorly understood Red ware types. Current data on absolute dates for these chronologies are then summarized.

The archaeological chronology developed here utilizes a typology approach to ceramics; that is, it focuses on typological units (types, variants, and subvariants) defined on the basis of consistent co-occurrences of stylistic (morphometric and decorative) attributes, rather than on attributes as separable phenomena. The typological approach, although potentially less sensitive to temporal change, has the advantage that it follows in the long tradition of ceramic chronology within the Valley of Mexico. As a result, the terminology and basic typological units are familiar to researchers and the results of the seriations may be more readily applied in the field.

Black/Orange Ceramics

The Black/Orange (B/O) ceramic types and variants form the backbone of Aztec ceramic chronology. The definition and relative order of these ceramics is based on a long history of detailed stratigraphic and stylistic analyses (Boas 1912; Gamio 1913; Brenner 1931; Noguera 1930, 1935; Vaillant 1938, 1941; Franco 1945, 1947; Griffin and Espejo 1947, 1950; Franco and Peterson 1957; J. Parsons 1966). In general, Black/Orange ceramics are divided into four chronological units (I, II, III, and IV) and assigned the phase names of Culhuacan, Tenayuca, Tenochtitlan, and Tlatelolco, respectively, after type sites of the same names. Aztec I and II (Culhuacan and Tenayuca phase) Black/Orange ceramics are attributed to the Early Aztec period (A.D. 1150-1350), while Aztec III (Tenochtitlan phase) ceramics belong the Late Aztec period (A.D. 1350-1520). Aztec IV (Tlatelolco phase) Black/Orange ceramics mark the end of the prehispanic ceramic tradition. The dates associated with these periods reflect the consensus chronology reported in Sanders, Parsons, and Santley (1979).

More recent research has revised two main aspects of this chronology, concerning the timing of both the initial and terminal phases of Aztec ceramics. The first revision concerns the relative temporal placement of Aztec I and II Black/Orange. Aztec I (Culhuacan) and Aztec II (Tenayuca) Black/Orange ceramics have long been considered as representing sequential phases of occupation in the Valley (Vaillant 1938; Griffin and Espejo 1947, 1950), with Culhuacan being earlier than and replaced by Tenayuca. During the course of the Valley of Mexico surveys, however, it was demonstrated that the occupations represented by Culhuacan and Tenayuca ceramics differ more in space than in time (Parsons et al. 1982:345-351; Whalen and Parsons 1982:437-438). Culhuacan Black/Orange ceramics predominate in the southern Valley around Lakes Chalco and

Xochimilco, while Tenayuca Black/Orange ceramics are found largely to the north in the Texcoco region (Parsons et al. 1982:345-351; Hodge and Minc 1990:428, Fig. 7). Although Tenayuca Black/Orange occurs in the southern Valley area, it is of relatively low frequency and almost always co-occurs with Aztec I Black/Orange ceramics in surface collections; thus, there does not appear to be a distinct phase of Aztec II Black/Orange ceramics in the south. The converse holds for the northern Valley, where Tenayuca Black/Orange is the dominant type. Further, stratigraphic excavations at Culhuacan (Séjourné 1970) and Chalco (O'Neill 1962) have revealed pure Aztec I Black/Orange deposits, but have found Aztec II Black/Orange in upper levels only in mixed deposits, again suggesting that a distinct temporal phase of Aztec II Black/Orange ceramics did not occur in this area. Whalen and Parsons (1982) conclude that it is likely that Aztec I pottery was in use for some time in the southern Valley before the advent of Aztec II Black/Orange in that region; the sudden appearance of Aztec II Black/Orange might indicate an intrusion of this material from a northerly source. Within the Valley as a whole, the present view is that these Early Aztec types are largely if not wholly contemporaneous (Sanders, Parsons, and Santley 1979:466-467; Whalen and Parsons 1982:437-438).[1]

The second major revision involves the timing of Aztec IV Black/Orange ceramics and the persistence of Aztec ceramic types following the Spanish conquest. Charlton (1969, 1972, 1975, 1976, 1979, 1980) has presented a detailed analysis of postconquest ceramic developments in the Teotihuacan Valley, through the correlation of historical documents reporting on the history of site occupation and the ceramic artifacts recovered from excavations in those sites. He observes that "The ceramic data from the Teotihuacan Valley do not suggest any direct, obvious, immediate, or striking ceramic acculturation on the part of the Aztecs during the 16th century and the first half of the 17th century. The Aztec III ceramic complex, manufactured and in use at the time of the conquest, underwent an initial 16th century florescence resulting in the production of Aztec IV Black/Orange" (1976:521). Charlton thus sees Aztec IV Black/Orange ceramics as a purely postconquest development, although he later concedes that Aztec IV designs may reflect preconquest urban developments, only spreading to rural areas (such as the Teotihuacan Valley) after the conquest. Based on C-14 dates from her excavations at Xaltocan, Elizabeth Brumfiel (personal communication, 1991) confirms that Aztec IV Black/Orange ceramics do occur somewhat earlier in the main Valley, with the Tlatelolco-phase style beginning by A.D. 1503.

With the exception of the Aztec IV Black/Orange florescence, Charlton describes postconquest changes in the larger Aztec ceramic complex as a process of simplification. Decorated wares declined in frequency gradually and by 1650, Plain Orange pottery represented 80-95% of the total assemblage. After 1650, Majolica and Monochrome Glazed pottery were introduced and gradually increased in frequency. Remnant Aztec decorated wares persisted in the archaeological sequence until about 1750 at which time they dropped out of the record (Charlton 1972); it is unclear, however, whether the low frequencies of these types represent curation or actual continued production of Aztec ceramics at this late date. Given the apparent longevity of Aztec ceramics after the conquest, the danger exists that pre- and postconquest economic patterns will be confused in a data base recovered from surface collections. However, the sharp decline in Aztec decorated ceramics (the focus of this study) in the early hispanic period suggests that decorated sherds dating to the postconquest period will be numerically low compared with those predating the conquest and thus are not likely to obscure distribution patterns established during the preconquest period.

Red Ware Chronology

Existing Chronologies

In comparison with the Black/Orange ceramic types, Aztec Red wares remain poorly known. The stratigraphic excavations that produced the detailed Black/Orange ceramic sequence promised an equally detailed analysis of Red ware chronology (cf. Vaillant 1938), but this promised chronology was never published. At a very general level, Tolstoy's (1958) seriation of surface collections in the Valley of Mexico indicated that within Aztec Red wares, Black/Red Engraved or Incised ceramics occurred relatively early in the Aztec sequence, while the Black/Red type as a whole peaked during the Late Aztec period (1958:63-64). Black-and-White/Red pottery also apparently peaked during the Early Aztec period, and experienced a sharp decline in popularity during the Late Aztec period (1958:63). In the postconquest era, Aztec Red ware, including both decorated and undecorated types, apparently persisted until some time after A.D. 1625 (Charlton 1980:205). Although Charlton has unfortunately not described or illustrated the Red ware types present in postconquest contexts, he indicates that most preconquest variants continued in use until A.D. 1750.

J. Parsons' (1966) analysis of ceramics in the Teotihuacan Valley remains the single most detailed presentation of Aztec Red ware typology and chronology. Parsons' study confirmed Tolstoy's chronological placement of the Black/Red, Black/Red-Incised, and Black&White/Red types and provided temporal information on stylistic variants within those types. Where possible, this study has built upon the chronology established by Parsons. However, in refining Parsons' Red ware typology, it has become necessary to refine the associated chronology as well. Further, Parsons' (1966) study is based at the northern edge of the Valley of Mexico and thus does not provide information on more southerly ceramic variants. This study has defined a number of stylistic variants that do not occur in the area of Parsons' study and so do not have a chronological placement in his analysis.

Red Ware Seriations from Surface Collections

Due to the lack of chronological control for Aztec Red wares, this study has relied on the Valley of Mexico survey collections to derive chronological information on Red ware types and variants included in this study. The use of surface collections is obviously not the preferred way to develop ceramic seriations and this analysis should be viewed as a last resort. It is hoped that on-going research in the Valley of Mexico will provide stratigraphic data to confirm and clarify the general temporal patterns observed in these surface data and that researchers will make an effort to publish that mundane but fundamental aspect of their excavation data.

The Valley of Mexico surface survey collections are not well suited to provide chronological information on ceramic types and variants. Three main problem areas can be identified:

(1) **Mixture of chronological markers due to continuous occupation**. Parsons et al. (1982:351) have described the Aztec period as an era of exceptional settlement continuity. Although more than 240 new sites were founded in the Chalco-Xochimilco region during the Late Aztec period, nearly 90% of Early Aztec sites continued to be occupied. Our study has compounded this problem by focusing our sample on sites with both an early and

a late component. Thus, most sites in our study contain a mix of early and late ceramic types, making it difficult to determine finer temporal associations among these ceramics from their co-occurrence in a site. The high degree of mixture may also generate temporally spurious associations based on spatial patterning (ceramic types that have similar patterns of distribution through time will tend to co-occur even if of different time periods) or differences in sample size (more abundant types have a greater probability numerically of co-occurring regardless of their temporal relationships). In order to reduce the degree of temporal mixture, this seriation has focused on individual collections taken from separate areas within a site, as these generally contain a much lower level of temporal mixing.

(2) **Small sample size/sparse data set.** Although they contain less chronological mixing, individual collections for Aztec-period sites are small and thus are poor representatives of ceramic assemblage composition. Any one collection may contain only a small subset of ceramic types/variants belonging to that region and time period. These small sample sizes greatly reduce the probability that contemporaneous types will be found to co-occur in collections and generate what is commonly called a "sparse data set". In such a case, direct measures of association between co-occurring types or variants appear low or insignificant, and can render direct seriations of types relative to one another unreliable.

(3) **Spatial patterning/non-coterminous ceramic distributions.** The problems of a sparse data set are compounded by the limited geographical distributions of some types and variants within the Valley of Mexico. Thus, if two ceramic types or variants do not co-occur, it is difficult to determine whether it is because they are of different time periods or because they have non-overlapping spatial distributions. Similarly, limited access, elite or ritual status, or a specific function may restrict contemporaneous ceramics to a small subset of the collections and make it difficult to determine their relative chronological placement.

In order to circumvent the problems introduced above, two different seriation approaches were used in developing the Red ware chronology: (1) an indirect seriation of Red ware variants based on their frequency of occurrence in collections collectively dated as belonging to the Early Aztec or Late Aztec period based on their Black/Orange and polychrome ceramics; and (2) a direct seriation of Red ware types and variants relative to one another based on their co-occurrence in the surface collections. Both approaches have their drawbacks, but they are sensitive to different problem areas. To the extent that these two approaches produce convergent results, the seriations can be considered reasonably robust. Finally, where possible, the results of these seriations have been compared with available published and unpublished data on Red ware typologies and chronologies.

Indirect Seriation of Aztec Red Wares

The indirect seriation of Red ware types and variants attempted to by-pass the problems generated by a sparse data set and non-overlapping spatial distributions of ceramic types, by assessing the chronological placement of Red ware types and variants based on their occurrence in groups of collections dated according to their better-known and more widely distributed Black/Orange and Chalco-Cholula polychrome (CCPC) components. This procedure explicitly assumes, however, that the Red wares are contemporaneous with the Black/Orange and polychrome variants with which they co-occur. This would **not** be the case, for example, if a site or region had access only to Red wares in the Early Aztec period but gained access to Black/Orange in the Late Aztec period through participation in a regional market system. The near ubiquity of Black/Orange ceramics from both early and late periods, however, suggests that this type provides a reliable temporal marker against which to assess Red ware chronology.

Methods and Approach

In the indirect seriation, 293 ceramic collections from the Chalco, Xochimilco, and Ixtapalapa survey regions were dated based on their constituent Black/Orange and polychrome types. Types and variants assigned to the Early Aztec and Late Aztec periods are presented in Table IV.1. The percentages of Early and Late sherds were determined for each collection. The histogram of the percent Late Aztec sherds in these collections (Fig. IV.1) indicates that a substantial number of collections contain predominantly (>80%) Early or Late sherds and can be viewed as single phase occupations. Collections consisting of 80% or more Early Aztec sherds were assigned to the Early Aztec period (N=83); collections consisting of 80% or more Late Aztec sherds were assigned to the Late Aztec period (N=124). All other collections were classified as Mixed (N=86). The Mixed category contains collections representing continuously occupied areas; occupations that were truly transitional in date between Early Aztec and Late Aztec periods presumably fall in this Mixed category.

In order to provide finer chronological resolution, collections in the Mixed and Late categories were subdivided on the basis of Black/Orange plates, dishes, and *molcajetes* (PDM), the shape classes for which the greatest degree of chronological control exists. Including the Early Aztec collections defined above, four chronological periods were defined: AZ I/II or Early Aztec, AZ I/II-III or transitional Early-to-Late Aztec, AZ III, and AZ III/IV (Table IV.2). Again, the mixed collections assigned to the AZ I/II-III category presumably represent continuously occupied areas; occupations and ceramic types that were truly transitional in date between Early Aztec and Late Aztec periods are anticipated to have a higher frequency of occurrence in this category.

Although the small sample sizes for many collections suggests that percentage data would provide a poor indicator of the temporal affiliation of an individual collection, the resulting chronological ceramic groups are internally quite consistent with respect to their temporal composition. Taken as a whole, the AZ I/II collections (N=83) consisted of 1012 Black/Orange and polychrome sherds of known date, of which the vast majority (93%) were of Early Aztec date (Table IV.3). The AZ I/II-III collections (N=63) contained 537 Black/Orange and polychrome sherds; 55% were Early Aztec while 45% were Late Aztec from which collections with Aztec IV material had been excluded. The Aztec III collections (N=66) contained 940 Black/Orange and polychrome sherds of known date, of which 5% were Early Aztec and 95% were Late Aztec. Using the Black/Orange PDM shape classes as an indicator, the Late Aztec in this category is largely Aztec III; only 3% were Aztec IV. The Aztec III/IV collections (N=50) contained 623 sherds, of which 5% were Early Aztec and 95% Late Aztec. Within the Black/Orange PDM shape classes, 41% were Aztec III and 48% were Aztec IV, indicating a fairly even balance of Aztec III and IV material in this category. Out of the initial 293 collections, 31 were not assigned to one of these four categories due to a high degree of chronological mixture or poor preservation.

Unfortunately, the Aztec I/II, I/II-III, III, and III/IV collections are not uniformly distributed throughout the three survey zones (Table IV.4). Overall, the Chalco survey zone accounted for 71% of the collections, the Xochimilco region accounted for 16%,

Table IV.1
Chronological Placement of Black/Orange and Chalco-Cholula Polychrome Ceramic Variants of "Known" Date

Ceramic Type	Variants
Early Aztec Black/Orange	Aztec I (all types and vessel forms) Plate Variants A-C; Indeter. EA plate Dish Variants A-C; Indeter. EA dish *Molcajete* Variants A-B; Indeter. EA *molcajete* Bowl Variants A-C, G1, M; Indeter. EA bowl Basin Variants A-C; Indeter. EA basin
Early Aztec Chalco-Cholula Polychrome	Dish Variants A, B, C, D, I, J, K; Bowl Variant H Indeterminate EA polychrome
Late Aztec Black/Orange	Plate Variants D-H; Indeter. LA plate Dish Variants D-J; Indeter. LA dish *Molcajete* Variants F; Indeter. LA *molcajete* Slab supports Bowl Variants D-F, G2, H; Indeter. LA bowl Basin Variants D-H; Indeter. LA basin
Late Aztec Polychrome	Bowl Variants E, F, G, L; Indeterminate LA polychrome

Table IV.2
Criteria Used to Define Chronological Periods Used in Indirect Seriations

Period	Criteria for Classifying Collection
Aztec I/II	≥ 80% Early Aztec based on all "known" B/O and CCPC sherds; equals the 'Early' collections defined above
Aztec I/II-III	< 80% Early Aztec and < 80% Late Aztec based on all "known" B/O and CCPC sherds (i.e. falls in the 'Mixed' category), but contains no PDM Vars. F-J (i.e. no Aztec IV B/O)
Aztec III	falls in 'Late' class based on all "known" B/O and CCPC sherds and has ≥ 80% AZ III based on PDM
Aztec III-IV	falls in 'Late' class based on all "known" B/O and CCPC sherds and has ≥ 80% AZ III and AZ IV based on PDM

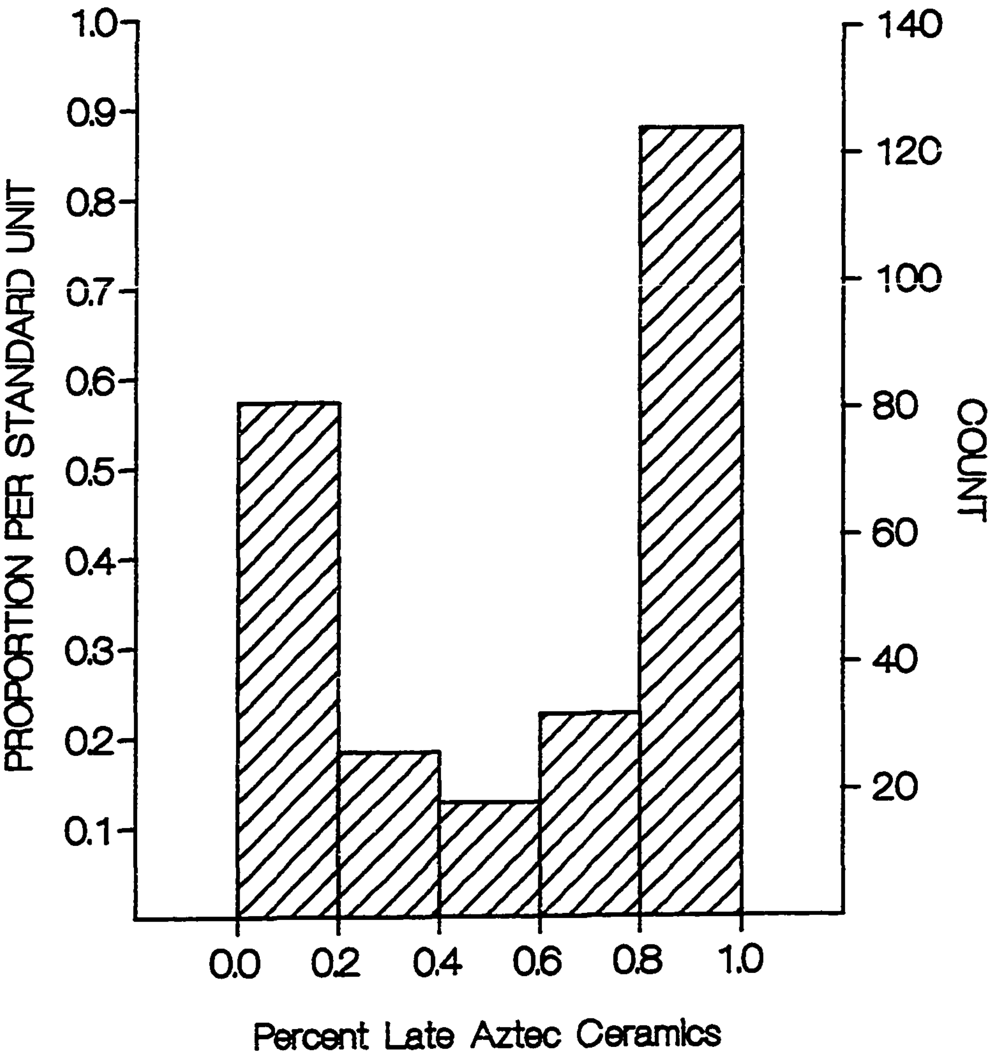


Figure IV.1. Histogram of percent Late Aztec ceramics in surface collections.

Table IV.3
Sherd Counts for Chronological Periods

Ceramic Variant	Aztec Phase			
	I/II	I/II-III	III	III/IV
Aztec I B/O	378	91	11	4
B/O PDM A	48	16	3	3
B/O PDM B	11	13	6	4
B/O PD C	0	1	0	0
B/O PDM D	13	38	146	33
B/O PDM E	16	95	368	154
B/O PDM F-J	9	0	19	181
B/O EA Bowl	36	16	5	6
B/O EA Basin	6	2	2	0
B/O LA Bowl	12	51	148	55
B/O LA Basin	2	5	5	6
CCPC A	80	30	1	2
CCPC B	68	19	1	2
CCPC C	57	25	3	2
CCPC D	18	2	1	0
CCPC E	0	0	1	0
CCPC F	2	7	10	2
CCPC G	0	2	9	1
CCPC H	18	9	12	2
CCPC I	4	3	0	0
CCPC J	3	0	0	0
CCPC K	1	2	0	0
CCPC L	1	0	0	0
CCPC EA Indet.	206	62	2	4
CCPC LA Indet.	9	10	11	4
CCPC Indet.	2	2	1	2
Total EA	939	294	48	33
Total LA	73	243	892	590
Total B/O	545	366	889	604
Total CCPC	469	173	52	21
Total "Known"	1012	537	940	623
Collections	83	63	66	50

while the Ixtapalapa survey region accounted for only 13% of the collections. The Chalco area has a higher percent of Early collections, while sites in the Ixtapalapa and Xochimilco zones have higher percentages of late collections. This non-uniform distribution indicates that both spatial patterns as well as chronological patterns may determine a ceramic type/variant's frequency of occurrence in the dated collections.

Table IV.4
Number of Collections Used in Seriation by Survey Region

Time Period	Survey Region					
	CH		IX		XO	
Aztec I/II	75	(36)	5	(11)	3	(8)
Aztec I/II-III	51	(24)	8	(18)	4	(10)
Aztec III	43	(20)	11	(24)	12	(32)
Aztec III/IV	25	(12)	11	(24)	14	(37)
Mixed/Undated	16	(8)	10	(23)	5	(13)
Total	210	(100)	45	(100)	38	(100)

Note: Numbers in parentheses are percent of total collections for each region in the sample.

The indirect seriation followed several steps. First, the internal consistency of the chronological assignments was checked by individually examining the distribution of the variants of known chronological date (i.e. those Black/Orange and polychrome variants used to assess the chronological placement of a collection) in the AZ I/II, I/II-III, III, and III/IV collections. If a Black/Orange or polychrome variant had been incorrectly assigned to a chronological period, the error would become apparent from its disproportionate occurrence in collections of a date different from its supposed affiliation. Once the chronological placement of types of known date had been confirmed, the chronological placement of ceramic variants of unknown date was assessed from their occurrence in the dated collections.

The chronological placement of an individual type or variant relative to the dated collections defined above was assessed using a goodness-of-fit X^2 test, following the methodology developed by Strahler (1978) for evaluating species' "preference/ avoidance" patterns. In the discussion of this methodology that follows, the terms "preference" and "avoidance" have been replaced with the terms "positive association" and "negative association", respectively, due to the anthropomorphic connotations of Strahler's original terminology.

The X^2 test determines whether a ceramic type or variant has a significantly non-uniform distribution relative to the dated collections. It was expected that if a type or variant showed no positive association with any chronological period (that is, if it showed a uniform distribution), its frequency of occurrence would be proportional to the assemblage size of the collections representing that period. Thus, the expected cell value is calculated as the proportion of total sherds occurring in the collections of a period multiplied by the total number of occurrences for each type or variant:

$$e_{(i,j)} = N_j/N \times N_i$$

where $e_{(i,j)}$ is the expected value for type I in time period J;

N_j is the total assemblage size for time period J;

N is the total number of sherds for all time periods; and

N_i is the total count for type I.

The expected values for each type/variant in each period directly depend on assemblage size for each period and are thus affected by what is included within that assemblage. In the present analyses, the total assemblage of Aztec decorated ceramics (slipped and/or painted rim and body sherds) was included; ritual vessels (censers, braziers, Texcoco Molded, and Texcoco Filleted) and unslipped wares were excluded.

Significant departures from the expected or uniform distribution, as determined by the total X^2 value for each ceramic type or variant, would indicate a non-uniform distribution reflecting that type's or variant's positive or negative association with a chronological period.

The significance of the X^2 test is strongly affected by sample size. A conservative guideline suggests that the sample size be great enough so that all expected cell frequencies are greater than 1, and at least 80% of expected values are greater than or equal to 5 (Hays 1973). Types and variants with expected cell frequencies of less than 1 were accordingly removed from the analysis due to insufficient sample size (i.e., $N_i < 8$). Types and variants with expected cell frequencies < 5 were retained, since low frequency types may have a very narrow chronological placement. However, the significance of the total X^2 value must be interpreted with caution in these cases, and the results for these cases treated as trends rather than as statistically significant results.

For types and variants showing significant departures from a uniform distribution, their chronological associations are presented in a matrix of standardized X^2 residuals for each type/variant across chronological periods. The residuals, standardized following Reynolds (1984), represent departures from the expected frequencies in standard deviations (Kendall and Stuart 1961); this standardization allows all ceramic types/variants to be compared on an equal footing. Values near 0 indicate that a type/variant occurred in the collections in the numbers expected as based on its total abundance and the number of sherds representing each chronological period. Positive residuals indicate a type/variant's positive association with a chronological period, while negative values indicate a type/variant's negative association. Positive standardized residuals greater than 2.0 have been highlighted to clarify chronological patterns.

The relative strength of type/variant's association with a chronological period were compared using Pearson's C statistic (Hays 1973). This statistic allows comparison of the strength of association among types/variants with different sample sizes. Pearson's C can range in value from 0 (no association) to 1 (a perfect association); thus, a higher C value for a type/variant indicates a stronger pattern of association relative to that of other types or variants.

The standardized residuals for ceramic types of known chronological date are presented in Table IV.5. (Ceramic variants with less than 8 occurrences should be regarded with caution.) The ceramic types and variants have been broken into four groups based on their chronological associations. The first group consists of variants with significant positive associations with the collections designated as Early Aztec or AZ I/II

Table IV.5
Standardized Residuals for Ceramic Variants of "Known" Date

Variant	Chronological Period				X^2	C	N
	I/II	I/II-III	III	III/IV			
Aztec I B/O	**15.46**	-1.06	-10.36	-8.50	419.65	0.68	484
B/O PDM A	**4.55**	0.34	-3.61	-2.52	40.21	0.60	70
B/O PDM B	-0.35	**2.19**	-1.00	-0.68	6.40	0.40	34
B/O PDM D	-7.66	-1.48	**10.89**	-0.81	180.20	0.66	230
B/O PDM E	-14.03	-3.29	**15.46**	**4.83**	469.75	0.65	633
B/O PDM F-J	-7.63	-6.63	-4.89	**24.92**	747.00	0.88	209
B/O Bowl A	**3.34**	-0.70	-2.23	-1.31	18.31	0.57	38
B/O Bowl B	0.15	-0.05	-0.28	0.19	0.14	0.17	5
B/O Bowl C	-0.91	**2.95**	-1.41	-0.21	11.54	0.67	14
B/O Bowl D	-3.06	-0.63	**4.23**	-0.14	27.66	0.72	26
B/O Bowl E	-1.83	0.99	1.18	0.10	5.72	0.45	23
B/O Bowl F	-6.17	-0.91	**8.03**	-0.04	103.38	0.68	122
B/O Bowl G1	1.30	0.17	-1.03	-0.81	3.45	0.68	4
B/O Bowl G2	-4.51	-0.28	**3.35**	**2.73**	39.09	0.62	62
B/O Bowl H	-1.58	1.76	0.25	0.02	5.65	0.44	24
B/O Bowl LA	-1.70	-1.65	1.91	1.95	13.07	0.71	13
B/O Basin A	0.47	0.17	-0.06	-0.81	0.91	0.43	4
B/O Basin B	-0.08	0.47	0.23	-0.70	0.77	0.45	3
B/O Basin C	1.85	-0.79	-0.89	-0.70	5.34	0.80	3
B/O Basin D	-1.20	2.36	-0.06	-0.81	7.65	0.81	4
B/O Basin E	-1.04	1.73	0.23	-0.70	4.60	0.78	3
B/O Basin F	-0.85	-0.65	0.65	1.16	2.91	0.77	2
B/O Basin G	1.51	-0.65	-0.73	-0.57	3.56	0.80	2
B/O Basin H	-0.85	-0.65	-0.73	2.90	10.10	0.91	2
B/O Basin N	-1.70	-1.30	0.60	**3.20**	15.15	0.81	8
B/O Basin LA	-1.34	-1.02	0.59	**2.39**	8.91	0.80	5
CCPC A	**6.18**	1.28	-5.29	-3.86	82.68	0.65	113
CCPC B	**6.27**	0.02	-4.68	-3.34	72.30	0.67	90
CCPC C	**4.60**	1.57	-4.18	-3.26	51.73	0.61	87
CCPC D	**3.80**	-1.15	-1.94	-1.86	23.00	0.72	21
CCPC E	-0.60	-0.46	1.43	-0.41	2.77	0.86	1
CCPC F	-2.02	1.23	1.88	-0.79	9.75	0.56	21
CCPC G	-2.08	-0.33	**3.26**	-0.70	15.55	0.75	12
CCPC H	0.85	0.13	0.34	-1.83	4.22	0.31	41
CCPC I	0.93	1.26	-1.36	-1.08	5.48	0.66	7
CCPC J	1.85	-0.79	-0.89	-0.70	5.34	0.80	3
CCPC K	-0.08	1.73	-0.89	-0.70	4.27	0.77	3
CCPC L	1.07	-0.46	-0.51	-0.41	1.78	0.80	1
CCPC EA Ind.	**10.83**	0.58	-8.29	-6.14	223.94	0.67	274
CCPC LA Ind.	-0.92	1.07	0.66	-0.68	2.90	0.28	34
CCPC Indet.	-0.33	0.44	-0.63	0.78	1.31	0.40	7
Total B/O	-10.86	-6.19	**9.97**	**10.37**	363.24	0.36	2404
Total CCPC	**13.22**	1.86	-9.99	-8.94	357.86	0.58	715

based on the existing Black/Orange chronology. Ceramics in this group include Aztec I Black/Orange, Black/Orange PDM Variant A, Black/Orange Bowl Variant A, and CCPC Variants A, B, C, and D. Black/Orange Bowl G1 (N=4) and CCPC Variant J (N=3) probably belong to this group as well, but sample sizes are too small to accurately determine their chronological associations.

The second group includes Black/Orange types that are transitional between Early and Late Aztec and show affiliations with the AZ I/II-III category. Types in this group include Black/Orange PDM Variant B and Black/Orange Bowl Variant C. Black/Orange Bowl Variant H, Black/Orange Basin Variant D, and CCPC Variants I (N=7) and K (N=3) also show their strongest positive association with the category.

Variants showing a strong positive association with the Aztec III collections include Black/Orange PDM Variants D and E, Black/Orange Bowl Variants D, E, F, and G2, and CCPC Variants F and G. Finally, variants showing a strong positive association with the AZ III/IV collections include Black/Orange PDM Variants E and F, Black/Orange Bowl Variant G2, and Black/Orange Basin Variant N. Indeterminate Late Aztec Bowls show a positive association with both the Aztec III and III/IV collections, while Late Aztec Indeterminate Basins show a positive association with only the Aztec III/IV collections. No polychromes demonstrated an affinity for the Aztec III/IV collections.

The chronological associations of the ceramic types of "known" date largely confirm their original chronological placement. Of the variants with sufficient sample size to adequately assess chronological affiliation, only two variants display insignificant or low positive associations with the collections of their presumed date. Black/Orange PDM Variant B was classified as Early, but shows an insignificant association with the AZ I/II collections. Instead, this variant shows a significant positive association with the AZ I/II-III collections and may be more transitional in date than previously thought. Black/Orange Bowl Variant E was classed with the Late Aztec period and this variant does show a negative association with the AZ I/II collections; however, it shows only low positive associations with the AZ III and with the AZ I/II-III collections.

Once the chronological placement of the "known" Black/Orange and polychrome variants had been checked individually against the dated groups of collections, an identical methodology was used to assess the chronological placement of Red wares of unknown date. Vessel morphology is assessed first, to determine whether differences in rim form and wall profile were temporally sensitive. Secondly, the chronological placement of Red ware types and decorative variants as defined in Hodge and Minc (1991) is examined. In these analyses, recurved (REC), interior thickened (INT), and direct (DIR) rim forms have been combined for a given type/variant, based on the results of the vessel-form analysis. Late Profile or exterior thickened (EXT) has been retained as a distinct category for all types and variants. Both variant and subvariant levels of the typology were examined; where the stylistic subvariants showed no significant departure from each other and from the larger variant grouping, only the results for the variant is presented. Total X^2 values ≥ 7.81 are significant at the .05 level.

Red Ware Rim and Vessel Forms

There is considerable, if subtle, morphological variation in bowl forms within the Red ware Black/Red, Black/Red-Incised, and Black&White/Red types. Most vessels are simple rounded bowls with walls ranging from slightly incurving to outcurving, with a gentle basal angle, and flat base. On these vessels with rounded profiles, the rim may take one of three forms: (1) simple with a rounded, direct lip (**direct**); (2) slightly thickened on the interior wall just below simple, rounded lip (**interior thickened**); or (3) slightly recurved (**recurved**). Recurved rims are generally held to be indicative of Early Aztec ceramics, due to their prevalence in the Black/Red-Incised type. Rims that have a slight interior thickening or bump at the lip have also been considered to be early (Elizabeth Brumfiel, personal communication). These early vessel forms co-occur with a natural orange-to-brownish paste with a grey medial core and burnished surfaces.

In addition to the above form categories, **Late Profile** bowls are found as well in the Black/Red and Black&White/Red types. These vessels have thin, outsloping walls and **exterior thickened** rims that show a slight exterior bulge below the rim above which the lip is thinned. Sherds of these vessels reveal a pronounced dark-grey-to-black medial core that extends almost the thickness of the vessel wall; surfaces are either polished to a high gloss finish or appear over-fired with dull, muddy colors (see Appendix 2 for detailed descriptions).

In the Black/Red type, Late Profile bowls have been distinguished as a separate category, as there is relatively little continuity in design between the so-called early profile bowls and the late profile bowls. In the Black&White/Red type, however, it is disturbing to note that design variants almost completely cross-cut these differences in vessel form, i.e. a design can occur on a range of distinct vessel forms. Although preferential associations do exist between specific design variants and vessel forms, the degree of stylistic continuity across changes in Black&White/Red vessel form argues that design variants are not in themselves temporally sensitive. Vessel form must also be considered.

All Black/Red-Incised, Black/Red, and Black&White/Red rims were cross-tabulated by vessel rim morphology and decorative variant. The four-fold rim typology, however, generated too many categories and resulted in very small sample sizes for some rim/variant combinations. Accordingly, vessel rim form alone was examined in order to determine which vessel rim categories could be combined.

The standardized residuals for the Red ware types and rim forms (Table IV.6) indicates that recurved, interior thickened, and direct rim forms for all types show positive associations with the Aztec I/II and/or Aztec I/II-III collections. It appears justifiable for present purposes to combine these three rim forms into a single category of early vessel forms, realizing, however, that recurved and interior thickened rims represent a slightly earlier time period. The late profile or exterior thickened bowls, in sharp contrast, show strong positive associations with the Aztec III and III/IV collections. The appellation of "Late Profile" is therefore confirmed.

In the following analyses of decorative variants and types, vessel morphology is condensed to two categories: an early form (including recurved, interior thickened, and direct), and a late form (consisting of the exterior thickened or Late Profile vessels). Body sherds have been included with rims when they could be assigned safely to either the early or late category based on vessel morphology, paste, and surface finish, as well as to decorative variant, based on design organization and motifs.

Table IV.6
Standardized Residuals for Red Ware Types and Vessel Rim Forms

Type/ Rim Form	Chronological Period				X^2	C	N
	I/II	I/II-III	III	III/IV			
B/R-I REC	**4.23**	-0.43	-3.00	-1.95	30.85	0.69	34
B/R-I INT	**1.89**	**3.24**	-3.09	-2.53	30.01	0.61	50
B/R-I DIR	1.08	**3.53**	-1.79	-3.30	27.73	0.54	66
B/R REC	**4.93**	-0.08	-3.10	-3.25	44.52	0.56	97
B/R INT	**3.86**	-0.43	-4.52	0.52	35.81	0.39	194
B/R DIR	**2.51**	**2.34**	-3.51	-1.90	27.72	0.23	504
B/R EXT	-5.54	-1.66	**5.65**	**2.90**	73.80	0.58	149
B&W/R REC	**1.65**	**2.57**	-2.67	-1.95	20.23	0.61	34
B&W/R INT	**3.57**	1.35	-3.82	-1.94	32.94	0.51	95
B&W/R DIR	**2.56**	**4.40**	-5.33	-1.99	58.23	0.41	289
B&W/R EXT	-8.49	-1.70	**11.95**	-0.69	218.29	0.69	238

Note: Expected values were based on total decorated assemblage size. Standardized residuals >2.00 have been highlighted to clarify patterns of association.

Black/Red-Incised Variants

The Black/Red-Incised type as a whole is believed to belong to the Early Aztec period (Tolstoy 1958:63-64; J. Parsons 1966:224); several authors have argued that within that period, graphite-painted variants may represent an earlier phase while mineral black paint variants represent a later phase (Whalen and Parsons 1982:447; M. Smith 1983:403-407). As discussed in Appendix III, however, the use of graphite or mineral black paint is inconsistent with respect to variants: both graphite and black mineral paint occur on all Black/Red-Incised variants, although graphite is more common on Variants C and D. Further, graphite paint is employed on Late Aztec and early colonial "Black/Red" ceramics as well, indicating that this pigment is not a good chronological marker for the Early Aztec. As a result, this analysis has focused on the incised designs as the major dimension of variability, and combines both graphite and black mineral painted forms under the rubric of Black/Red-Incised.

Although the bulk of the Black/Red-Incised type belongs to the Early Aztec period, the variants of this type examined here indicate that Black/Red-Incised continued into the transitional Aztec I/II-III period. In the standardized residuals analysis (Table IV.7), the cane and scroll variants (Variants C and D) appear to be the earliest Black/Red-Incised variants and show a strong positive association only with the Aztec I/II collections. In contrast, the panelled variants (Variants A and B) appear to be slightly later but overlapping in date. Variant B shows a strong positive association with the Aztec I/II collections and a substantial positive association with the transitional Aztec I/II-III collections as well. Variant A is slightly later yet, showing a significant positive association primarily with the Aztec I/II-III collections.

Table IV.7
Standardized Residuals for Red Ware Types and Variants

Type/ Rim Form	Chronological Period				X^2	C	N
	I/II	I/II-III	III	III/IV			
B/R-I A	0.44	**5.18**	-2.30	-3.57	45.03	0.61	77
B/R-I B	**3.31**	1.54	-3.17	-2.59	30.09	0.61	52
B/R-I C	**3.89**	-0.44	-2.77	-1.73	26.05	0.69	29
B/R-I D	**2.62**	-1.12	-1.26	-1.00	10.69	0.80	6
B/R-I Panel	**5.90**	**2.76**	-5.18	-5.25	96.82	0.53	244
B/R-I C&D	**4.65**	0.04	-3.53	-2.43	39.95	0.68	47
B/R-I Other	**2.41**	0.48	-1.99	-1.57	12.51	0.67	15
B/R-I *Copa*	1.51	-0.65	-0.73	-0.57	3.56	0.80	2
Total B/R-I	**7.72**	**2.52**	-6.49	-6.01	144.28	0.56	308
B/R A	**6.82**	1.33	-5.51	-4.58	99.60	0.63	150
B/R B	**6.74**	0.12	-4.70	-4.13	84.66	0.52	234
B/R C	-3.22	1.90	1.03	1.30	16.76	0.44	70
B/R D	0.26	1.76	-2.17	0.39	8.01	0.45	31
B/R E	**2.94**	**2.18**	-2.91	-3.11	31.53	0.53	81
B/R F	-1.11	1.79	-0.77	0.59	5.36	0.63	8
B/R G	1.08	0.16	-0.78	-0.78	2.40	0.40	13
B/R H	0.21	0.42	-0.72	0.13	0.76	0.11	64
B/R H1	1.34	-0.98	-1.41	0.92	5.59	0.43	25
B/R H2	-0.13	1.18	-0.61	-0.36	1.91	0.25	29
B/R H3	-1.37	0.62	1.44	-0.51	4.60	0.56	10
B/R I	-1.55	**2.54**	-0.49	0.05	9.12	0.20	210
B/R I1	-1.67	1.02	0.65	0.49	4.51	0.21	97
B/R I2	-0.15	**2.35**	-1.52	-0.51	8.13	0.28	97
B/R I3	-1.15	0.89	0.37	0.22	2.30	0.35	16
B/R BRO	1.09	-0.24	-3.15	**2.66**	18.26	0.44	76
B/R Late Bowl	-5.54	-1.66	**5.65**	**2.90**	73.80	0.58	149
B/R Basin	-0.52	1.02	-0.77	0.59	2.24	0.47	8

Note: Recurved, Interior Thickened, and Direct rim forms have been combined. Late Profile or Exterior Thickened has been retained as a distinct category. Expected values were based on total decorated assemblage size. Standardized residuals >2.00 have been highlighted to clarify patterns of association.

Table IV.7, continued
Standardized Residuals for Red Ware Types and Variants

Type/ Variant	Chronological Period				X^2	C	N
	I/II	I/II-III	III	III/IV			
B&W/R AW	**2.41**	1.43	-2.47	-2.04	18.10	0.38	106
B&W/R AN	**3.52**	0.51	-2.85	-2.15	25.36	0.48	85
B&W/R B	-1.68	**3.61**	-0.61	-0.82	16.89	0.61	29
B&W/R C	-2.10	**2.04**	0.07	0.72	9.08	0.54	22
B&W/R C1	-0.59	**2.88**	-1.15	-0.91	10.79	0.83	5
B&W/R C2	-1.11	0.25	-0.77	**2.33**	7.30	0.69	8
B&W/R D1	-1.24	**3.19**	-1.86	0.58	15.48	0.74	13
B&W/R D2	0.15	1.37	-0.78	-0.78	3.13	0.44	13
B&W/R D3	1.52	**1.94**	-2.63	-1.11	14.20	0.59	26
B&W/R E1	**2.66**	0.56	-2.68	-1.17	15.91	0.61	27
B&W/R E2	**3.74**	**2.47**	-4.02	-3.21	46.53	0.57	95
B&W/R E3	-0.09	**3.26**	-1.66	-1.44	15.46	0.63	23
B&W/R E4	**2.65**	-1.38	-0.90	-1.22	11.20	0.74	9
B&W/R F	-2.47	**3.50**	1.06	-1.64	22.16	0.67	27
B&W/R G	-1.80	-1.38	**2.99**	0.42	14.23	0.78	9
B&W/R AW EXT	-1.89	-0.65	**3.52**	-0.94	17.29	0.73	15
B&W/R AN EXT	-1.20	-0.92	**2.85**	-0.81	11.09	0.86	4
B&W/R B EXT	-1.80	0.08	**2.99**	-1.22	13.65	0.78	9
B&W/R C EXT	-4.85	0.28	**4.65**	0.95	46.19	0.63	71
B&W/R D2 EXT	-0.59	-0.05	0.59	0.19	0.74	0.36	5
B&W/R E3 EXT	-1.47	0.66	1.12	0.01	3.84	0.62	6
B&W/R F EXT	-4.26	-0.81	**5.75**	-0.08	51.91	0.69	56
B&W/R Late	-7.26	-0.55	**8.91**	0.04	132.39	0.66	168
Yellow/Red	-2.61	-0.50	**3.10**	0.49	16.94	0.69	19
B&W&Y/Red	-2.53	-1.74	**3.20**	**1.64**	22.37	0.70	23
White/Red	-1.47	-0.23	1.12	1.01	4.49	0.65	6

Note: Recurved, Interior Thickened, and Direct rim forms have been combined. Late Profile or Exterior Thickened (EXT) has been retained as a distinct category. Expected values were based on total decorated assemblage size. Standardized residuals >2.00 have been highlighted to clarify patterns of association.

The relative ordering of the Black/Red-Incised variants observed here is consistent with that encountered by O'Neill (1962) in his stratigraphic excavations at Chalco. An examination of O'Neill's type collection at the American Museum of Natural History suggested that our Variants C and D were encountered throughout the lower strata (Levels 9-23) of O'Neill's excavations in conjunction with Aztec I Black/Orange and CCPC pottery. The panelled variants, in contrast, occurred only in the upper-most strata (Levels 1-8), which contained a mix of Aztec I-IV Black/Orange variants.

Black/Red Variants

The standardized residuals analysis of Black/Red variants is presented in Table IV.7; for descriptions and illustrations of decorative variants see Appendix III, this volume. Variant A, equivalent to Parsons' (1966) wide-line Variant A, is strongly associated with the Aztec I/II collections and belongs to the Early Aztec period. This temporal placement is consistent with that of Parsons (Table IV.8). Variants B and C both fall within Parsons' Variants A (narrow line) and B. Variant B shows a strong positive association with the Early Aztec collections in our analysis. In contrast, Variant C shows a strong negative association with the Early Aztec collections. This variant occurs throughout the Late Aztec period, but shows its strongest affinities to the transitional Aztec I-II/III collections. Black/Red Variant D (incorporating Parsons' Variants C, D, and E) also shows its strongest positive association with the Aztec I-II/III collections while exhibiting a significant negative association with the Aztec III collections. Thus, Variant D appears somewhat earlier than Variant C. Both Variants C and D reveal temporal affiliations in this analysis that are somewhat earlier than the placement attributed to these variants by Parsons, who suggested that they were both dominantly Chimalpa (Aztec III) in date. However, the BRO (Black Rim Only) bowls -- sherds that most likely represent Black/Red Variant C vessels on which the comb motif is not visible -- show a strong positive association with the Aztec III and III/IV collections, a temporal affiliation that is consonant with Parsons' placement of this variant.

Black/Red Variants E through I are not covered by Parsons' typology. Our Variant E is strongly associated with both the Aztec I/II and the transitional Aztec I/II-III collections. In contrast, Black/Red variants (F, G, and H) do not show strongly significant patterns of association with the dated collections. Variants F and G, defined on the basis of distinctive motifs (the pendant scroll and lazy-S, respectively) may well be mixed categories. Where these variants represent elaborations of the E and D variants, respectively, they most likely belong to the Early Aztec and Early-to-Late transitional period. Variant H and its subvariants are more puzzling. These subvariants stylistically appear to be a coherent and internally consistent unit and one with a fairly restricted spatial distribution, but they show insignificant associations with all time periods, possibly suggesting an extended period of use for this simple decoration. The similarly simple B/R Variant I and its subvariants (I1, I2, and I3) all show their strongest positive association with the Aztec I/II-III collections while showing negative associations for the early Aztec I/II collections. However, the low C value for this variant (0.20) indicates that the temporal association is relatively weak for the available sample size and that Variant I may also have been used over a long period of time. Black/Red basins appear in too low a frequency in the south (N=8) to adequately assess their chronological position; however, their stylistic similarities with Black/Red Variant D would suggest an early or transitional date. Within the Black/Red type, only the Late Profile bowls and BRO (Black Rim Only) bowls show a strong positive association with the Aztec III and III/IV collections.

Black-&-White/Red

The Black&White/Red type shows significant temporal associations for all variants of sufficient sample size. Within the subvariants occurring on early profile vessels, only F1 and F2 were too low frequency to assess.

Variants AW and AN and the horizontally organized or panelled Subvariants D3, E1, E2, and E4 belong to the Early Aztec period and show strong positive associations

Table IV.8
Concordance of Red Ware Typologies and Chronologies

Variant (This Study)	Variant (Parsons 1966)	Temporal Placement (after Parsons 1966)
B/R A	B/R A wide	Hueoxtoc (Aztec I)
B/R B&C	B/R A&B	Chimalpa (Aztec III)
B/R D	B/R C&D&E	dominantly Chimalpa (Aztec III)
B&W/R AW	B&W/R AW	peaks during Hueoxtoc and Zocango (Aztec I/II)
B&W/R AN	B&W/R AN	peaks during Chimalpa (Aztec III)
B&W/R B&C	B&W/R B	highest proportions in Zocango/Chimalpa (Aztec II/III); surprisingly high proportion in Teacalco (Aztec IV)
B&W/R E2	B&W/R C	distinctly Hueoxtoc (Aztec I)
B&W/R D1&E3	B&W/R D	peak in Zocango (Aztec II)
B&W/R F&G	B&W/R G	peak in Chimalpa (Aztec III)
Yellow/Red	Yellow/Red	peak in Teacalco (Aztec IV)
White/Red	White/Red	late Chimalpa phase (late Aztec III)
B&W&Y/Red	B&W&Y/Red	middle-to-late Chimalpa (Aztec III)

with the Aztec I/II collections (Table IV.7). The horizontally organized variants continue into the transitional collections, with the stylistically similar Subvariants D1 and E3, and are joined by the vertically and obliquely organized Variants B and C, all of which show strong positive associations with the Aztec I/II-III collections. Of the variants occurring on the recurved, interior thickened, or direct rim bowls, only Subvariant C2 appears to be late in date. This subvariant is the most prevalent decorative variant occurring on Late Profile or exterior-thickened rim bowls.

All Black&White/Red variants occurring on exterior thickened bowls (Variants AW, AN, B, C, and F) show strong positive associations with the Aztec III collections, while showing insignificant associations with the Aztec III/IV collections. Thus, this vessel form appears to begin well within Aztec III times, although it may continue into Aztec III/IV. The intricately decorated Black&White/Red Variant G shows a similar temporal distribution.

Within the Black&White/Red variants assessed here as belonging to the Early Aztec period (AW, AN, D3, E1, E2, and E4), Parsons' typology also assigned Variants AW (equals Parsons' Variant AW) and E2 (equals Parsons' Variant C) to the Early Aztec period. Variant AN, in contrast, was believed to belong to Aztec III times. The temporal placement of Variants B, C, D1, and E3 accords well with Parsons' chronology, who also attributed them to Aztec II and II/III phases. It is interesting, however, that Parsons noted a strong bimodality in his Variant B (our Variants B and C). Although Parsons' Variant B had its highest proportions in Zocango/Chimalpa (Aztec II/III) times, it also showed a surprisingly high proportion in Teacalco (Aztec IV). It is quite likely that this bimodality results from the prevalence of vertical and oblique designs on Late Profile bowls, which in Parsons' typology were included within the same variant. Thus, the bimodality could reflect the strong continuity in design across a marked temporal change in vessel form. Only Black&White/Red Variant G was securely dated to the Late Aztec period (Aztec III) by Parsons; this is in accordance with its temporal placement here.

Miscellaneous Low Frequency Red Ware Types

Among the low frequency Red ware types, Yellow/Red (Y/R) shows a strong positive association with the Aztec III collections, while showing insignificant associations with the Aztec III/IV collections (Table IV.7). The Black&White&Yellow/Red or Black-&Yellow/Red type (B&W&Y/R), in contrast, shows its strongest positive association with the Aztec III collections, but continues into the Aztec III/IV collections as well. White/Red (W/R) appears as a low-frequency Late Aztec type.

Tolstoy (1958:64) and Parsons (1966:246) assigned these three low frequency Red ware types to late in the Aztec sequence. White/Red was seen by Parsons to have a peak in late Aztec III times, while Black&White&Yellow/Red probably had a peak in middle to late Chimalpa (Aztec III) times. Yellow/Red was felt to attain a peak in the Teacalco (Aztec IV) phase. Similarly, at Chalco, O'Neill (1962:49, Table 2) associated Yellow/Red (termed "lacquered bichrome") with the appearance of Aztec IV Black/Orange. Our analysis thus sees Yellow/Red as beginning somewhat earlier and Black&White&Yellow/Red as continuing somewhat later than reported based on excavated contexts. Graphite/Red soup bowls or plates were of too low frequency in the south to quantitatively assess their temporal placement; T. Charlton (personal communication 1991) gives these a colonial date based on vessel form, although they clearly fall (on the basis of physical and technological characteristics) within the Aztec Red ware tradition.

Miscellaneous Ceramic Types and Ritual Vessels

In addition to the Red ware types, there occur in the Aztec collections a number of miscellaneous types and ritual vessels of largely unknown date (Table IV.9). Of these, the Black/White type, also called Xochimilco Polychrome or Churrubusco ware (Hodge and Minc 1991:242-243) is of particular interest. This type shows strong affinities with the Late Aztec III/IV collections; thus this polychrome type may emerge concurrent with the decline of the Chalco-Cholula polychromes in the southern Valley area. González Rul (1988:84), in his excavations at Tlatelolco, associated this low-frequency ware (called "*Cerámica de decoración café o guinda de Chalco*", citing Séjourné 1970, Fig. 6) with Aztec III collections. Séjourné (1970:70) associates this type (called "*cerámica pintada con líneas negras o sepias sobre un fondo blanco*") with the phase of Culhua hegemony [note that her figure citations appear inconsistent with the verbal description here]. However, Mary Hodge (personal communication) suggests that Séjourné may be referring to an Early

Aztec type with a similar paste, that of white-slipped grater bowls (see Hodge and Minc 1991:252, Fig. 8.8).

Table IV.9
Standardized Residuals for Miscellaneous Types and Ritual Vessels

Type	Chronological Period				X^2	C	N
	I/II	I/II-III	III	III/IV			
Black/White[a]	-3.37	0.08	0.70	**4.00**	27.85	0.66	37
White Ware	-3.40	-2.22	**2.20**	**4.74**	43.84	0.59	82
Colonial/Glazed	-2.08	-0.96	-0.66	**4.98**	30.49	0.85	12
Spiked Braziers	**1.91**	-0.28	-0.51	-1.86	7.48	0.44	32
Censers[b]	0.70	0.18	0.60	-1.99	4.86	0.31	45
Texcoco Molded	-3.84	-1.91	**6.11**	0.09	55.70	0.76	41
Texcoco Filleted	-0.52	1.79	-0.08	-1.15	4.80	0.61	8
Texcoco Censer[c]	-3.72	-1.03	**5.55**	-0.39	45.88	0.70	49
Black/Red *Copa*	-1.69	-1.53	**2.35**	**1.25**	12.25	0.38	71
Variant A	-1.56	-1.29	**3.77**	-1.01	19.32	0.74	16
Variant B	-0.70	-1.00	-0.02	**2.18**	6.23	0.50	19
Variant C	-1.70	-1.30	**2.66**	0.59	12.00	0.77	8
Variant D	-1.70	**1.98**	-0.24	0.58	7.20	0.60	13
Plain Red *Copa*	**1.68**	**2.05**	-2.13	-2.08	15.90	0.40	83
Conical *Copa*[d]	0.08	0.47	0.03	-0.68	0.69	0.07	154

[a]Equals "Xochimilco Polychrome" or Churrubusco ware.

[b]Includes red handles and punched bowl fragments belonging to *sahumadores* that do not exhibit molded or filleted decoration (cf. González Rul 1988, Lám. 24).

[c]Combines Texcoco Molded and Texcoco Filleted censers.

[d]Includes both Black/Red and Plain Red conical-cup *copas*.

White ware, which appears similar in paste and slip to the preceding Black/White type but without decoration, shows affinities to both the Aztec III and III/IV collections (Table IV.9). Glazed sherds (undifferentiated in our sample as to type or color of glaze) are strongly associated (as anticipated) with only the Aztec III/IV collections -- a comforting note of support for the general validity of this approach.

Among the class of ritual vessels, spiked braziers or *braseros* show their strongest association with the Early Aztec collections (Table IV.9). This is consistent with their occurrence in Parsons' excavations at CH-AZ-195, which dates entirely to the Early Aztec period, as well as in O'Neill's excavations at Chalco, where *braseros* are firmly dated to the Early Aztec period (1962:49, Table 2). Punched censers or *sahumadores*, in contrast, appear to occur throughout the sequence, except in the latest phase or Aztec III/IV collections. *Sahumadores* exhibiting molded or filleted decoration (i.e. Texcoco Molded and Texcoco Filleted) appear strongly associated with the Aztec III collections. Thus, the general ritual vessel form of *sahumador* has a long period of use in Aztec society; molded and filleted decoration on these vessels appears to emerge in Aztec III times. This placement is consistent with their appearance in O'Neill's excavations at Chalco where embossed *sahumadores* (1962:141, Fig. 34) enter the sequence only in conjunction with Aztec III Black/Orange (1962:49, Table 2).

Copas were also included in the class of ritual vessels. Overall, Plain red conical *copas* show strong positive associations with the Early Aztec collections, while Black/Red conical *copas* show negative associations with the Early collections, indicating a general Late Aztec date (Table IV.9). Within the Black/Red *copas*, Variant D (decorated with the grill design) appears to earliest, and is associated with the transitional Aztec I/II-III assemblages. Stylistically, this variant is similar to Black/Red bowl Variant E, which showed strong positive affiliations with Aztec I/II and the transitional Aztec I/II-III collections. Variant A (decorated with vertical lines) and Variant C (bearing the "*espumoso*" motif) appear most strongly associated with the Aztec III collections, while Variant B (decorated with horizontal lines) shows stronger affinities with the Aztec III/IV collections. Black/Red conical *copas* have been generally associated with the Late Aztec period (J. Parsons, personal communication). *Copas* with rounded or globular cups have been associated with the Early Aztec period; however, there were too few of this vessel type in the survey collections to test its chronological placement.

Relative Placement of Red Ware Types and Variants in Indirect Seriation

The relative chronological order of the Red ware types and decorative variants resulting from the indirect seriation was summarized using a nonmetric multi-dimensional scaling analysis (MDS) based on the standardized residuals for each type as distributed across the dated collections (I/II, I/II-III, III, III/IV) (see Tables IV.7 and IV.9). These standardized residuals reflect the degree of affinity of each type, variant, or subvariant for the four chronological periods. Temporal distances between types were calculated as a matrix of euclidean distances based on the standardized residuals. This distance matrix was then analyzed using MDS, which maps out relationships among types in terms of relative spatial proximity in a reduced dimensional space (Drennan 1976; Kendall 1971; Kruskal and Wish 1983; Marquardt 1978). The Kruskal scaling algorithm was employed, which minimizes Form 1 stress (a measure of the degree of fit between true and mapped distances); stress values $\leq$ .2 indicate an acceptable fit between real and scaled distances.

The MDS seriation included Black/Red-Incised, Black/Red, and Black&White/Red variants and low frequency Red ware types, from which extremely low frequency variants were excluded. The coefficient of alienation (stress) for the two dimensional solution was low (.07 in 38 iterations), indicating a good fit between euclidean and scaled distances. The plot of the resulting configuration of points in two dimensions (Fig. IV.2a) divides the Red wares into two main groups, as indicated by the dashed line. Ceramic types, variants, and subvariants falling to the right of the line include early profile bowls of the Black/Red, Black/Red-Incised, and Black&White/Red types, while those falling to the left of the line include late profile bowls of Black/Red and Black&White/Red as well as bowls of the low frequency types (Yellow/Red, Black&White&Yellow/Red, and White/Red (Figs. IV.2b

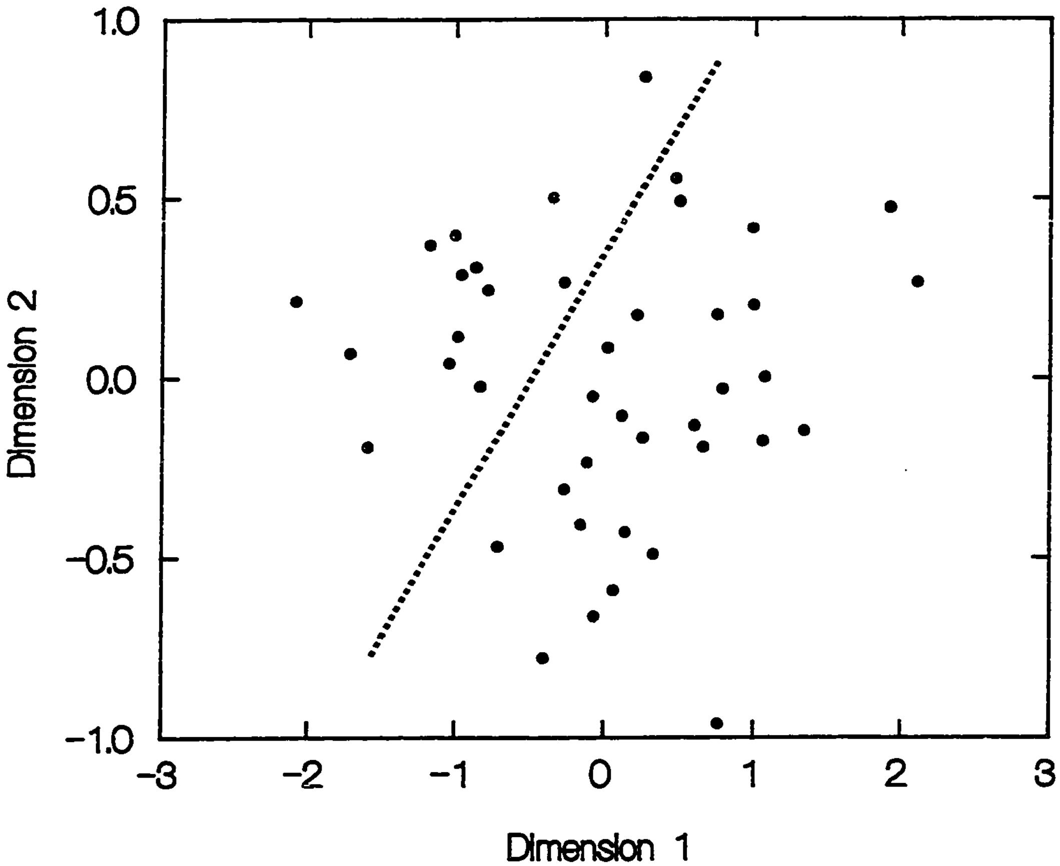


Figure IV.2a. MDS seriation of Red Ware variants based on standardized residuals across collections of known date.

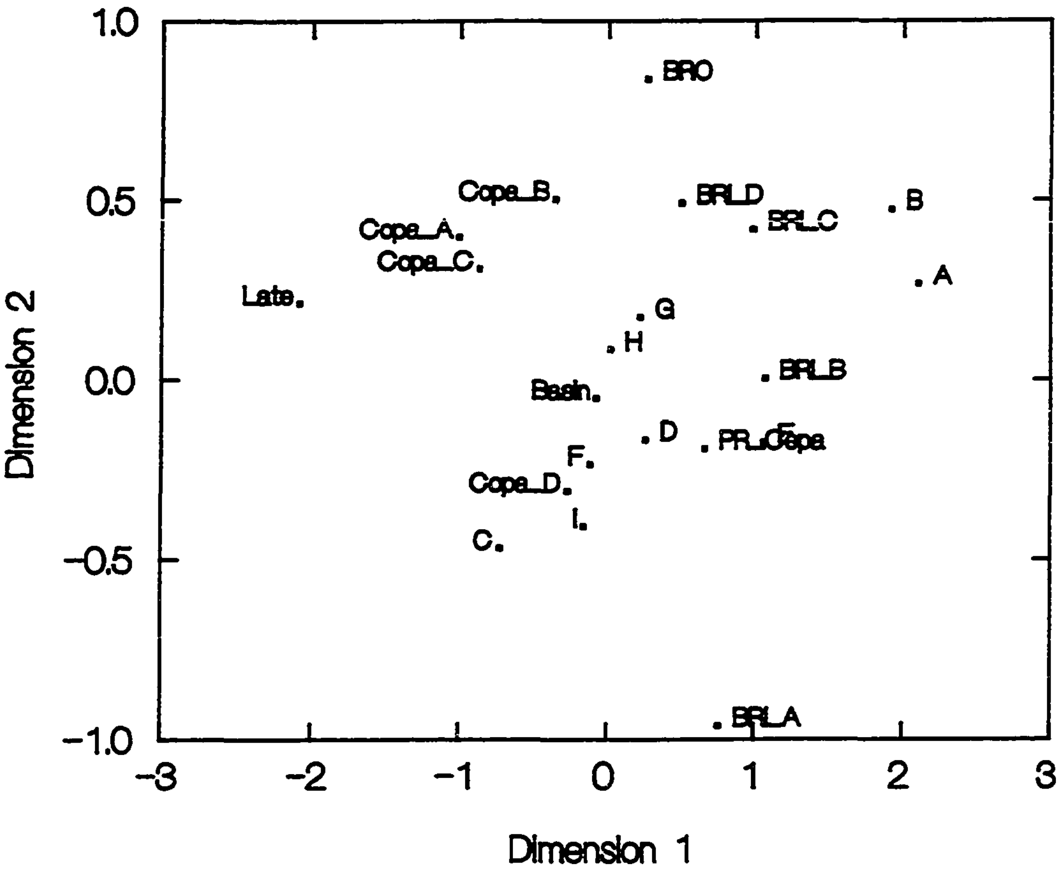


Figure IV.2b. Relative order of Black/Red and Black/Red-Incised variants in MDS seriation based on standardized residuals across collections of known date. All variants are Black/Red unless otherwise indicated.

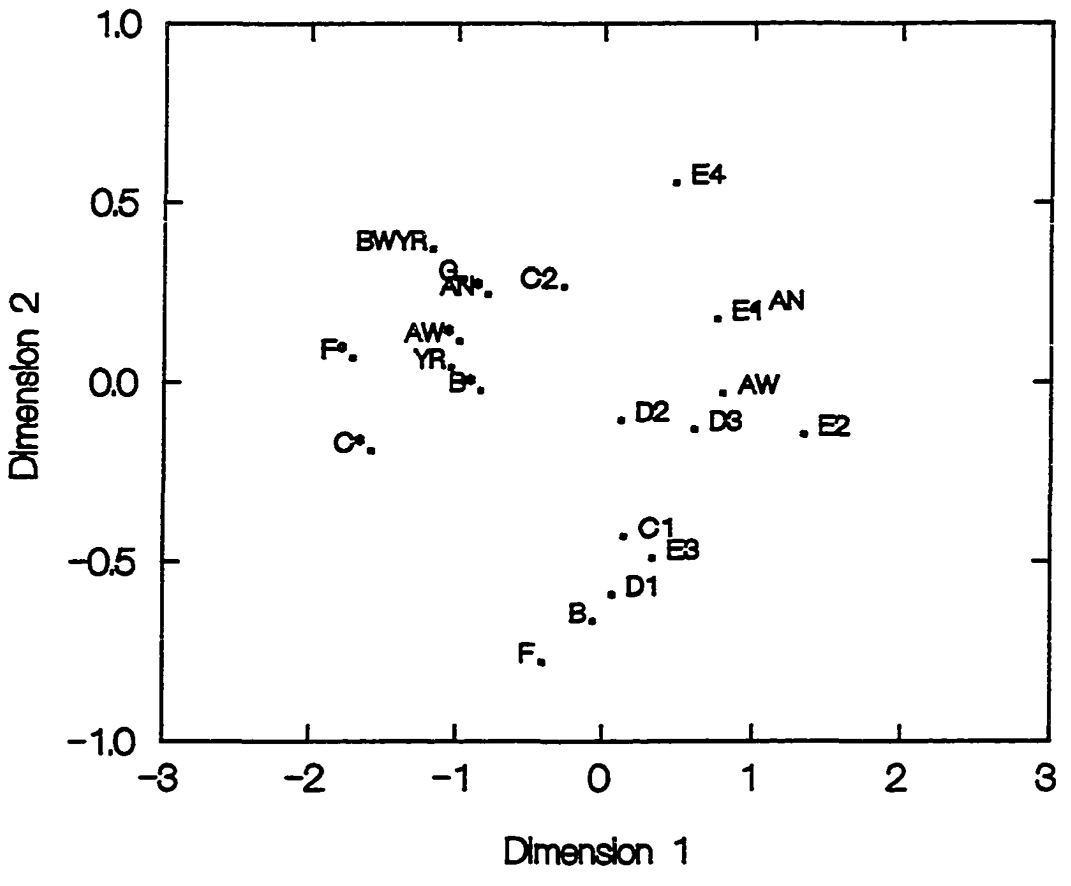


Figure IV.2c. Relative order of Black&White/Red variants and miscellaneous types in MDS seriation based on standardized residuals across collections of known date. (An * indicates exterior thickened or Late Profile.)

- Fig. IV.2c). *Copas* were divided across this line, with Plain Red *copas* and Black/Red Variant D *copas* falling in with the early bowls, and Black/Red Variant A, B, and C *copas* falling with the late bowls.

Further, within the group of earlier Red ware vessels, a temporal trend can be noted along the vertical axis of the plot. Within the Black/Red and Black/Red-Incised variants (Fig. IV.2b), for example, Black/Red Variants A and B, along with Black/Red-Incised Variants C and D at the top of the plot appear to be earliest, while Black/Red bowls C, F, and I and *Copa* D appear at the late end of this group; Black/Red-Incised A and BRO bowls are obvious outliers to this general pattern. Similarly, within the Black&White/Red bowls (Fig. IV.2c), a temporal trend can be noted from Variant E4 at the top down to Variant F near the bottom. In general, however, this seriation gives a fairly coarse representation of temporal relationships among Red ware types, with the primary distinction being between an earlier and a later group.

Because major differences in sample size can affect the absolute value of the standardized residuals (and hence the strength of temporal associations when types are compared against one another), a second seriation of Red ware types and decorative variants was based on the percentage of each type occurring in the dated collections (I/II, I/II-III, III, III/IV). Percentages were adjusted for overall differences in assemblage size, using a weighting factor (W_i) inversely proportional to the percent of total assemblage size (P_i) represented by these collections (Table IV.10). As in the preceding case, temporal distances between types and variants were quantified using euclidean distances and summarized with nonmetric multi-dimensional scaling analysis (MDS).

The two dimensional solution had a final stress of .10 in 19 iterations, again indicating a fair fit between euclidean and scaled distances. The plot of the resulting configuration of points in two dimensions (Fig. IV.3a) reveals a rough arch (with several outliers); such a configuration suggests that a single dimension (presumably time) adequately expresses the major relationships among types. Position along this arch can therefore be interpreted as indicating the relative chronological placement of Red ware types and variants (Figs. IV.3b and IV.3c). The sequence begins at the lower right corner with Black/Red-Incised Variants C and D and continues to the lower left corner with Black&White/Red Late Profile Variants AW, AN, and B, and Black&White/Red Variant G.

The two-dimensional configuration also suggests of a break in the seriation (at a point just less than 0 on Dimension 1) that divides the variants into two main clusters. The cluster on the right (Figs. IV.3b and IV.3c) includes all Black/Red-Incised, and most early forms of Black/Red and Black&White/Red. In contrast, the cluster to the left of the break contains all Late profile (exterior-thickened) forms of Black/Red and Black&White/Red, along with the intricately decorated Black&White/Red Variant G and the low frequency Red ware types (Yellow/Red, White/Red, and Black&White&Yellow-/Red). Black/Red *Copas* Variants A, B, and C also fall within this latter group. Of the early rim forms, only Black/Red Variant C and Black&White/Red Variants C2 and F fall slightly to the left of this break; Black/Red bowl Variants F, H, I, and BRO, as well as basins and *Copa* Variant D appear borderline or temporally transitional.

The relative temporal "spread" of the Red ware types and variants along the MDS seriation is presented in Figure IV.3d, based on the Pearson's C value (a measure of the strength of association between a type and the dated collections). Here, the size of the

Table IV.10
Percentage of Red Ware Types and Variants in Dated Collections Corrected for Differences in Total Assemblage Size

Variant	Collections				Total
	I/II	I/II-III	III	III/IV	
B/R-I A	0.283	0.588	0.129	0.000	77
B/R-I B	0.508	0.416	0.042	0.034	52
B/R-I C	0.684	0.251	0.000	0.065	29
B/R-I D	1.000	0.000	0.000	0.000	6
B/R-I Panel	0.462	0.387	0.102	0.049	244
B/R-I Cane	0.654	0.306	0.000	0.040	47
B/R-I Other	0.620	0.380	0.000	0.000	15
B/R-I *Copa*	1.000	0.000	0.000	0.000	2
B/R A	0.574	0.363	0.038	0.024	150
B/R B	0.498	0.288	0.117	0.097	234
B/R C	0.080	0.329	0.280	0.310	70
B/R D	0.258	0.400	0.059	0.283	31
B/R E	0.432	0.421	0.106	0.042	81
B/R F	0.074	0.500	0.102	0.324	8
B/R G	0.412	0.298	0.162	0.129	13
B/R H	0.259	0.273	0.208	0.260	64
B/R H1	0.368	0.143	0.117	0.372	25
B/R H2	0.237	0.360	0.196	0.207	29
B/R H3	0.066	0.335	0.455	0.145	10
B/R I	0.198	0.329	0.228	0.245	210
B/R I1	0.171	0.288	0.272	0.269	97
B/R I2	0.240	0.369	0.175	0.216	97
B/R I3	0.121	0.339	0.276	0.264	16
B/R BRO	0.288	0.221	0.072	0.420	76
B/R Late Bowl	0.054	0.156	0.432	0.358	149
B/R Basin	0.156	0.395	0.107	0.341	8
B/R *Copa*	0.159	0.142	0.372	0.327	71
Variant A	0.089	0.075	0.737	0.098	16
Variant B	0.164	0.110	0.225	0.501	19
Variant C	0.000	0.000	0.654	0.346	8
Variant D	0.046	0.464	0.189	0.301	13
Plain Red *Copa*	0.347	0.390	0.147	0.117	83
B/R-I REC	0.687	0.258	0.000	0.056	34
B/R-I INT	0.392	0.534	0.041	0.033	50
B/R-I DIR	0.328	0.516	0.156	0.000	66
B/R-I TOT	0.499	0.373	0.082	0.046	308
B/R REC	0.542	0.286	0.116	0.056	97
B/R INT	0.379	0.239	0.097	0.285	194
B/R DIR	0.304	0.310	0.181	0.204	504
B/R EXT	0.054	0.156	0.432	0.358	149

Table IV.10, continued.
Percentage of Red Ware Types and Variants in Dated Collections
Corrected for Differences in Total Assemblage Size

Variant	Collections				Total
	I/II	I/II-III	III	III/IV	
B&W/R AW EA	0.373	0.344	0.145	0.138	106
B&W/R AN EA	0.458	0.309	0.113	0.120	85
B&W/R B EA	0.111	0.561	0.183	0.145	29
B&W/R C EA	0.055	0.418	0.227	0.301	22
B&W/R C1 EA	0.129	0.871	0.000	0.000	5
B&W/R C2 EA	0.069	0.233	0.095	0.603	8
B&W/R D1 EA	0.091	0.612	0.000	0.297	13
B&W/R D2 EA	0.272	0.459	0.150	0.119	13
B&W/R D3 EA	0.397	0.479	0.000	0.124	26
B&W/R E1 EA	0.527	0.346	0.000	0.128	27
B&W/R E2 EA	0.460	0.430	0.056	0.054	95
B&W/R E3 EA	0.241	0.610	0.083	0.066	23
B&W/R E4 EA	0.853	0.000	0.147	0.000	9
B&W/R F EA	0.048	0.568	0.331	0.053	27
B&W/R G	0.000	0.000	0.688	0.313	9
B&W/R AW EXT	0.046	0.156	0.697	0.101	15
B&W/R AN EXT	0.000	0.000	1.000	0.000	4
B&W/R B EXT	0.000	0.260	0.740	0.000	9
B&W/R C EXT	0.009	0.236	0.469	0.287	71
B&W/R D2 EXT	0.131	0.221	0.361	0.287	5
B&W/R E3 EXT	0.000	0.348	0.426	0.226	6
B&W/R F EXT	0.012	0.175	0.586	0.227	56
B&W&Y/Red	0.027	0.045	0.517	0.411	23
Yellow/Red	0.000	0.167	0.544	0.289	19
White/Red	0.000	0.166	0.405	0.429	6
Black/White	0.015	0.205		0.530	37
White Ware	0.081	0.099		0.497	82
Colonial (Glazed)	0.000	0.070		0.816	12
Red Ware Ass.	2158	1261	1591	992	6002
P_i	.36	.21	.265	.165	
W_i	.16	.27	.22	.35	

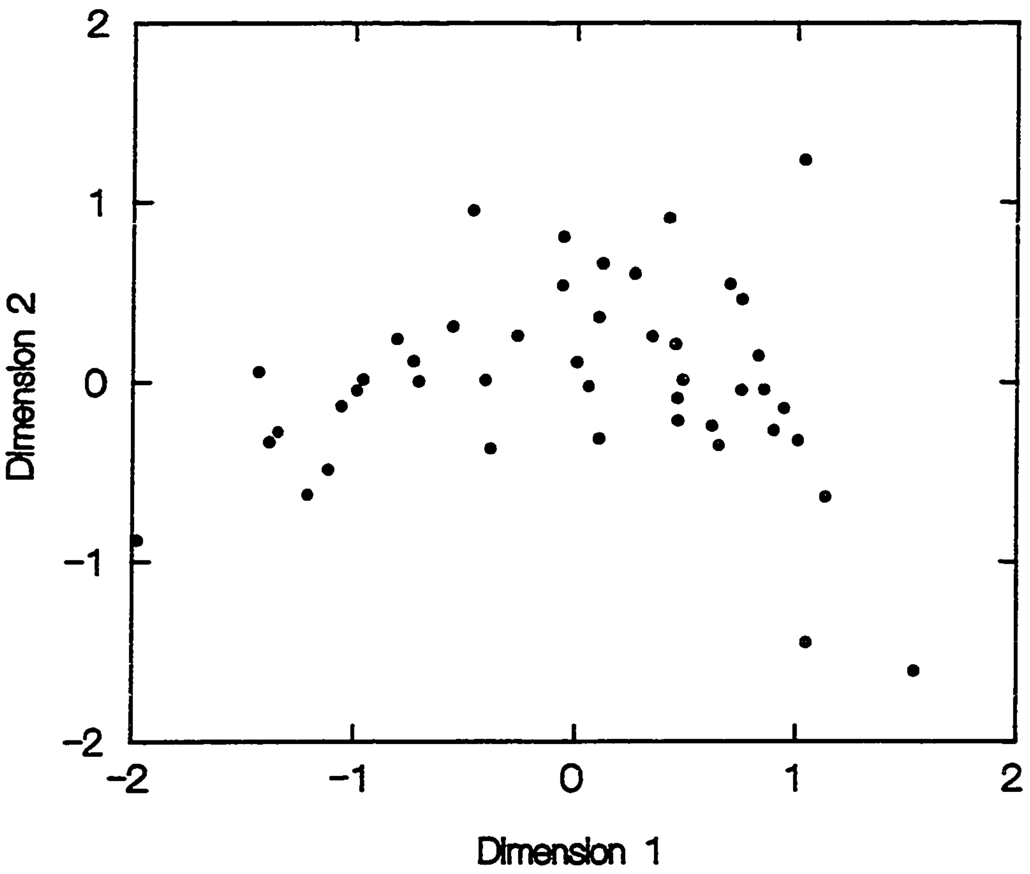


Figure IV.3a. MDS seriation of Red Ware variants based on weighted percentages in collections of known date.

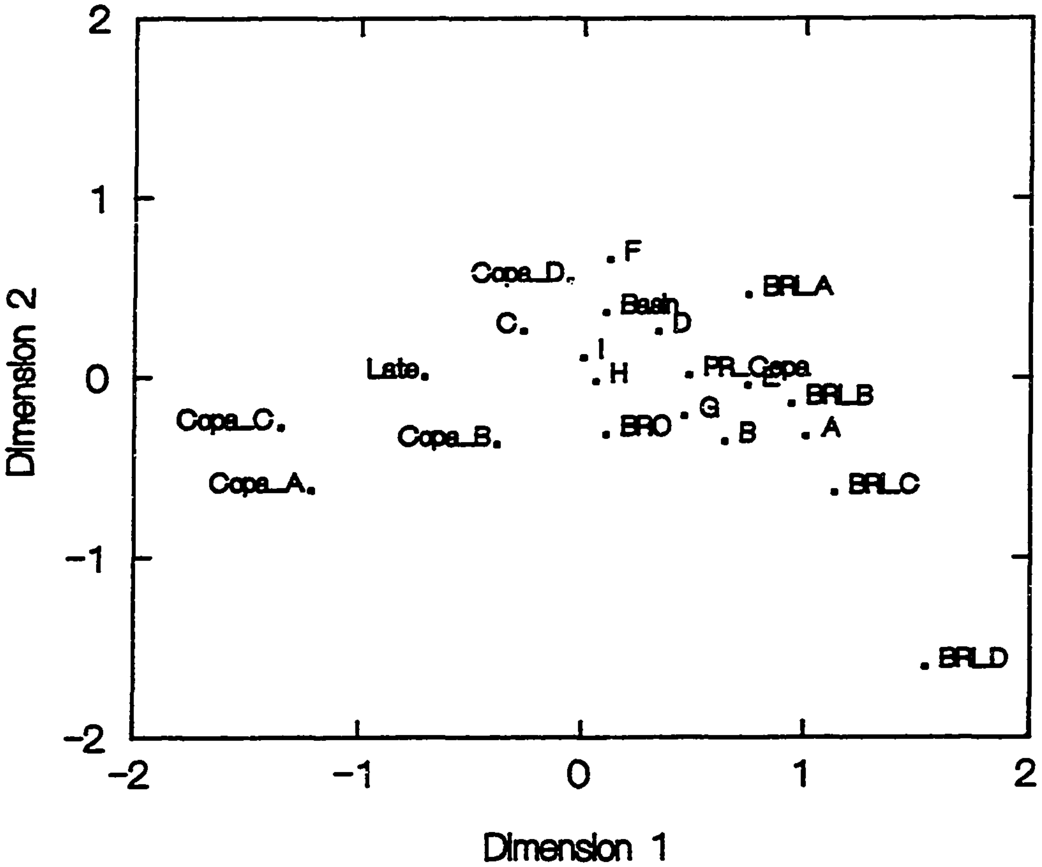


Figure IV.3b. Relative order of Black/Red and Black/Red-Incised variants in MDS seriation based on weighted percentages in collections of known date. All variants are Black/Red unless otherwise indicated.

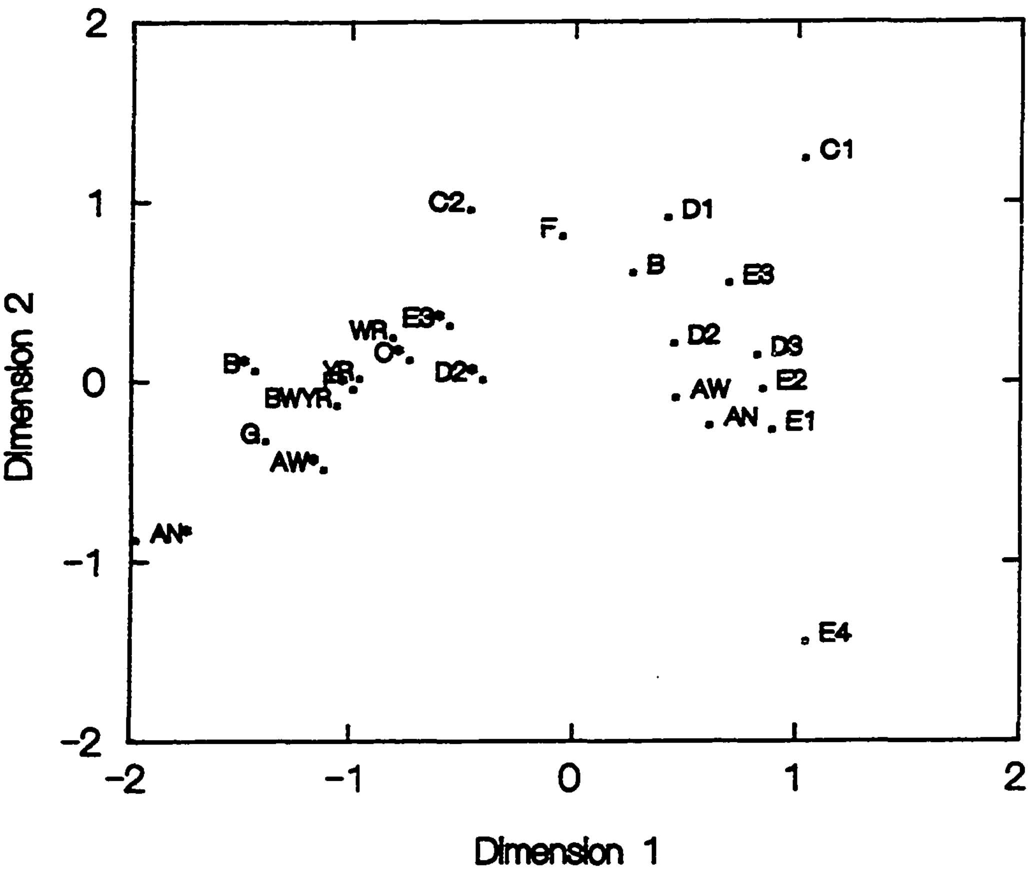


Figure IV.3c. Relative order of Black&White/Red variants and miscellaneous types in MDS seriation based on weighted percentages in collections of known date. (An * indicates exterior thickened or Late Profile.)

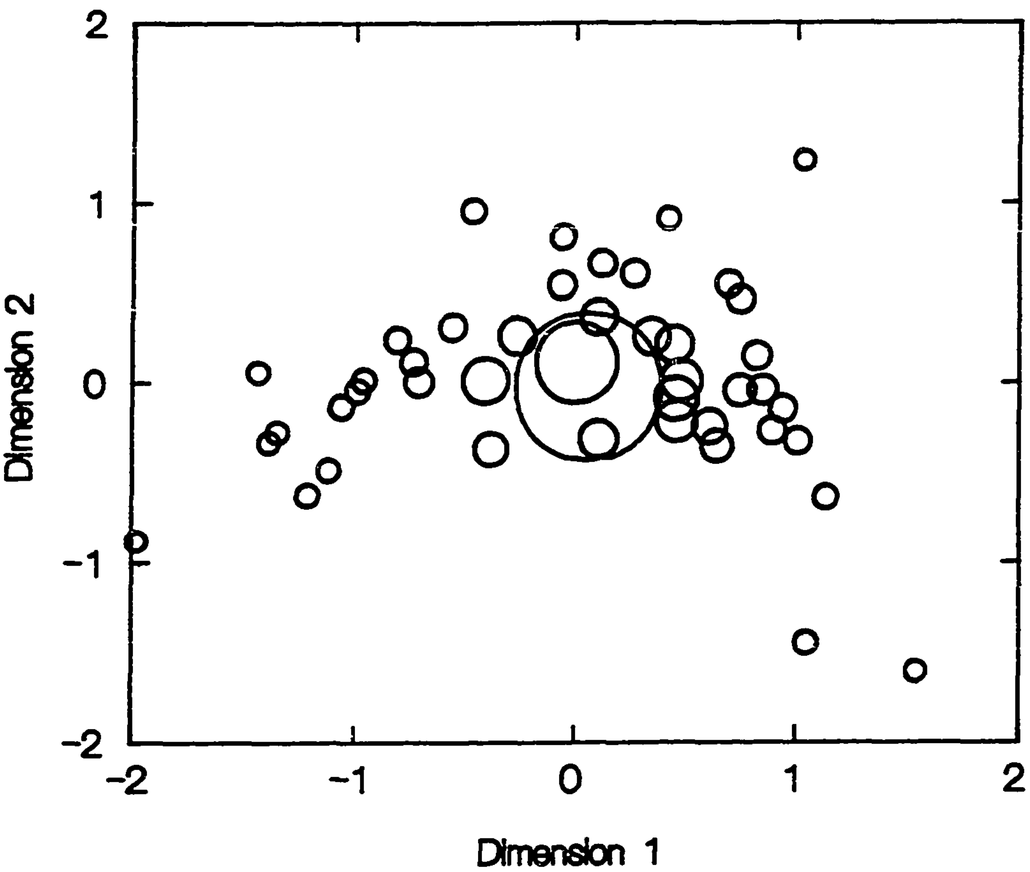


Figure IV.3d. Relative temporal duration of Red Ware decorated variants in MDS seriation of Red Ware types. Size of symbol is inversely proportional to Pearson's C value for each variant. (Note that scale of symbol size bears no direct relationship to scale of MDS configuration.)

symbol is indicative of the **relative** longevity or duration of a type or variant in the Aztec ceramic sequence. Types or variants with large symbols have a greater life-span and are less temporally sensitive than those with small symbols.

Two points are of interest in this plot. First, there are two variants with relatively large temporal spreads that fall in the center of the graph. In order of decreasing size, these are Black/Red Variant H and Black/Red Variant I. Although these variants appear as transitional according to their placement along the arch, the broad span of these variants suggests that, in fact, a strict temporal placement for Variants H and I is somewhat misleading. Rather, these variants may have experienced a relatively long popularity relative to other Red ware types. Secondly, most of the remaining types and variants have temporal spans that are all on roughly the same order. The relative temporal order of these variants is therefore fairly well represented by their placement along the arch configuration.

In summary, the indirect seriation of Red ware types and variants suggests a division of this ware into two main temporal groups on the basis of rim form: (1) early profile bowls, which were positively associated with the Early Aztec I/II and transitional Aztec I/II-III collections, and (2) the Late Profile or exterior thickened bowls, which showed positive associations with Aztec III and III/IV collections. Low frequency types, including Yellow/Red, Black&White&Yellow/Red, and White/Red bowls were associated with the latter group, as were most Black/Red conical *copas*. Several variants with relatively narrow temporal spreads appear transitional; variants that continue from transitional into late times include Black/Red bowl Variants C, F, and BRO, Black&White/Red early bowl Variants C2 and F, as well as Black/Red basins and *Copa* Variant D.

Direct Seriation of Red Ware Types

An alternative seriation of Red ware types and variants was produced through direct comparison of these types against each other, based on their co-occurrence in surface collections. Unlike the preceding indirect seriation, the direct seriation does not assume that Orange wares and Red wares within a surface collection are contemporaneous and allows for differences in the availability of these two wares through time. Further, the direct seriation does not tie the Red wares to the Black/Orange sequence and allows for different rates of change or timing of change within the two wares. The direct seriation therefore offers the possibility of identifying breaks in the Red ware typological sequence that may be independent of typological changes in the Black/Orange sequence. On the other hand, the direct seriation is more vulnerable to problems of chronological mixture in surface collections, confusion of temporal and spatial patterns of ceramic distribution, and the constraints imposed on quantitative analyses by a sparse data set. The problems introduced by different spatial distributions are particularly worrisome here, given preliminary indications of multiple distribution networks within the Valley, since types with distinct spatial distributions may appear temporally distinct as well. Finally, while the direct seriation presents the relative ordering of types/variants, it provides no basis for determining the duration of a given type/variant or of its absolute temporal placement.

The direct seriation was based on the co-occurrence of Red ware types and variants on a presence/absence basis in surface collections from the CH, IX, and XO survey regions. In order to partially alleviate problems in assessing co-occurrence that can arise from a sparse data matrix, only collections containing at least two different Red ware types or variants were included in this analysis (N=207). Attempts to further limit the sample in favor of larger collections preferentially excluded collections of late date, potentially increasing the difficulty in assessing the chronological placement of later Red ware vessels. The degree of co-occurrence between any two types/variants was quantified using the Jaccard co-efficient, a similarity measure that counts only positive matches (co-presence) of types/variants. In essence, this co-efficient represents the proportion of collections containing both types out of a total that contain either or both types. Relationships among all types were then examined using non-metric multi-dimensional scaling (MDS), as in the preceding indirect seriations.

The initial MDS seriation included Black/Red-Incised, Black/Red, and Black&White/Red variants, from which extremely low frequency variants were excluded. Recurved, interior thickened, and direct rim forms were combined into a single category for each variant and contrasted with exterior thickened forms. The final stress for the three dimensional solution was acceptably low (.14 in 50 iterations).

A plot of the configuration of points on the first two dimensions (Fig. IV.4a) reveals that the seriation divided the variants into two main clusters. The right-hand cluster contains all Black/Red-Incised, all early forms of Black/Red and most early Black&White/Red, as well as Plain Red and Black/Red Variant D *copas* (Figs. IV.4b and IV. 4c). In contrast, the cluster on the left includes all exterior-thickened forms of Black/Red and Black&White/Red, along Black&White/Red Variant G and the low frequency Red ware bowl types (Yellow/Red, White/Red, and Black&White&Yellow/Red) and Black/Red *Copas* A, B, and C. The only early variant to fall in the left-hand cluster is Black&White/Red Variant F. Thus this initial seriation also supports the division of Red ware variants on the basis of rim form into two main temporal groups (i.e. the Late Profile or exterior thickened bowls and early profile bowls).

There also appears, however, to be something of a temporal gradient within the earlier cluster, ranging from Black/Red-Incised Variants C and D at the top, down to Black&White/Red Variant C. In order to clarify this finer level of temporal patterning, a second MDS seriation was run that included only those variants falling into the right-hand cluster. The final stress for the two-dimensional solution was somewhat higher (0.20).

The plot of this second seriation (Fig. IV.5) presents finer (presumably temporal) subdivisions within the early (pre-Late Profile) Red ware variants. The position of these variants along the primary dimension indicate the existence of three temporal groups. At the top of the plot (Fig. IV.5, Table IV.11), Black/Red-Incised Variants C and D and Black&White/Red Variant E4 form a separate group. In the standardized residuals analysis, all three of these variants showed strong positive associations with the Aztec I/II collections, but negative associations with the Aztec I/II-III collections, suggesting that they are very early in the sequence. The middle portion of the graph consists of a large cluster of variants, including Black/Red-I Variants A and B, Black/Red Variants A, B, G, H, and I, and Black&White/Red Variants AW, AN, D2, D3, E1, and E2. Most of these variants showed stronger associations with the Aztec I/II collections than with the transitional Aztec I/II-III collections. Black/Red Variants D and E, and Black&White/Red Variants D1 and E3 form the lower edge of this middle cluster. In the indirect seriation, this latter group either had higher positive associations with the transitional Aztec I/II-III collections than with the Early Aztec I/II collections, or had significant associations with both periods. Finally, Black/Red Variants C and F, Black/Red basins, and Black&White/Red Variants

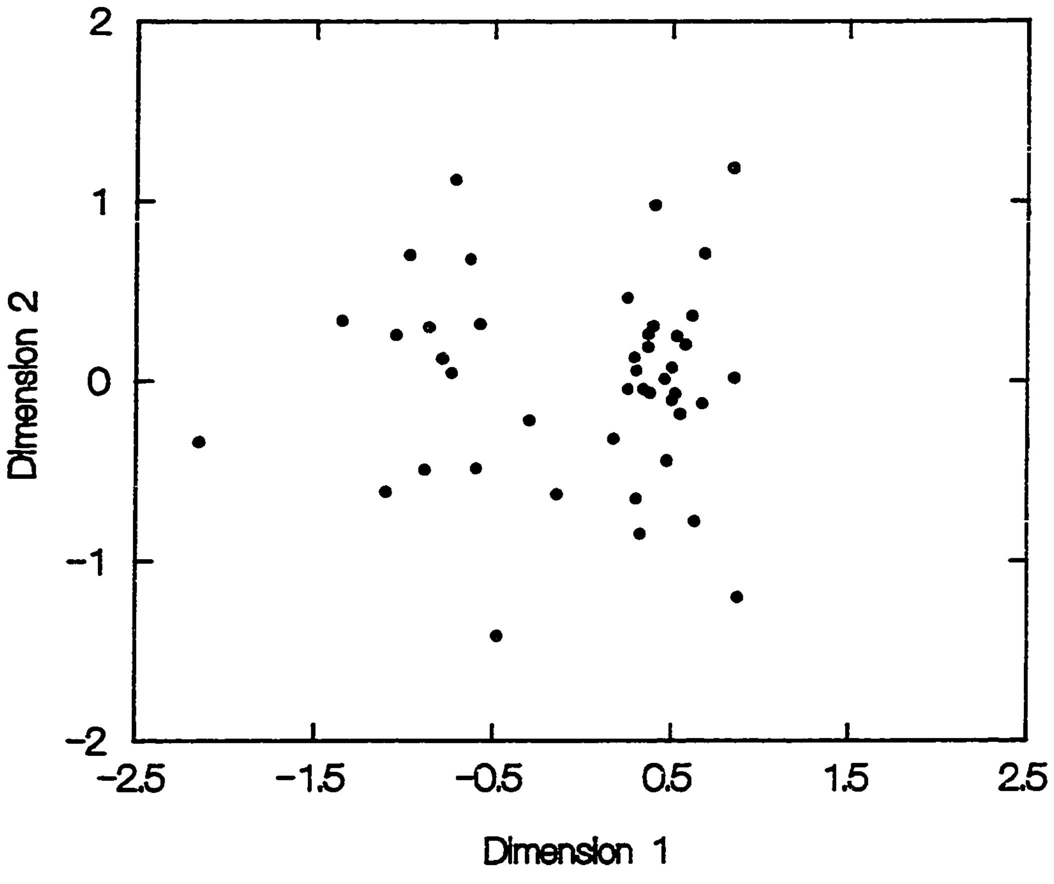


Figure IV.4a. MDS seriation of Red Ware variants and types based on their co-occurrence in surface collections.

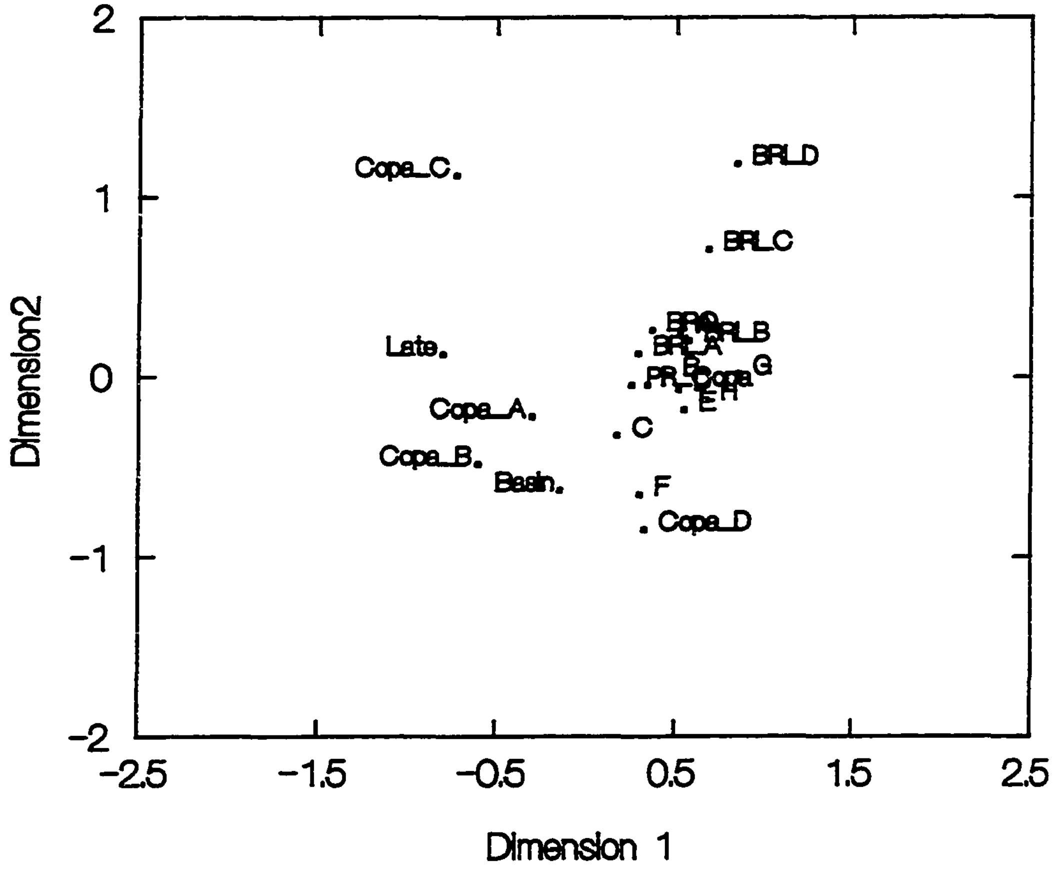


Figure IV.4b. Position of Black/Red and Black/Red-Incised variants in MDS seriation based on co-occurrence of types and variants in surface collections.

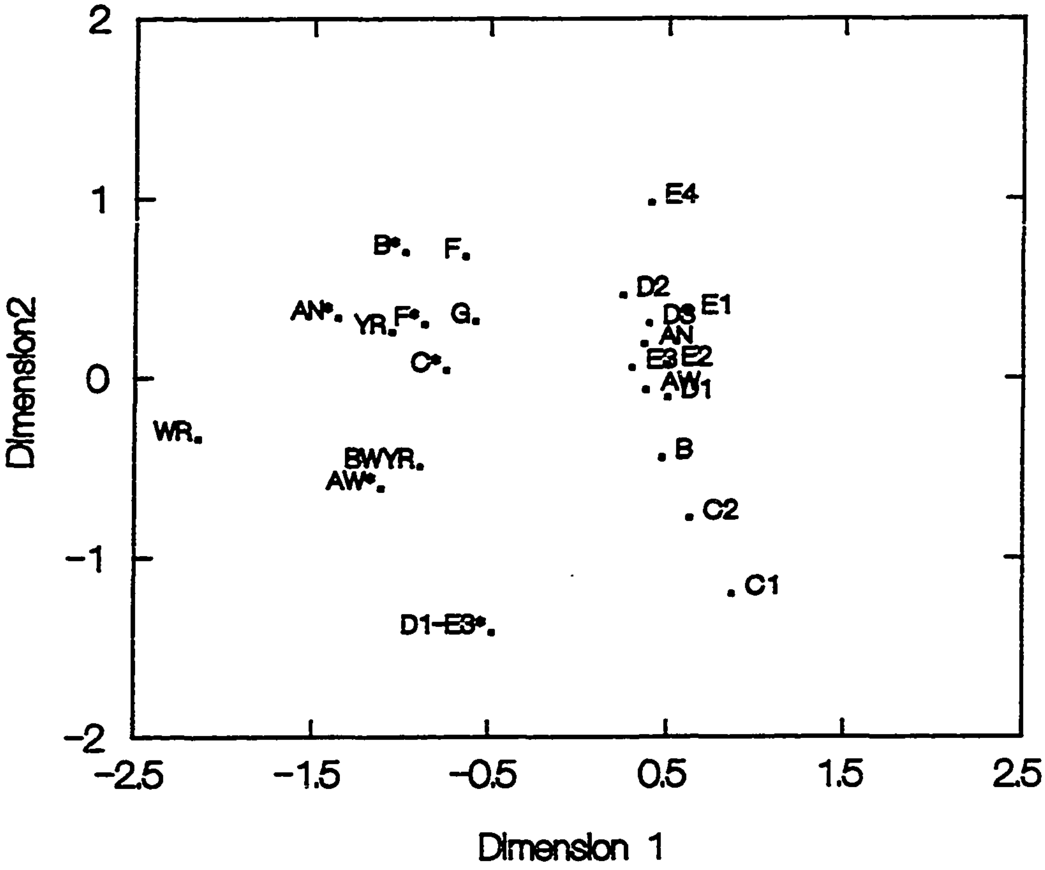


Figure IV.4c. Position of Black&White/Red variants and miscellaneous types in MDS seriation based on co-occurrence of types and variants in surface collections.

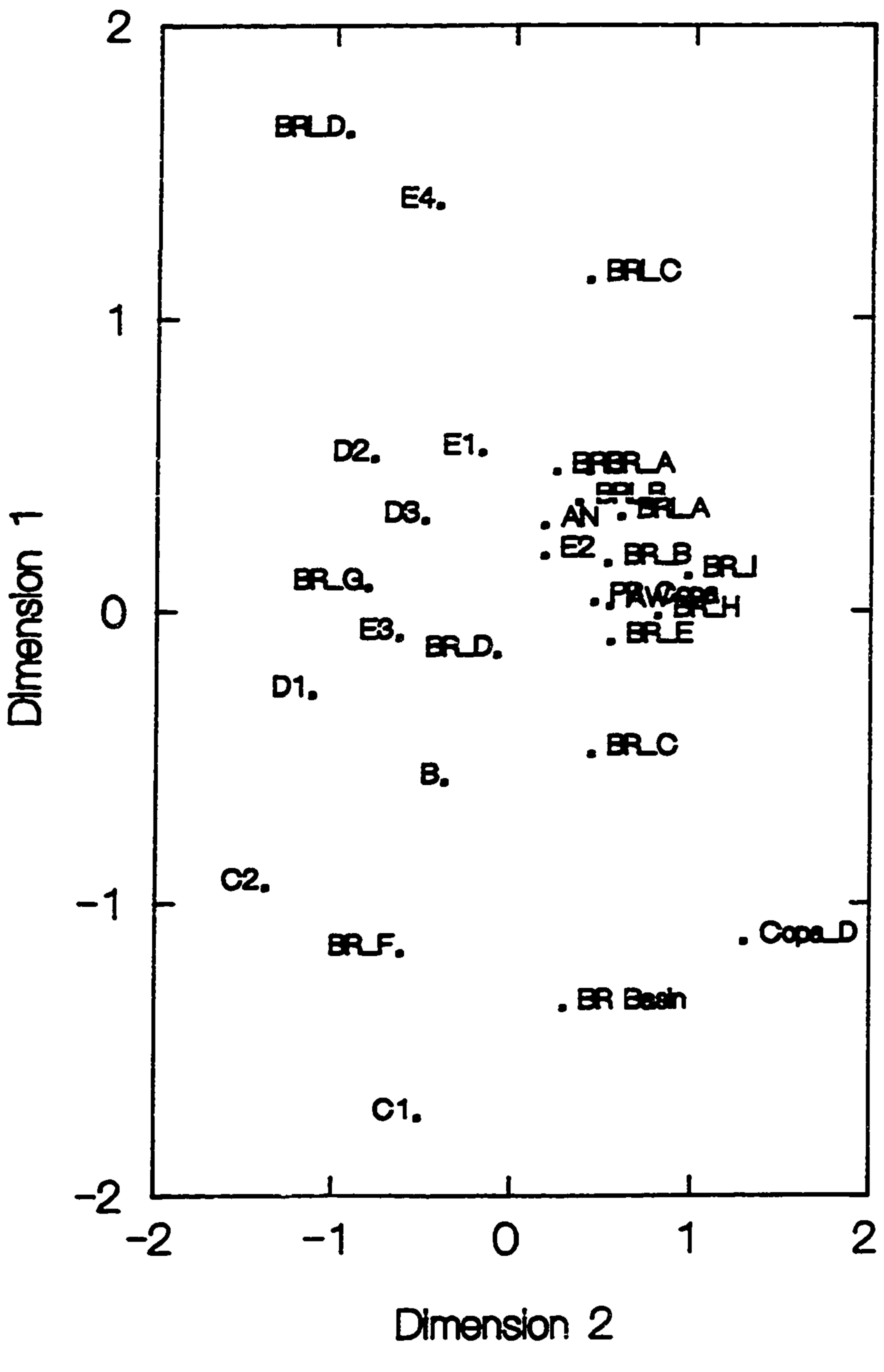


Figure IV.5. MDS Seriation of early Red Ware variants based on their co-occurrence in surface collections.

Table IV.11
Relative Order of Earlier Red Ware Types and Variants
Based on Direct MDS Seriation

Order	Variant	Position on MDS Dimension 1	
1	B/R-I D	1.632	Earlier
2	B&W/R E4	1.387	
3	B/R-I C	1.133	
4	B&W/R E1	0.540	
5	B&W/R D2	0.519	
6	B/R A	0.475	
7	BRO	0.474	
8	B/R-I B	0.372	
9	B/R-I A	0.321	
10	B&W/R D3	0.309	
11	B&W/R AN	0.292	
12	B&W/R E2	0.188	
13	B/R B	0.163	
14	B/R I	0.119	
15	B/R G	0.081	
16	Plain Red *Copa*	0.031	
17	B&W/R A	0.016	
18	B/R H	-0.018	
19	B&W/R E3	-0.089	
20	B/R E	-0.106	
21	B/R D	-0.149	
22	B&W/R D1	-0.284	
23	B/R C	-0.488	
24	B&W/R B	-0.583	
25	B&W/R C2	-0.946	
26	B/R *Copa* D	-1.130	
27	B/R F	-1.169	
28	B/R Basin	-1.356	
29	B&W/R C1	-1.734	Later

B, C1, and C2 form a distinct group at the bottom of the plot, suggesting that they are late relative to the other variants within the early group.

The direct seriation offers general confirmation for the results obtained in the indirect seriation. Overall, the results of the two independent analyses are quite consistent in classing variants as either early or late; the results are somewhat less consistent for finer temporal assignments. Even at the coarser level of temporal analysis, however, several apparent discrepancies exist between the two seriations. Primary among these is the temporal position of Black/Red Variant C. In the standardized residuals analysis, Black/Red Variant C appears relatively late, and was the only early profile variant to show positive associations with the Late Aztec collections. The direct seriation, however, places this variant substantially earlier than several variants (Black/Red Variant F, Black/Red Basins, and Black&White/Red Variant B) that have affiliations with only the transitional collections. Part of the problem may result from the fact that all of these are fairly low frequency variants in the south, a factor that makes it difficult to assess their chronological relationships relative to one another. Based on the standardized residuals analysis, as well as on the generally accepted Late Aztec date for Black/Red Variant C in the Texcoco (Parsons 1971:309), Huexotla (Brumfiel 1976), and Teotihuacan (Parsons 1966) regions, a late date is accepted here for this variant.

A second set of discrepancies involves types and variants that have a variable or inconsistent placement, and includes BRO bowls, Black/Red Basins, Black/Red bowls Variants H and I, and Black&White/Red bowl Variant C1. These discrepancies appear to result from one of three causes: small sample size, extended period of use, or a mixed category. In the case of Black/Red Basins and Black&White/Red Variant C1, the problems appear to result from inadequate sample size. In general, however, an early date seems plausible for Black&White/Red C1 (based on rim form), while a transitional to late date is accepted for basins, based on stylistic similarities to Black/Red bowl Variants C and D. With respect to Black/Red Bowls H and I, their relatively long-lived popularity (see Fig. IV.3d) could obviously confound attempts to seriate these variants relative to other more temporally restricted ones. Finally, BRO bowls may represent the inadvertent combination of temporally distinct entities. It is interesting to note that many of the aforementioned discrepancies involve a temporal placement that is earlier in the direct than in the indirect seriation. This temporal skewing may well result from similar patterns of spatial distribution among temporally dissimilar types and variants.

Stratigraphic Evidence for Temporal Placement of Aztec Red Ware Types

Stratigraphic excavations in the Lake Chalco-Xochimilco area reporting ceramic data are few (O'Neill 1962; Grove 1964; Séjourné 1970; Parsons, Brumfiel, Parsons, Popper, and Taft 1982). Supporting information from O'Neill's excavations, based on his published report and on an examination of his type collections (housed at the American Museum of Natural History in New York), has already been presented where applicable in the foregoing discussion. Descriptions of the Culhuacan (Séjourné 1970) and Ixtapaluca Viejo (Grove 1964) ceramic data are presented in typological units that are unfortunately too coarse to permit comparison. This section reviews the general ceramic sequence found at Chalco by O'Neill and by Parsons in the *chinampa* zone, as these excavated materials confound or support points of the basic chronology derived from surface collections.

Early Aztec Deposits

O'Neill's (1962) excavations at Chalco, excavated in arbitrary 25 cm levels, extended to a depth of 7 m below ground surface. O'Neill's lowest stratum, Stratum I (Levels 25-28) contained Aztec I Black/Orange ceramics of the Mixquic type, but no polychrome or Red ware sherds were encountered (1962:49, Table 2). The succeeding two strata, Strata II and III (Levels 15-24 and 9-14, respectively) were dominated by a mix of Chalco and Mixquic Aztec I Black/Orange and Chalco polychrome ceramics, and included Red ware sherds of the Graphite Black/Red-Incised type. It is only in Stratum IV (Levels 2-8), containing a mix of Aztec I-III Black/Orange ceramics, that the panelled Black/Red-Incised variants, as well as Black/Red and Black&White/Red variants, enter into the sequence. O'Neill summarizes the Early Aztec sequence as composed of a brief, very early (pre-Red ware) Chalco period and an early Chalco period dominated by Aztec I Black/Orange, Chalco polychrome, and Graphite Black/Red Incised.

As noted above, the relative ordering of the Black/Red-Incised variants observed in O'Neill's excavations at Chalco is consistent with the placement of these variants in both the indirect and direct seriations. The cane and scroll variants (our Variants C and D) appear very early in the sequence, while the panelled variants (our Variants A and B), appear later and continue in use until the transitional Aztec I/II-III times.

Parson's excavations at CH-AZ-195, Op. B, in Lake Chalco provide a pure Early Aztec midden deposit extending to a depth of 3 m (Parsons, Brumfiel, Parsons, Popper, and Taft 1982; Parsons et al. 1985). Decorated ceramics from this unit are fairly low frequency and consist almost entirely of Aztec I Black/Orange ceramics of the Mixquic type. Red/Grey-Buff, a type bearing curvilinear red-orange designs over a grayish or buff slip, appears to be transitional from Late Toltec ceramics and is found in the lowest levels of the excavation. It is of particular interest that not one sherd of Red ware or polychrome ceramics was encountered in this excavation. Thus, it is possible that this excavation represents a pre-Red ware Early Aztec context, comparable to the basal levels of O'Neill's excavations at Chalco (1962:264-265; cf. also 1962:49, Table 2).

The interpretation of the temporal relationship between these two units is less straight forward, however, when the spatial distributions of the diagnostic types are considered. Mixquic Black/Orange has a very limited spatial distribution restricted to the eastern end of Lake Chalco (Minc et al. 1989, 1994). In contrast, Chalco Black/Orange extends throughout the Chalco lakeplain and up into the Tenango and Amecameca subvalleys, but is not found within Lake Chalco proper. The site of Chalco appears to be a point of overlap in the spatial distributions of these types. Parsons and Whalen (1982:438) similarly report that Chalco polychrome, while abundant throughout much of the Chalco survey area, is extremely low frequency in the lakebed area of Lakes Chalco-Xochimilco. Spatial analyses of Red ware variants from the surface collections revealed that definitively Early Aztec Red wares (such as Black/Red-Incised) do not occur in the lakebed west of Xico Island. In excavations at Culhuacan, it appears that Red wares (primarily Black/Red) do not enter the stratigraphic sequence until the appearance of Aztec III Black/Orange (Séjourné 1970, Figs. 80, 81, 81a).

These distribution patterns suggest that the composition of Early Aztec ceramic assemblages varies regionally within the southern Valley area, making the cross-dating of deposits from different regions difficult at best. My view is to interpret the spatial patterns as representing two contemporaneous but non-interacting exchange systems in the Chalco area: one characterized by Chalco Black/Orange, Chalco polychrome, and early Red ware types, and the other by Mixquic Black/Orange. Unfortunately, neither sequence provides any information on the phase for which it is most needed: the late Early Aztec and Early-to-Late transition.

Late Aztec Deposits

No pure Aztec III deposits were found in J. Parsons' excavations in the *chinampa* zones of Lake Chalco and Lake Xochimilco. Most deposits dated to the Late Aztec period contained a mixed of Aztec III and IV Black/Orange or stylistically intermediate Aztec III/IV variants.

In the Lake Chalco lakebed, J. Parsons' excavations at CH-AZ-236 and CH-AZ-237 provide ceramic collections dating to the Aztec III/IV phase (Parsons, Brumfiel, Parsons, Popper, and Taft 1982; Parsons et al. 1985). The Black/Orange ceramics are a mix of Aztec III/IV and IV variants, with Black/Orange dish Variant F predominating. Red ware types are low frequency in these excavations, but all Red ware sherds illustrated and/or photographed appear to be Late Profile. Black/Red Late Profile Variant A is present, along with Black&White/Red Variants AW, B, C, and E3, all on exterior thickened rims. Yellow/Red and Texcoco Molded are also found in very low numbers.

Parsons' excavations at XO-AZ-46 and XO-AZ-47 in the *chinampa* zone of Lake Xochimilco provide ceramic collections securely dating to Aztec III/IV and IV phases, respectively (Parsons, Brumfiel, Parsons, Popper, and Taft 1982). In the excavations at XO-AZ-46, Op. A, the Black/Orange ceramics are an even mix of Aztec III and IV variants, with Black/Orange dish Variants E and F predominating; glazed sherds occur only in the upper-most levels (Parsons et al. 1982:107). Red ware types are scarce in these excavations, but Black/Red Late Profile Variants A, B, and E are present. Black&White/Red sherds are less common than the Black/Red variants, and include Variants B and C, both on exterior thickened rims. Yellow/Red is also present.

The excavations at XO-AZ-47, in contrast, represent pure Aztec IV ceramics; Black/Orange dish Variant F and *molcajete* Variant M1 are most common. The excavations also produced numerous cow and pig bones, and this association between introduced fauna and a practically pure Aztec IV ceramic assemblage has led the excavators to suggest an early post-hispanic date for the collection, probably within the first half century or so after European contact (Parsons et al. 1982:93). Again, Red ware types are scarce, but Black/Red Late Profile variants A and E are represented in the collections, as is Black&White/Red Variant B (exterior thickened) and Yellow/Red. These excavations confirm that Red ware types were declining in popularity during the late prehispanic era, although they continued in use during early postconquest times.

Summary of Red Ware Chronology

The indirect and direct seriations agree in making a primary break in the decorated Aztec Red ware ceramics of the southern Valley area into an earlier and a later group. The early group, which predates pure Aztec III collections, consists of all Black/Red-Incised vessels, as well as most early profile vessels (i.e. recurved, interior thickened or direct rim bowls with rounded profiles) of Black/Red and Black&White/Red. Little stratigraphic evidence is available from the southern Valley to support the assignment of specific Black/Red and Black&White/Red variants to the Early Aztec period. O'Neill's (1962) pure Early Aztec deposits at Chalco appear to either predate the use of Black/Red and Black&White/Red types or fall outside their area of distribution. Many of these Early Aztec assignments appear to conflict with Parsons' (1966) well-known chronology from the northern Valley, where only the Black/Red-Incised type, Black/Red Variant A, and Black&White/Red Variants AW, D1/E3, and E2 are firmly attributed to the Early Aztec period. At Huexotla, however, Brumfiel's (1976, Fig. 2a) MDS analysis of decorated types co-occurring in surface collections found most Black&White/Red variants to date from the Early Aztec period, a finding that is consistent with the results of this study.

The later group in the seriations comprises all so-called "Late Profile" or exterior-thickened rim vessels with outsloping walls of the Black/Red and Black&White/Red types, as well as the low frequency Red ware types (Yellow/Red, Black&White&Yellow/Red, and White/Red) and the intricately decorated Black&White/Red Variant G. Although the Late Profile variants showed their strongest affiliations with the Aztec III collections, excavations in Lakes Chalco and Xochimilco (Parsons et al. 1982, 1985) confirm that these types extend into the Aztec III/IV and IV periods.

There are relatively few variants that cross-cut this early vs. late division. Most notable is Black/Red Variant C (bearing comb decoration), which appears to persist in the Aztec III and III/IV collections on early profile vessels, contemporaneous with comb-motif decoration on Late Profile bowls. Black/Red Variant C is the single most abundant Late Aztec Red ware variant in the northern Valley (J. Parsons 1966:285, Table 33), where Late Profile bowls occur in fairly low frequency. Thus, the persistent early vessel form of this variant in the south may reflect an origin from a northern source where vessel morphology was more resistant to change.

Two other Black/Red variants, H and I, showed less patterning relative to the dated collections. Both consist of very simple horizontal decoration on early profile vessels; both are distinctly southern variants, with distributions concentrated in the Tenango area. Their frequency of occurrence in the dated collections suggests that these variants may be long-lived; their use may extend throughout much of the Aztec sequence. Finally, several variants probably represent mixed categories and have weaker or mixed temporal associations. These include Black/Red Variants F and G, and BRO (Black Rim Only; possibly a mix of Black/Red Variant I1 and Variant C1 without the comb motif).

Finer chronological divisions are indicated within both the early and late periods. Within the early period, the indirect and direct seriations agree in identifying an earlier and a later phase, although there is some intergrading of these phases. Black/Red-Incised Variants B, C, and D, Black/Red Variants A and B, and Black&White/Red Variants AW, AN, D2, D3, and E4 definitely belong to the earlier phase. Black/Red-I Variant A, Black/Red Variants D, E, G (and possibly F and H), and Black&White/Red Variants B, C, D1 and E3 are somewhat later and appear transitional to the Late Aztec period. Black/Red C begins during this transitional phase and continues into the Late Aztec period.

Within the late period, Black&White/Red G and all late profile Black&White/Red variants are strongly associated with the Aztec III collections and appear somewhat earlier than the low frequency Red ware types (Yellow/Red, Black&White&Yellow/Red, and White/Red) associated with both Aztec III and the mixed Aztec III/IV collections. The Late Profile Black/Red bowls show strong affiliations with both the Aztec III and III/IV collections; the direct seriation (Fig. IV.3a) confirms an intermediate placement for these vessels within the late period.

The final relative chronology of Aztec decorated Red wares based on the combined information from seriations of surface collections and stratigraphic data is presented in Table IV.12. Temporal assignments are based on a subjective weighting and evaluation of three lines of evidence. In order of descending importance these are (1) the relative strength of standardized residuals in the indirect seriation (Table IV.7 and Fig. IV.2), (2) contextual associations in stratigraphic and excavated contexts (as discussed in the text), and (3) the relative order of types and variants in the direct seriation (Table IV.10 and Fig. IV.4).

Table IV.12
Final Red Ware Chronology for Southern Valley of Mexico Based on Seriations of Surface Collections and Stratigraphic Evidence

Variant	Early Aztec		Late Aztec	
	I/II	I/II-III	III	III/IV
B/R-I C	XX			
B/R-I D	XX			
B&W/R E4	XX			
B&W/R AW	XX	X		
B&W/R AN	XX			
B&W/R E1	XX			
B&W/R E2	XX	X		
B/R-I B	XX	X		
B/R A	XX	X		
B/R B	X	X		
B&W/R D3	X	X		
Plain Red *Copas*	X	XX		
B/R-I A	X	XX		
B/R E	X	XX		
B/R G	x	x		
B/R D		X		
B/R F		X		
B/R I		XX		
B/R *Copa* D		XX		
B&W/R B		XX		
B&W/R C1		XX		
B&W/R D1		XX		
B&W/R D2		x		
B&W/R E3		XX		
B&W/R F		x	x	
B/R C		x	X	x
B/R Basin		x	X	
B/R *Copa* A			XX	
B&W/R G			XX	
B&W/R AW EXT			XX	
B&W/R AN EXT			XX	
B&W/R B EXT			XX	x
B&W/R C EXT			XX	x
B&W/R E3 EXT			x	x
B&W/R F EXT			XX	x
B/R *Copa* C			XX	x
Yellow/Red			XX	x
B&W&Y/Red			XX	X
White/Red			x	x
B/R Late Profile			XX	XX
B/R *Copa* B			XX	XX

Temporal association: XX=very strong; X=strong; x=weak.

Aztec Ceramic Chronology and Political History in the Valley of Mexico

Absolute Dates for Aztec Ceramic Chronology

Absolute dates for the Aztec ceramic phases were initially derived from Vaillant's (1938, 1941) correlation of cyclical dumps of ceramics and temple rebuilding activities with ceremonies marking the end of the Aztec "century" of 52 years. According to Vaillant (1938:552), the last new-fire ceremony before the conquest fell in 1507, and the latest ceramic dumps are those of late Aztec III Black/Orange ceramics. Working back from this point in time, Vaillant (1938:554, Table 3) suggests that late Aztec III ceramics date to A.D. 1455-1507, while early Aztec III ceramics were in use from A.D. 1403 to 1455. For the Early Aztec sequence, Vaillant correlated the appearance of new ceramic types with the movements of peoples (as recorded in native chronicles). Aztec I Black/Orange was felt to begin with either the establishment of Culhuacan "Toltec" lineage in A.D. 1114 (1938:566) or, more likely, with the foundation of a new dynasty at Culhuacan in 1251. Aztec II Black/Orange necessarily fell between Aztec I and Aztec III in time, with transitional Aztec II/III materials in use between A.D. 1351 and 1403 and associated with the rise of the Tepanec empire (Table IV.13).

Table IV.13
Absolute Dates for Aztec Black/Orange Ceramics after Vaillant (1938)

Phase	Dates A.D.
Aztec IV	1507-1519
Late Aztec III	1455-1507
Early Aztec III	1403-1455
Late Aztec II (II/III	1351?-1403?
Early Aztec II	1299?-1351?
Aztec I	1251?-1299?

Current consensus dates for the Aztec period (Sanders, Parsons, and Santley 1979:466-467) date the Early Aztec period between A.D. 1150-1350, and the Late Aztec period from A.D. 1350-1520. This chronology represents several major revisions of Vaillant's sequence. First, the Early Aztec period is extended back in time to the fall of Tula, around A.D. 1150. Second, Aztec I and II are now viewed as more or less equivalent in time. Third, Aztec III or Tenochtitlan Black/Orange is now believed to span the entire Late Aztec period with Aztec IV or Tlatelolco phase material representing an early colonial development.[2]

Relatively little hard data exists, however, to substantiate the dates associated with the preconquest Black/Orange ceramic chronology. Recent and on-going excavations providing C-14 and obsidian hydration dates (Brumfiel 1991b; Evans and Freter 1989; Hodge 1993; Norr 1987a; Parsons et al. 1985; M. Smith 1983, 1987a; Smith and Doershuk 1991; Parsons, Brumfiel, and Hodge 1993) may revise and refine our current understanding of the timing of the ceramic sequence and its relationship to political events in the Valley. At present, however, the few absolute dates available for the Aztec period appear as much to confuse as to clarify the existing chronology.

In the southern Valley area, Parsons et al. (1985) report very early radiocarbon dates from Early Aztec midden deposits in Lake Chalco. Four dates on wood charcoal from the site CH-AZ-195 cluster within a fairly tight range in the 7th to 9th centuries A.D. (Parsons et al. 1985:64-65). Similarly, two C-14 dates on wood charcoal from Late Toltec/Early Aztec deposits from CH-AZ-237 yielded dates of A.D. 570 and 930 (Parsons et al. 1985:67). These dates are quite at variance with the apparent Early Aztec age of the midden deposits, and the authors suggest that fuel wood may have been scavenged from the near-by Toltec site on Xico Island. (Alternatively, the authors suggest that some geochemical characteristic of the swampy environment of Lake Chalco may produce erroneous C-14 dates that are consistently 400-500 years too old.) In contrast, five calibrated radiocarbon dates from charred maize cobs from CH-AZ-195B range from the 11th to early 15th centuries, and most of these maize-cob dates fall within, or close to, the traditionally accepted chronological range of Aztec I (Parsons, Brumfiel, and Hodge 1993).

Early dates for the Early Aztec period are also reported for the site of Xaltocan, in the northern Valley of Mexico (Brumfiel 1992; Parsons, Brumfiel, and Hodge 1993). Five radiocarbon dates from materials associated with Aztec I Black/Orange ceramics span a period of A.D. 785-1158, thus suggesting a very early date for the inception of the Early Aztec period. Aztec II ceramics apparently overlap this phase and continued in use up to ca. A.D. 1350. This sequence of dates from Xaltocan has re-opened the issue of the degree of contemporaneity in Aztec I and Aztec II ceramics and argues that Aztec I has clear temporal priority over Aztec II, although there is considerable temporal overlap between the two. It is at present difficult, however, to determine how broadly applicable this chronology is for the Valley as a whole. Xaltocan appears to be an isolated island of Aztec I ceramic use in an area dominated by Tenayuca/Aztec II ceramics. Based on the Valley of Mexico survey collections from the Texcoco, Teotihuacan, and Zumpango regions (J. Parsons, personal communication), Xaltocan is the only northern site yielding abundant Aztec I Black/Orange ceramics. Why Xaltocan should be unique in this regard is an intriguing question, but it suggests that the Xaltocan sequence may not be representative of region-wide trends in ceramic styles. The sequence of C-14 dates from Xaltocan does, however, concur with the current consensus dates in placing the end of the Early Aztec period (and the introduction of Aztec III Black/Orange ceramics) at ca. A.D. 1350.

The very early dates from the lakebed sites within Valley of Mexico should be assessed against more reasonable dates for the Early Aztec period from well-drained sites within the Valley and from eastern Morelos, south of the Valley. Recent excavations at the site of Chalco conducted by Mary Hodge have yielded a series of C-14 dates in association with Aztec I Black/Orange ceramics that conform well to the consensus dates for the Early Aztec period (Hodge 1993; Parsons, Brumfiel, and Hodge 1993). Unmixed Aztec I deposits provided 7 radiocarbon dates with a calibrated range of A.D. 1195 to 1411, while a mixed Aztec I-II deposit yielded a single calibrated date of A.D. 1223. Similarly, a carbon sample from the site of Tenayuca (from an Early Aztec context containing Geometric Tenayuca Black/Orange and Black&White/Red Variant AN ceramics) gave a radiocarbon date of A.D. 1120 (Mary Hodge, personal communication). South of the Valley, excavations of a single component, Early Aztec-period house by Norr (1987a, 1987b) in eastern Morelos contained both apparent Chalco Black/Orange ceramics and types very similar to Mixquic Black/Orange. A charcoal sample from the house floor yielded a radiocarbon date of A.D. 1230±75, while an intrusive feature provided an end-date for the Early Aztec occupation of A.D. 1340±75 (Norr 1987a:406-407). All these dates are consistent with the traditional chronology for the Early Aztec period.

The 23 radiocarbon dates (available to date) from unmixed Early Aztec deposits within the Valley are presented in Table IV.14 in chronological order. It is clear from this presentation that many of the calibrated dates do fall close to or within the traditionally accepted dates for the Early Aztec period. Those that are substantially earlier come from two contexts: wood charcoal from CH-AZ-195 (possibly representing wood scavenged from near-by Toltec-age sites) and Xaltocan. As noted above, Xaltocan is an apparent oddity in that it is the only known northern site with abundant Aztec I ceramics. Overall these data provide general support for the consensus dates, while indicating a degree of regional variability in the onset of the Early Aztec period that is not yet well understood.

Table IV.14
Radiocarbon Dates from Early Aztec Contexts Within the Valley of Mexico

Uncalibrated Age (Dates A.D.)	Calibrated Age or Range (Dates A.D.)	Associated Ceramics	Sample Provenience	Sample Lab No.
640 +/- 60	677	Aztec I	CH-AZ-195 (charcoal)	Beta 4458
770 +/- 60	785-868	Aztec I	Xaltocan	Beta 50317
830 +/- 90	898-942	Aztec I	Xaltocan	Beta 50313
830 +/- 70	898-942	Aztec I	CH-AZ-195 (charcoal)	Beta 4457
840 +/- 60	910-975	Aztec I	Xaltocan	Beta 41913
880 +/- 90	983	Aztec I	Xaltocan	Beta 41911
990 +/- 50	1028-1145	Aztec I	CH-AZ-195 (maize cob)	Beta 8918
1030 +/- 50	1044-1140	Aztec I	CH-AZ-195 (maize cob)	Beta 8920
1060 +/- 60	1158	Aztec I	Xaltocan	Beta 41914
1100 +/- 90	1195-1208	Aztec I	Chalco	Beta 57748
1130 +/- 70	1219	Aztec I/II	Xaltocan	Beta 41910
1140 +/- 90	1223	Aztec I/II	Chalco	Beta 57759
1190 +/- 70	1263	Aztec I	Chalco	Beta 57757
1240 +/- 70	1280	Aztec I	Chalco	Beta 57752
1240 +/- 50	1280	Aztec I	CH-AZ-195 (maize cob)	Beta 8919
1340 +/- 80	1321-1388	Aztec I	Chalco	Beta 57756
1350 +/- 50	1326-1389	Aztec I	CH-AZ-195 (maize cob)	Beta 8922
1350 +/- 70	1326-1389	Aztec II	Xaltocan	Beta 41912
1370 +/- 60	1330-1393	Aztec I	Chalco	Beta 57754
1390 +/- 60	1334-1403	Aztec I	Chalco	Beta 57755
1410 +/- 50	1410	Aztec I	CH-AZ-195 (maize cob)	Beta 8921
1520 +/- 60	1411	Aztec I	Chalco	Beta 57758
1440 +/- 60	1418	Aztec II	Xaltocan	Beta 50315

Note: Data from Parsons, Brumfiel, and Hodge (1993:Tables 2-4).

A series of 97 obsidian hydration dates from the site of Cihuatecpan, in the Teotihuacan Valley (Evans and Freter 1989) has been presented as evidence contesting the absolute dates associated with the consensus chronology. Three obsidian specimens associated with Aztec II Black/Orange ceramics dated from A.D. 1329 to 1398, dates that overlap the radiocarbon dates associated with Aztec II ceramics at Xaltocan. Specimens associated with Aztec III Black/Orange ceramics (N=57) ranged from A.D. 1228-1568, indicating a much earlier starting date for the spread of those ceramics than previously thought, as well as a substantial period of overlap with Aztec II Black/Orange. However, improbable or impossibly early dates associated with Aztec IV Black/Orange (N=6, A.D. 1235-1520) and glazed Colonial pottery (N=4, A.D. 1355-1547) would seem to suggest that the series is unreliable. The apparent inconsistencies of this sequence are placed in greater doubt by a growing body of evidence demonstrating that a range of environmental factors (including effective temperature [Ericson 1988], soil chemistry [McGrail et al. 1988], and local hydrology [Ridings 1991]) affect the hydration rates of archaeological obsidian, indicating that dates determined with this method should be viewed with caution.

The currently most fine-grained chronology available for the postclassic period is that developed for western Morelos (M. Smith 1983, 1987a; Smith and Doershuk 1991). Working with large collections from unmixed stratigraphic levels, M. Smith and associates have developed a three-phase ceramic sequence for the Aztec period based on the percentages of descriptive ceramic types and frequencies of paste categories and vessel forms. The ceramic phases are the Temazcalli phase (corresponding to the Early Aztec period), and the Early and Late Cuauhnahuac phases (representing subdivisions of the Late Aztec period). Unfortunately, however, the ceramics of the earlier and later phases of the Late Aztec period (Early and Late Cuauhnahuac, respectively) are very similar, varying primarily in their relative proportions, and it is not generally possible to classify a deposit based on inspection, since the phase transition did not involve any major technological, stylistic, or functional shifts that might provide easy differentiation. Only two diagnostic types were determined for each of the Late Aztec phases, and both are extremely low frequency ($< 1\%$); further, both phase markers for the Late Cuauhnahuac are local traits, making it difficult to extend this phasing outside of western Morelos.

Radiocarbon dates for the Morelos sequence are in general conformity with consensus dates for the Aztec period in the Valley of Mexico. The Temazcalli phase is dated to A.D. 1200-1350, with a starting date somewhat later than the Early Aztec period in the Valley of Mexico. However, the preceding Tilancingo phase (A.D. 1100-1200) is apparently transitional from Mazapan to Early Aztec, and shows cross-ties to Early Aztec material in the Valley of Mexico (M. Smith 1983). Early Cuauhnahuac is dated to A.D. 1350-1430, while Late Cuauhnahuac extends from A.D. 1430 to ca. 1550. Thus, while the Morelos ceramic chronology represents a refinement on the existing chronology, absolute dates for the sequence are in general agreement with the coarser temporal phasing available for the Valley of Mexico represented by the current consensus dates.

Aztec Ceramic Chronology and Political History

Chronological resolution in archaeology optimally should match the temporal scale of the processes or events under study (Braudel 1980; Plog and Hantman 1990; Smith and Doershuk 1991). In the Valley of Mexico, the current chronology of 200-year phases was developed to address long-term adaptations and evolutionary trends, and as Smith and Doershuk (1991) have noted, this scale of temporal resolution is adequate for such issues. The existing Aztec-period chronology, however, is not well-suited to the more rapid pace of political developments that occurred in the centuries preceding the Spanish conquest. Investigations concerned with processes of political centralization or the impact of Aztec imperial expansion are increasingly hampered by chronologies that combine distinct periods of political history into a single archaeological phase.

For the present investigation, the Late Aztec period presents just such a problem. Although the entire period is one of increasing political centralization under a series of conquest states, the Triple Alliance was not formed until A.D. 1428-31, at a point midway through the Late Aztec period. Thus, the Late Aztec period contains roughly equal portions of time before and after the founding of the Aztec empire. The need clearly exists for a more refined ceramic chronology that subdivides the Late Aztec period.

While little progress has been made in the refinement of the Aztec Black/Orange ceramic sequence for chronological purposes, the Red ware ceramic seriation developed above suggests that temporal subdivisions can be made within the existing ceramic chronology. The temporal associations of Red ware types, variants, and subvariants presented in Table IV.12 indicate that these ceramics can be divided into four temporal groups, although with some degree of intergrading. These groups are: (1) Red wares associated strictly with the Early Aztec period (Aztec I/II Black/Orange); (2) Red wares that appear transitional from Early Aztec to Late Aztec; (3) Red wares that are associated strictly with the Late Aztec or Aztec III Black/Orange; and (4) a minority of types that show affinities with the Aztec III/IV phase.

These temporal subdivisions are, however, as yet uncorrelated with an absolute time frame or with political events in the Valley. Stratigraphic excavations are still required to substantiate the relative order of Red ware types and variants, and to secure chronometric indicators of their temporal span. Some linkages do exist, however, that suggest chronological connections between the proposed temporal groups of Red wares and political history. Primary is the prevalence of Late Profile bowls, as well as the near absence of earlier Red ware types, in the *chinampa* zone of Lakes Chalco-Xochimilco. This distribution suggests that the circulation of the distinctive Late Profile vessel form corresponds to the period of state-sponsored *chinampa* construction in the lakebed, while earlier Red ware types had been largely discontinued by that time. The period of principal swamp drainage and *chinampa* construction in the southern lakebed has been dated to A.D. 1426-1467 based on ethnohistoric and archaeological data (Parsons 1976:237). Thus, the Late Profile Black/Red and Black&White/Red bowls and associated types (including Yellow/Red, Black&White&Yellow/Red, and Black&White/Red Variant G) appear to relate temporally to the period following the foundation of the Triple Alliance and may well provide phase-markers for the period of Aztec imperial expansion.

In summary, the Red ware seriation developed here indicates that the current phasing of the Aztec occupation in the Valley of Mexico into the Early Aztec (A.D. 1150-1350) and Late Aztec (A.D. 1350-1520) periods can be refined into four narrower temporal units: an Early Aztec period, a transitional Early-to-Late Aztec period, a Late Aztec period, and a contact period of Late Aztec/Early Colonial. Although it is currently not possible to assign secure absolute dates to the three earliest units, the following tentative dates are suggested: Early Aztec (ca. A.D. 1150-1350), Transitional (ca. A.D. 1350-1430), Late Aztec (ca. A.D. 1430-1500, and Late Aztec/Early Colonial (ca. A.D. 1500-1550).

Dates for the Early Aztec period are based on current consensus dates (Sanders, Parsons, and Santley 1979), with the consensus date of A.D. 1350 for the inception of Aztec III Black/Orange and the beginning of the Transitional period supported by radiocarbon dates from Xaltocan (E. Brumfiel, personal communication) and western Morelos (Smith and Doershuk 1991), as discussed above. The beginning date for the later Late Aztec period is suggested by the apparent association of Late Profile bowls with the period of *chinampa* construction, while the date for the Aztec III/IV transition in the central Valley is based on Vaillant's (1938) original work supported by recent C-14 dates from Xaltocan (E. Brumfiel, personal communication). The greater overlap in ceramic types between the first two time periods suggests that the Early and Transitional periods intergrade in the southern Valley, while the transition to the Late Aztec period was more abrupt. The ceramic types, variants, and subvariants associated with these temporal units are indicated in Table IV.15.

Table IV.15
Chronological Phasing of Aztec Decorated Ceramics

Ceramic Unit	Aztec I/II Early Aztec	Aztec I/II-III Transitional	Aztec III Late Aztec	Aztec III/IV Contact
Black/Orange	Aztec I B/O PDM A Bowl A, G1 (Basin A-C)	PDM B, C Bowl C, H Basin D, E	PDM D, E Bowl D, E, F, & G2	PDM F-J Bowl G2 Basin N
Black/Red-Incised	Variants B, C, & D Variant A ------------			
Black/Red	Variants A & B Plain Red Copas -----	Variants D, E, F, G, H, & I Basins -------------- Copa D ---------	Variant C Late Profile Bowls A, B, & E ----------- Copa A & C ----- Copa B ------	
Black&White/Red	Variants AW, AN, D3, E1, E2, & E4	Variants B, C1, D1, D2, E3 Early Variant C2 ------? Early Variant F -------?	Variant G All Late Profile Bowls	Late Profile Bowls B, C, & F
Miscellaneous Red Types			Yellow/Red, White/Red, Black&White&Yellow/Red, Black&Red/Tan[3]	
Polychromes	CCPC A-D	CCPC I, K	CCPC E, F, & G	Black/White (Xochimilco)
Ritual Vessels	Spiked braziers		Texcoco censers	

Notes to Appendix IV

[1]Brumfiel's (1991) recent excavations at Xaltocan in the northern Valley of Mexico have reopened the question of Early Aztec Black/Orange ceramic chronology. Based on a series of C-14 dates from excavated midden deposits (see below), Brumfiel (personal communication) suggests that at Xaltocan, Aztec I Black/Orange ceramics clearly predate Aztec II ceramics; however, there is quite a long period where the two overlap. (For more discussion of the Xaltocan dates, see text on absolute chronology.)

CONTEXT	CERAMIC ASSOCIATION	DATE
Op. I, Level 15	Aztec I B/O, no Aztec II B/O; little CCPC, no Red wares.	840 ± 60
Op. G, Level 16	Aztec I B/O, no Aztec II B/O; some CCPC; sparse Red wares.	880 ± 80
Op. J	Similar to above but with higher frequencies of Red wares; (B/R-I cane/scroll but no panel).	1060 ± 60
Op. D	Aztec I and Calligraphic Aztec II; B/R-I cane/scroll and panel; CCPC well represented; B&W/R Variants D & E.	1130 ± 30
Ops. E and F	Mostly Calligraphic Aztec II; CCPC quite sparse; B&W/R well represented (Variants AN, AW, and B).	no dates
Op. H, Level 7	Lots of Geometric Aztec II; CCPC quite scarce.	1350 ± 70
Op. C	Aztec III-IV Black/Orange.	

A similar situation apparently holds in the south. For example, in her analyses of excavated materials from Culhuacan, Séjourné (1970:figs. 80-81A) notes that the stratigraphy does not indicate a clear replacement of Aztec I by Aztec II materials, but rather a long period of coexistence. In commenting on the stylistic evolution of Aztec I into Aztec II proposed by Griffin and Espejo (1950:37), Séjourné (1970:55-56) concludes:

> "*La estratigrafía certifica ampliamente estas deducciones de tipo estilísticos, ya que ese grupo [Azteca II] emerge cuando el I está aún en plena fuerza, se multiplica a cada nivel hasta trastornar la proporción original: alcanza altas cifras mientras que el I reduce a lo mínimo sus vestigios.* ***La diferencia reside en que este no llega a desaparecer y que el II no goza por consiguiente nunca del aislamiento de su antecesor***" (emphasis added).

[2]The absolute dates for Aztec IV or Tlatelolco phase Black/Orange ceramics continue to be debated. Originally, Vaillant (1938) dated Aztec IV material to the brief period A.D. 1507-1519. Griffin and Espejo (1947, 1950) similarly felt that Aztec IV Black/Orange came

into existence in the early 16th century, but argued that it persisted through the early decades of the colonial period based on the inclusion of hispanic decorative elements. In contrast, Charlton (1972) found Aztec IV Black/Orange ceramics to be largely a colonial complex in rural Teotihuacan Valley. However, Brumfiel (personal communication 1991) now puts Aztec IV Black/Orange ceramics earlier in the main Valley, with the Tlatelolco phase style beginning by 1503 A.D., based on C-14 dates from excavations at Xaltocan.

[3]The Black&Red/Tan or Black&Red/Buff is a low frequency type that occurs primarily within the Texcoco survey region and only as far south as Ixtapaluca. Thus, it has not been possible assess its chronological placement in the seriations developed here. In paste and vessel form, however, it reveals pronounced similarities with the Yellow/Red type, suggesting a Late Aztec date. Further, the sites from which this type was recovered in surface collections have predominantly Late Aztec ceramics.

APPENDIX V

NEUTRON ACTIVATION ANALYSES OF AZTEC CERAMICS

Introduction

This appendix reports on Instrumental Neutron Activation (INA) analyses of decorated Aztec ceramics from the Valley of Mexico that use trace elements to characterize and distinguish different production sources for this commodity both before and after the consolidation of the Aztec empire. Clay sources carry a signature of trace elements characteristic of the specific parent material from which the clay was derived. Examination of the trace-element composition of ceramics potentially enables the archaeologist to identify ceramics that were produced from the same clay source, or conversely, to identify a plurality of production sources for a single ceramic type (e.g. Harbottle 1976; Bishop and Neff 1989; Arnold et al. 1991).

A preliminary analysis of 60 Aztec ceramic samples (Minc et al. 1989, 1994) has shown that INA analysis of trace elements can readily distinguish clay sources in the Valley of Mexico, even over a relatively small spatial scale, owing to the area's complex volcanic history. For this study, an additional 252 ceramic vessels were analyzed for trace-element composition. This sample focuses on the decorated Aztec Red ware types, and provides a basis for comparing Red ware production and distribution with that of Aztec Orange wares (Minc et al. 1989, 1994; Hodge et al. 1992, 1993).

Ceramic types are examined for two archaeological periods: the pre-imperial Early Aztec period (A.D. 1150-1350), and the Late Aztec period (A.D. 1350-1520), when the Aztec empire emerged. The resulting trace-element data are used to examine changes in the organization of ceramic production through time along the dimensions of: (1) **centralization** (the number and distribution of Red ware production sources); (2) **scale** (the relative volume produced by each source); (3) **standardization** (the uniformity of ceramics pastes from each source); and (4) **specialization** (the range of ceramic vessels produced at each source). The results of those comparisons are presented in Chapter 8, while this appendix presents the more technical and quantitative aspects of clay group identification.

Sampling Strategy

The trace-element study analyzes ceramics representing the two predominant Aztec ceramic wares: Red ware and Orange ware. A total of 252 decorated Aztec Red ware sherds were included in the analysis (Table V.1). This sample includes the most common Red ware ceramic types and decorative variants selected from regional archaeological survey collections from the Valley (Blanton 1972; J. Parsons 1969; Parsons et al. 1982; Sanders, Parsons, and Santley 1979). In addition, 12 samples of Aztec I Black/Orange ceramics (Table V.2) were included to supplement the sample of 60 Early Aztec Orange wares previously analyzed (Table V.3) and to help verify the comparability of results produced at different labs. All Orange ware samples included in this study date to the Early Aztec period; Late Aztec Orange wares have been treated in a separate analysis (Hodge et al. 1992, 1993). Red ware samples included in this analysis represent both the Early Aztec and Late Aztec periods.

Table V.1
Aztec Red Ware Sherds Included in Trace-Element Analysis

ID#	Type/Variant/Form	Provenience (UM Catalog #)
200	B/R-I A	Huexotla, UMMA 31055
201	B/R-I A	Ixtapalapa, UMMA 82042
202	B/R-I A	TX-A-87, Tl. 32
203	B/R-I A	TX-A-109, Tl. 39
204	B/R-I A	TX-A-87, Loc. A
205	B/R-I A	CH-AZ-30, Loc. 23
206	B/R-I A	CH-AZ-172, Loc. Q
207	B/R-I A	CH-AZ-88, Loc. 63
208	B/R-I A	CH-AZ-172, Loc. Q
209	B/R-I A	CH-AZ-111, Loc. 82
210	B/R-I B	CH-AZ-172, Tl. 65
211	B/R-I B	CH-AZ-29, Loc. 18
212	B/R-I B	CH-AZ-172, Loc. Q
213	B/R-I B	TX-A-87, Tl. 32
214	B/R-I B	IX-AZ-26, Tl. 170
215	B/R-I B	CH-AZ-103
216	B/R-I B	CH-AZ-111, Loc. 28
217	B/R F-1	IX-AZ-26, Area 103
218	B/R E-1	CH-AZ-29, Loc. 18
219	B/R E-1	CH-AZ-29, Loc. 18
220	B/R E-1	IX-AZ-26, Tl. 215
221	B/R E-1	TX-A-87, Loc. C
222	B&R/T	TX-A-24, Tl. 461
223	B&R/T	TX-A-80, Tl. 9
224	B&R/T	TX-A-28, Tl. 808
225	B&R/T	TX-A-78, Tl. 177
226	B&R/T	TX-A-27, Tl. 567
227	B&R/T	TX-A-109, Tl. 53
228	B&R/T	TX-A-26, Tl. 613
229	B&R/T	TX-A-87, Tl. 28
232	Y/R Cable	TX-A-78, Tl. 165
233	Y/R Cable	CH-AZ-190, Tl. 52
234	Y/R Cable	CH-AZ-190, Tl. 52
235	Y/R Cable	CH-AZ-190, Tl. 52
236	Y/R Cable	CH-AZ-192, Tl. 35
237	Y/R Cable	IX-AZ-26, Tl. 215
238	Y/R Cable	XO-AZ-66, Loc. 78
239	B/R E-2	CH-AZ-111, Loc. 28
240	B/R E-2	IX-AZ-26, Area 104
241	B/R E-2	IX-AZ-26, Tl. 116
242	B/R E-2	CH-AZ-66, Loc. 31
243	B/R E-2	CH-AZ-132, Fea. I
244	B/R E-2	CH-AZ-132, Fea. I
245	B/R I-1	CH-AZ-148, Loc. 93

Table V.1 (continued)
Aztec Red Ware Sherds Included in Trace-Element Analysis

ID#	Type/Variant/Form	Provenience (UM Catalog #)
246	B/R I-1	CH-AZ-152, FEA. VV
247	B/R I-1	CH-AZ-51, Loc. 65
248	B/R I-2	CH-AZ-66, Loc. 31
249	B/R I-2	CH-AZ-51, Loc. 69
250	B/R I-2	CH-AZ-87, Loc. 32
251	B/R I-2	CH-AZ-41, Loc. 50
252	B/R I-2	CH-AZ-44, Loc. 50
253	B/R I-3	CH-AZ-67, Loc. 57
254	B/R H-2	CH-AZ-41, Loc. 49
255	B/R H-2	CH-AZ-41, Loc. 48
256	B/R H-2	CH-AZ-139, Loc. 8
257	B/R H-2	TX-A-72, Tl. 345
258	B/R H-2	TX-A-100, Loc. 40
259	B/R H-4	CH-AZ-41, Loc. 50
260	B/R H-4	CH-AZ-139, Loc. 8
261	B&W/R C-2 LATE	XO-AZ-32, FEA. AG
262	B&W/R C-2 LATE	XO-AZ-66, Loc. 78
263	B&W/R C-2 LATE	CH-AZ-238, Loc. G(W)
264	B&W/R C-2 LATE	CH-AZ-248, FEA. P
265	B&W/R C-1 LATE	CH-AZ-257, FEA. R
266	B&W/R F-2 LATE	CH-AZ-257, FEA. R
267	B&W/R F-2 LATE	CH-AZ-192, Tl. 3
268	B&W/R F-2 LATE	CH-AZ-192, Loc. B
269	B&W/R F-2 LATE	CH-AZ-130, Loc. 92
270	B/R BASIN A	TX-A-87, Tl. 34
271	B/R BASIN A	TX-A-100, Tl. 24
272	B/R BASIN B	TX-A-87, Tl. 49
273	B/R BASIN B	TX-A-100, Loc, 44
278	B&W/R G	TX-A-87, Loc. D
279	B&W/R G	IX-AZ-26, Tl. 215
280	B&W/R G	TX-A-87, Tl. 51
281	B&W/R G	TX-A-109, Tl. 57
282	B&W/R G	TX-A-87, Loc. I
283	B&W/R G	TX-A-87, Loc. C
284	B&W/R G	TX-A-56, Tl. 18
286	B/R LATE E	CH-AZ-190, Tl. 60
287	B/R LATE E	TX-A-56, Tl. 18
288	B/R LATE E	CH-AZ-257, FEA. R
289	B/R LATE E	CH-AZ-192, Loc. B
290	B/R LATE E	TX-A-87, Tl. 24
291	B/R LATE E	CH-AZ-20, Tl. 85
292	B/R LATE E	CH-AZ-249, FEA. K(W)
293	B/R LATE E	CH-AZ-192, Tl. 3
294	B/R LATE E	XO-AZ-32, FEA. AG

Table V.1 (continued)
Aztec Red Ware Sherds Included in Trace-Element Analysis

ID#	Type/Variant/Form	Provenience (UM Catalog #)
295	B/R A-1	CH-AZ-172, Tl. 65
296	B/R A-1	CH-AZ-172, Tl. 65
297	B/R A-1	CH-AZ-172, Tl. 65
298	B/R A-1	CH-AZ-164, Loc. 100
299	B/R A-1	TX-A-87, Loc. D
300	B/R-I C	CH-AZ-21, Loc. UU
301	B/R-I C	TX-A-87, Tl. 24
302	G/R-I C	CH-AZ-172, Tl. 65
303	B/R-I D	CH-AZ-172, Tl. 65
304	B/R-I D	CH-AZ-172, Tl. 65
305	B/R-I D	CH-AZ-172, Tl. 79
306	B/R-I D	CH-AZ-172, Loc. Q
307	B/R-I D	TX-A-87, Loc. A
308	B/R-I D	TX-A-87, Loc. D
309	B/R-I D	CH-AZ-111, Loc. 79
310	B&W/R AW-2	CH-AZ-172, Loc. Q
311	B&W/R AW-2	CH-AZ-111, Loc. 82
312	B&W/R AW-2	CH-AZ-111, Loc. 82
313	B&W/R AW-1	TX-A-10, Tl. 10
314	B&W/R AW-1	TX-A-40, Tl. 105
315	B&W/R AW-1	TX-A-109, Loc. 12
316	B&W/R AW-1	TX-A-40, Tl. 104
317	B&W/R AW-1	CH-AZ-6
318	B&W/R AW-1	CH-AZ-111, Loc. 82
319	B&W/R AN-2	CH-AZ-6
320	B&W/R AN-2	CH-AZ-111, Loc. 28
321	B&W/R AN-2	CH-AZ-111, Loc. 81
322	B&W/R AN-2	CH-AZ-164, Loc. 100
323	B&W/R AN-2	TX-A-24, Tl. 305
324	B&W/R E-2	TX-A-87, Tl. 32
325	B&W/R E-2	TX-A-109, Loc. 17
326	B&W/R E-2	CH-AZ-111, Loc. 28
329	B/R C-1	TX-A-109, Tl. 47
330	B/R C-1	TX-A-109, Tl. 22 EAST
331	B/R C-1	TX-A-109, Loc. 5
332	B/R C-1	TX-A-24, Tl. 205
333	B/R C-1	TX-A-24, Tl. 205
334	B/R C-1	TX-A-24, Tl. 271
335	B/R C-1	TX-A-24, Tl. 271
336	B/R E-2	CH-AZ-111, Loc. 80
337	B/R-I C	CH-AZ-111, Loc. 80
338	B/R B-1	CH-AZ-164, Loc. 100
339	B/R B-1	CH-AZ-111, Loc. 82
340	B/R B-1	CH-AZ-111, Loc. 28

Table V.1 (continued)
Aztec Red Ware Sherds Included in Trace-Element Analysis

ID#	Type/Variant/Form	Provenience (UM Catalog #)
341	B/R B-1	CH-AZ-111, Loc. 79
342	B/R B-1	CH-AZ-111, Loc. 82
343	B/R B-1	CH-AZ-172, Loc. Q
344	B/R B-1	TX-AZ-87, Tl. 49
345	B/R A-4	Huexotla, UMMA 31058
346	B/R-I B	Huexotla, UMMA 31055
347	B/R-I D	Culhuacan, UMMA 30865
348	G/R-I C	Chalco, UMMA 30636
349	B/R-I C	Huexotla, UMMA 31109
350	B/R-I C	IX-AZ-11, UMMA 82041
351	B/R A-1	Chalco, UMMA 30633
352	B/R A-1	Chalco, UMMA 30633
353	B/R A-1	Chalco, UMMA 30633
354	B/R A-1	Chalco, UMMA 30633
355	B/R B-1	Chalco, UMMA 30633
356	B/R B-1	Chalco, UMMA 30633
369	B/R A-1	Huexotla, UMMA 31058
370	B/R A-1	Huexotla, UMMA 31058
371	B/R A-1	Huexotla, UMMA 31079
372	B/R B-1	Huexotla, UMMA 31112
373	B/R C-1	Los Melones, UMMA 31175
374	B/R C-1	Los Melones, UMMA 31175
375	B/R C-1	Los Melones, UMMA 31175
376	B/R C-1	Los Melones, UMMA 31175
377	B/R C-1	Huexotla, UMMA 31058
378	B/R C-1	Huexotla, UMMA 31112
379	B/R C-1	Huexotla, UMMA 31112
380	B/R C-1	Huexotla, UMMA 31079
381	B/R E	Huexotla, 31079
382	B/R LATE E (G/R	Culhuacan, UMMA 30868
383	B/R LATE E (G/R	Culhuacan, UMMA 30868
384	Y/R Cable	Culhuacan, UMMA 30864
385	B&W/R G	Culhuacan, UMMA 30866
386	B&W/R G	Culhuacan, UMMA 30866
387	B&W/R AN-2 INT	Chalco, UMMA 30633
388	B&W/R AN-1 DIR	Huexotla, UMMA 31111
389	B&W/R AN-1 EXT	Huexotla, UMMA 31111
390	B&W/R AN-1 EXT	Culhuacan, UMMA 30870
391	B&W/R AN-1 EXT	Culhuacan, UMMA 30866
392	B&W/R AW-1 DIR	Culhuacan, UMMA 30866
393	B&W/R AW-1 INT	Huexotla, UMMA 31092
394	B&W/R AW-1 INT	Huexotla, UMMA 31058
395	B&W/R AN	Culhuacan, UMMA 30866
396	B&W/R AW-1 EXT	Culhuacan, UMMA 30869

Table V.1 (continued)
Aztec Red Ware Sherds Included in Trace-Element Analysis

ID#	Type/Variant/Form	Provenience (UM Catalog #)
397	B&W/R B-2 INT	Chalco, UMMA 30641
398	B&W/R B-2 INT	Huexotla, UMMA 31111
399	B&W/R B-2 INT	Huexotla, UMMA 31058
400	B&W/R B-1 INT	Huexotla, UMMA 31058
421	B&W/R B-2 THIN	Culhuacan, UMMA 30866
422	B&W/R B-2 EXT	Culhuacan, UMMA 30869
423	B&W/R B-2 EXT	Culhuacan, UMMA 30869
424	B&W/R B-1 DIR	Huexotla, UMMA 31092
425	B&W/R B-1 DIR	Huexotla, UMMA 31057
426	B&W/R C-2 LATE	Culhuacan, UMMA 30866
427	B&W/R C-2 LATE	Culhuacan, UMMA 30866
428	B&W/R C-2 LATE	Culhuacan, UMMA 30869
429	B&W/R C-2 LATE	Culhuacan, UMMA 30869
430	B&W/R C-1 DIR	IX-AZ-26, UMMA 82047
431	B&W/R F-LATE	Chalco, UMMA 30641
432	B&W/R F-1 LATE	Culhuacan, UMMA 30866
433	B&W/R F-1 LATE	Culhuacan, UMMA 30866
435	B&W/R F-LATE	Culhuacan, UMMA 30866
436	B&W/R F-1 LATE	Culhuacan, UMMA 30870
437	B&W/R E-1 INT	Culhuacan, UMMA 30870
438	B&W/R E-1 INT	Huexotla, UMMA 31092
439	B&W/R E-2 DIR	CH-AZ-172, UMMA 82099
440	B&W/R E-2 DIR	CH-AZ-172, UMMA 82099
441	B&W/R E-2 INT	Chalco, UMMA 30633
442	B&W/R E-2 INT	Chalco, UMMA 30641
443	B&W/R E-2 DIR	Chalco, UMMA 30641
444	B&W/R E-2 DIR	Chalco, UMMA 30641
445	B&W/R E-2 DIR	Huexotla, UMMA 31058
446	B&W/R E-2 DIR	Huexotla, UMMA 31092
447	B&W/R E-2 INT	Huexotla, UMMA 31092
448	B&W/R E-3 LATE	Culhuacan, UMMA 30866
449	B&W/R E-3 DIR	Huexotla, UMMA 31111
450	B&W/R D-1 LATE	Culhuacan, UMMA 30866
452	B&W/R D-1 INT	Huexotla, UMMA 31092
453	B&W/R D-2 DIR	Chalco, UMMA 30641
454	B&W/R D-4 DIR	Chalco, UMMA 30641
455	B&W/R C-1 INT	Los Melones, UMMA 31175
456	B&W/R C-1 DIR	Huexotla, UMMA 31096
457	B&W/R B-1 DIR	Huexotla, UMMA 31057
458	B&W/R E-2/E-3 DIR	IX-AZ-28, UMMA 82047
459	B&W/R E-3/D-1 REC	Chalco, UMMA 30641
460	B&W/R D-1 DIR	Los Melones, UMMA 31125
461	B&W/R D-1 DIR	IX-AZ-28, UMMA 82047
462	B&W/R D-1 INT	Huexotla, UMMA 31057

Table V.1 (continued)
Aztec Red Ware Sherds Included in Trace-Element Analysis

ID#	Type/Variant/Form	Provenience (UM Catalog #)
463	B&W/R D-1 DIR	Huexotla, UMMA 31058
464	B&W/R D-1 DIR	Huexotla, UMMA 31058
466	B&W/R D-4 INT	Huexotla, UMMA 31057
467	B&W/R D-4 DIR	Huexotla, UMMA 31112
470	B&W/R F-2 LATE	IX-AZ-28, UMMA 82047
476	B/R H-3	Chalco, UMMA 30633
477	B&W/R AW-1 DIR	Chalco, UMMA 30641
478	B&W/R AN-2 DIR	Chalco, UMMA 30641
501	Y/R Cable	El Risco, UMMA 30944
502	B/R LATE A	El Risco, UMMA 30946
503	B/R LATE A	El Risco, UMMA 30946
504	B/R LATE A	El Risco, UMMA 30946
505	B/R LATE A/B	El Risco, UMMA 30961
506	B/R LATE	El Risco, UMMA 30972
507	B/R LATE E	El Risco, UMMA 30935
508	B/R LATE E	El Risco, UMMA 30963
509	BRO	El Risco, UMMA 30963
510	B/R LATE A	El Risco, UMMA 30936
511	B&W/R LATE	El Risco, UMMA 30936
512	Y/R Cable	El Risco, UMMA 30956
513	B&W/R LATE	Ahuitzotla, UMMA 30920
514	B&W/R LATE	Ahuitzotla, UMMA 30920
515	B/R C/LATE A	Santa Clara, UMMA 30580
516	B&W/R LATE C	Santa Clara, UMMA 30580
517	B&W/R LATE F	Santa Clara, UMMA 30580
518	B&W/R LATE F	Santa Clara, UMMA 30580
519	B&W/R LATE F	Santa Clara, UMMA 30580
520	Y/R Cable	Santa Clara, UMMA 30580
521	Y/R Cable	Santa Clara, UMMA 30580
522	Early B&W/R	Tenayuca, UMMA 56323
523	Early B&W/R AN	Tenayuca, UMMA 56323
524	B&W/R LATE F	Santa Clara, UMMA 30580

Key to ceramic types in Table V.1:

B/R = Black-on-Red
B/R-I = Black-on-Red Incised
G/R = Graphite-Black-on-Red
G/R-I = Graphite-Black-on-Red-Incised
B&W/R = Black-and-White-on-Red
B&R/T = Black-and-Red-on-Tan
Y/R = Yellow-on-Red

Table V.2
Black/Orange Sherds Included in Trace-Element Analysis
Processed at Phoenix Memorial Lab

ID#	Type/Variant/Form	Provenience (UM Catalog #)
357	Chalco Chunky	IX-AZ-11, UMMA 82041
358	Chalco Chunky	IX-AZ-11, UMMA 82041
359	Chalco Chunky	Chalco, UMMA 30646
360	Chalco comb min.	Chalco, UMMA 30646
361	Chalco comb ext.	Chalco, UMMA 30645
362	Aztec I B/O Indet.	CH-AZ-192, Loc. N, UMMA 82098
363	Aztec I B/O Indet.	CH-AZ-192, Loc. N, UMMA 82098
364	Aztec I B/O Indet.	CH-AZ-172, Tl. 79, UMMA 82099
365	Aztec I B/O Indet.	CH-AZ-172, Tl. 79, UMMA 82099
366	Mixquic key support	CH-AZ-195, Tl. 71, UMMA 82100
367	Mixquic key support	CH-AZ-192, Loc. N, UMMA 82098
368	Mixquic key support	CH-AZ-192, Loc. N, UMMA 82098

The ceramics were chosen to provide a judgmental cross-section of available ceramics types and decorative variants, guided by the relative frequency of a type or variant (how common it is), its temporal affiliation (Appendix IV), and its spatial distribution. Preference was given to commonly occurring variants with clear temporal placement, while variants with both restricted and valley-wide distributions were included. In addition, two low frequency types were included: Yellow/Red, because of its apparent high status affiliation, and Black&Red/Tan, because of its restricted geographic distribution.

In selecting the specific sherds for analysis, an attempt was made to sample a type or variant from throughout its apparent geographic range within the study area. This attempt was often constrained by the availability of materials for analysis in museum collections. Aztec ceramics in the University of Michigan Museum of Anthropology[1] derive from two types of collections: (1) relatively small type collections made in the course of the Valley of Mexico surface surveys that have a broad spatial orientation in the Valley, and (2) earlier and more extensive surface collections (such as those of James B. Griffin) that focused on major sites. In drawing on these collections as a source of samples for this study, an obvious bias in favor of large sites was unavoidable. Fortunately, the four major sites that are best represented provide a broad regional coverage for the study area. These are: Huexotla (TX-A-87), Ixtapaluca (IX-A-26), Chalco (CH-AZ-172), and Culhuacan (IX-A-72).

Methods

Analytic Procedures Used at the University of Michigan

Sample Collection. Sherds to be sampled were first "cleaned" by removing all traces of slip and weathered surfaces with a carbide burr. If sherd samples were very

Table V.3
Black/Orange Sherds Included in Trace-Element Analysis
Processed at Smithsonian Conservation Analytical Lab

ID#	Type/Variant/Form	Provenience
AZPO01	Chalco Chunky	TX-A-40
AZPO02	Chalco Chunky	TX-A-87
AZPO03	Chalco Chunky	CH-AZ-164
AZPO04	Chalco Chunky	CH-AZ-111
AZPO05	Chalco Chunky	CH-AZ-103
AZPO06	Chalco Chunky	CH-AZ-29
AZPO07	Chalco Bowl	CH-AZ-76
AZPO08	probably Chalco	CH-AZ-172
AZPO68	Chalco Chunky	CH-AZ-172
AZPO69	Chalco Chunky	CH-AZ-172
AZPO70	Chalco Chunky	IX-A-11
AZPO11	Mixquic Bolstered	CH-AZ-190
AZPO12	Mixquic Bolstered	CH-AZ-195
AZPO13	Mixquic Bolstered	CH-AZ-192
AZPO14	Mixquic Bolstered	CH-AZ-249
AZPO15	Mixquic Bolstered	CH-AZ-252
AZPO16	Mixquic Grooved	CH-AZ-195
AZPO17	Mixquic Grooved	CH-AZ-190
AZPO18	Mixquic Grooved	CH-AZ-192
AZPO19	Mixquic Shouldered	CH-AZ-195
AZPO20	Mixquic Shouldered	CH-AZ-249
AZPO21	Geometric Tenayuca	IX-A-26
AZPO22	Geometric Tenayuca	IX-A-26
AZPO23	Geometric Tenayuca	IX-A-26
AZPO24	Geometric Tenayuca	CH-AZ-6
AZPO25	Geometric Tenayuca	TX-A-87
AZPO26	Geometric Tenayuca	IX-A-26
AZPO27	Geometric Tenayuca	TX-A-87
AZPO28	Geometric Tenayuca	TX-A-40
AZPO29	Geometric Tenayuca	TX-A-87
AZPO30	Geometric Tenayuca	TX-A-87
AZPO31	Geometric Tenayuca	TX-A-87
AZPO32	Geometric Tenayuca	TX-A-16
AZPO33	Geometric Tenayuca	TX-A-40
AZPO34	Geometric Tenayuca	TX-A-109
AZPO35	Geometric Tenayuca	TX-A-87

Table V.3 (continued)
Black/Orange Sherds Included in Trace-Element Analysis
Processed at Smithsonian Conservation Analytical Lab

ID#	Type/Variant/Form	Provenience
AZPO09	Culhuacanoid	CH-AZ-263
AZPO56	Culhuacan	Culhuacan
AZPO57	Culhuacan	Culhuacan
AZPO58	Culhuacan	Culhuacan
AZPO59	Culhuacan	Culhuacan
AZPO60	Culhuacan	Culhuacan
AZPO61	Culhuacan	Culhuacan
AZPO62	Culhuacan	Culhuacan
AZPO63	Culhuacan	Culhuacan
AZPO64	Culhuacan	Culhuacan
AZPO65	Culhuacan	Culhuacan
AZPO66	Culhuacan	Culhuacan
AZPO67	Culhuacan	Culhuacan
AZPO36	Calligraphic Tenayuca	TX-A-87
AZPO37	Calligraphic Tenayuca	TX-A-87
AZPO38	Calligraphic Tenayuca	CH-AZ-111
AZPO39	Calligraphic Tenayuca	XO-AZ-69
AZPO40	Calligraphic Tenayuca	XO-AZ-69
AZPO41	Calligraphic Tenayuca	XO-AZ-71
AZPO45	Calligraphic Tenayuca	Culhuacan
AZPO46	Calligraphic Tenayuca	Culhuacan
AZPO47	Calligraphic Tenayuca	Culhuacan
AZPO48	Calligraphic Tenayuca	Culhuacan
AZPO49	Calligraphic Tenayuca	Culhuacan

small, the entire sherd was cleaned in this manner; the sherd was then pulverized in an agate mortar. If the sherds were sufficiently large, only a portion of the sherd surface was removed with the burr; the burr was then cleaned and a sample of sherd power was collected on filter paper by burring or drilling into the sherd wall. Powdered sherd samples were stored in liquid scintillation vials and then dried in a desiccating oven at 250° F. for 48 hours.

The risks of cross-sample contamination during sample preparation were reduced by scrubbing all equipment (such as drill bits, burrs, tweezers. mortar, etc.) in soapy water after each sample and rinsing well with distilled water. All work surfaces were cleaned between processing samples to reduce air-borne sherd dust.

Preparation for Irradiation. Individual samples were encapsulated in vials of high-purity quartz tubing for irradiation. Although expensive and difficult to work with, quartz-tubing was preferred over polyethylene capsules because it can withstand longer irradiation times, generating more precise results. Polyethylene capsules are used at other labs, however, with acceptable results (see below).

Vials approximately 3" long were made from clear-fused quartz tubing (4 mm ID x 6mm OD x 1mm wall), by scoring and breaking the tubing and fusing one end closed in an oxygen-enriched gas flame.[2] The vials were washed in a phosphate-free cleansing solution (RBS-ph, manufactured by Pierce Chemical Co.), in a normal concentration of 20 cc/liter of tap water at approximately 50° C. The vials were immersed completely for 30 minutes and agitated every 5 minutes, then rinsed thoroughly with tap water. Each vial was then individually rinsed five times with de-ionized water and placed in the desiccating oven for a minimum of 24 hours to remove all moisture.

Samples of approximately 200 mg of powered sherd was weighed out into the quartz vials and the weight of the samples recorded to the nearest mg. The vials were sealed immediately after weighing with parafilm to prevent rehydration of the ceramic powder. Each vial was labelled with the sample number both in indelible ink and by etching the number into the quartz. Finally, the vials were fused closed. Surgical gloves were worn while handling the vials to prevent contamination with skin oils.

Standards and Check Standards. The ceramic samples were processed in batches of 24 vials for irradiation and counting. Each batch of samples included three replicates of NBS-SRM-1633A (coal fly ash) as the standard reference material, as well as one check standard of NBS-SRM-1633A and one check standard of Ohio Red Clay. The Ohio Red Clay check standard was included on the recommendation of Hector Neff (University of Missouri-Columbia), who generously supplied the necessary standard material. Finally, one blank vial was included for environmental correction. The blank consists of a sample which is identical in preparation and processing to the samples of interest except that the substance sought (in this case powdered sherd) is absent; any trace-element peaks in the blank are therefore due to impurities in the quartz tubing or to air-borne contamination such as dust. The inclusion of a blank allows the researcher to subtract out or correct for the effects of environmental contamination in the trace-element concentrations of the samples of interest.

Sample Irradiation and Gamma Spectra Counting. The ceramic samples were irradiated and analyzed at the Ford Nuclear Reactor, Phoenix Memorial Laboratory.[3] Samples were irradiated for a period of 20 hours in a dry irradiation facility on the core-face of the reactor, at a typical flux rate of 5.5 x 10-12th n/cm^2/sec. Samples were automatically rotated throughout the irradiation period. Gamma spectra for each sample were then counted using a GE(LI) (Lithium-drifted geramium) detector, coupled to a 4K spectrum (4096 channels at 1/2 Kev/channel) analyzer system. Gamma emissions were counted for 4000 seconds live time after a 1-week and again after a 5-week decay. The resulting spectra were analyzed for the concentrations of 27 elements: As, Ba, Ce, Co, Cr, Cs, Eu, Fe, Hf, K, La, Lu, Na, Nd, Ni, Rb, Sb, Sc, Sm, Sr, Ta, Tb, Th, U, Yb, Zn, Zr.

Analytic Procedures Used at the Smithsonian Analytical Laboratory

Samples analyzed at the University of Michigan were compared with results of prior analyses of Early Aztec Black/Orange ceramics processed at the Smithsonian Analytic Laboratory by James Blackman (Minc et al. 1994). Analytic procedures and standards differed between the two labs.

At the Smithsonian, powdered samples (prepared as described above) were weighed into high density polyethylene vials and packaged for irradiation. Eighteen unknowns along with 2 multi-element standards (NBS-SRM-1633, coal fly ash) and one check standard (Ohio Red Clay) were irradiated together for six hours at a neutron flux of 7.7 x 10-13th n/cm^2/sec. Gamma spectra for each specimen were collected twice, once after a 6-day decay and once after a 30-day decay. Elements determined from first-count spectra included Na, K, Ca, As, Br, Sb, Ba, La, Nd, Sm, Yb, Lu, and U. Elements determined from the second-count spectra include Sc, Cr, Fe, Co, Zn, Rb, Sr, Cs, Ce, Eu, Tb, Hf, Ta, and Th.

Spectra and Element Abundances

Element abundances in the ceramic samples were determined by direct comparison against a standard with known element concentrations. Element concentrations in standard reference materials have been independently measured by a plurality of analytical methods and are reported by the National Bureau of Standards (Gladney et al. 1987). At the University of Michigan, NBS-SRM-1633A (coal fly ash) was employed as the standard, and three replicates of this material were irradiated with each batch of samples. Element concentrations reported for 1633A (based on atomic absorption, neutron activation analysis, plasma atomic emission spectrometry, and X-ray fluorescence) are listed in Table V.4. In contrast, samples irradiated at the Smithsonian were analyzed using two replicates of NBS-SRM-1633 as the standard.

Element abundances are determined through four steps: (1) peak search; (2) environmental correction of spectra; (3) development of element constants in standards; and (4) calculation of element abundances in samples. Briefly, the peak search is performed to identify and quantify peaks in the spectra representing the energies characteristic of specific elements of interest. Using a sliding 20-channel window, the slope of the spectra is examined for deviations from the background curve. End points of a peak are identified by positive deviations (increase in height) above the steadily declining background curve. The area under the peak is then calculated assuming a Gaussian distribution centered on the energy characteristic of the specific element; the background area behind the peak is also calculated and subtracted out to determine the true area under the curve attributable to the element. Second, the environmental correction is made using the spectra for the blank vial by subtracting out these peaks from the spectra of the standards and samples.

Third, constants are developed for each element based on the standards which serve as conversion factors to transform the area under a peak to absolute element abundances in ppm (μg/g). The constant (K) for each element (e) is determined from the equation:

$$K_e = \frac{[\text{area dc}/\text{live time}] = \text{cps (counts per second)}}{\text{mass} \times \text{concentration}}$$

where K_e = element constant;

area dc = decay-corrected area under peak, since counting takes time during which sample decays;

live time = live counting time (here 4000 seconds);

mass = weight of standard in mg; and

concentration = element concentration in standard
as certified by NBS or other source.

The mean value for K_c is then computed across multiple standards (here N=3) to derive a conversion factor for each batch. Up to 20% variation in K_c for standards can be expected (Edward Birdsall [Phoenix Lab], personal communication); inter-standard variability is worrisome if the range exceeds that value.

Table V.4
Element Concentrations in NBS-SRM-1633A

Element	Unit	NBS Certified[a] Mean (± SD)	Consensus[a] Mean (± SD)	Reported Range[a]	Value Used[b]
As-76	ug/g	145 (15)	146 (4)	138.4 - 153	145
Ba-131	ug/g	1500	1420 (100)	1210 - 1600	1320
Ce-141	ug/g	180	175 (7)	163 - 186	168.3
Co-60	ug/g	46	43 (3)	37 - 47	44.1
Cr-51	ug/g	196 (6)	194 (7)	185 - 210	193
Cs-134	ug/g	11	10.5 (0.7)	9.3 - 11.8	10.42
Eu-152	ug/g	4	3.7 (0.2)	3.19 - 4.06	3.57
Fe-59	%	9.4 (0.1)	9.37 (0.23)	8.83 - 9.70	9.38
Hf-181	ug/g	8	7.4 (0.3)	6.6 - 7.8	7.29
K-42	%	1.88 (0.06)	1.88 (0.05)	1.77 - 1.99	1.89
La-140	ug/g		84 (8)	66 - 100	79.1
Lu-177	ug/g		1.12 (0.18)	0.93 - 1.44	1.075
Na-24	ug/g	1700 (100)	1730 (110)	1484 - 2020	1650
Nd-147	ug/g		74 (10)	65.6 - 89	75.7
Ni (Co-58)	ug/g	127 (4)	124 (13)	97 - 140	130
Rb-86	ug/g	131 (2)	138 (11)	121 - 163	134
Sb-124	ug/g	6.8 (0.4)	6.9 (0.5)	6.3 - 7.8	6.15
Sc-46	ug/g	40	39 (3)	34 - 43	38.6
Sm-153	ug/g		17.0 (1.5)	14.5 - 20	16.8
Sr-85	ug/g	830 (30)	810 (40)	740 - 890	835
Ta-182	ug/g		2.0 (0.2)	1.71 - 2.30	1.93
Tb-160	ug/g		2.5 (0.3)	2.1 - 2.9	2.53
Th (Pa-233)	ug/g	24.7 (0.3)	25.1 (1.4)	22.4 - 28	24
U (Np-239)	ug/g	10.2 (0.1)	10.3 (0.3)	9.66 - 11	10.3
Yb-175	ug/g		7.4 (0.7)	6.02 - 8.3	7.5
Zn-65	ug/g	220 (10)	226 (22)	189 - 263	220
Zr-95	ug/g		330 (80)	220 - 410	240

[a]Reported in Gladney et al. 1987, Table 1633A-1.
[b]Reported in Glascock 1991, Table 26.

Finally, element concentrations are determined for the unknown samples in a batch based on direct comparison with the standards:

$$CONC_e = \frac{\frac{[\text{area dc/live time}]}{\text{mass}_u}}{\text{mean } K_e \text{ in standards}} = \text{cps/m}$$

where $CONC_e$ = concentration of element *e* in sample;

area dc = decay corrected area of peak;

live time = live counting time;

mass_u = unit mass of sample in mg; and

mean K_e = mean constant for element *e* in standards.

Assessing Accuracy and Precision of Element Concentrations

A number of sources of error potentially confound the accurate determination of element concentrations. Although extreme care was taken in all steps of analysis, **contamination** of samples, standards, or quartz vials can significantly increase the quantities of certain elements relative to their true concentrations. Similarly, **imprecise weighing** of standards or samples will lead to erroneous results, since all element concentrations are based on mass. **Variations in irradiation intensity** due to uneven rotation (with some samples receiving more irradiation than others) or variations in flux over the lifespan of a core (resulting in some batches receiving more irradiation than others) can alter gamma emissions for a given elemental concentration. Finally, **counting geometry** (the position of the samples relative to the detector), differences in **decay times**, and **error propagation** can introduce both systematic and random error within and between batches.

All of these sources of error are more worrisome for the standards, since these form the basis of determining element concentrations in the samples through direct comparison. Thus, before the trace-element concentrations were employed to evaluate questions of research interest, the data were checked for accuracy (the closeness of a measure to its true value) and precision (the closeness of repeated measurements of the same quantity) (Sokal and Rohlf 1981:13; Harbottle 1982; Bishop et al. 1990).

Check standards provide a necessary measure of the internal consistency of results, at both the intra- and inter-batch levels, and provide for inter-lab comparisons. Check standards consist of certified uniform or standard material (generally with known element concentrations) that are treated in the analysis as unknowns. Thus, the element concentrations in the check standards as derived through direct comparison with the standards can be compared with the known or true element concentrations to determine the accuracy of results. Alternatively, element concentrations for check standards can be compared either across batches to assess the precision and consistency of results, or between labs to evaluate the comparability of results.

The accuracy of results for samples processed at the University of Michigan was assessed using a check standard of the same material as the standards, i.e. coal fly ash (NBS-SRM-1633A). By treating the 1633A check standard as an unknown, the element concentrations determined for this specimen can be compared with the known concentrations as a measure of how closely the direct comparison method approximates the true values. In this case, accuracy was assessed by the mean percent deviation from the true or analytic value for each element, i.e. the mean of [(observed value-analytic)/analytic].

Within the NBS-SRM-1633A check standard, it is clear that accuracy of element concentrations varies by element, with the mean percent deviation ranging from less than 1% to 50% (Table V.5). Four groups of elements can be identified, representing different levels of accuracy. Arranged from highest to lowest accuracy, these are:

(1) 0-2% deviation: As, Ce, Co, Cr, Fe, La, Sc, Th

(2) 2-4% deviation: Ba, Cs, Eu, Hf, Lu, Sm, U, Yb

(3) 5-10% deviation: Na, Nd, Rb, Sb, Ta, Tb, Zn

(4) >10% deviation: Ni (15%), Sr (17%), Zr (26%), K (50%)

Elements with mean percent deviations of greater than 10% in the NBS-SRM-1633A check standard are considered relatively inaccurate and were excluded from analyses of the unknown samples.

The precision of element concentrations was assessed using two check standards, one of NBS-SRM-1633A and one of Ohio Red Clay. Precision or consistency of results also varies by element; certain elements are considered more precise than others, and thus are more reliable indicators of similarities and differences in trace-element composition.

The relative precision of trace elements was assessed from the coefficient of variation for element concentrations in both the NBS-SRM-1633A and Ohio Red Clay check standards (Table V.6). The coefficient of variation (the standard deviation expressed as a percentage of the mean) is a measure of the degree of variability that is independent of the unit of measurement and is expressed as a percentage (Sokal and Rohlf 1981:59). Low coefficients of variation represent low variability and hence more precise elements, while higher coefficients indicate less precise elements.

The two check standards indicate general agreement on the relative precision of element concentrations (Fig. V.1). Thirteen elements are considered most precise on both reference materials, with coefficients of variation ≤ 5% (Ce, Co, Cr, Cs, Eu, Fe, Hf, La, Lu, Sc, Sm, Th, Yb). An additional three elements (As, Ba, and U) appear precise on SRM-1633A, but not on the Ohio Red Clay check standards. Conversely, Na appears reasonably precise with reference to Ohio Red Clay but fairly imprecise relative to SRM-1633A. The remaining elements (K, Nd, Ni, Rb, Sb, Ta, Tb, Zn, and Zr) are considered less precise on one or both standards.

The relative precision of the most precise elements (i.e. those with coefficients of variation ≤ 5%) compare favorably with precision levels reported from other labs. At Brookhaven, for example, Harbottle (1982:74) suggests that the best routine precision

Table V.5

Accuracy of Results: Element Concentrations in NBS-SRM-1633A Check Standard Compared with Expecied Values

Element	Unit	Analytic Value[a]	Observed Values		Mean % Deviation[b]
			Mean	S.D.	
As-76	ug/g	145	145.36	3.96	1.8
Ba-131	ug/g	1320	1305.45	70.76	3.9
Ce-141	ug/g	168.3	168.27	1.68	0.8
Co-60	ug/g	44.1	43.96	.47	0.8
Cr-51	ug/g	193	193.46	4.01	1.6
Cs-134	ug/g	10.42	10.39	.50	3.8
Eu-152	ug/g	3.57	3.58	.10	2.2
Fe-59	%	9.38	9.37	.01	0.7
Hf-181	ug/g	7.29	7.26	.24	2.9
K-42	%	1.89	2.70	1.63	50.2
La-140	ug/g	79.1	79.14	1.10	1.0
Lu-177	ug/g	1.075	1.08	.05	3.6
Na-24	ug/g	1650	1758.18	413.37	10.0
Nd-147	ug/g	75.7	77.04	7.25	6.1
Ni (Co-58)	ug/g	130	130.67	23.51	14.7
Rb-86	ug/g	134	129.10	15.27	8.5
Sb-124	ug/g	6.15	6.03	.51	6.5
Sc-46	ug/g	38.6	38.57	.35	0.7
Sm-153	ug/g	16.8	17.12	.53	2.2
Sr-85	ug/g	835	934.09	135.18	17.1
Ta-182	ug/g	1.93	1.93	.22	8.8
Tb-160	ug/g	2.53	2.52	.33	9.8
Th (Pa-233)	ug/g	24	24.01	.55	1.6
U (Np-239)	ug/g	10.3	10.60	.41	3.6
Yb-175	ug/g	7.5	7.69	.29	3.2
Zn-65	ug/g	220	215.18	16.66	5.7
Zr-95	ug/g	240	248.90	76.11	26.5

[a]Based on Korotev (1987).

[b]Mean percent deviation from analytic value.

Table V.6

Precision of Results: Variability of Element Concentrations in NBS-SRM-1633A and Ohio Red Clay Check Standards

Element	Unit	NBS-SRM-1633A			Ohio Red Clay		
		Mean	S.D.	C.V.	Mean	S.D.	C.V
As-76	ug/g	145.36	3.96	2.7	13.34	1.24	9.3
Ba-131	ug/g	1305.46	70.76	3.9	691.09	56.96	8.2
Ce-141	ug/g	168.27	1.68	1.0	105.48	3.76	3.6
Co-60	ug/g	43.96	.47	1.1	20.37	.67	3.3
Cr-51	ug/g	193.46	4.01	2.1	91.57	3.74	4.1
Cs-134	ug/g	10.39	5.04	4.9	10.21	.34	3.3
Eu-152	ug/g	3.58	.10	2.8	1.55	.07	4.8
Fe-59	%	9.37	.09	1.0	5.25	1.08	2.1
Hf-181	ug/g	7.26	.24	3.4	7.43	.26	3.5
K-42	%	2.70	1.63	60.5	3.20	.29	9.0
La-140	ug/g	79.14	1.10	1.4	47.86	.97	2.0
Lu-177	ug/g	1.08	.05	4.5	.59	.04	6.0
Na-24	ug/g	1758.18	413	23.5	1370.91	67.60	4.9
Nd-147	ug/g	77.04	7.25	9.4	39.80	4.27	10.7
Ni (Co-58)	ug/g	130.67	23.51	18.0	87.34	28.57	32.7
Rb-86	ug/g	129.10	15.27	11.8	174.7	14.64	8.4
Sb-124	ug/g	6.03	.51	8.6	51.55	.15	9.6
Sc-46	ug/g	38.57	.35	0.9	17.82	.38	2.1
Sm-153	ug/g	17.13	.53	3.1	8.17	.20	2.4
Sr-85	ug/g	934	135.18	14.5	~	~	~
Ta-182	ug/g	1.93	.22	11.6	1.42	.17	12.0
Tb-160	ug/g	2.52	.33	13.2	1.25	.24	19.3
Th (Pa-233)	ug/g	24.01	.55	2.3	14.42	.44	3.0
U (Np-239)	ug/g	10.60	.41	3.9	3.08	.33	10.8
Yb-175	ug/g	7.69	.29	3.8	4.06	.13	3.3
Zn-65	ug/g	215.18	16.66	7.7	96.30	16.72	17.4
Zr-95	ug/g	248.90	76.11	30.6	199.11	45.93	23.1

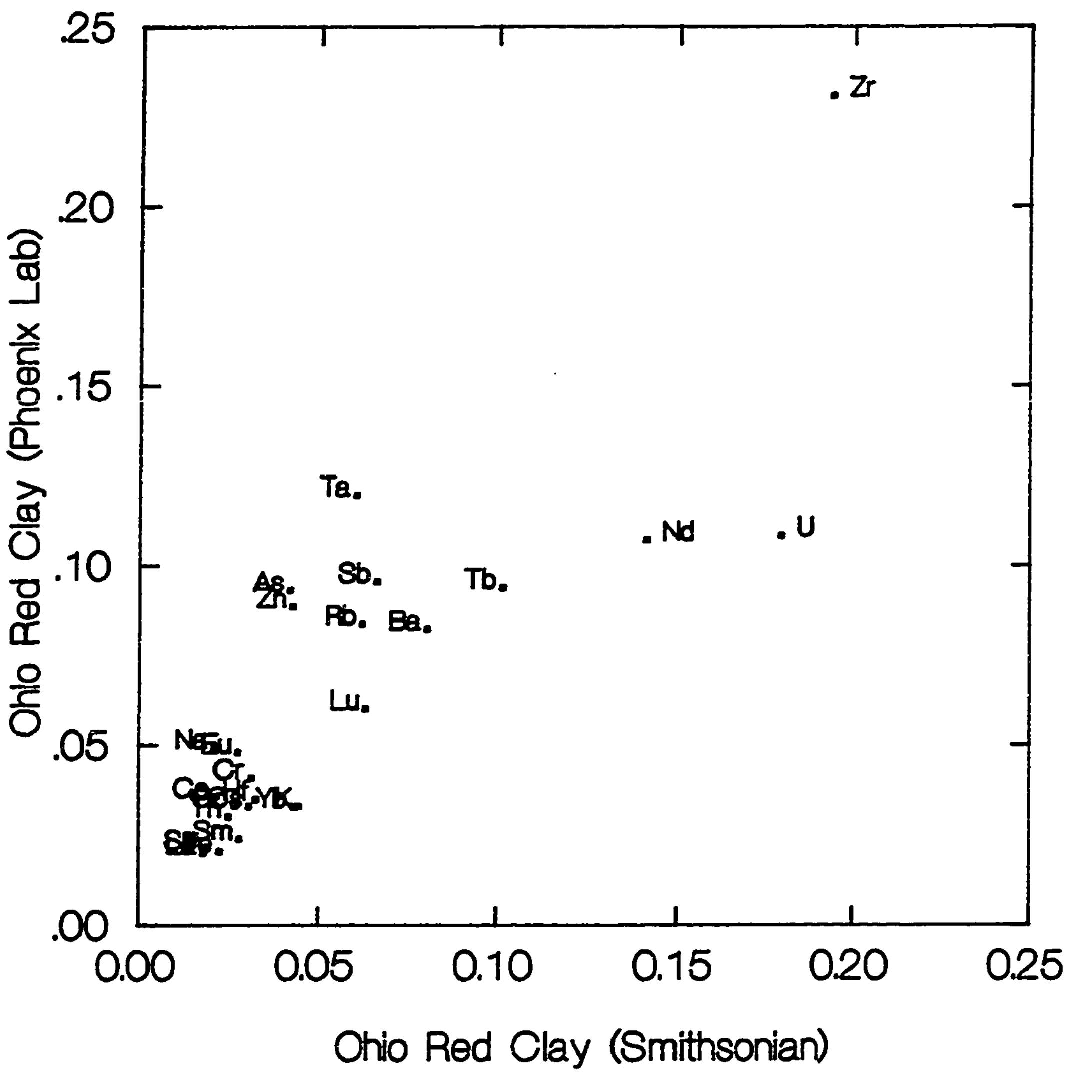


Figure V.1. Relative precision of elements in the NBS-SRM-1633A and Ohio Red Clay check standards represented by their coefficient of variation. The cluster of the most precise elements for both standards falls the lower left corner and includes Ce, Co, Cr, Cs, Eu, Fe, Hf, La, Lu, Sc, Sm, Th, and Yb.

attainable is around 2.5-3%. It therefore appears that the analyses carried out at the University of Michigan are acceptably precise and free of processing errors. Aside from processing errors, lack of precision can result from either weak activation of the radioisotope of interest or from a short-half life; both factors lead to poor counting statistics (Harbottle 1982:74).

Inter-Lab Calibrations

Comparisons of results with other labs were based on the Ohio Red Clay check standards. Analytic procedures (including irradiation time, flux levels, counting time, counting geometry, etc.) can vary greatly between reactor facilities, potentially making direct comparison of results unreliable.[4] Archaeologists are circumventing this problem through inclusion of the same check standard material in their analyses (Glascock 1992:15). Since this material is uniform, differences in the element concentrations derived for this material are due to differences in analytic procedure alone. Thus, conversion factors between labs can be developed through comparison of the element concentrations determined for this check standard at different labs.

The Ohio Red Clay check standard was used as a basis for comparing samples analyzed at the University of Michigan with those Aztec ceramics analyzed previously at the Smithsonian Institution.[5] Intercalibration of data was based on replicate analyses of Ohio Red Clay undertaken in the two labs. Conversion factors were developed based on 135 Ohio Red Clay samples processed at the Smithsonian and the 11 samples analyzed at Michigan.

Box plots (Tukey 1977) were first examined for all elements as determined at each lab, and extreme values (identified as values exceeding the outer hinges) were removed from the analysis. Mean values were then computed for all elements for the two labs and inter-lab conversion ratios determined (Table V.7). Using the coefficient of variation as a measure of precision (see above), the two labs are in agreement in identifying certain elements as substantially more precise than others (Fig. V.2). The most precise elements at both labs are Ce, Co, Cr, Cs, Eu, Fe, Hf, La, Lu, Na, Sc, Sm, Th, and Yb, with coefficients of variation $\leq$ 5%. These elements therefore represent the most reliable elements for inter-lab comparisons.

Steps in Interpreting INA Results

Sources of Variability in Element Concentrations

It is generally recognized that clay sources carry a signature of trace elements characteristic of the specific parent material from which the clay was derived. Through examination of the trace-element composition, it is therefore theoretically possible to identify ceramics that were produced from the same clay source from their similar geochemical profiles and to exclude samples with distinct geochemical profiles as representing different production sources. Thus, the primary objectives of trace-element analysis of ceramics involve the identification of homogeneous compositional groups and the association of these groups with specific clay sources or production loci.

Several factors confound this approach, however. First, ceramics contain two distinct components: clays and aplastic inclusions (naturally occurring or introduced as tempering agents). Further, both natural and cultural factors can affect the composition of

Table V.7
Calibration of Element Concentrations at Smithsonian and Phoenix Labs Based on Ohio Red Clay Check Standard

Element[a]	Smithsonian Mean Value (N=135)	Phoenix Mean Value (N=11)	Conversion Factor[b]
As	14.064	13.336	1.055
Ba	687.335	691.091	0.995
K	33423.021	33155.556	1.008
La**	54.555	47.864	1.140
Lu**	0.659	0.590	1.118
Na**	1438.574	1370.909	1.049
Nd	44.027	39.800	1.106
Sm**	8.252	8.167	1.010
U	2.552	3.083	0.828
Yb**	4.435	4.056	1.093
Ce**	105.418	105.482	0.999
Co**	20.554	20.373	1.009
Cr**	89.973	91.573	0.983
Cs**	10.134	10.209	0.993
Eu**	1.456	1.540	0.946
Fe**	51466.383	52481.818	0.981
Hf**	7.388	7.432	0.994
Rb	200.150	174.727	1.145
Sb	1.487	1.546	0.962
Sc**	17.761	17.818	0.997
Ta	1.465	1.423	1.030
Tb	1.101	1.152	0.955
Th**	15.231	14.418	1.056
Zn	106.617	91.830	1.161
Zr	214.679	199.111	1.078

[a]The most precise elements at both Smithsonian and Phoenix Labs are marked with **.

[b]Conversion Factor = Smithsonian/Phoenix. To convert Smithsonian to Phoenix divide Smithsonian by conversion factor; to convert Phoenix to Smithsonian multiply Phoenix by conversion factor.

either of these constituent components and their associated trace elements. As a result, variability in ceramic composition may reflect a combination of (1) natural chemical and mineralogic heterogeneity in the raw materials; and/or (2) heterogeneity introduced by the potter during manufacture through the selection, modification, or combination of different raw materials according to accepted cultural recipes (Rice 1987; Neff et al. 1988, 1989). The heterogeneity due to these multiple factors often serves to complicate the formation of

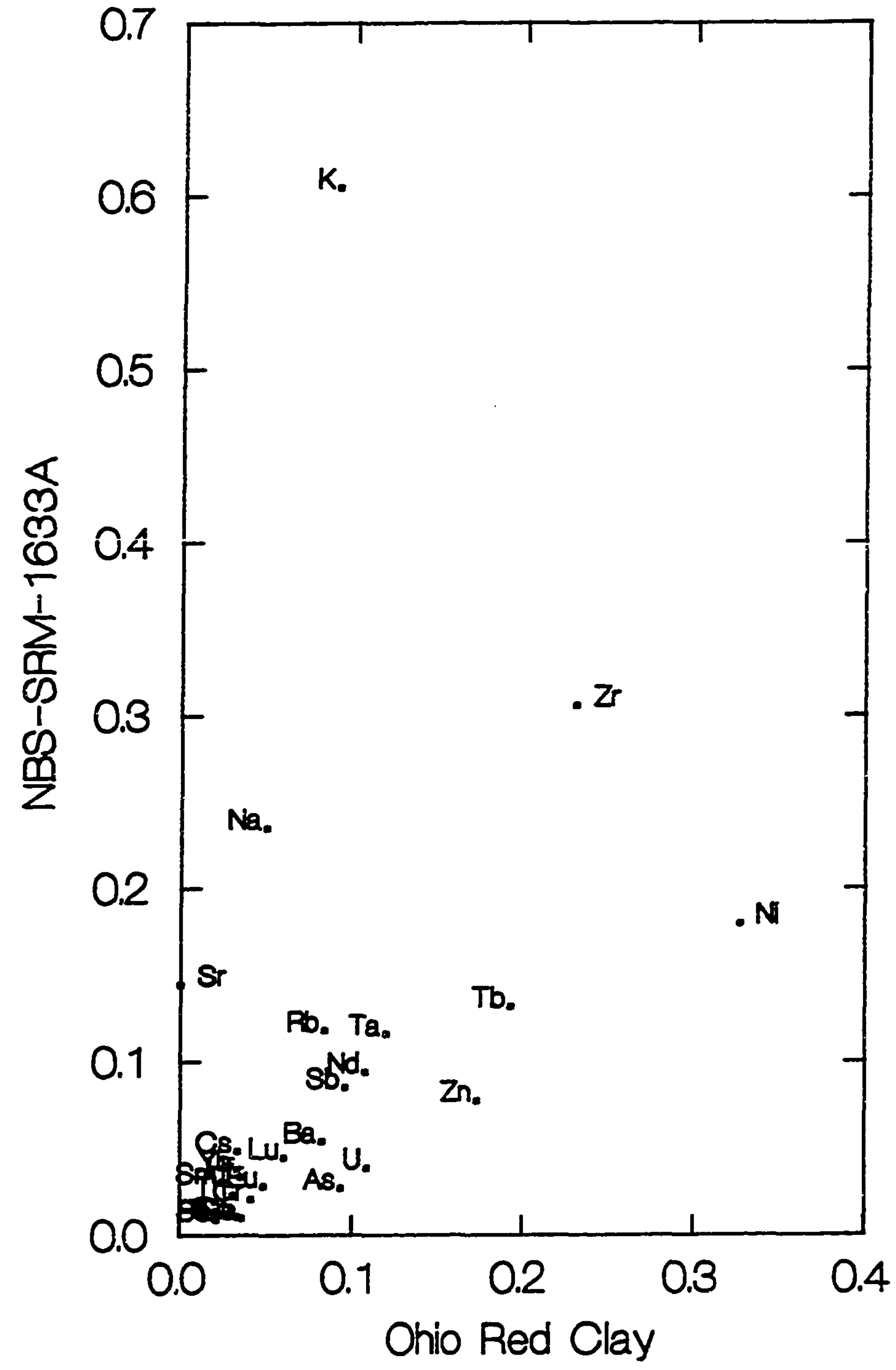


Figure V.2. Reliability of elements for inter-lab calibrations based on their precision in Ohio Red Clay check standards analyzed at the Smithsonian and at Phoenix Memorial Lab. The cluster of the most reliable elements falls the lower left corner and includes Ce, Co, Cr, Cs. Eu, Fe, Hf, La, Na, Sc, Sm, Th, Yb, and possibly Lu.

compositional groups and may confound identification of the sources of the raw clay or aplastics.

Because multiple processes may create observed differences in element concentrations, it is first necessary to understand the contributions of different natural and cultural processes and to develop expectations about the nature of element distributions in the ceramic constituents. These expectations necessarily include considerations of (a) natural variability based on the known mineralogy of the ceramics and the geological environment of clay formation as well as (b) cultural modifications elucidated through examination of the ceramics in order to determine the type, amount, and size range of aplastic inclusions. Finally, because coarse-grained processes may obscure fine-grained ones, a hierarchical approach to group identification is recommended (Bishop and Neff 1989).

Natural Variability in Clays and Aplastic Mineralogy. Natural variability in clay and aplastic trace-element composition can be clarified by a basic knowledge of the geochemical processes linking parent rock types to their constituent minerals and minerals in turn to characteristic elements. For the Valley of Mexico, these geochemical relationships are determined primarily by volcanic history and subsequent weathering of igneous rock minerals.

The Valley of Mexico falls within the Mexican Volcanic Belt (MVB), an extensive region of ancient and active vulcanism in central Mexico. The MVB consists of two provinces: (1) an older, and presently inactive northern area mainly formed between 2.5 and 1.5 million years ago; and (2) a southern area of active vulcanism, dating back 1.5 million years ago to present, containing 10 major central volcanoes or volcanic systems and several thousand simple monogenetic cones (Robin 1982). The oldest volcanic rocks in the MVB include relatively undifferentiated lavas and basalts that are intermediate between alkaline and calc-alkaline. In contrast, the active MVB cones contain basalt to acidic andesite compositions but are generally of basaltic andesite composition (Robin 1982:140).[6] The boundary between these two volcanic provinces falls within the Valley of Mexico just to the north of Mexico City.

The geochemistry of basaltic and andesitic rocks varies with their characteristic mineralogical composition. Andesite consists primarily of plagioclase (50-60%) with lesser amounts of pyroxene, amphibole, quartz, orthoclase, and biotite. Basalt, in contrast, contains predominantly plagioclase and pyroxene along with significant amounts of olivine and minor amounts of amphibole.

Predictable relationships exist, in turn, between these mineral types and the concentration of specific elements (Table V.8). Plagioclase, for example, characteristically contains relatively high concentrations of Ba and Sr, while orthoclase contains higher concentrations of Ba and Rb. Co and Ni tend to concentrate in olivine, while Co, Cr, and Sc are characteristic of pyroxenes. Amphibole, pyroxene, biotite, and olivine are all mafic (ferromagnesian) minerals and contain significant concentrations of Fe and Mg. Since basalts generally contain more olivine and pyroxene, while andesites contain relatively more plagioclase, we can expect the concentrations of Ba, Co, Cr, Fe, Mg, Ni, and Sc to vary regionally within the Valley with the distributions of these rock types.

The distribution of basalts, basaltic andesites, andesites, and undifferentiated lavas have been mapped within the Valley of Mexico (DETENAL n.d.; Carta Geológica de

Table V.8
Element Concentrations in Igneous Rock Minerals

Ba:	Found mainly in feldspars and feldspathoids; feldspathoids are generally Ba rich. However, Ba covaries with K, such that K-feldspars are richer in Ba than coexisting calcic or sodic plagioclase.
Co:	Enters the same minerals as Ni, but in lesser amounts. Olivine, and to a lesser extent, pyroxene contain moderate amounts of Co. Co covaries with Fe, since Co occurrence is a function of Fe-Mg sites: higher Fe/Mg ratios lead to higher Co.
Cr:	Initially enters the chrome spinels, especially chromite and picotite. Cr greatly prefers pyroxene, while olivine discriminates against Cr; within the pyroxenes, CPX has more Cr than coexisting OPX. Feldspar, feldspathoids, and other minerals in basaltic rocks contain little or no Cr, thus pyroxenes should mainly determine the Cr content of basaltic rocks; however, if chrome spinels are incorporated as inclusions in olivine crystals, Cr values are greatly increased. The effect of fractionation stage on Cr content is strong.
Ni:	Enriched in early olivine and to a lesser extent in early orthopyroxene. Olivine has a marked influence on the Ni distribution in basalts.
Rb:	Present in detectable amounts only in feldspars and feldspathoids; Rb prefers K feldspar to plagioclase; substitutes for K in K feldspar, but it is not certain that it replaces Na or Ca in plagioclase.
Sc:	Concentrated in pyroxenes, amphiboles, and to a lesser extent, biotite. Olivines have practically no Sc, while in plagioclase, Sc is usually below detection limits. Since amphiboles and biotites are not abundant in basaltic rocks, most Sc is in pyroxenes.
Sr:	Mainly distributed in Ca-rich minerals such as plagioclase, clinopyroxene, K feldspar, and feldspathoids.

Note: Date from M. Prinz (1967), "Geochemistry of Basaltic Rocks: Trace Elements". In **Basalts**, edited by H. H. Hess and A. Poldervaart, pp. 215-323. Interscience Publishers, New York.

México 1968; Schlaepfer 1968). These maps indicate that different bedrock types predominate over large portions of the Valley. As a result, we can expect that clays weathered within a hydrological unit containing predominantly one parent material should differ significantly in mineralogy and trace element concentrations from hydrological units dominated by different rock type. These relationships should be interpreted as general trends, however. In actuality, a greater degree of interdigitation of rock types occurs than is apparent from bedrock maps and ash fall associated with a given eruption can blanket a far larger area than that associated with lava flows, contributing to regional similarities in geochemistry. Further, there is considerable latitude in element concentrations within a rock or lava type such that individual cones or even eruptions can vary in element concentrations (Robin 1982). Thus, the relative enrichment or dilution of elements predicted for specific locations should be viewed as hypotheses for further testing.

The weathering of basaltic and andesitic rock and undifferentiated lavas provide the raw materials for both clays and aplastic mineral inclusions utilized in the production of Valley of Mexico pottery. These two ceramic components, however, can carry different geochemical information. In general, the characteristic mineralogy of basalts and andesites is strongly reflected in mineralogy of aplastics, while this mineralogy is strongly modified in the formation of clays.

To the extent that aplastic inclusions consist of fragments and microcrysts of characteristic minerals, the aplastic component will reflect the element concentrations of the constituent minerals. Element concentrations will tend to covary with the amount and size of aplastics, although aplastic inclusions can lead to complex patterns of enrichment and dilution of elements depending on their specific mineralogy. Mafic rock minerals, for example, characteristically enrich a sample in Fe, Cr, Mn, and Ni, as noted above. In contrast, quartz contains insignificant trace elements, so its presence dilutes all elements proportionately.

The further weathering of these minerals to form clays, however, significantly alters elemental composition. During the formation of a clay, elements that define the type of parent rock are removed from the clay through mechanical and chemical agents. For example, the most common class of parent rock minerals -- orthoclase and plagioclase feldspars -- have their characteristic elements of Na, Ca, and K diluted during weathering due to their removal as mobile cations (Elam et al. 1992). The loss of feldspathic minerals leads in turn to the relative concentration of more stable elements. Thus, the lanthanides or rare earth elements tend to concentrate in a clay relative to the parent material.

These relationships have been substantiated in experimental studies examining trace element concentrations separately for the clay and aplastic components of ceramics (Kilikoglou et al. 1988; Allen et al. 1989; Blackman 1992; Elam et al. 1992). In general, these studies have found that the lanthanide elements to be enriched in the fine (clay) fraction and diluted in the coarse (sand) fraction, as expected, while the aplastics tended to be enriched in elements characteristic of their specific mineralogy (for example, Na, K, and Ca in feldspathic sands vs. Cr, Co, and Fe in mafic sands) (Elam et al. 1992:101; Kilikoglou et al. 1988). In contrast, at least one study concludes that the transition metals (including Cr, Co, Fe, and Sc) tend to be relatively stable as clays weather from parent material or to be enriched in the clays relative to the parent material (H. Neff, personal communication). Two other elements, Hf and Zr, are consistently enriched in the coarse fraction, a pattern that is consistent regardless of the specific geologic environment, and may reflect the resistance of zircons to environmental degradation.

The degree of enrichment or dilution, however, varies markedly by particle size. Blackman (1992:122), for example, notes that removal of the sand-size fraction from a bulk sample yielded concentration changes of less than 5% for most elements. In contrast, removal of the silt fraction effected concentration changes on the order of 20-40% were effected for all elements excepting the rare earths. These findings have significant implications for understanding natural as well as cultural variability in ceramic clays. For example, primary clays that naturally contain higher levels of silt particles would be expected to have substantially higher concentrations of many elements than would secondary or naturally sorted clays derived from the same parent material.

In sum, different suites of elements tend to be associated with aplastics and with clays, and the concentrations of these will be differentially affected by natural and cultural factors. Elements associated with aplastic minerals derived from andesitic and basaltic rock types include Ba, Co, Cr, Fe, Mn, Sc and Sr. Concentrations of these elements will be affected by the relative proportions of different type of mineral inclusions which in turn varies naturally with regional geology (with basalts yielding higher quantities of Co, Cr, Sc, Fe, and Mn, and andesites contributing higher levels of Ba and Sr). In addition, concentrations of these elements can be expected to vary with cultural factors affecting amount and size of aplastic inclusions.

Other elements, including the REE or lanthanide elements (La, Ce, Nd, Sm, Eu, Tb, Yb, and Lu, as well as Sc, Hf, Zr, and Th) are associated with the clay fraction.[7] Variation in these elements primarily reflects natural stochastic regional variation in clays. Concentrations of these elements may also, however, reflect cultural recipes affecting clay:aplastic ratios, and are expected to covary with percent matrix in a sherd.

Cultural Variability in Paste Composition. Many primitive potters minimally process the clay prior to vessel fabrication (Rice 1987:118-121), resulting in a significant amount of naturally occurring aplastics in the clay. In this case, mineral aplastics constitute part of the source's natural geochemical signature. Cultural factors, however, may frequently distort natural patterns through modification of raw materials. The introduction of aplastics as tempering agents during manufacture may alter both the kind and amount of aplastic materials. Conversely, the refinement of clays to remove larger fractions or the selection of naturally levigated clays results in the reduction of aplastic inclusions. The addition and/or removal of aplastics leads to complex patterns of enrichment and dilution of elements relative to those in the clay source. Further, since elemental concentrations in sediments vary depending upon grain size, the size distributions of the aplastic fraction will also contribute to compositional complexity (Bishop and Neff 1989:69; Blackman 1992). Thus, although naturally occurring inclusions constitute part of the clay source signature, cultural decisions regarding the addition or removal of aplastics can significantly distort the signature of that clay source. Accordingly, cultural factors must be incorporated into our expectations for trace element concentrations.

Simulation studies of the effects of aplastics on the identification of clay source predicted that the amount of aplastics required to confound formation of compositional groups is 75-80% of the total volume of the ceramic (Neff et al. 1988, 1989). In contrast, Elam et al. (1992) found aplastics in the 30-40% range to significantly affect the identification of ceramic groups, although in this case the temper in question was also mineralogically very diverse.

Within the Valley of Mexico, documentary sources from the 16th century suggest that the clays utilized by Aztec potters were minimally processed prior to the manufacture of ceramic vessels. Raw clays appropriate for ceramic production were termed *teçoquitl*, i.e. hard or firm clays [*tetl* = rock + *çoqui* = mud) (Sahagún 1950-1982, Book 11:252). These clays were prepared for pottery production through the addition of cattail fiber followed by kneading and trampling to produce a thoroughly mixed clay body ready for forming (Branstetter-Hardesty 1978:21; Sahagún 1950-1982, Book 11:257 and sketches #850, 873).

The practice of adding cattail fiber (actually "reed stem fibers") to the clay body as the primary tempering agent is recorded at contact by Sahagún (1950-1982, Book 11:257). Within the Florentine Codex, bunches of cattails are prominently displayed in the foreground of the sketches accompanying the descriptions of potters, probably to indicate the use and importance of cattail fiber as a temper in the clay (Sahagún 1950-82, Book 11: #871 and #872). The presence of fiber temper, apparent as small hollow troughs often containing carbonized fibers, can be easily seen in the dark cores of Aztec-period ceramics (J. Parsons 1966:213; Branstetter-Hardesty 1978:136).[8]

Ethnographic descriptions report that modern potters in the Texcoco and Teotihuacan areas still modify their clays **only** by the addition of cattail fibers (*plumilla*) and by the removal of the occasional gravel-size piece of mineral inclusion (Branstetter-Hardesty 1978:137, 193; Foster 1955). Cattail fiber is apparently added as needed to absorb moisture, thereby balancing the plasticity and the viscosity of the clays (Branstetter-Hardesty (1978:136).

The minimal processing of clays and the primary use of fiber temper in Aztec ceramics has two important implications for interpreting INA results. First, it suggests that existing inclusions are natural and therefore constitute part of the clay signature. Secondly, organic tempers generally contribute little to either the enrichment or dilution of trace elements (Elam et al. 1992), thus the natural clay source signature is not distorted.

Within Aztec Red wares, however, a major shift is apparent in the texture of ceramic pastes from Early Aztec to Late Aztec times. Branstetter-Hardesty, for example, describes two ceramic body compositions for Aztec Red wares (1978:124; see also Red ware ceramic descriptions, Appendix III, this volume). Early Aztec ceramic pastes are characterized as medium textured, with some evidence of fiber temper and moderate amounts of medium-to-coarse mineral inclusions. In contrast, Late Aztec Red wares are described as fine textured and porous, with abundant fiber temper, and very fine mineral inclusions.

Petrographic Analysis of Paste Composition. In order to quantitatively assess apparent differences in paste composition, petrographic analysis of a limited sample of ceramics was carried out to determine kind, quantity, and size of aplastic inclusions in Early Aztec and Late Aztec Red wares. Twenty-two sherds was selected for analysis, including 12 Early Aztec Red ware samples and 10 Late Aztec Red ware samples. The sherds were thin-sectioned to a standard thickness (30 microns) and the sections examined under a petrographic microscope. Percentage composition of voids (air spaces), matrix (clay fraction), and inclusions (grain size greater than a clay-sized particle) was determined by point-counting 100 grains; inclusions were recorded by size fraction (silt, very fine sand, fine sand, medium sand, and coarse sand). Mineral species were recorded on a presence/absence basis, since the small particle size of many inclusions made a definitive identification of crystalline structure difficult.

The petrographic analysis confirms that a significant difference exists in both the quantity and size of aplastic inclusions between Early Aztec and Late Aztec Red wares (Fig. V.3, Table V.9). Early Aztec samples contain an average of only 40% matrix, in contrast to an average value of 60% matrix in Late Aztec samples. Conversely, Early Aztec samples contain significantly more aplastics (50%) than do Late Aztec sherds (31%). Differences in the amount of aplastic inclusions are most noticeable in the silt and very fine sand fractions. It should be noted, however, that the Early Aztec samples are more

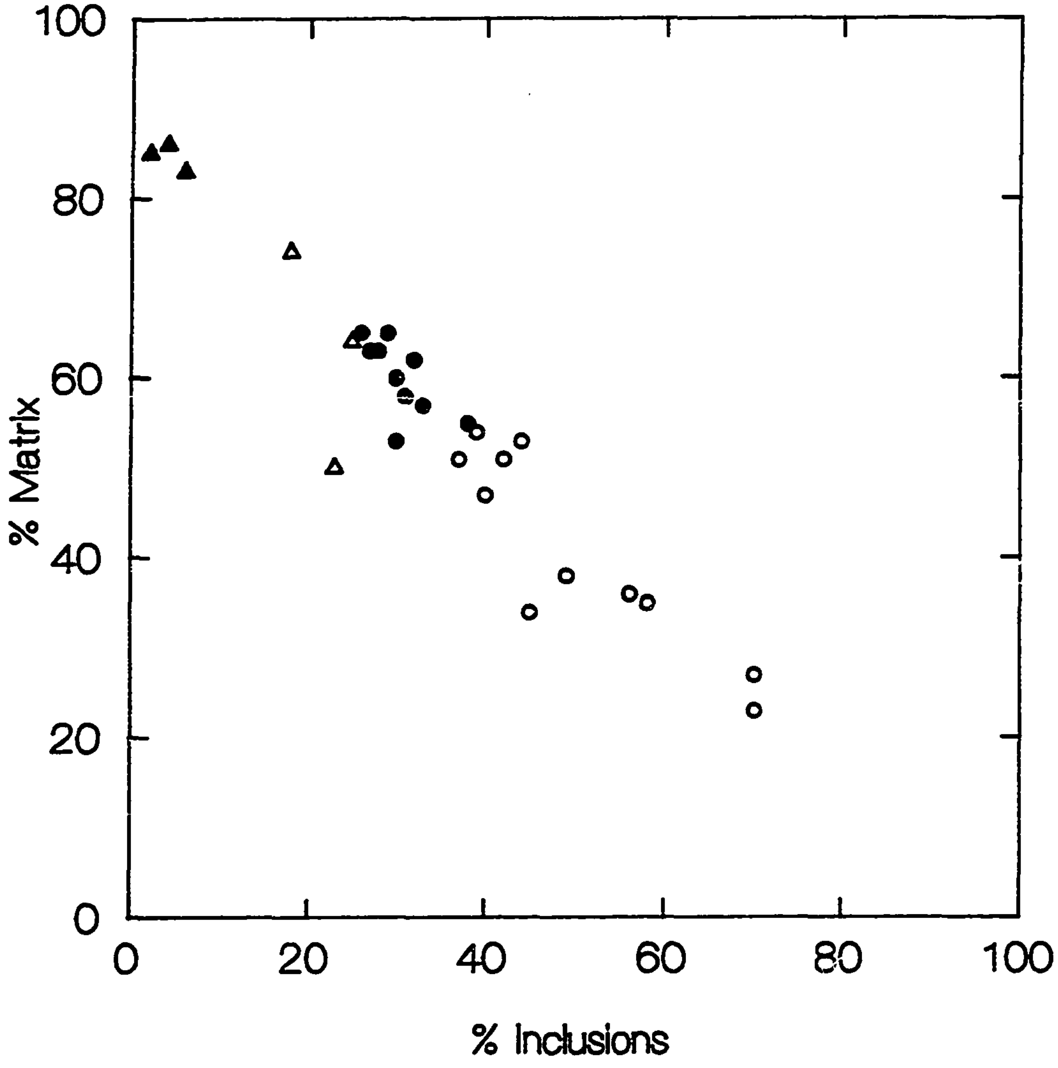


Figure V.3. Petrographic analysis of Aztec ceramic wares: percent matrix (clay fraction) and aplastic inclusions (grain size > clay fraction) based on 100 pt. count of standard thin-sections. Samples are identified as follows: Early Aztec Red wares (open circles), Late Aztec Red wares (filled circles), Early Aztec Orange wares (open triangles), Late Aztec Orange wares (filled triangles).

Table V.9

Percentage Composition of Aztec Ceramic Samples

Sherd	Type & Variant	Voids (%)	Matrix (%)	Inclusions (%) Total	Silt	VFS	FS	MS	CS
Early Aztec Red Ware									
200	B/R-I C	21	34	45	28	6	7	2	2
345	B/R A	13	38	49	23	13	9	2	2
346	B/R-I B	8	36	56	25	17	7	5	2
* 348	B/R-I C	9	77	14	14	0	0	0	0
349	B/R-I C	13	53	44	16	19	4	5	0
351	B/R A	7	35	58	41	11	5	1	0
352	B/R A	7	23	70	55	7	2	2	4
353	B/R A	3	27	70	52	6	7	3	2
354	B/R A	7	54	39	20	9	4	4	2
369	B/R A	7	51	42	32	3	6	1	0
370	B/R A	12	51	37	18	9	5	3	2
371	B/R A	13	47	40	21	11	5	2	1
Mean for Early Red		10	40	50	30	10	5	3	2
Late Aztec Red Ware									
374	B/R C	17	53	30	21	3	3	1	2
375	B/R C	6	62	32	27	1	2	1	1
376	B/R C	10	63	27	24	0	2	0	1
377	B/R C	10	60	30	23	4	3	0	0
378	B/R C	9	63	28	21	1	2	1	3
427	BWR Late C	7	55	38	35	2	0	1	0
428	BWR Late C	11	58	31	29	2	0	0	0
429	BWR Late C	6	65	29	26	2	0	1	0
432	BWR Late F	10	57	33	27	3	3	0	0
470	BWR Late F	9	65	26	22	1	1	2	0
Mean for Late Red		9	60	31	25	2	2	1	3
Black/Orange									
2	Mixquic B/O	8	74	18	2	4	3	5	4
3	Mixquic B/O	11	64	25	14	4	3	3	1
13	Mixquic B/O	17	50	23	7	4	5	6	1
32	Aztec IV B/O	10	86	4	0	0	2	2	0
33	Aztec IV B/O	13	85	2	0	2	0	0	0
34	Aztec IV B/O	11	83	6	0	1	3	1	1

*Extreme outlier; not included in calculation of mean.

variable as a group in both the quantity and size range of aplastic inclusions. Regional differences appear to exist within the early sample that may reflect a greater utilization of primary clays in the south (characterized by higher silt content) that contrasts with the use of better-sorted secondary clays in the north.

The primary minerals present as inclusions in all samples were plagioclase and pyroxene, with olivine and amphibole present in lower quantities (Table V.10); chlorite and hypersthene were present as accessory minerals. Quartz crystals were extremely rare, and calcite (reported as present by Branstetter-Hardesty [1978:124]) was not encountered. Subjective evaluation suggests that the relative proportions of these mineral inclusions are consistent with the range of natural mineral types associated with basaltic and andesitic rock types.

Both Early Aztec and Late Aztec sherds appear to contain the same suite of minerals, although comparisons are difficult due to the low volume of inclusions in late material. Late Aztec samples appear to contain less olivine and amphibole relative to the Early Aztec samples; however, this is partially a function of the small sample of mineral inclusions in the late material in combination with the fact that olivine and amphibole are less common over all. In addition, the apparent lower frequencies of olivine and amphibole may partially be an artifact of the smaller particle size in Late Aztec ceramics, since olivine and amphiboles are less readily identifiable from minute fragments than are plagioclase and pyroxene.

In summary, the petrographic analyses indicate that while Early and Late Aztec Red wares contain the same general suite of mineral aplastics, substantial differences in paste composition do exist between early and late wares involving both the quantity and size of aplastics. In contrast to Early Aztec samples, Late Aztec ceramics consistently show a more refined ceramic body with significantly less as well as smaller aplastic inclusions, a trend that is noticeable in both Red wares and the Black/Orange types. The utilization of finer ceramic pastes suggest either that (a) potters had access to finer, naturally levigated (sorted) clays, or (b) potters began to refine clays by the process of elutriation (Branstetter-Hardesty 1978:136). In either case, the selection and consistent use of finer clays over coarser clays is expected to significantly affect concentrations of elements associated with the aplastic fraction.

Predictions. In conclusion, the regional distribution of basaltic and andesitic bedrock types with the Valley of Mexico is expected to generate significant regional variability in natural aplastic mineral inclusions in Aztec ceramics. This mineralogical variability is complemented by an unknown degree of variability in the REE concentrated in the clay fraction to constitute the geochemical signature of a given source. For Aztec ceramics, it is probable that this geochemical signature was not modified by the incorporation of additional mineral temper, in that cattail fiber is the only tempering agent cited as consciously added by Aztec potters.[9]

However, a temporal trend involving the refinement of clays or selection of naturally refined clays substantially reduced the quantity of natural mineral inclusions relative to amount of clay matrix through time, a shift that potentially affects the concentrations of both mineral elements and the REE. As a result, Early Aztec and Late Aztec ceramics produced in the same region may have significantly different element concentrations.

Table V.10
Mineral Species Present in Aztec Ceramic Samples

Sherd	Mineral			
	Plagioclase	Pyroxene	Olivine	Amphibole
Red Ware Samples				
200	+	+	+	+
345	+	+	+	+
346	+	+	+	
348		+	+	
349	+	+	+	
351	+	+	+	+
352	+	+	+	+
353	+	+	+	+
354	+	+	+	+
369	+	+	+	
370	+	+		+
371	+	+	+	
374	+	+	+	+
375	+	+	?	
376	+	+	+	
377	+	+	+	
378	+	+		
427	+	+		+
428	+	+		
429	+	+	+	
432	+	+		
470	+	+		+
Black/Orange Samples				
2	+			+
3			+	
13	+		+	+
32	+			
33	+	+		
34	+	+		

Given the differences in paste texture apparent between Early and Late sherds (i.e. the general decline in amount and size of aplastic inclusions), the question arises as to whether observed variation in element concentrations will likely reflect regional variation in clay source or temporal variation in paste preparation techniques affecting the amount of aplastics incorporated into the clay.

Two approaches have been proposed for modelling and removing elemental variation arising from culturally induced texture and temper differences among pottery produced from a single clay resource. The first approach models the effect of differing amounts of aplastics as similar to that arising from differences in size, and utilizes strategies developed in multivariate morphometrics for distinguishing size-related variability from shape. Theoretically, temper-related variability will manifest itself in principal components analysis as strong positive loadings on the first component for mineral-related elements (Bishop and Neff 1989:72). The contribution of the first principle component may therefore be removed as one means of controlling for variable amounts and sizes of aplastics. In practice, however, addition or deletion of aplastics will rarely lead to the uniform enrichment or dilution of elements, thus the signs of the coefficients may differ while the magnitude of the coefficients will vary considerably (Bishop and Neff 1989:72).

A second approach advocates the disaggregation of ceramics into their fine and coarse fractions, followed by separate analyses for these components (Elam et al. 1992). This approach is both labor intensive and expensive, and in practice has yielded little or no improvement in the definition of compositional groups, except where aplastics were present in large quantities, the quantity of aplastics varied significantly from sherd to sherd, and/or the aplastic particles were mineralogically diverse (e.g. glacial tills).

Both approaches, however, are inappropriate for cases in which the aplastic fraction potentially reflects significant natural variability in mineral distributions. In this case, separation of clays and aplastics (either through modelling or disaggregation) may actually reduce the resolution of compositional groups, since their natural aplastics form part of the source's geochemical signature (Elam et al. 1992).

This study adopted an alternative approach. This study assumes that those mineral inclusions present are naturally occurring, (i.e. no additional minerals were incorporated into the clay matrix); thus, the aplastics form part of the geochemical signature. However, the amount and size of aplastic inclusions was culturally determined in the Late Aztec period. In order to control for this culturally introduced variability, separate group formation analyses were conducted for Early and Late Red wares. Within either the Early or Late ceramics, the assumption is made that observed element concentrations primarily reflect spatial variability in both aplastic minerals and REE.

Group Formation Analyses to Identify Production Sources

Programmatic statement. The primary objective of trace-element analysis of ceramics is the identification of homogeneous compositional groups representing specific clay sources or production loci (Glascock 1992). Although there is no established quantitative methodology for the empirical identification of homogeneous groups representing the products of a single production or clay source, Neff and associates (Bishop and Neff 1989; Glascock 1992) recommend a series of three main steps involving (1) preliminary group formation, (2) group refinement to create statistically homogeneous core groups, and (3) classification of non-core members into their most likely clay group.

Preliminary group identification frequently utilizes cluster analysis to gain initial insight into possible groups within the data set. Element concentrations are first transformed to either log base-10 or standardized values in order to compensate for differences in magnitude between major elements such as Fe and trace elements such as the REE. Previous researchers have debated whether geological materials better conform to a normal or to a lognormal distribution and thus whether standardization or a logarithmic transformation of the data is most appropriate; differences may well relate to the type of material being investigated (Glascock 1992:16). An additional argument raised against standardization is that the implicit assumption of an underlying normal distribution would clearly be erroneous if multiple sources led to multimodalities in element concentrations. In practice, however, the choice of transformation is considered moot, since standardization and log transformations have led to equivalent results (Bishop and Neff 1989; Glascock 1992).

Alternatively, an initial principal components or factor analysis may be used to reduced the dimensionality of the data set prior to clustering. If based on an initial correlation matrix, the principal component scores reflect an implicit standardization of the original data. In contrast, the use of a variance-covariance matrix preserves the euclidean relationships between data points. Thus a variance-covariance matrix should be used if the original variables were transformed to a log distribution in order to avoid working in a standardized logged data space.

Average linkage cluster analysis is then used to identify groups based on mean euclidean distance between data points. This initial clustering, however, may provide a relatively poor representation of actual data structure. Cluster analysis tends to generate clusters that are hyperspherical in shape, while in reality, clay groups tend to be hyperellipsoidal due to inter-element correlations (Bishop and Neff 1989). Although the average linkage algorithm is most likely to replicate original data space (Aldenderfer and Blashfield 1984), even this method will rarely recover the true groups in a compositional data set. Bishop and Neff, however, stress that the groups so identified are preliminary and merely provide a starting point from which to apply other techniques of pattern recognition and group refinement (see also Glascock 1992).[10]

A second step in group formation, then, is the refinement of groups suggested by the initial clustering using multivariate statistical criteria to assess internal consistency or homogeneity. The probability of group membership is determined for each case based on the Mahalanobis D^2 statistic, a measure of the multivariate distance between that case and a group centroid relative to the dispersion of other group members around the centroid. In the present analyses, the distance between a case X and the centroid of group K is calculated as:

$$D^2(X|K) = \sum_{i}^{V}\sum_{j}^{V} (X_i - K_i)\, a_{ij}\, (X_j - K_j)$$

where a_{ij} is the corresponding element from the inverted covariance matrix. Preferably, the multivariate distances should be jack-knifed, since inclusion of a case in the calculation of the group centroid and dispersion measures can substantially increase the probability of group membership.[11] The significance of the D^2 is assessed from the associated F-statistic and the probability of group membership is indicated by the attained significance value for the F-statistic:

$$F = \frac{D^2 \times N_k \times [1 + N_k - V - 1]}{V \times [1+N_k] \times [1 + N_k - 2]}$$

with $(V, [1 + N_k - V - 1])$ degrees of freedom;

where N_k = sample size of Group K; and

V = number of variables.

The goal of the group refinement step is the identification and statistical verification of core members for a clay group, that is, an internally homogenous group distinct from other such groups. The calculation of the D^2 statistic therefore proceeds iteratively. At each pass through the data, outliers (defined as cases with low probability of group membership) and cases showing multiple group affiliations are removed until an internally consistent core group is defined.

The third step in group formation utilizes canonical discriminant analysis to illustrate the separation of core groups and to describe the key dimensions of variability distinguishing them. Interpretation of the canonical variates rests on the total structure coefficients, i.e. correlations between the canonical variates and the original discriminating variables.

Finally, discriminant function scores are utilized in conjunction with the Mahalanobis D^2 statistic to classify non-core members into the most likely clay group. Classification following discriminant analysis is based on posterior probabilities of group membership, determined from the relative distances between a case and the centroids of all core groups calculated in canonical variates space. The case is classified as belonging to the core group to which it is closest. Typically, the classification assumes homogeneity of variance-covariance structure across clay groups (an assumption that may well not be met) and the Mahalanobis D^2 statistics are based on the pooled variance-covariance matrix. In this case, the posterior probabilities sum to 1.0 and all cases (even extreme outliers) are assigned to one of the core groups.

An alternative method allows for the calculation of probabilities of group membership within discriminant function space while recognizing that each group has its own variance-covariance structure. In this case, the Mahalanobis D^2 statistics are calculated on the within-group variance-covariance matrix. The procedure is directly analogous to the group refinement process described above and the discriminant axes become an alternative set of reference dimensions for the jack-knifed calculation of group membership probabilities. This is the generally preferred method of classification in INA studies in that it enables the identification of cases with low probability of group membership in any of the core groups that may represent products of a distinct source.

Analytical Procedures Utilized. In this study, the choice of elements for pattern recognition was based on their relative accuracy and precision in the NBS-SRM-1633A standards, with somewhat greater emphasis placed on precision. Cluster analyses and discriminant analyses were consistently based on the 17 most precise elements (Ce, Co, Cr, Cs, Eu, Fe, Hf, La, Lu, Rb, Sc, Sm, Ta, Tb, Th, Yb, Zn). Four elements (K, Na, Ni, Zr) were neither accurate nor precise, while an additional four (U, Sb, Sr, Nd) had a large number of missing values due to element concentrations below detection limits. Finally, two elements (As and Ba) were excluded as probably representing contamination with modern industrial pollution.

Preliminary investigations into the current data set indicated that while many elements displayed normal or near normal distributions, others revealed significant departures from normality. As a result, initial explorations of data structure utilized both standardized values and log base-10 values as input to cluster analyses, as well as principal component scores based alternatively on an initial correlation matrix (that also effectively standardized the original data) and on a covariance matrix of logged data values. Overall, a fairly strong correspondence was found among the different cluster solutions, confirming the findings of earlier studies that standardization and logged values yield equivalent results. Given this assurance, subsequent stages of the analysis were based on standardized values or on principal component scores that also implicitly standardized values in order to force element concentrations into the same range -- an alignment that is only incompletely accomplished with log transformations.

Probabilities of group membership were based on principal component scores derived from an initial correlation matrix, calculated separately for Early Aztec and Late Aztec samples. The substitution of PC scores for element concentrations was necessary in order not to preclude the recognition of small core groups, since the calculation of the D^2 statistic requires that the number of cases in a clay group exceed the number of variables on which the D^2 statistic is based. A major concern of this study was to determine whether many small-scale producers or fewer larger-scale producers were actively engaged in ceramic manufacture, thus, the use of principal components was employed as a means of reducing the number of variables while still retaining significant dimensions of variability between groups, thereby permitting the formation and testing of small core groups.

PCA theoretically provides a less subjective means for variable reduction than does the elimination of elements, per se. However, the use of a limited number of principal components also entails the loss of some information, hopefully (but not assuredly) insignificant for the process of group definition and refinement. Thus, choices concerning the number of components to utilize in calculating the distance statistic can significantly affect results.[12]

In this analysis, the number of principal components to retain was guided by considerations of their relative significance (eigenvalues), the cumulative percentage of variance explained (preferably > 70-80%), and the number of elements loading strongly on each component. In practice, it was found that group separation was more easily achieved when probabilities were based on fewer, more significant components (eigenvalues > 1.0), especially when the components demonstrated a sharp fall-off in percentage of variance accounted for. The use of a greater number of components including those with lower eigenvalues tended to muddy the waters, making all groups appear more similar to one another. Presumably this results because inter-group differences along the most significant dimensions of variability are effectively 'diluted' by the inclusion of lower-order components. In general it seems reasonable to assume that if a fewer number of elements or major components demonstrate significant differences between groups, the groups are in fact distinct. The risk, however, lies in combining samples or subgroups into a 'homogeneous' group based on a few variables when inclusion of further dimensions of variability would reveal them to be compositionally distinct.

The canonical variates analyses were based on the concentrations of the 17 most precise elements, as listed above. Following discriminant analysis, classification of non-core members utilized a plurality of criteria, including the position of a case relative to the 90% confidence interval ellipses for group membership defined on the canonical variates, and the probabilities of group membership calculated from the Mahalanobis D^2 statistic based on principal components as well as on discriminant function scores. The determination of posterior probabilities did not assume homogeneity of variances across groups and therefore utilized the within-groups variance-covariance matrices. A case was classed as mixed if these criteria revealed multiple or conflicting group affiliations; a case was classed as an outlier if it had low probabilities of membership in any group or fell significantly outside the confidence intervals for group membership as plotted in canonical variate space.

Locating Production Source

The definitive location of ceramic production loci is usually based on the comparison of ceramics with the geochemical signatures of raw clay samples, although modification of raw clays prior to ceramic manufacture can make such comparisons difficult. Unfortunately, few comparative clay samples exist for the Valley of Mexico (Branstetter-Hardesty 1978; Slayton 1985). Given the valley-wide distribution of lacustrine clays as potential raw materials, linking ceramics to a probable clay source would require a thorough and fine-grained sampling of clay beds within the Valley along the lines of the sampling strategy implemented by Neff et al. (1992) in Pacific coastal Guatemala.

In this study, the approximate location of production sources was based on the distribution and concentration of products from that source. Assuming (in conformance with gravity models and the so-called "criterion of relative abundance" [Rice 1987:177, 413]) that frequency declines with distance from the source, the general location of a production source can be reconstructed from the distribution of sherds bearing similar geochemical signatures. Thus, although provenience labels are given for each source, it is with the understanding that these reflect regional and not site-specific production locales.

Results

Ware and Temporal Differences

Preliminary analyses indicated that substantial differences exist in element concentrations between Orange wares and Red wares, and within Red wares, between Early Aztec and Late Aztec samples. These results confirm the observed differences in ceramic paste illustrated through petrographic analysis. In general, the Orange wares have a much smaller range of variation in element concentrations relative to Red wares (compare, for example, Figs. V.4 and V.5).

Comparison of Orange wares with all Red ware samples, with Early Aztec Red ware samples, and with Late Aztec Red ware samples indicate the Orange wares differ significantly from Red wares on a majority of elements (Table V.11). Although these two wares were largely analyzed at different labs (Orange wares at the Smithsonian and Red wares at Michigan), it is unlikely that the observed differences can be attributed solely to inter-lab calibration error. Within the Orange ware sample, comparison of samples processed at different labs indicated that while significant inter-lab differences do exist (most notably in Co, Hf, La, Lu, and Ta), the scale of inter-lab differences is relatively small in comparison with the inter-ware differences.

Differences between Early Aztec and Late Aztec Red wares are equally striking (Table V.12). Univariate comparisons of element concentrations revealed that Early and Late Red wares differ significantly in all but two elements (Na and Th). Differences are greatest in Co, Cr, and Fe -- elements associated with rock mineral inclusions. As anticipated from the petrographic analyses, concentrations of these elements are markedly lower in Late Aztec samples, presumably since these ceramics contain significantly less mineral inclusions. However, the concentrations of most other elements are lower in Late Aztec samples as well, with only Cs and Rb obtaining higher mean concentrations in Late

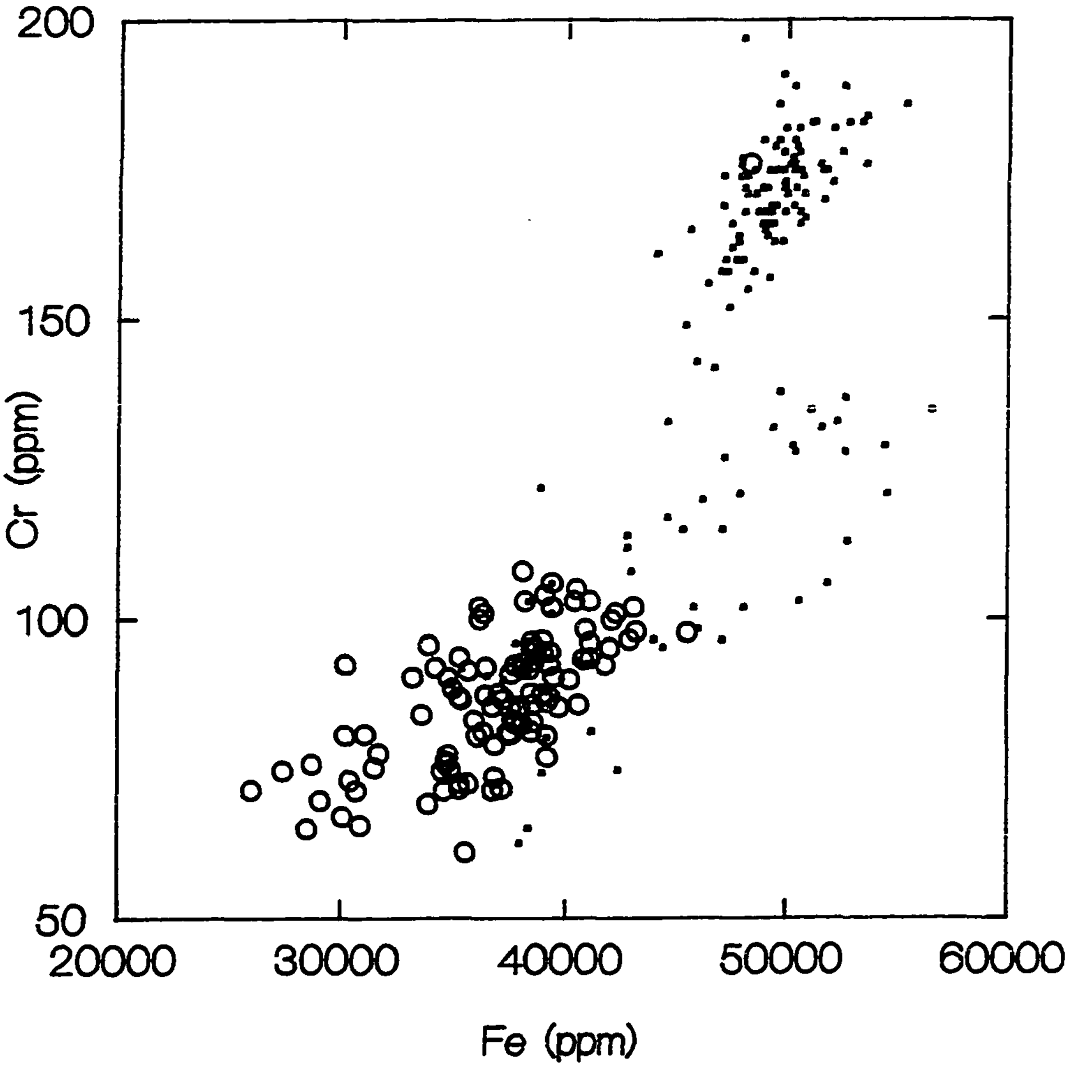


Figure V.4. Elemental concentrations of Cr and Fe in Aztec Red wares (N=252). Samples are identified by date: Early Aztec vessels (dots) and Late Aztec vessels (open circles).

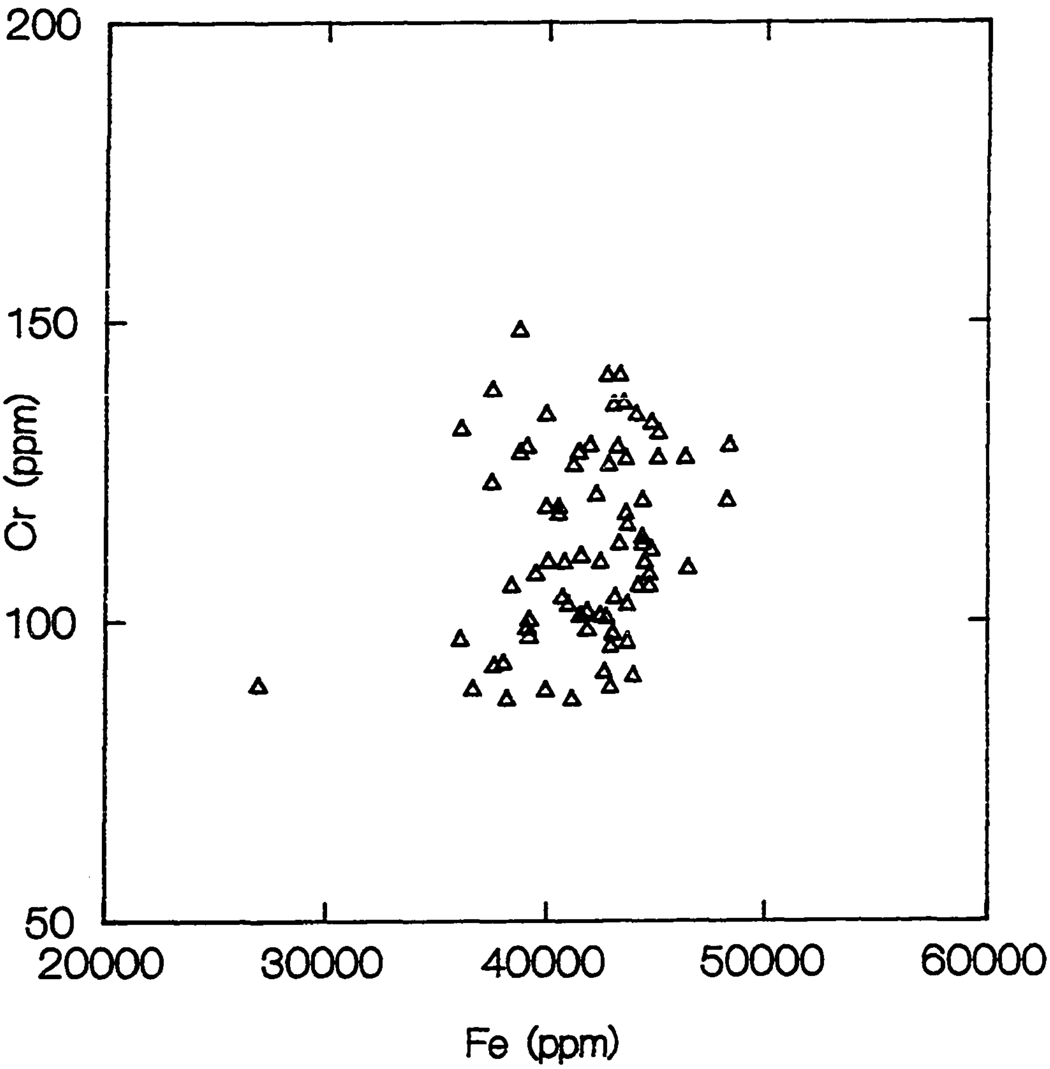


Figure V.5. Elemental concentrations of Cr and Fe in Early Aztec Orange wares (N=72).

Table V.11
Comparison of Orange and Red Wares: Element Concentrations and T-Tests

Element	Mean Values for Elements (ppm)				T-Tests Significance Levels B/O vs. Red		
	Early B/O (N=72)	All Red (N=252)	Early Red (N=147)	Late Red (N=105)	All	Early	Late
Ce	52.36	48.36	50.86	44.87	.324	.065	.000
Co	18.46	17.97	20.01	15.12	.000	.001	.000
Cr	112.84	123.48	149.83	86.58	.031	.000	.000
Cs	3.40	3.13	3.07	3.22	.000	.000	.028
Eu	1.55	1.43	1.51	1.32	.000	.063	.000
Fe	41737.26	43318.25	47933.33	36857.14	.057	.000	.000
Hf	5.79	5.93	6.21	5.54	.069	.000	.000
La	24.47	22.26	23.07	21.14	.000	.001	.000
Lu	0.27	0.29	0.31	0.26	.013	.000	.306
Na	16768.57	17287.18	17099.32	17550.19	.259	.411	.171
Rb	54.97	53.95	52.32	56.23	.516	.128	.383
Sc	14.37	14.22	15.54	12.38	.536	.000	.000
Sm	5.50	5.21	5.49	4.82	.001	.895	.000
Ta	0.70	0.76	0.80	0.70	.001	.000	.989
Tb	0.80	0.72	0.77	0.66	.001	.201	.000
Th	5.90	5.99	6.05	5.91	.378	.160	.938
Yb	2.00	1.98	2.09	1.83	.767	.036	.000
Zn	75.17	70.66	77.75	60.64	.015	.154	.000

Red wares. It is noteworthy that similar temporal differences were apparently not encountered within the Orange wares. Hodge et al. (1992, 1993) found that clay groups identified for Early Aztec Black/Orange ceramics were conformable to those identified for the Late Aztec period, implying a greater continuity in clay source and technology in the production of Orange wares.

Because of the differences between wares and between time periods, group identification analyses were conducted separately for three groups. These are Early Aztec Orange wares, Early Aztec Red wares, and Late Aztec Red wares.

Clay Group Identification for Early Aztec Orange Wares

INA analyses of Early Aztec Black/Orange ceramics are reported elsewhere (Minc et al. 1989, 1994). The results of this earlier study are summarized briefly here in order to incorporate additional samples of Early Aztec Black/Orange with those analyses.

Briefly, the previous trace-element study examined compositional differences between five distinctive stylistic types and included samples of Chalco Black/Orange (N=11), Mixquic Black/Orange (N=10), Culhuacan Black/Orange (N=13), Geometric Tenayuca (N=15), and Calligraphic Tenayuca (N=11) (Table V.3). The study found that

Table V.12
Comparison of Early and Late Red Wares: Element Concentrations and T-Tests

Element	Element Concentrations				T-Tests
	Early Red (N=147)		Late Red (N=105)		Significance Level
	Mean	S.D.	Mean	S.D.	
Ce	50.86	6.16	44.87	6.76	.000
Co	20.01	3.40	15.12	2.79	.000
Cr	149.83	33.26	86.58	10.64	.000
Cs	3.07	0.53	3.22	0.55	.029
Eu	1.51	0.16	1.32	0.15	.000
Fe	47933.33	4276.64	36857.14	3672.90	.000
Hf	6.21	0.57	5.54	0.41	.000
La	23.07	3.26	21.14	3.17	.000
Lu	0.31	0.05	0.26	0.05	.000
Na	17099.32	3049.33	17550.19	4475.44	.342
Rb	52.32	13.83	56.23	10.74	.016
Sc	15.54	1.40	12.38	0.91	.000
Sm	5.49	0.62	4.82	0.67	.000
Ta	0.81	0.14	0.70	0.11	.000
Tb	0.77	0.20	0.66	0.15	.000
Th	6.05	0.85	5.91	0.85	.185
Yb	2.09	0.34	1.83	0.34	.000
Zn	77.75	14.43	60.64	9.42	.000

these five Early Aztec Black/Orange types represented three geographically and geochemically distinct production zones.

Two regions of Early Aztec Black/Orange production were identified within the southern Valley, corresponding to the eastern (Lake Chalco) and western (Lake Xochimilco) drainage basins (see Figs. 7.25 and 7.26). The SE area was the source area for the production of Chalco and Mixquic Black/Orange, while the southwestern or Culhuacan-Ixtapalapa area produced Culhuacan and Calligraphic Tenayuca Black/Orange. The third region identified represents a northern or Texcocan-area source that produced Geometric Tenayuca. In addition, on-going research (Hector Neff, personal communication) indicates that additional sources produced and distributed Early Aztec Black/Orange ceramics within the area west of Lake Texcoco and to the north around Xaltocan.

Probabilities of group membership based on the first three principal components (Table V.13) confirmed group separation of the Chalco, Culhuacan, and Texcoco sources (Table V.14). Canonical variates analysis indicated that major differences exist between these clay sources in Cr, Cs, and Sc (Table V.15).

Table V.13
Principal Components Analysis of Early Aztec Black/Orange

Statistic	Component				
	1	2	3	4	5
Eigenvalue	6.33	3.92	2.14	1.42	1.07
% Variance Explained	31.66	19.52	10.68	7.11	5.37
Cumulative % Variance	31.66	51.28	61.96	69.07	74.44
Element	**Component Loadings**				
Ce	**0.763**	0.174	0.089	-0.142	-0.364
Co	0.316	**-0.626**	0.198	-0.345	-0.435
Cr	-0.166	**-0.875**	0.051	-0.150	0.182
Cs	0.368	**0.596**	0.447	0.239	-0.019
Eu	**0.727**	0.024	**0.521**	-0.174	0.085
Fe	0.519	**-0.534**	0.014	-0.082	-0.300
Hf	**0.694**	-0.483	-0.040	0.341	0.071
K	0.084	**0.613**	0.340	0.237	-0.263
La	**0.902**	0.204	0.141	-0.076	0.117
Lu	**0.581**	0.274	-0.175	0.091	0.381
Na	-0.491	-0.026	0.401	0.419	-0.194
Rb	0.446	0.303	**-0.490**	0.290	-0.285
Sc	0.428	**-0.777**	0.311	0.091	0.218
Sm	**0.807**	0.341	0.150	-0.152	0.101
Sr	**-0.573**	-0.175	0.380	-0.293	0.021
Ta	**0.542**	-0.439	-0.302	0.352	-0.106
Tb	**0.505**	0.204	-0.204	**-0.503**	-0.252
Th	**0.640**	-0.472	-0.206	0.343	-0.009
Yb	**0.562**	0.260	-0.371	-0.312	0.335
Zn	0.417	-0.003	**0.686**	0.105	0.155

Note: N = 60. High loadings have been highlighted to clarify patterns of association.

An additional 12 samples of Aztec I Black/Orange ceramics (Table V.2) were later analyzed at Phoenix Lab to supplement the sample of 60 Early Aztec Orange wares previously analyzed and to ascertain the comparability of results produced at different labs. This sample included an additional five examples of Chalco Black/Orange, three key supports associated with Mixquic Black/Orange, and four indeterminate Aztec Black/Orange vessels recovered from the sites of Chalco and Xico.

Because significant differences were found to exist between labs even after inter-lab calibration, no attempt was made to incorporate samples analyzed at Phoenix Memorial Lab into the core groups defined for samples processed at the Smithsonian. Instead, the canonical variates derived for the Smithsonian-based core groups were utilized to classify the samples processed at Phoenix -- with uncertain results.

Table V.14
Division of Early Aztec Black/Orange Types: Probabilities of Core Group Membership Based on Three Primary Principal Components

INA ID	Ceramic Type	INA Clay Group	Probability of Group Membership		
			CH	TX	CUL
AZPO01**	Chalco Chunky	Texcoco	.019	.458	.008
AZPO02**	Chalco Chunky	Texcoco	.016	.726	.021
AZPO03	Chalco Chunky	Chalco	.256	.002	.000
AZPO04	Chalco Chunky	Chalco	.394	.002	.002
AZPO05	Chalco Chunky	Chalco	.302	.006	.002
AZPO06	Chalco Chunky	Chalco	.595	.003	.000
AZPO07	Chalco Bowl	Chalco	.464	.000	.000
AZPO08	probably Chalco	Chalco	.548	.001	.000
AZPO68	Chalco Chunky	Chalco	.600	.012	.021
AZPO69	Chalco Chunky	Chalco	.583	.002	.001
AZPO70	Chalco Chunky	Chalco	.550	.004	.000
AZPO11	Mixquic Bolstered	Chalco	.422	.002	.007
AZPO12	Mixquic Bolstered	Chalco	.513	.036	.018
AZPO13	Mixquic Bolstered	Chalco	.573	.002	.000
AZPO14	Mixquic Bolstered	Chalco	.592	.025	.015
AZPO15	Mixquic Bolstered	Chalco	.434	.015	.001
AZPO16	Mixquic Grooved	Chalco	.578	.001	.000
AZPO17	Mixquic Grooved	Chalco	.905	.003	.001
AZPO18	Mixquic Grooved	Chalco	.201	.112	.021
AZPO19	Mixquic Shouldered	Chalco	.434	.001	.000
AZPO20	Mixquic Shouldered	Chalco	.522	.003	.001
AZPO21	Geometric Tenayuca	Texcoco	.002	.687	.040
AZPO22	Geometric Tenayuca	Texcoco	.006	.569	.018
AZPO23	Geometric Tenayuca	Texcoco	.005	.292	.115
AZPO24	Geometric Tenayuca	Texcoco	.033	.205	.005
AZPO25	Geometric Tenayuca	Texcoco	.001	.400	.003
AZPO26	Geometric Tenayuca	Texcoco	.065	.279	.011
AZPO27	Geometric Tenayuca	Texcoco	.000	.486	.004
AZPO28	Geometric Tenayuca	Texcoco	.001	.823	.021
AZPO29	Geometric Tenayuca	Texcoco	.002	.541	.014
AZPO30	Geometric Tenayuca	Texcoco	.006	.750	.031
AZPO31	Geometric Tenayuca	Texcoco	.000	.443	.002
AZPO32	Geometric Tenayuca	Texcoco	.005	.599	.047
AZPO33	Geometric Tenayuca	Texcoco	.001	.730	.005
AZPO34	Geometric Tenayuca	Texcoco	.003	.796	.030
AZPO35	Geometric Tenayuca	Texcoco	.001	.485	.003

Table V.14 (continued)

Division of Early Aztec Black/Orange Types: Probabilities of Core Group Membership Based on Three Primary Principal Components

INA ID	Ceramic Type	INA Clay Group	Probability of Group Membership		
			CH	TX	CUL
AZPO09	Culhuacanoid	Culhuacan	.065	.010	.111
AZPO56	Culhuacan	Culhuacan	.004	.001	.691
AZPO57	Culhuacan	Culhuacan	.025	.004	.992
AZPO58	Culhuacan	Culhuacan	.023	.001	.689
AZPO59	Culhuacan	Culhuacan	.077	.009	.544
AZPO60	Culhuacan	Culhuacan	.007	.046	.413
AZPO61	Culhuacan	Culhuacan	.035	.003	.591
AZPO62	Culhuacan	Culhuacan	.005	.001	.761
AZPO63	Culhuacan	Culhuacan	.005	.001	.433
AZPO64	Culhuacan	Culhuacan	.063	.016	.573
AZPO65	Culhuacan	Culhuacan	.053	.004	.796
AZPO66	Culhuacan	Culhuacan	.012	.004	.471
AZPO67	Culhuacan	Culhuacan	.004	.001	.603
AZPO36	Calligraphic Tenayuca	Culhuacan	.004	.015	.498
AZPO37	Calligraphic Tenayuca	Culhuacan	.034	.008	.872
AZPO38	Calligraphic Tenayuca	Culhuacan	.002	.048	.455
AZPO39	Calligraphic Tenayuca	Culhuacan	.002	.005	.409
AZPO40	Calligraphic Tenayuca	Culhuacan	.015	.001	.385
AZPO41	Calligraphic Tenayuca	Culhuacan	.028	.001	.694
AZPO45	Calligraphic Tenayuca	Culhuacan	.010	.000	.313
AZPO46**	Calligraphic Tenayuca	Culhuacan	.000	.000	.007
AZPO47	Calligraphic Tenayuca	Culhuacan	.006	.000	.405
AZPO48	Calligraphic Tenayuca	Culhuacan	.194	.008	.359
AZPO49	Calligraphic Tenayuca	Culhuacan	.003	.001	.422

Note: **Indicates non-core members; not included in calculation of within-group covariance matrix nor canonical variates.

All of the additional Black/Orange samples were classified to the Chalco region clay group, a result that is consistent with the provenience of these samples. However, only three out of the twelve additional samples fell within the 95% confidence interval for the Chalco clay group; the remainder display a wide dispersion relative to the location of core group members (Fig. V.6). It remains unclear at present whether this non-conformity results purely from inter-lab calibration problems, or whether additional clay groups are represented here. In partial support of the second alternative, it is of interest that the two samples located farthest from the group centroid are indeterminate Aztec I Black/Orange, and may in fact represent a distinct clay source.

Table V.15

Canonical Variates Analysis of Early Aztec Black/Orange Clay Groups

Statistic	Canonical Variate	
	1	2
Eigenvalue	31.14	6.87
% Cumulative Variance	81.94	100.00
Canonical Correlation	.98	.93
% Variance Explained by elements	98.66	87.29
Element	**Structure Coefficients**	
Ce	-0.31	0.08
Co	0.48	-0.07
Cr	**0.90**	0.03
Cs	**-0.62**	-0.50
Eu	-0.08	-0.42
Fe	0.26	0.31
Hf	0.34	0.16
La	-0.23	-0.02
Lu	-0.24	0.28
Na	0.08	-0.32
Rb	-0.32	0.39
Sc	**0.79**	-0.22
Sm	-0.41	0.06
Ta	0.25	**0.46**
Tb	-0.26	0.30
Th	0.45	0.23
Yb	-0.21	0.40
Zn	-0.04	**-0.48**

Note: N = 57 core group members.

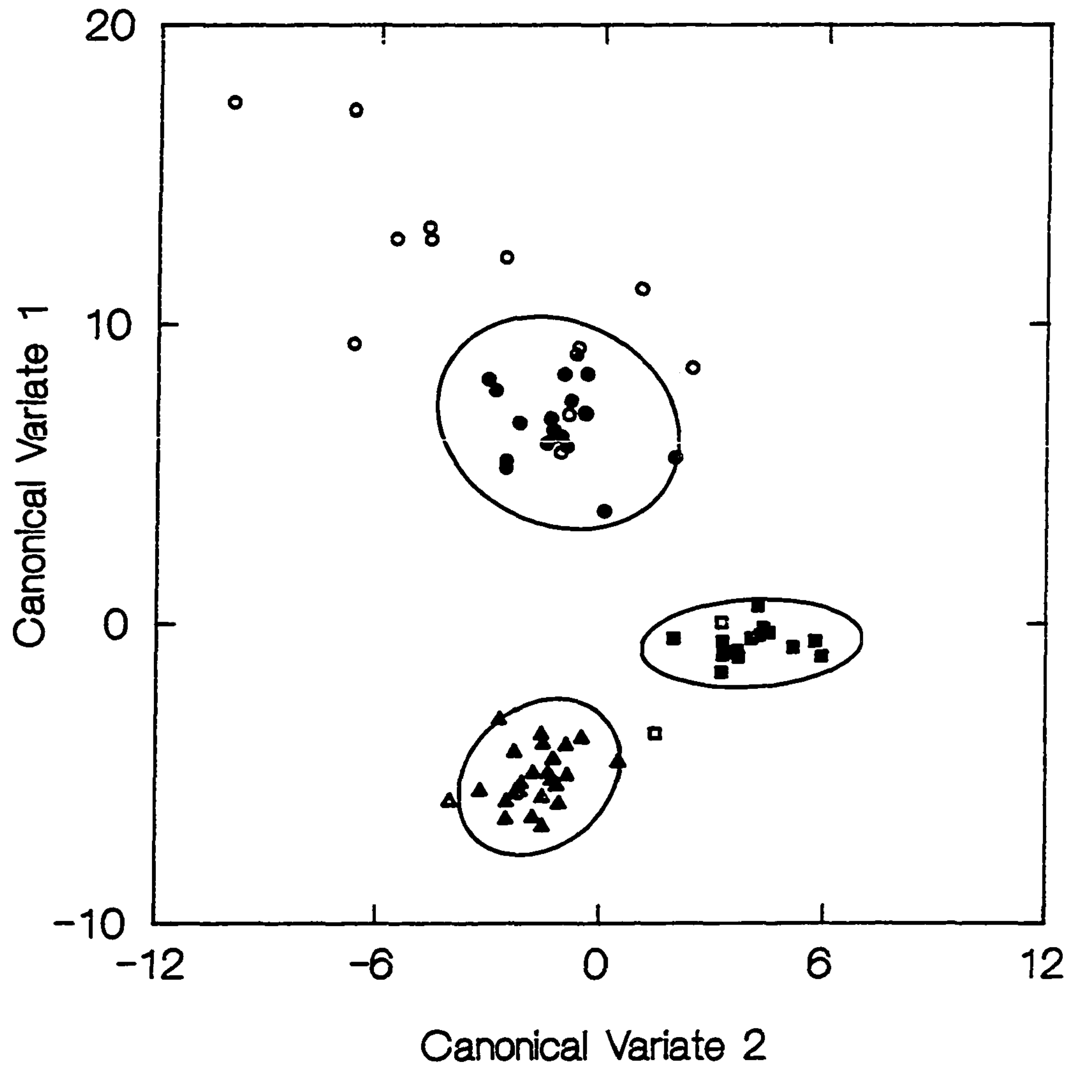


Figure V.6. Separation of the three Early Aztec Black/Orange clay groups based on canonical variates analysis. Ellipses represent 95% confidence intervals for group membership (canonical variates and ellipses based on core members only [N=60]). Group members are identified as follows: Chalco clay source (circles), Culhuacan clay source (triangles), and Texcoco clay source (squares). Solid symbols represent core members, open symbols represent non-core members classified to that group. All non-core members classified to the Chalco source were processed at Phoenix Memorial Lab; their distribution relative to core members may reflect problems with inter-lab calibration.

Clay Group Identification for Early Aztec Red Wares

Three distinct clay groups were initially identified within the sample of Early Aztec ceramics (N=147) based on the bivariate distribution of Cr and Fe (Fig. V.7). Two distinct regression lines indicate a high Cr group (labelled Early Aztec Group 1 [N=98]), and a low Cr group, while within the low Cr group, a strong bimodality on Fe suggests a subdivision into higher and lower Fe groups (Early Aztec Group 2 [N=31] and Group 3 [N=18], respectively). This initial three-fold division was supported by bivariate plots of rare earth elements and by the results of multivariate cluster analyses in which group members were consistently clustered together based on the standardized concentrations of 17 elements as well as on principal component scores.

Multivariate probabilities of group membership calculated on the first 4 principal components (eigenvalues ≥ 1.0, accounting for 72% of the variance; Table V.16) showed strong support for the preliminary group separation and integrity (Table V.17). Group refinement identified the following internally consistent and statistically distinct core groups: Group 1 (N=74), Group 2 (N=22), and Group 3 (N=16), while 35 sherds either showed roughly equal probabilities of belonging to several groups or no strong affiliation to any group. Subsequent canonical discriminant analysis of core group members (N=112) based on 17 elements showed excellent group separation and posterior probabilities of group membership classified 100% of core members correctly.

Posterior probabilities also classified all but 7 of the non-core cases to their initial group affiliation as determined from the bivariate plot of Cr × Fe, in spite of low or mixed probabilities of group membership based on principal component scores. Six of the cross-overs occurred between Groups 2 and 3, indicating the closer degree of relatedness between these two clay sources. Final classification of non-core members generally followed group membership as predicted by the canonical variates analysis. The exceptions were cross-overs (N=5) that fell outside of the 90% confidence interval of the group to which they were assigned.

Separation of the three clay groups in canonical variate space is illustrated in Figure V.8. The first canonical variate, correlated negatively with Cr and positively correlated with Th and Cs (Table V.18), separates Group 1 from Groups 2 and 3, reflecting the higher Cr values in Group 1 and the higher Cs and Th concentrations in Groups 2 and 3. The second canonical variate separates Group 2 from Group 3 and is strongly correlated with Fe, Hf, Sc, and Co, with significant positive correlations with most REE as well.

Members of the Early Aztec Group 1 clay source are found primarily in the south of the study area, between Chalco and Amecameca, and were likely produced within this southern area (Fig. V.9). The high values of Cr, Co, and Fe in Group 1 ceramics may reflect the use of primary or piedmont riverine clays rather than lacustrine clays, since upland clays are less refined and contain more and larger natural mineral inclusions than naturally sorted or levigated lakeshore sediments. In addition, the concentration of basaltic bedrocks within this area (CETENAL, map sheets E14B31 and E14B41) potentially contribute naturally high levels of these elements to the local clays.

In contrast, both Early Aztec Groups 2 and 3 occur primarily in the northern portion of the study area, and have strongly overlapping distributions (Figs. V.10 and V.11). However, Early Aztec Group 2 is tentatively linked with the Huexotla area, in that

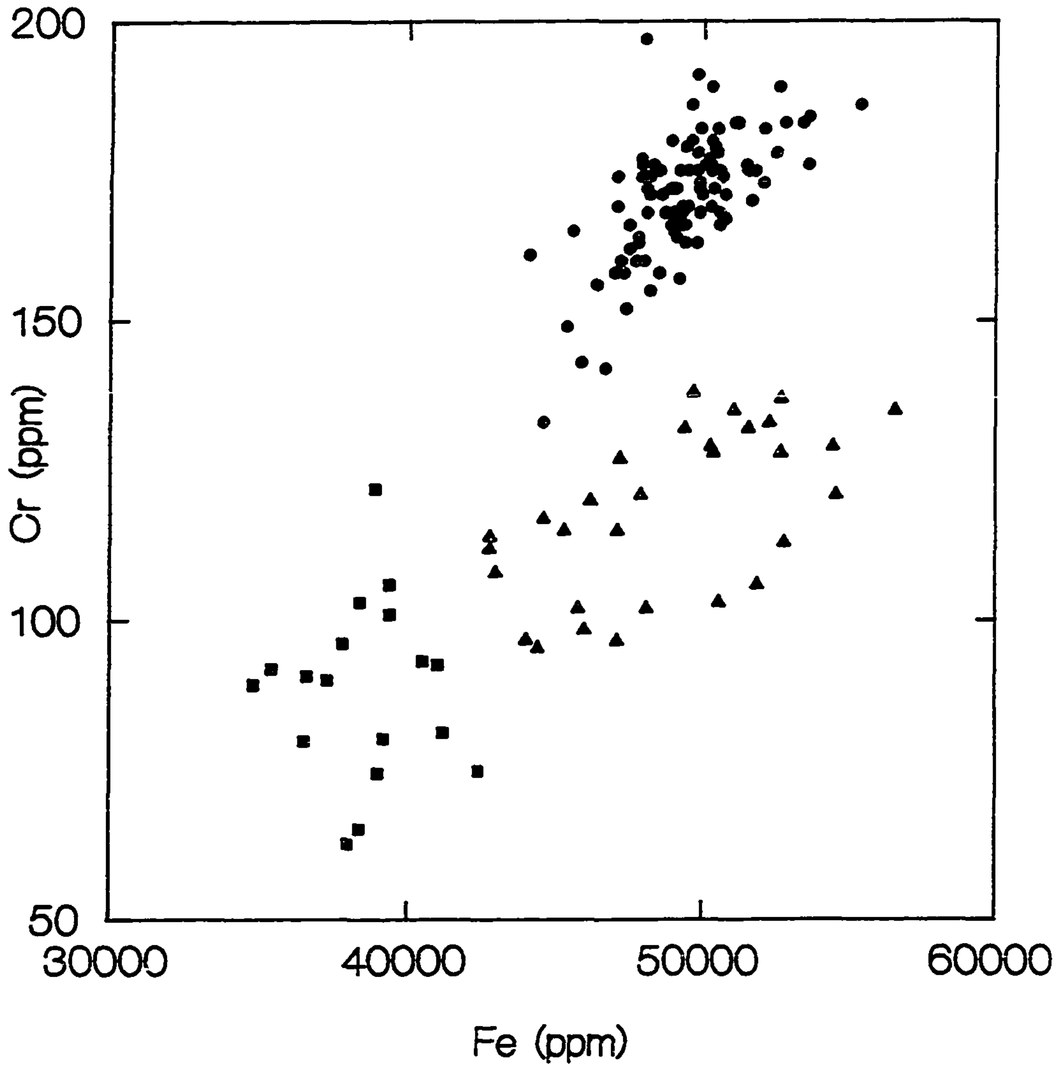


Figure V.7. Preliminary group formation for Early Aztec Red ware ceramic samples based on the bivariate scatter-plot of Cr and Fe. Group members are identified as follows: Group 1 (circles), Group 2 (triangles) and Group 3 (squares).

Table V.16

Principal Components Analysis of Early Aztec Red Wares

Statistic	Component			
	1	**2**	**3**	**4**
Eigenvalue	6.80	3.02	1.30	1.11
% Variance Explained	40.12	17.75	7.67	6.53
Cumulative % Variance	40.12	57.87	65.54	72.07
Element	**Component Loadings**			
Ce	**0.770**	-0.214	0.014	-0.176
Co	**0.736**	0.284	0.256	-0.028
Cr	0.017	**0.919**	0.106	-0.027
Cs	0.320	-0.482	**0.546**	0.067
Eu	**0.839**	0.133	-0.163	0.166
Fe	**0.576**	**0.737**	0.231	-0.077
Hf	**0.771**	0.196	0.332	-0.276
La	**0.836**	-0.257	-0.278	0.061
Lu	**0.764**	-0.217	-0.349	0.035
Rb	0.026	-0.239	0.485	**0.656**
Sc	**0.617**	**0.657**	0.068	-0.103
Sm	**0.864**	0.026	-0.289	0.222
Ta	**0.523**	-0.306	0.297	-0.105
Tb	**0.438**	0.010	-0.197	0.042
Th	**0.612**	**-0.580**	0.236	-0.209
Yb	**0.791**	-0.263	-0.183	0.046
Zn	0.247	0.339	-0.013	**0.639**

Note: N = 147.

this clay group appears to have been a primary producer of the Black&White/Red Variant B -- a variant that overwhelmingly predominates in collections from this site. Examples of this variant showing a vertical row of 'pennants' are particularly associated with Huexotla and are well represented among the core members of Group 2. Early Aztec Group 3 has a slightly more northerly distribution and is tentatively associated with the Texcoco area.

Table V.17
Division of Early Aztec Red Wares: Probabilities of Core Group Membership Based on Four Primary Principal Components

INA I.D.	Probability of Membership in		
	Group 1	Group 2	Group 3
Samples Assigned to Group 1 (N=74)			
200	0.693	0.145	0.001
201	0.417	0.108	0.002
203	0.920	0.047	0.001
204	0.346	0.041	0.004
205	0.092	0.013	0.001
206	0.135	0.001	0.027
207	0.208	0.012	0.001
208	0.676	0.015	0.001
209	0.677	0.033	0.001
212	0.356	0.001	0.002
213	0.430	0.026	0.001
214	0.136	0.001	0.000
215	0.501	0.109	0.008
216	0.293	0.018	0.000
217	0.753	0.091	0.005
218	0.839	0.072	0.007
219	0.431	0.107	0.013
239	0.555	0.041	0.004
240	0.297	0.039	0.042
241	0.404	0.155	0.007
242	0.467	0.065	0.001
243	0.982	0.065	0.006
244	0.092	0.017	0.013
245	0.225	0.009	0.034
250	0.621	0.108	0.001
253	0.656	0.011	0.001
254	0.506	0.055	0.003
256	0.814	0.106	0.001
258	0.423	0.049	0.000
259	0.707	0.030	0.001
260	0.774	0.012	0.004
295	0.577	0.017	0.001
296	0.349	0.003	0.000
297	0.202	0.001	0.001
300	0.552	0.072	0.002
303	0.411	0.041	0.015
304	0.759	0.113	0.001
306	0.624	0.015	0.000
308	0.526	0.098	0.000
309	0.929	0.069	0.001
311	0.521	0.005	0.001

Table V.17 (continued)
Division of Early Aztec Red Wares: Probabilities of
Core Group Membership Based on Four Primary Principai Components

INA I.D.	Probability of Membership in		
	Group 1	Group 2	Group 3
318	0.568	0.097	0.020
320	0.408	0.074	0.000
321	0.617	0.045	0.001
322	0.763	0.037	0.001
324	0.997	0.058	0.002
326	0.430	0.020	0.005
336	0.827	0.020	0.003
337	0.161	0.032	0.012
338	0.827	0.142	0.001
339	0.979	0.048	0.002
340	0.969	0.049	0.003
342	0.521	0.004	0.001
343	0.477	0.017	0.075
345	0.819	0.045	0.001
350	0.441	0.031	0.002
351	0.211	0.018	0.004
352	0.527	0.044	0.002
353	0.434	0.040	0.001
371	0.278	0.004	0.001
387	0.799	0.033	0.003
439	0.114	0.009	0.005
440	0.826	0.022	0.005
441	0.447	0.029	0.008
442	0.248	0.014	0.000
443	0.932	0.044	0.001
444	0.912	0.088	0.001
445	0.742	0.040	0.002
453	0.391	0.099	0.000
454	0.467	0.064	0.001
459	0.710	0.058	0.005
476	0.432	0.019	0.009
477	0.543	0.110	0.001
478	0.278	0.031	0.000
Samples Assigned to Group 2 (N=22)			
257	0.000	0.415	0.050
301	0.000	0.219	0.084
315	0.000	0.444	0.002
317	0.001	0.498	0.018
319	0.000	0.589	0.000
370	0.000	0.687	0.000
392	0.000	0.724	0.004

Table V.17 (continued)
Division of Early Aztec Red Wares: Probabilities of Core Group Membership Based on Four Primary Principal Components

INA I.D.	Probability of Membership in		
	Group 1	Group 2	Group 3
393	0.000	0.995	0.004
394	0.000	0.063	0.000
398	0.000	0.560	0.000
399	0.000	0.846	0.006
400	0.000	0.653	0.003
424	0.000	0.608	0.000
425	0.000	0.740	0.001
446	0.000	0.066	0.022
452	0.000	0.420	0.015
456	0.000	0.407	0.000
461	0.015	0.267	0.001
462	0.000	0.888	0.000
463	0.000	0.553	0.008
464	0.000	0.402	0.001
523	0.000	0.496	0.013
Samples Assigned to Group 3 (N=16)			
299	0.000	0.062	0.541
302	0.000	0.002	0.127
314	0.000	0.146	0.354
316	0.000	0.009	0.908
323	0.000	0.173	0.803
344	0.000	0.009	0.513
356	0.000	0.005	0.328
369	0.000	0.003	0.544
372	0.000	0.007	0.057
430	0.000	0.031	0.829
437	0.000	0.024	0.664
438	0.000	0.092	0.980
449	0.000	0.080	0.364
455	0.000	0.010	0.433
457	0.000	0.080	0.425
522	0.000	0.038	0.401
Unclassified (N=35)			
210	0.007	0.555	0.001
211	0.000	0.001	0.001
220	0.204	0.098	0.112
246	0.205	0.016	0.106
247	0.001	0.394	0.000
248	0.206	0.205	0.005

Table V.17 (continued)
Division of Early Aztec Red Wares: Probabilities of Core Group Membership Based on Four Primary Principal Components

INA I.D.	Probability of Membership in		
	Group 1	Group 2	Group 3
249	0.023	0.380	0.001
251	0.181	0.133	0.000
252	0.206	0.144	0.001
255	0.180	0.299	0.001
298	0.023	0.003	0.000
305	0.095	0.150	0.002
307	0.001	0.003	0.000
310	0.088	0.155	0.001
312	0.000	0.000	0.000
341	0.465	0.258	0.002
346	0.024	0.000	0.001
347	0.014	0.269	0.000
349	0.115	0.246	0.012
354	0.003	0.260	0.000
355	0.001	0.011	0.001
395	0.246	0.121	0.002
397	0.431	0.183	0.008
458	0.058	0.127	0.000
202	0.000	0.009	0.000
325	0.000	0.414	0.287
348	0.025	0.184	0.070
388	0.008	0.170	0.025
447	0.000	0.030	0.000
221	0.000	0.222	0.098
313	0.000	0.002	0.014
381	0.000	0.081	0.062
460	0.012	0.159	0.040
466	0.061	0.065	0.172
467	0.074	0.091	0.020

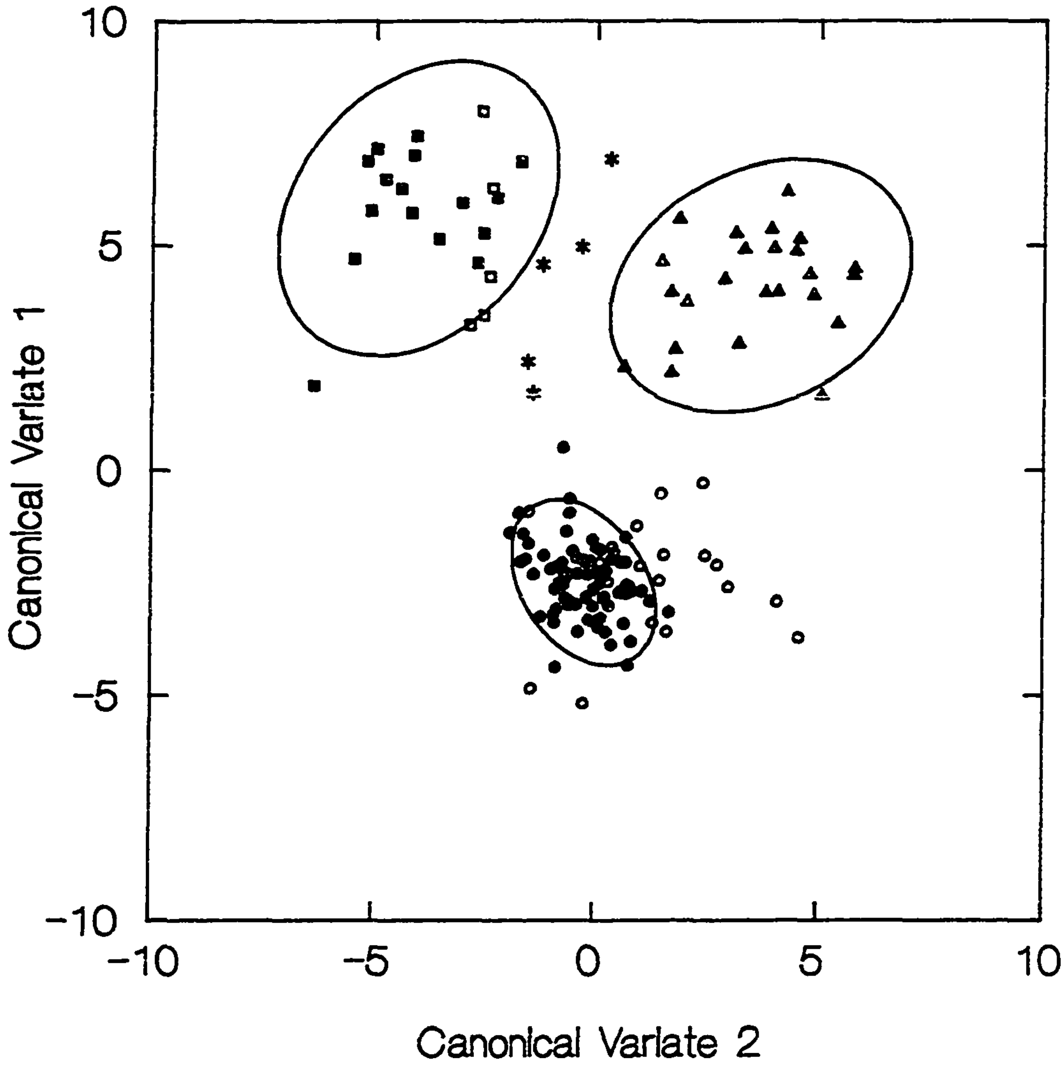


Figure V.8. Separation of the three Early Aztec Red ware clay groups based on canonical variates analysis. Ellipses represent 90% confidence intervals for group membership (canonical variates and ellipses based on core members only). Group members are identified as follows: Group 1 (circles), Group 2 (triangles) and Group 3 (squares). Solid symbols represent core members, open symbols represent non-core members classified to that group. Asterisks indicate unclassified samples.

Table V.18

Canonical Variates Analysis of Early Aztec Red Ware Clay Groups

Statistic	**Canonical Variate**	
	1	**2**
Eigenvalue	12.55	5.14
% Cumulative Variance	70.96	100.00
Canonical Correlation	.96	.92
% Variance Explained by elements	95.62	83.70
Element	**Structure Coefficients**	
Ce	0.43	**0.61**
Co	0.07	**0.73**
Cr	**-0.96**	0.19
Cs	**0.55**	0.33
Eu	0.05	**0.62**
Fe	**-0.54**	**0.78**
Hf	0.06	**0.92**
La	0.36	**0.55**
Lu	0.34	0.49
Rb	0.23	0.05
Sc	-0.43	**0.68**
Sm	0.09	**0.61**
Ta	0.40	0.47
Tb	0.01	0.34
Th	**0.68**	**0.63**
Yb	0.35	**0.61**
Zn	-0.33	0.23

Note: N = 112 core group members.

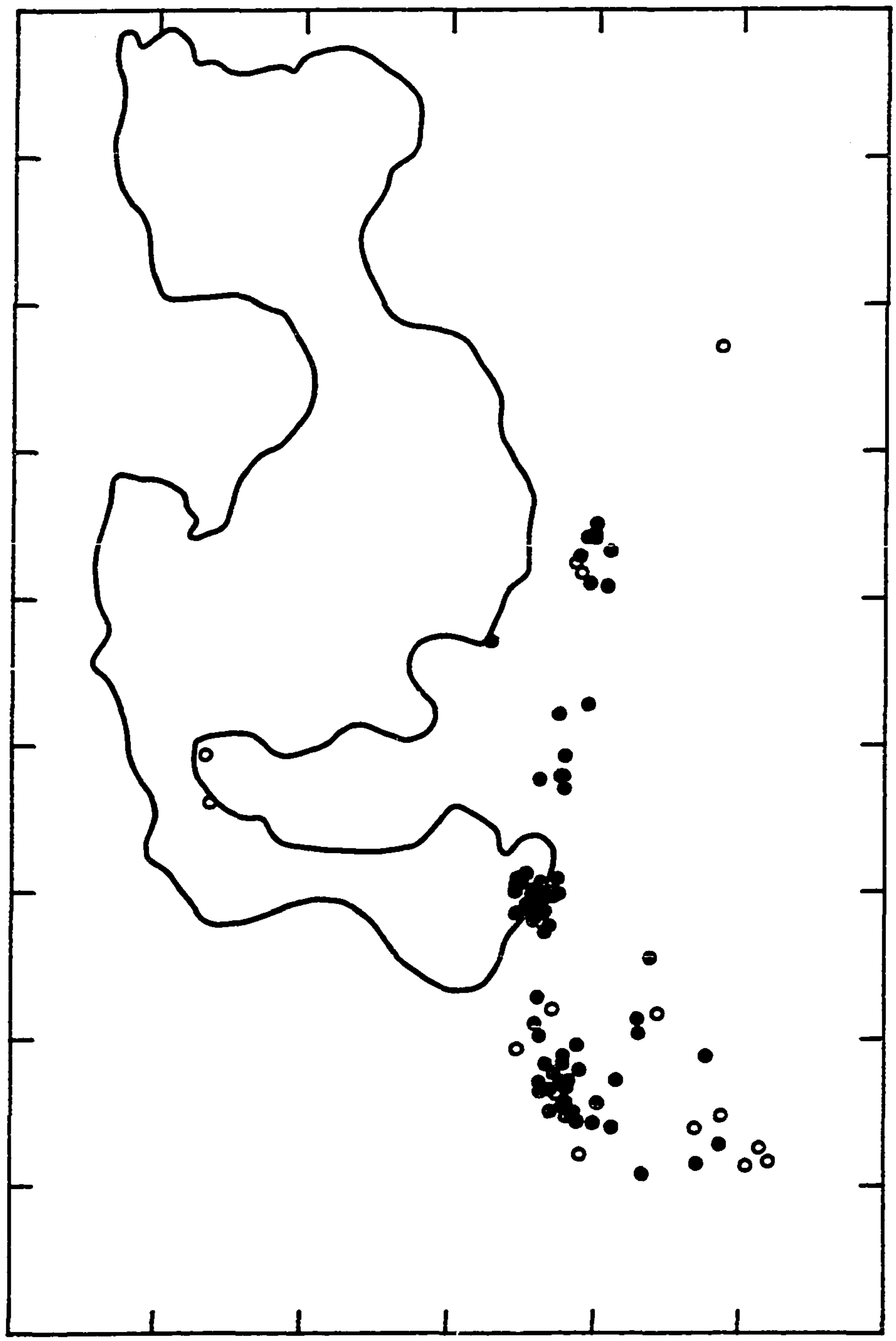


Figure V.9. Distribution of vessels belonging to Early Aztec Red ware Clay Group 1 relative to the ancient lakebed margin. Vessels show a spatial concentration in the southern Chalco region. (Vessel proveniences have been jittered to avoid overlap of data points).

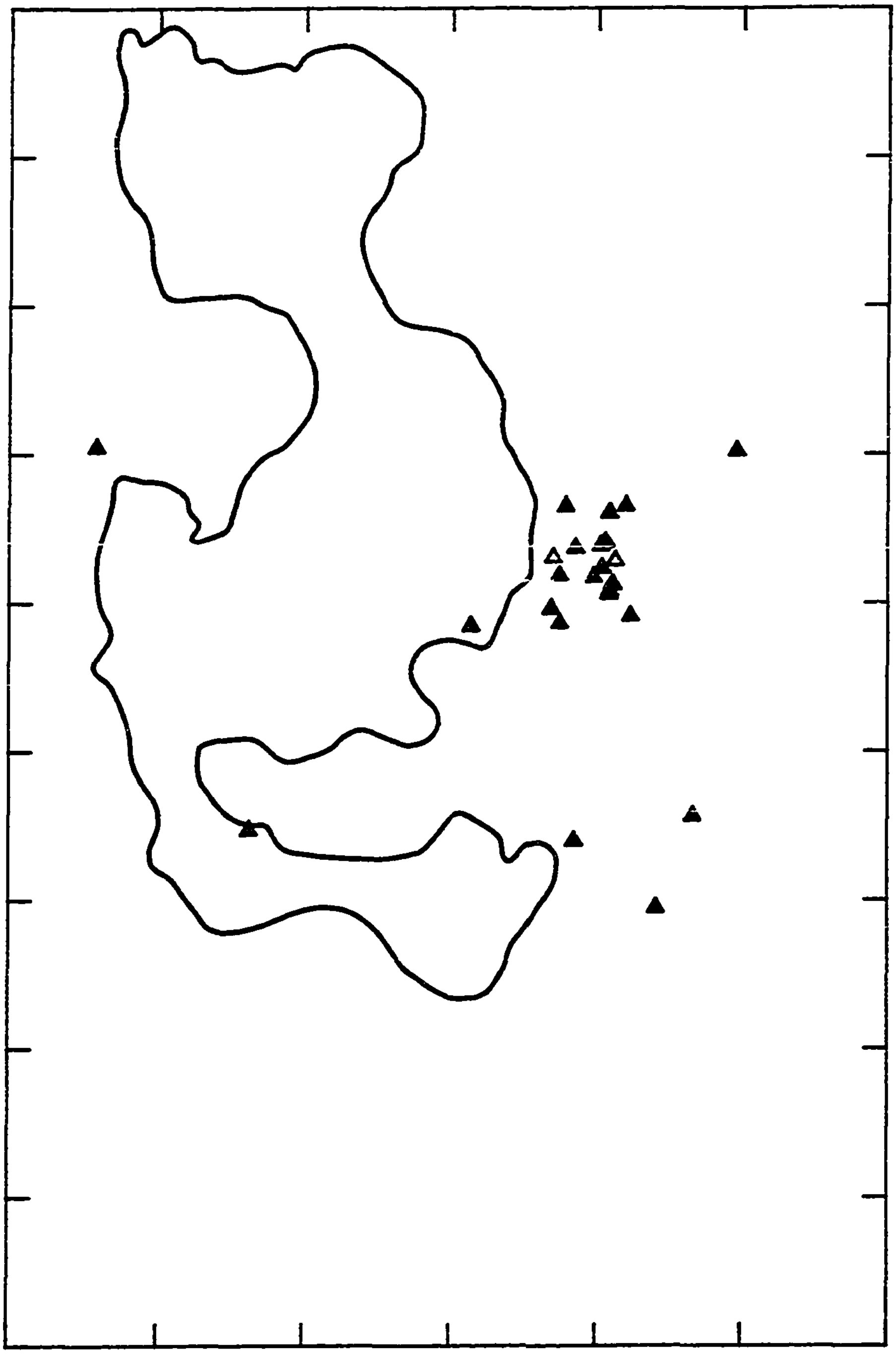


Figure V.10. Distribution of vessels belonging to Early Aztec Red ware Clay Group 2 relative to the ancient lakebed margin. Vessels show a spatial concentration in the Texcoco region. (Vessel proveniences have been jittered to avoid overlap of data points.)

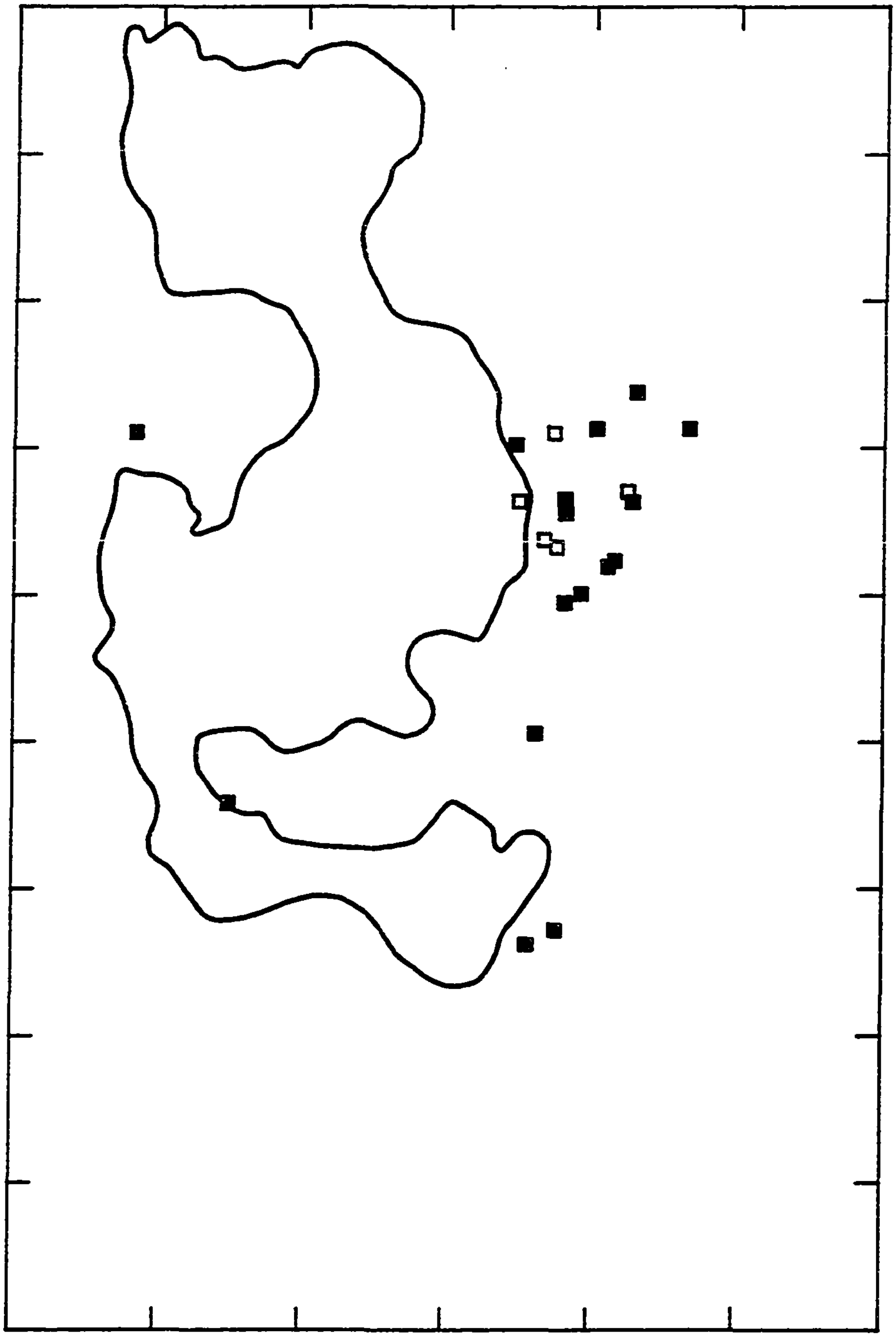


Figure V.11. Distribution of vessels belonging to Early Aztec Red ware Clay Group 3 relative to the ancient lakebed margin. Vessels show a spatial concentration in the Texcoco region. (Vessel proveniences have been jittered to avoid overlap of data points.)

Subdivision of Early Aztec Red Ware Group 1

Although Early Aztec Group 1 appears to be a fairly tight group relative to the other Early Aztec clay groups, several factors indicated that possible subgroups needed to be identified, including the large size of this group, the bimodal distributions of certain elements, and the non-conformity between core and non-core members in derived canonical variate space. A separate analysis of these cases (N=98) led to the definition of four sub-groups: 1-A (N=30), 1-B (N=19), 1-C (N=9), and 1-D (N=17), with 23 non-core and unclassified sherds.

The subdivision of Early Aztec Group 1 was not wholly satisfactory, however. Although cluster analyses based on element concentrations as well as principal component scores consistently identified sub-groups within the data set, the multivariate probabilities of group membership (based on the first four Early Aztec principal components) indicated that differences between these sub-groups are not strong. All core members have the highest probability of membership in their own group, but many sherds show significant affiliations with other groups as well (Table V.19). These multiple group affiliations may reflect either the close geochemical relationships among the clay sources, or the arbitrary division of a continuum of variability.

The canonical discriminant analysis of sub-groups (N=75/98) based on 17 elements indicates satisfactory group separation; posterior probabilities of group membership led to 100% correct classification of core members. The separation of these sub-groups along the derived canonical variates is illustrated in Figures V.12 and V.13. The first canonical variate, representing a strong bimodality in Rb (Table V.20), separates Group 1-D from the other three. The second and third variates separate Groups 1-A, 1-B, 1-C (Fig. V.13); differences in Sm and Lu (Canonical Variate 2) distinguish Sub-group 1-A from 1-B, while strong differences in all the REE as well as Co and Fe distinguish these two sub-groups jointly from 1-C.

Classification of non-core members (N=23) to sub-group was based on the jack-knifed probabilities of group membership calculated from scores on the first 4 principal components and on the 3 canonical variates. In the final classification (Table V.21), the majority (70%) of non-core members remained unclassified as to sub-group. Of these, a few are outliers relative to all sub-groups as well as to the larger Group 1. Most, however, had multiple or conflicting sub-group affiliations based on the classification criteria, but are securely associated with Group 1. Those sherds that could be confidently identified as non-core members of a clay sub-group were associated either with Sub-group 1-A or Sub-group 1-D.

There is no apparent difference in distribution of these sub-groups within the southern Valley. It is therefore not possible to locate sources more precisely within the Chalco-Tenango-Amecameca area based on the present sample.

Summary of Early Aztec Red Ware Divisions

In summary, a hierarchical approach to group formation identified a primary distinction between southern and northern clay sources based on major differences in Cr and Fe, while subdivisions within each region were recognized through multi-element comparisons. Thus, the southern clay group (Group 1), was subdivided into Sub-groups 1-A, 1-B, 1-C, and 1-D, while the north separates into Groups 2 and 3. The difference here

Table V.19
Subdivision of Early Aztec Red Ware Group 1: Probabilities of Sub-Group Membership Based on Four Primary Principal Components

INA I.D.	Probability of Membership in Core Group			
	1-A	1-B	1-C	1-D
Samples Assigned to Group 1-A (N=30)				
200	0.596	0.006	0.161	0.159
201	0.467	0.001	0.024	0.017
203	0.700	0.003	0.027	0.135
204	0.428	0.001	0.011	0.020
209	0.640	0.004	0.013	0.038
217	0.429	0.160	0.029	0.026
239	0.457	0.050	0.012	0.009
241	0.419	0.030	0.036	0.019
242	0.412	0.003	0.018	0.006
248	0.209	0.008	0.046	0.015
251	0.193	0.050	0.123	0.006
254	0.394	0.001	0.021	0.083
256	0.862	0.149	0.064	0.031
258	0.072	0.000	0.011	0.007
259	0.421	0.171	0.015	0.010
295	0.339	0.002	0.010	0.094
304	0.580	0.007	0.112	0.133
308	0.636	0.016	0.071	0.028
309	0.905	0.006	0.040	0.094
320	0.544	0.151	0.081	0.022
321	0.551	0.002	0.014	0.013
322	0.678	0.034	0.014	0.016
324	0.558	0.027	0.058	0.200
338	0.709	0.019	0.125	0.111
340	0.578	0.109	0.030	0.077
345	0.787	0.033	0.021	0.022
444	0.996	0.031	0.051	0.046
445	0.420	0.205	0.014	0.008
453	0.464	0.076	0.171	0.036
477	0.714	0.071	0.128	0.042
Samples Assigned to Group 1-B (N=19)				
215	0.059	0.740	0.027	0.025
219	0.001	0.628	0.048	0.103
240	0.002	0.596	0.011	0.028
244	0.000	0.085	0.006	0.015
318	0.041	0.480	0.021	0.033
326	0.041	0.491	0.009	0.013
349	0.001	0.408	0.022	0.031
350	0.054	0.113	0.011	0.004

Table V.19 (continued)
Subdivision of Early Aztec Red Ware Group 1: Probabilities of Sub-Group Membership Based on Four Primary Principal Components

INA I.D.	Probability of Membership in Core Group			
	1-A	1-B	1-C	1-D
352	0.015	0.740	0.061	0.044
353	0.073	0.578	0.035	0.010
387	0.038	0.783	0.039	0.085
395	0.010	0.487	0.072	0.017
397	0.017	0.525	0.090	0.084
441	0.002	0.624	0.011	0.022
442	0.033	0.443	0.013	0.009
454	0.207	0.737	0.079	0.020
459	0.006	0.866	0.057	0.086
476	0.003	0.530	0.019	0.081
478	0.098	0.263	0.082	0.044
Samples Assigned to Group 1-C (N=9)				
210	0.010	0.001	0.074	0.033
247	0.003	0.004	0.327	0.004
249	0.040	0.058	0.750	0.023
252	0.058	0.028	0.435	0.110
255	0.191	0.035	0.525	0.059
305	0.003	0.103	0.425	0.080
310	0.008	0.026	0.618	0.100
347	0.052	0.023	0.780	0.011
354	0.020	0.021	0.607	0.004
Samples Assigned to Group 1-D (N=17)				
205	0.000	0.000	0.026	0.478
206	0.000	0.000	0.047	0.199
207	0.000	0.000	0.030	0.546
212	0.000	0.000	0.011	0.700
214	0.000	0.000	0.009	0.583
245	0.000	0.004	0.220	0.499
246	0.000	0.001	0.095	0.599
260	0.004	0.001	0.060	0.952
296	0.004	0.000	0.010	0.711
297	0.000	0.000	0.007	0.415
300	0.022	0.001	0.162	0.440
311	0.007	0.000	0.013	0.662
337	0.000	0.002	0.297	0.435
342	0.003	0.000	0.015	0.854
343	0.000	0.012	0.076	0.341
346	0.000	0.000	0.007	0.406
371	0.002	0.019	0.033	0.269

Table V.19 (continued)
Subdivision of Early Aztec Red Ware Group 1: Probabilities of Sub-Group Membership Based on Four Primary Principal Components

INA I.D.	Probability of Membership in Core Group			
	1-A	1-B	1-C	1-D
Unclassified Group 1 Samples (N=23)				
208	0.207	0.004	0.019	0.357
211	0.000	0.000	0.006	0.009
213	0.044	0.000	0.016	0.300
216	0.089	0.000	0.006	0.041
218	0.153	0.005	0.083	0.381
220	0.003	0.004	0.064	0.251
243	0.112	0.078	0.109	0.345
250	0.237	0.024	0.356	0.275
253	0.077	0.008	0.024	0.476
298	0.004	0.095	0.005	0.035
303	0.000	0.381	0.076	0.232
306	0.094	0.000	0.017	0.606
307	0.000	0.000	0.001	0.000
312	0.000	0.000	0.001	0.009
336	0.176	0.011	0.027	0.337
339	0.361	0.375	0.050	0.114
341	0.494	0.024	0.313	0.089
351	0.000	0.030	0.357	0.193
355	0.000	0.000	0.025	0.035
439	0.000	0.018	0.036	0.088
440	0.006	0.267	0.091	0.397
443	0.232	0.234	0.092	0.210
458	0.008	0.000	0.077	0.004

in terminology between "group" and "sub-group" indicates different levels of group distinctiveness, but it may also reflect differences in sample size. Had sample sizes for the north been comparable to those of the south, finer levels of group discrimination might have been possible, thereby permitting the identification of possible sub-groups within the northern region as well.

The final classification of Early Aztec Red ware samples is presented in Table V.22. Core/non-core composition of these groups is presented in Table V.23.

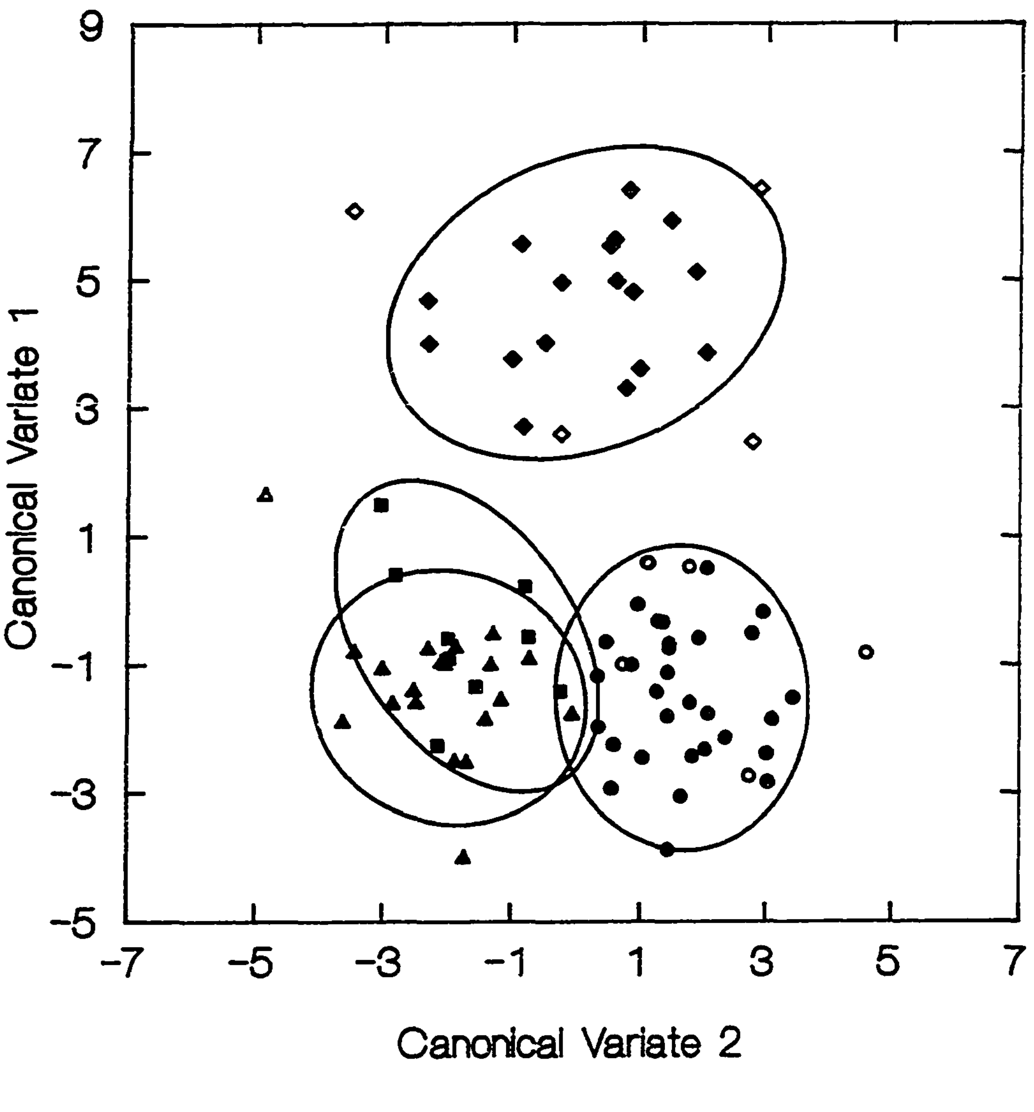


Figure V.12. Separation of Early Aztec Red ware Group 1 subdivisions on the first and second canonical variates. Ellipses represent 90% confidence intervals for group membership (canonical variates and ellipses based on core members only). Group members are identified as follows: Sub-group 1-A (circles), Sub-group 1-B (triangles), Sub-group 1-C (squares), and Sub-group 1-D (diamonds). Solid symbols represent core members, open symbols represent non-core members classified to that group.

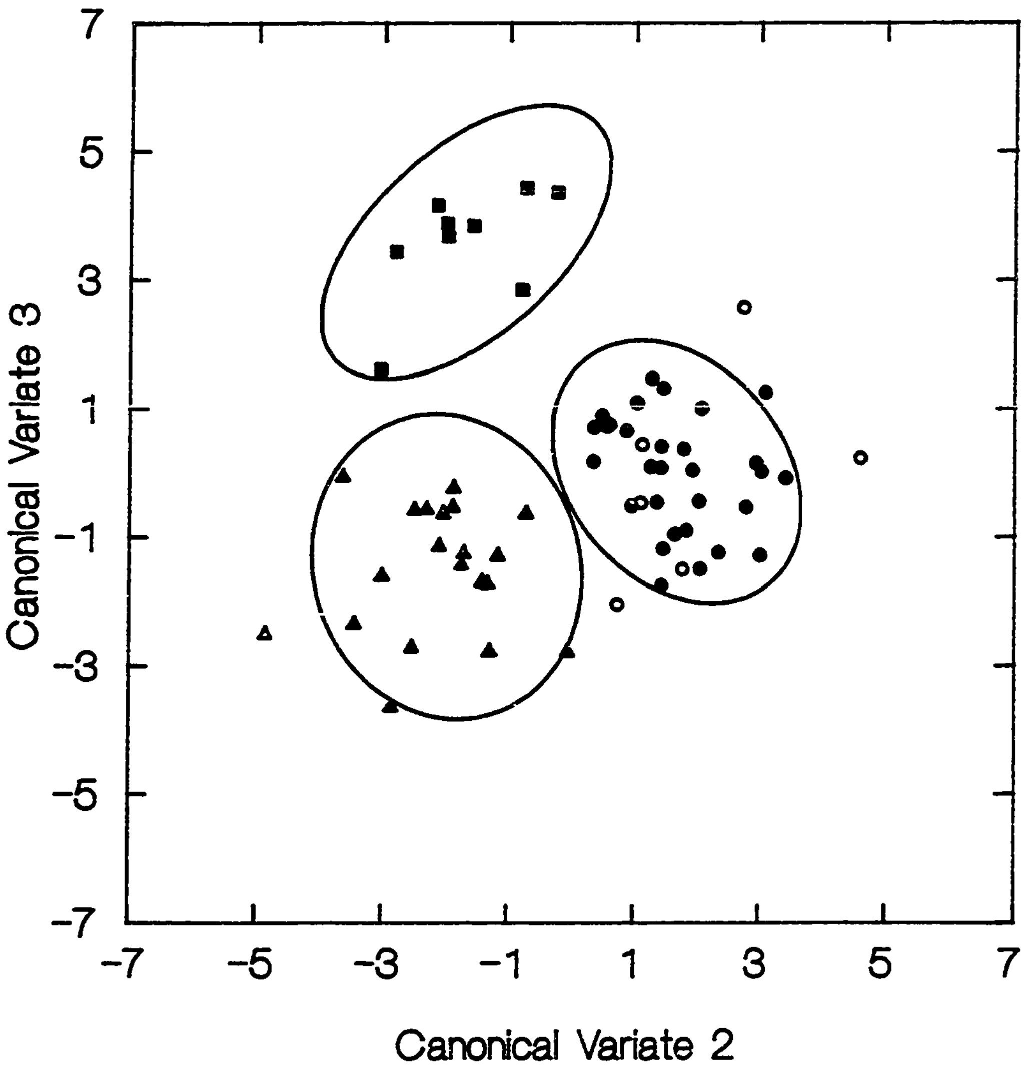


Figure V.13. Separation of Early Aztec Red ware Group 1 subdivisions on the second and third canonical variates. Ellipses represent 90% confidence intervals for group membership (canonical variates and ellipses based on core members only). Group members are identified as follows: Sub-group 1-A (circles), Sub-group 1-B (triangles), and Sub-group 1-C (squares). Solid symbols represent core members, open symbols represent non-core members classified to that group.

Table V.20

Canonical Variates Analysis of Early Aztec Red Ware Group 1 Sub-Groups

Statistic	Canonical Variate		
	1	2	3
Eigenvalue	6.78	2.60	2.32
% Cumulative Variance	58.41	80.84	100.00
Canonical Correlation	0.93	0.85	0.83
% Variance Explained by elements	87.14	72.25	68.96
Element	**Structure Coefficients**		
Ce	-0.42	-0.04	**0.71**
Co	0.00	-0.32	**0.55**
Cr	0.10	-0.42	0.23
Cs	0.37	-0.30	0.48
Eu	-0.11	0.16	**0.67**
Fe	-0.04	-0.40	**0.53**
Hf	-0.43	-0.18	0.34
La	-0.15	0.38	**0.69**
Lu	-0.24	**0.46**	**0.55**
Rb	**0.92**	0.00	-0.11
Sc	-0.22	0.10	**0.62**
Sm	-0.05	**0.48**	**0.75**
Ta	-0.15	-0.40	0.43
Tb	0.01	0.06	0.14
Th	-0.35	-0.09	**0.61**
Yb	-0.02	0.33	**0.59**
Zn	0.41	0.17	0.38

Note: N = 75 core group members.

Table V.21
Classification of Early Aztec Group 1 Non-Core Members

INA I.D.	Probability of Membership in Sub-Groups Based on:									Final Class
	4 Principal Components				3 Canonical Variates					
	1-A	1-B	1-C	1-D	1-A	1-B	1-C	1-D	Pred.	
208	.207	.004	.019	.357	.367	.019	.004	.034	1-A	1-A
211	.000	.000	.006	.009	.000	.000	.001	.009	1-D	O
213	.044	.000	.016	.300	.015	.000	.011	.084	1-D	1-D
216	.089	.000	.006	.041	.054	.000	.001	.001	1-A	1-A
218	.153	.005	.083	.381	.481	.011	.009	.027	1-A	1-A
220	.003	.004	.064	.251	.374	.004	.006	.031	1-A	M
243	.112	.078	.109	.345	.102	.064	.005	.062	1-A	M
250	.237	.024	.356	.275	.054	.024	.107	.050	1-A	M
253	.077	.008	.024	.476	.003	.006	.007	.458	1-D	1-D
298	.004	.095	.005	.035	.143	.169	.001	.004	1-A	M
303	.000	.381	.076	.232	.000	.012	.004	.030	1-B	M
306	.094	.000	.017	.606	.076	.002	.015	.183	1-A	1-D
307	.000	.000	.001	.000	.000	.000	.000	.000	1-B	O
312	.000	.000	.001	.009	.000	.000	.000	.002	1-D	O
336	.176	.011	.027	.337	.204	.011	.001	.022	1-A	1-A
339	.361	.375	.050	.114	.141	.308	.004	.015	1-A	M
341	.494	.024	.313	.089	.137	.174	.005	.027	1-A	M
351	.000	.030	.357	.193	.000	.003	.039	.092	1-D	M
355	.000	.000	.025	.035	.000	.000	.002	.017	1-D	1-D
439	.000	.018	.036	.088	.000	.072	.002	.033	1-B	M
440	.006	.267	.091	.397	.001	.058	.012	.204	1-B	M
443	.232	.234	.092	.210	.012	.090	.018	.099	1-A	M
458	.008	.000	.077	.004	.034	.001	.006	.000	1-A	M

Note: O = Outlier to Group 1 and its sub-groups; M = Mixed sub-group affiliation, but securely a member of Group 1.

Table V.22
Final Classification of Early Aztec Red Ware Samples

INA I.D.	Site	Type/Variant	Clay Group	Status
200	TX-AZ-87	B/R-I A	Early 1A	Core
201	IX-AZ-26	B/R-I A	Early 1A	Core
203	TX-AZ-109	B/R-I A	Early 1A	Core
204	TX-AZ-87	B/R-I A	Early 1A	Core
208	CH-AZ-172	B/R-I A	Early 1A	Non-Core
209	CH-AZ-111	B/R-I A	Early 1A	Core
216	CH-AZ-111	B/R-I B	Early 1A	Non-Core
217	IX-AZ-26	B/R E	Early 1A	Core
218	CH-AZ-29	B/R E	Early 1A	Non-Core
239	CH-AZ-111	B/R E	Early 1A	Core
241	IX-AZ-26	B/R E	Early 1A	Core
242	CH-AZ-66	B/R E	Early 1A	Core
248	CH-AZ-66	B/R I	Early 1A	Core
251	CH-AZ-41	B/R I	Early 1A	Core
254	CH-AZ-41	B/R H	Early 1A	Core
256	CH-AZ-139	B/R H	Early 1A	Core
258	TX-AZ-100	B/R H	Early 1A	Core
259	CH-AZ-41	B/R H	Early 1A	Core
295	CH-AZ-172	B/R A	Early 1A	Core
304	CH-AZ-172	B/R-I D	Early 1A	Core
308	TX-AZ-87	B/R-I D	Early 1A	Core
309	CH-AZ-111	B/R-I D	Early 1A	Core
320	CH-AZ-111	B&W/R AN	Early 1A	Core
321	CH-AZ-111	B&W/R AN	Early 1A	Core
322	CH-AZ-164	B&W/R AN	Early 1A	Core
324	TX-AZ-87	B&W/R E2	Early 1A	Core
336	CH-AZ-111	B/R E	Early 1A	Non-Core
338	CH-AZ-164	B/R B	Early 1A	Core
340	CH-AZ-111	B/R B	Early 1A	Core
345	TX-AZ-87	B/R A	Early 1A	Core
444	CH-AZ-172	B&W/R E2	Early 1A	Core
445	TX-AZ-87	B&W/R E2	Early 1A	Core
453	CH-AZ-172	B&W/R D2	Early 1A	Core
477	CH-AZ-172	B&W/R AW	Early 1A	Core
215	CH-AZ-103	B/R-I B	Early 1B	Core
219	CH-AZ-29	B/R E	Early 1B	Core
240	IX-AZ-26	B/R E	Early 1B	Core
244	CH-AZ-132	B/R E	Early 1B	Core
318	CH-AZ-111	B&W/R AW	Early 1B	Core
326	CH-AZ-111	B&W/R E2	Early 1B	Core
349	TX-AZ-87	B/R-I C	Early 1B	Core
350	IX-AZ-11	B/R-I C	Early 1B	Core
352	CH-AZ-172	B/R A	Early 1B	Core
353	CH-AZ-172	B/R A	Early 1B	Core

Table V.22 (continued)
Final Classification of Early Aztec Red Ware Samples

INA I.D.	Site	Type/Variant	Clay Group	Status
387	CH-AZ-172	B&W/R AN	Early 1B	Core
395	IX-AZ-72	B&W/R AN	Early 1B	Core
397	CH-AZ-172	B&W/R B	Early 1B	Core
441	CH-AZ-172	B&W/R E2	Early 1B	Core
442	CH-AZ-172	B&W/R E2	Early 1B	Core
454	CH-AZ-172	B&W/R D3	Early 1B	Core
459	CH-AZ-172	B&W/R D1	Early 1B	Core
476	CH-AZ-172	B/R H	Early 1B	Core
478	CH-AZ-172	B&W/R AN	Early 1B	Core
210	CH-AZ-172	B/R-I B	Early 1C	Core
247	CH-AZ-51	B/R I	Early 1C	Core
249	CH-AZ-51	B/R I	Early 1C	Core
252	CH-AZ-44	B/R I	Early 1C	Core
255	CH-AZ-41	B/R H	Early 1C	Core
305	CH-AZ-172	B/R-I D	Early 1C	Core
310	CH-AZ-172	B&W/R AW	Early 1C	Core
347	IX-AZ-72	B/R-I D	Early 1C	Core
354	CH-AZ-172	B/R A	Early 1C	Core
205	CH-AZ-30	B/R-I A	Early 1D	Core
206	CH-AZ-172	B/R-I A	Early 1D	Core
207	CH-AZ-88	B/R-I A	Early 1D	Core
212	CH-AZ-172	B/R-I B	Early 1D	Core
213	TX-AZ-87	B/R-I B	Early 1D	Non-Core
214	IX-AZ-26	B/R-I B	Early 1D	Core
245	CH-AZ-148	B/R I	Early 1D	Core
246	CH-AZ-152	B/R I	Early 1D	Core
253	CH-AZ-67	B/R I	Early 1D	Non-Core
260	CH-AZ-139	B/R H	Early 1D	Core
296	CH-AZ-172	B/R A	Early 1D	Core
297	CH-AZ-172	B/R A	Early 1D	Core
300	CH-AZ-21	B/R-I C	Early 1D	Core
306	CH-AZ-172	B/R-I D	Early 1D	Non-Core
311	CH-AZ-111	B&W/R AW	Early 1D	Core
337	CH-AZ-111	B/R-I C	Early 1D	Core
342	CH-AZ-111	B/R B	Early 1D	Core
343	CH-AZ-172	B/R B	Early 1D	Core
346	TX-AZ-87	B/R-I B	Early 1D	Core
355	CH-AZ-172	B/R B	Early 1D	Non-Core
371	TX-AZ-87	B/R A	Early 1D	Core
243	CH-AZ-132	B/R E	Early 1	Core
250	CH-AZ-87	B/R I	Early 1	Core
298	CH-AZ-164	B/R A	Early 1	Non-Core
303	CH-AZ-172	B/R-I D	Early 1	Core
307	TX-AZ-87	B/R-I D	Early 1	Non-core
339	CH-AZ-111	B/R B	Early 1	Core

Table V.22 (continued)
Final Classification of Early Aztec Red Ware Samples

INA I.D.	Site	Type/Variant	Clay Group	Status
341	CH-AZ-111	B/R B	Early 1	Non-Core
351	CH-AZ-172	B/R A	Early 1	Core
439	CH-AZ-172	B&W/R E2	Early 1	Core
440	CH-AZ-172	B&W/R E2	Early 1	Core
443	CH-AZ-172	B&W/R E2	Early 1	Core
458	TX-AZ-26	B&W/R E3	Early 1	Non-Core
202	TX-AZ-87	B/R-I A	Early 2	Non-Core
257	TX-AZ-72	B/R H	Early 2	Core
301	TX-AZ-87	B/R-I C	Early 2	Core
315	TX-AZ-109	B&W/R AW	Early 2	Core
317	CH-AZ-6	B&W/R AW	Early 2	Core
319	CH-AZ-6	B&W/R AN	Early 2	Core
370	TX-AZ-87	B/R A	Early 2	Core
392	IX-AZ-72	B&W/R AW	Early 2	Core
393	TX-AZ-87	B&W/R AW	Early 2	Core
394	TX-AZ-87	B&W/R AW	Early 2	Core
398	TX-AZ-87	B&W/R B	Early 2	Core
399	TX-AZ-87	B&W/R B	Early 2	Core
400	TX-AZ-87	B&W/R B	Early 2	Core
424	TX-AZ-87	B&W/R B	Early 2	Core
425	TX-AZ-87	B&W/R B	Early 2	Core
446	TX-AZ-87	B&W/R E2	Early 2	Core
447	TX-AZ-87	B&W/R E2	Early 2	Non-Core
452	TX-AZ-87	B&W/R D1	Early 2	Core
456	TX-AZ-87	B&W/R C	Early 2	Core
461	IX-AZ-26	B&W/R D1	Early 2	Core
462	TX-AZ-87	B&W/R D1	Early 2	Core
463	TX-AZ-87	B&W/R D1	Early 2	Core
464	TX-AZ-87	B&W/R D1	Early 2	Core
523	Tenayuca	B&W/R AN	Early 2	Core
299	TX-AZ-87	B/R A	Early 3	Core
302	CH-AZ-172	B/R-I C	Early 3	Core
313	TX-AZ-10	B&W/R AW	Early 3	Non-Core
314	TX-AZ-40	B&W/R AW	Early 3	Core
316	TX-AZ-40	B&W/R AW	Early 3	Core
323	TX-AZ-24	B&W/R AN	Early 3	Core
344	TX-AZ-87	B/R B	Early 3	Core
356	CH-AZ-172	B/R B	Early 3	Core
369	TX-AZ-87	B/R A	Early 3	Core
372	TX-AZ-87	B/R B	Early 3	Core
381	TX-AZ-87	B/R E	Early 3	Non-Core
430	IX-AZ-26	B&W/R C	Early 3	Core
437	IX-AZ-72	B&W/R E1	Early 3	Core
438	TX-AZ-87	B&W/R E1	Early 3	Core
449	TX-AZ-87	B&W/R E3	Early 3	Core

Table V.22 (continued)
Final Classification of Early Aztec Red Ware Samples

INA I.D.	Site	Type/Variant	Clay Group	Status
455	TX-AZ-56	B&W/R C	Early 3	Core
457	TX-AZ-87	B&W/R B	Early 3	Core
460	TX-AZ-56	B&W/R D1	Early 3	Non-Core
466	TX-AZ-87	B&W/R D3	Early 3	Non-Core
467	TX-AZ-87	B&W/R D3	Early 3	Non-Core
522	Tenayuca	B&W/R AN	Early 3	Core
211	CH-AZ-29	B/R-I B	Unclass.	Outlier Gr. 1
220	IX-AZ-26	B/R E	Unclass.	Mixed 1/3
221	TX-AZ-87	B/R E	Unclass.	Mixed 2/3
312	CH-AZ-111	B&W/R AW	Unclass.	Outlier Gr. 1
325	TX-AZ-109	B&W/R E2	Unclass.	Mixed 2/3
348	CH-AZ-172	B/R-I C	Unclass.	Mixed 2/3
388	TX-AZ-87	B&W/R AN	Unclass.	Mixed 2/3

Table V.23
Core/Non-Core Composition of Early Aztec Red Ware Groups

Group	Core	Non-Core	Total
1	74	21	95
1-A	30	4	34
1-B	19	0	19
1-C	9	0	9
1-D	17	4	21
Ind. 1	0	12	12
2	22	2	24
3	16	5	21
Uncl.	--	7	7
Total	112	35	147

Clay Group Identification for Late Aztec Red Wares

During the Late Aztec period, decorated Red wares diverged into three distinct status classes of ceramic vessels based on labor input and function. The first class, represented by Black/Red Variant C and Black/Red basins (N=20), represents a lower status, presumably utilitarian class of vessels with extremely simple decoration consisting of sets of 2-12 vertical or oblique lines spaced around the vessel wall. Vessel forms continue in the Early Aztec tradition of simple rounded bowls with direct lips. Black/Red Variant C is the single most abundant Late Aztec Red ware encountered in the Texcoco and Teotihuacan regions, where it accounts for upwards of 90% of the total Late Aztec Red ware assemblage (Hodge and Minc 1990; J. Parsons 1966). Further south and southwest, this variant declines markedly in abundance; the predominance of this variant west of Lake Texcoco is unknown.

The second class of vessels includes the so-called Late Profile vessels (N=65) of the Black/Red and Black&White/Red types -- vessels with out-sloping walls, exterior thickened rims, and thinned lips. Vessel walls are noticeably thinner than those of Black/Red Variant C and the paste is a distinctive dark grey to black in color while surfaces are generally glossy. Although the decorative motifs range from simple to quite complex, as a group these vessels represent a better made and presumably higher status good.

The third and highest status class consists of the low frequency Red ware types, and is represented here by Yellow/Red (Lacquered Bichrome or Fiesta ware) and Black&Red/Tan (N=20). Vessel form is again distinct, with barrel-shaped bowls being the most common; pastes are similar to those of Late Profile vessels.

Petrographic analyses of Black/Red Variant C and Late Profile bowls indicated that in spite of differences in firing practice leading to differences in paste color, paste textures and compositions are remarkably similar between these two classes of bowls (Tables V.9 and V.10). Paste characteristics of basins have not been quantified, but pastes appear much coarser in texture.[13] Given the apparent similarity in bowl paste composition, Late Aztec samples of all status classes were included in the same group formation analyses; lower class vessels (Black/Red Variant C and basins), however, were excluded from core-member status.

Relative to the Early Aztec sample, the Late Aztec sample (N=105) of Red wares proved more difficult to divide into distinct, homogeneous compositional groups, owing in part to the decreased dispersion of element concentrations. As noted earlier, this reduced variability results in part from a greater degree of clay refinement during Late Aztec times -- a practice that effectively removed naturally occurring aplastic inclusions (and hence a significant portion of the natural geochemical signature) from the clay.

Cluster analyses based on both standardized element concentrations and principal component scores indicated that consistent clusters of ceramic samples did exist. The final analysis indicated that four distinctive production sources were active in the Late Aztec period. However, the large number of unclassified sherds (N=26/105) suggests that a number of other, as yet unidentified sources may also have been producing Late Aztec Red wares.

Probabilities of membership in these Late Aztec clay groups were based on the first 6 principal components (accounting for 81% of the variance; see Table V.24) and are presented in Table V.25. Subsequent canonical discriminant analysis of core group members (N=63) based on 17 elements indicates that the four compositional groups separate well on axes derived from canonical variates analysis and posterior probabilities of group membership yielded a 100% correct classification of core members. Although Group 4 overlaps Groups 2 and 3 on the first two canonical variates (Fig. V.14), the second and third variates display adequate group separation (Figs. V.15 and V.16). The total structure coefficients (Table V.26) indicate that significant differences in most REE as well as in Cr and Fe separate Group 1 from the other three. Groups 2 and 3 separate on the basis of differences in Lu, Ta, and Th, while higher levels of Cr and Zn distinguish Group 4.

Classification of non-core members (N=42) was based on probabilities of group membership calculated from scores on the first 6 principal components and on the 3 canonical variates (Table V.27). The final classification of all Late Aztec Red ware samples is presented in Table V.28.

This classification left a substantial number of non-core members unclassified as to clay group (Table V.29). The distribution of the unclassified sherds relative to the status classes defined (Table V.30) above reveals that approximately 80% of the higher status vessels could be classified to clay source, suggesting that this analysis has successfully identified the major producers of these vessels. Many of the unclassified higher status vessels showed mixed affiliations to Groups 1 and 4, i.e. to the southern sources (see below). A few, however, such as #292 and #293, appear as couplets or small groups of closely related outliers, and probably reflect the existence of additional production sources of higher status Red wares. An examination of unclassified higher status vessels by regional provenience indicates that the vast majority of the unclassified samples come from the southern lakebed and Chalco regions (Table V.31), possibly reflecting the presence of other producers active in this area.

In contrast, less than half of the lower status vessel could be assigned with certainty to clay source (Table V.30). Many of these vessels appeared as extreme outliers relative to the confidence interval ellipses for group membership, while a fewer number revealed mixed group affiliations. The most secure classifications are those that assign Black/Red Variant C sherds to Texcocan Group 2 -- an assignment that is consistent with the provenience of the samples. Other assignments, however, seem less plausible, such as those classed as belonging to Group 1. Group 1 appears to be a southern source whose goods circulated almost exclusively within the southern lakebed area; in contrast, Black/Red Variant C has its greatest density in north and the samples included here are from northern sites. It seems unlikely that these lower class vessels were produced in the south (an area with relatively few examples of this variant), especially when the putative source was apparently not exporting any other products northward. Bivariate scatter-plots show that most of these Group 1 assignments are, in fact, peripheral to the 90% confidence interval ellipses for Group 1 core members when plotted along the major principle component axes, although they do fall within the 90% confidence interval ellipses plotted on the canonical variate axes. The assignment of Black/Red Basins to Group 4 is even more problematical due to probable differences in paste texture as well as non-overlapping spatial distributions; the classification of these vessels is accordingly regarded as highly tentative.

Table V.24

Principal Components Analysis of Late Aztec Red Wares

Statistic	Component					
	1	2	3	4	5	6
Eigenvalue	7.00	2.30	1.37	1.28	0.99	0.85
% Variance Explained	41.15	13.50	8.07	7.56	5.82	5.01
Cumulative % Variance	41.15	54.65	62.72	70.28	76.10	81.11
Element	**Component Loadings**					
Ce	**0.848**	0.082	0.038	-0.121	-0.194	-0.223
Co	0.294	**-0.580**	0.037	0.233	-0.471	-0.286
Cr	0.417	**-0.647**	-0.167	-0.068	0.333	0.152
Cs	0.140	**0.585**	0.134	**0.610**	0.091	0.219
Eu	**0.846**	-0.029	0.239	-0.056	-0.197	0.267
Fe	**0.614**	**-0.652**	-0.130	0.081	-0.019	0.013
Hf	0.281	-0.196	0.321	**0.743**	0.080	-0.139
La	**0.757**	0.225	0.369	-0.094	-0.257	0.186
Lu	**0.802**	0.237	-0.048	-0.070	0.294	-0.089
Rb	0.175	0.348	**-0.637**	0.276	-0.437	0.065
Sc	**0.725**	-0.496	0.076	0.193	0.164	0.198
Sm	**0.889**	0.185	0.189	-0.217	-0.167	0.113
Ta	**0.615**	0.129	-0.440	0.096	0.161	-0.452
Tb	**0.630**	0.006	-0.109	-0.191	-0.181	-0.093
Th	**0.757**	0.407	0.023	0.111	0.228	-0.173
Yb	**0.853**	0.187	0.027	-0.193	0.232	-0.082
Zn	0.432	-0.021	**-0.596**	0.091	0.040	0.458

Table V.25
Division of Late Aztec Red Wares: Probabilities of
Core Group Membership Based on Six Primary Principal Components

INA I.D.	Probability of Membership in Core Group			
	1	2	3	4
Samples Assigned to Group 1 (N=19)				
227	0.449	0.002	0.001	0.001
235	0.804	0.002	0.003	0.001
236	0.511	0.000	0.001	0.001
238	0.122	0.000	0.002	0.001
264	0.303	0.004	0.058	0.001
265	0.538	0.008	0.008	0.001
266	0.585	0.001	0.001	0.000
268	0.793	0.008	0.001	0.001
286	0.579	0.001	0.000	0.001
288	0.217	0.000	0.000	0.000
294	0.302	0.006	0.012	0.001
382	0.579	0.003	0.000	0.001
383	0.714	0.000	0.001	0.001
384	0.970	0.007	0.003	0.001
385	0.623	0.002	0.002	0.001
421	0.166	0.003	0.000	0.001
428	0.761	0.003	0.002	0.002
431	0.555	0.000	0.000	0.001
514	0.280	0.010	0.001	0.001
Samples Assigned to Group 2 (N=19)				
222	0.050	0.329	0.000	0.003
223	0.094	0.600	0.001	0.015
224	0.028	0.781	0.000	0.006
225	0.012	0.390	0.001	0.025
226	0.048	0.473	0.002	0.001
228	0.008	0.653	0.000	0.002
229	0.032	0.491	0.002	0.004
232	0.042	0.349	0.001	0.023
267	0.121	0.433	0.070	0.001
278	0.021	0.904	0.001	0.003
279	0.009	0.600	0.000	0.012
282	0.072	0.506	0.001	0.002
283	0.025	0.447	0.001	0.002
284	0.014	0.592	0.000	0.014
436	0.109	0.496	0.016	0.012
501	0.009	0.053	0.001	0.001
513	0.056	0.889	0.001	0.001
517	0.151	0.506	0.063	0.002
521	0.026	0.456	0.010	0.001

Table V.25 (continued)
Division of Late Aztec Red Wares: Probabilities of Core Group Membership Based on Six Primary Principal Components

INA I.D.	Probability of Membership in Core Group			
	1	2	3	4
Samples Assigned to Group 3 (N=15)				
233	0.120	0.101	0.378	0.002
502	0.007	0.000	0.120	0.068
503	0.080	0.009	0.539	0.004
504	0.010	0.000	0.449	0.023
505	0.098	0.011	0.508	0.001
506	0.108	0.058	0.973	0.002
507	0.061	0.053	0.519	0.001
508	0.167	0.006	0.501	0.001
511	0.105	0.004	0.197	0.001
512	0.031	0.025	0.684	0.002
515	0.021	0.013	0.399	0.003
516	0.046	0.040	0.314	0.001
519	0.083	0.043	0.705	0.002
520	0.043	0.005	0.500	0.003
524	0.061	0.003	0.707	0.001
Samples Assigned to Group 4 (N=10)				
261	0.031	0.004	0.001	0.421
263	0.043	0.028	0.003	0.503
269	0.145	0.049	0.001	0.511
287	0.079	0.034	0.001	0.500
290	0.022	0.002	0.046	0.610
390	0.148	0.006	0.004	0.493
423	0.024	0.008	0.005	0.101
426	0.132	0.058	0.014	0.977
433	0.029	0.004	0.016	0.245
450	0.097	0.062	0.001	0.303

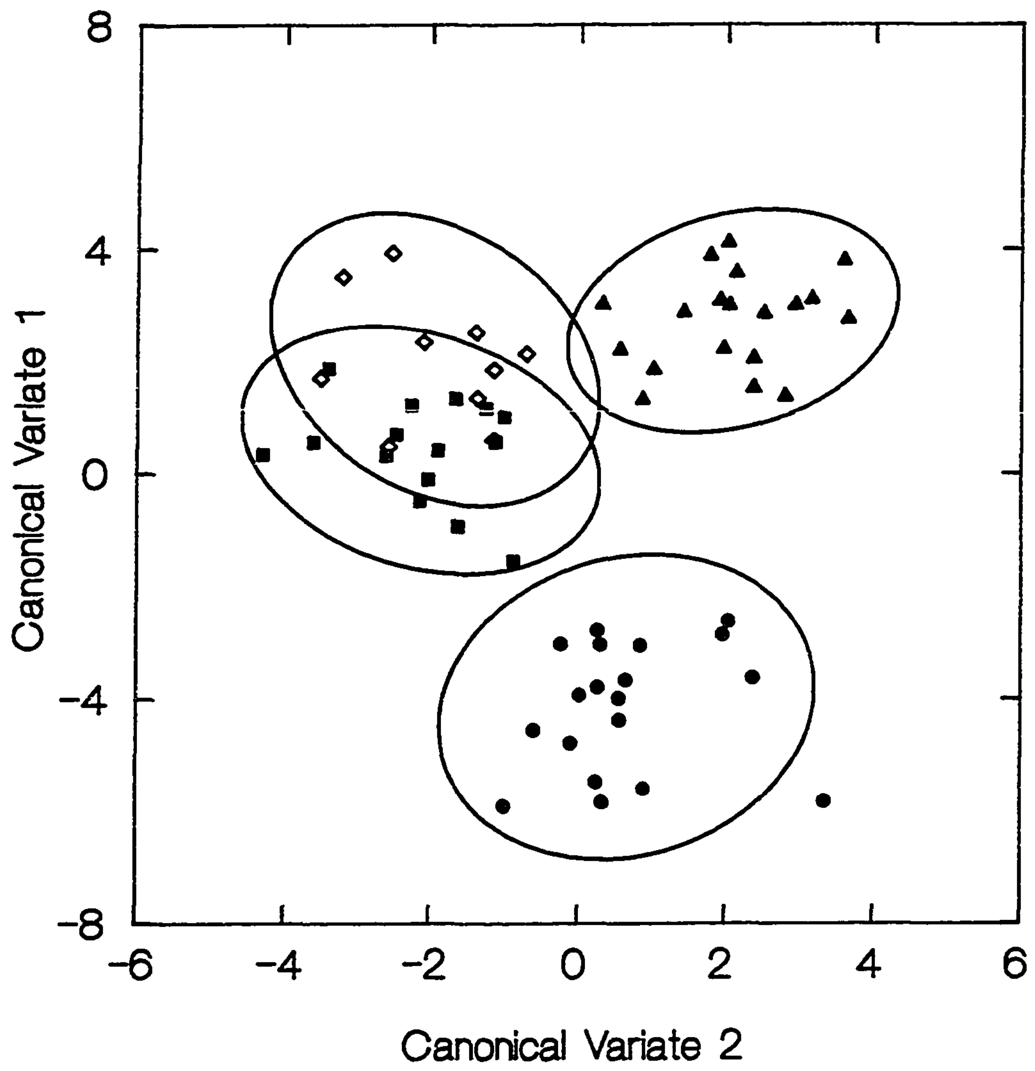


Figure V.14. Separation of the four Late Aztec Red ware clay groups based on the first two canonical variates; these axes separate Group 1 from Groups 2, 3, and 4. Ellipses represent 90% confidence intervals for group membership (canonical variates and ellipses based on core members only). Group members are identified as follows: Group 1 (circles), Group 2 (triangles), Group 3 (squares), and Group 4 (diamonds).

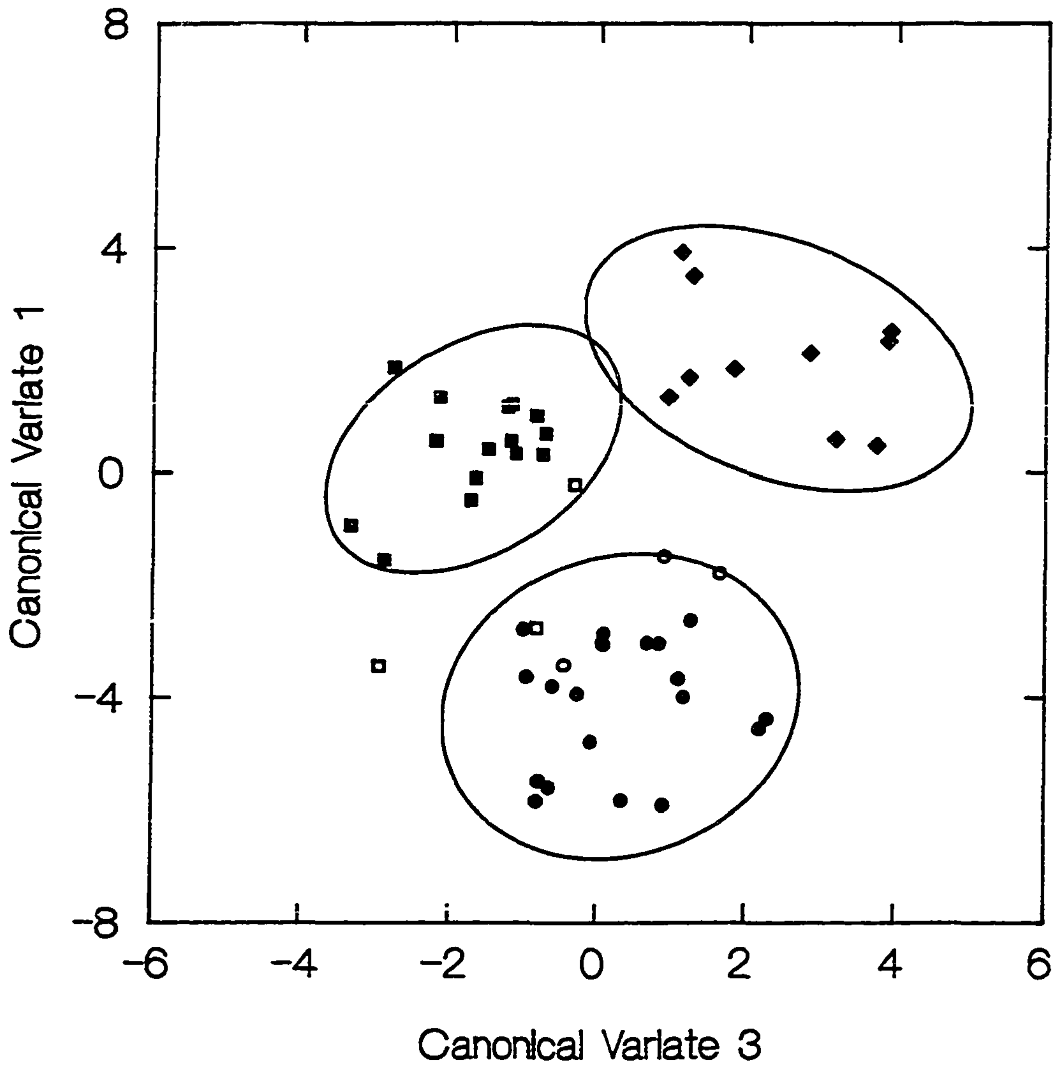


Figure V.15. Separation of Late Aztec Red ware Clay Groups 1, 3, and 4 based on the first and third canonical variates. Ellipses represent 90% confidence intervals for group membership (canonical variates and ellipses based on core members only). Group members are identified as follows: Group 1 (circles), Group 3 (squares), and Group 4 (diamonds).

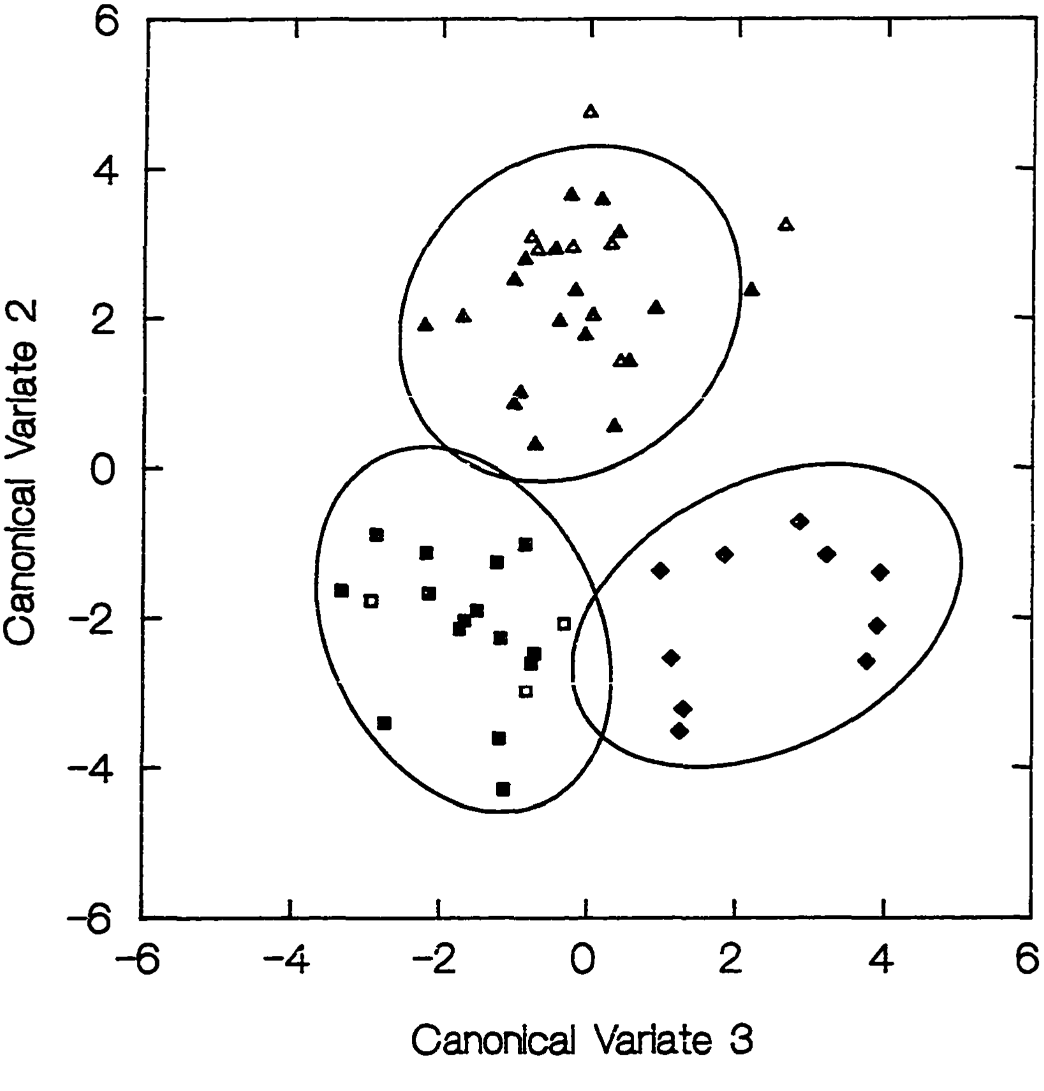


Figure V.16. Separation of Late Aztec Red ware Clay Groups 2, 3, and 4 based on the second and third canonical variates. Ellipses represent 90% confidence intervals for group membership (canonical variates and ellipses based on core members only). Group members are identified as follows: Group 2 (triangles), Group 3 (squares), and Group 4 (diamonds).

Table V.26
Canonical Variates Analysis of Late Aztec Red Ware Clay Groups

Statistic	**Canonical Variate**		
	1	**2**	**3**
Eigenvalue	8.67	3.36	1.75
% Cumulative Variance	62.93	87.30	100.00
Canonical Correlation	0.95	0.88	0.80
% Variance Explained by elements	89.66	77.05	63.62
Element	**Structure Coefficients**		
Ce	**0.68**	0.19	0.24
Co	0.23	**-0.57**	0.04
Cr	**0.55**	-0.25	**0.52**
Cs	-0.32	**0.52**	0.22
Eu	**0.67**	0.07	0.26
Fe	**0.65**	-0.30	0.39
Hf	0.25	-0.00	0.14
La	**0.68**	0.25	0.18
Lu	**0.63**	**0.53**	0.22
Rb	-0.42	0.40	0.40
Sc	**0.75**	-0.23	0.35
Sm	**0.74**	0.24	0.22
Ta	0.31	**0.61**	0.36
Tb	**0.61**	0.30	0.17
Th	**0.60**	**0.64**	0.05
Yb	**0.76**	0.44	0.16
Zn	0.01	0.17	**0.87**

Note: N = 63 core-group members.

Table V.27
Classification of Late Aztec Non-Core Members

INA ID	Probability of Membership in Clay Groups Based on: 6 Principal Components 1	2	3	4	3 Canonical Variates 1	2	3	4	Pred.	Final Class
234	.394	.001	.037	.001	.041	.005	.500	.027	1	M
237	.018	.095	.000	.007	.002	.037	.000	.162	4	M
262	.017	.000	.009	.000	.014	.000	.003	.001	3	O
280	.018	.070	.002	.104	.000	.011	.001	.023	2	M
281	.062	.226	.000	.005	.022	.231	.003	.017	2	2
289	.170	.001	.021	.011	.027	.002	.154	.090	1/3	M
291	.260	.001	.000	.006	.004	.000	.000	.060	1	1&4
292	.056	.000	.000	.001	.013	.018	.001	.005	2	O
293	.059	.000	.000	.000	.033	.000	.000	.002	1	O
386	.378	.009	.007	.034	.015	.001	.005	.223	4	1&4
389	.451	.049	.001	.002	.080	.029	.002	.206	1	1&4
391	.467	.006	.001	.015	.134	.002	.002	.195	1	1&4
396	.454	.002	.004	.013	.084	.001	.004	.120	1	1&4
422	.465	.016	.012	.003	.059	.006	.050	.196	1	1&4
427	.495	.002	.014	.001	.540	.000	.009	.013	1	1
429	.497	.323	.003	.003	.060	.200	.014	.077	1	M
432	.206	.002	.004	.055	.002	.001	.108	.302	4	1&4
435	.365	.007	.046	.007	.059	.004	.026	.224	1	1&4
448	.278	.013	.017	.162	.010	.004	.019	.406	4	1&4
470	.344	.428	.006	.002	.021	.456	.022	.063	1/2	M
509	.083	.000	.216	.001	.024	.000	.044	.005	3	3
510	.003	.000	.001	.001	.030	.000	.033	.018	3	3
518	.449	.015	.165	.002	.014	.010	.494	.164	3	3
270	.061	.017	.001	.332	.006	.036	.004	.544	4	4?
271	.014	.021	.001	.214	.000	.021	.002	.132	2	M
272	.018	.006	.009	.415	.000	.008	.003	.203	4	4?
273	.020	.011	.187	.019	.000	.016	.016	.466	4	M
329	.369	.005	.000	.010	.327	.003	.004	.113	1	1?
330	.475	.001	.005	.003	.013	.000	.000	.027	1	O
331	.021	.355	.000	.002	.001	.670	.002	.010	2	2
332	.043	.812	.001	.002	.002	.811	.002	.014	2	2
333	.744	.025	.025	.001	.329	.008	.012	.091	1	1?
334	.023	.478	.000	.002	.001	.798	.002	.012	2	2
335	.009	.007	.054	.075	.000	.003	.004	.160	4	M
373	.251	.002	.000	.002	.806	.001	.005	.015	1	1?
374	.001	.392	.000	.018	.000	.097	.000	.016	2	2
375	.002	.002	.000	.011	.028	.034	.000	.043	1	O
376	.002	.038	.000	.039	.001	.233	.000	.004	2	2
377	.446	.000	.000	.001	.024	.000	.000	.001	1	O
378	.016	.037	.000	.005	.020	.009	.002	.004	1	O
379	.014	.003	.001	.495	.001	.870	.012	.036	1	M
380	.075	.265	.000	.055	.004	.787	.010	.073	2	2

Note: O = Outlier; M = Mixed group affiliation; 1-4 = Group affiliation.

Table V.28
Final Classification of Late Aztec Red Ware Samples

INA I.D.	Site	Type/Variant	Clay Group	Status
227	TX-AZ-109	B&R/Tan	Late 1	Core
235	CH-AZ-190	Yellow/Red	Late 1	Core
236	CH-AZ-192	Yellow/Red	Late 1	Core
238	XO-AZ-66	Yellow/Red	Late 1	Core
264	CH-AZ-248	B&W/R Late C	Late 1	Core
265	CH-AZ-257	B&W/R Late C	Late 1	Core
266	CH-AZ-257	B&W/R Late F	Late 1	Core
268	CH-AZ-192	B&W/R Late F	Late 1	Core
286	CH-AZ-190	B/R Late E	Late 1	Core
288	CH-AZ-257	B/R Late E	Late 1	Core
294	XO-AZ-32	B/R Late E	Late 1	Core
382	IX-AZ-72	B/R Late E	Late 1	Core
383	IX-AZ-72	B/R Late E	Late 1	Core
384	IX-AZ-72	Yellow/Red	Late 1	Core
385	IX-AZ-72	B&W/R G	Late 1	Core
421	IX-AZ-72	B&W/R Late B	Late 1	Core
427	IX-AZ-72	B&W/R Late C	Late 1	Non-Core
428	IX-AZ-72	B&W/R Late C	Late 1	Core
431	CH-AZ-172	B&W/R Late F	Late 1	Core
514	Ahuitzotla	B&W/R Late Ind.	Late 1	Core
222	TX-AZ-24	B&R/Tan	Late 2	Core
223	TX-AZ-80	B&R/Tan	Late 2	Core
224	TX-AZ-28	B&R/Tan	Late 2	Core
225	TX-AZ-78	B&R/Tan	Late 2	Core
226	TX-AZ-27	B&R/Tan	Late 2	Core
228	TX-AZ-26	B&R/Tan	Late 2	Core
229	TX-AZ-87	B&R/Tan	Late 2	Core
232	TX-AZ-78	Yellow/Red	Late 2	Core
267	CH-AZ-192	B&W/R Late F	Late 2	Core
278	TX-AZ-87	B&W/R G	Late 2	Core
279	IX-AZ-26	B&W/R G	Late 2	Core
281	TX-AZ-109	B&W/R G	Late 2	Non-Core
282	TX-AZ-87	B&W/R G	Late 2	Core
283	TX-AZ-87	B&W/R G	Late 2	Core
284	TX-AZ-56	B&W/R G	Late 2	Core
331	TX-AZ-109	B/R C	Late 2	Non-Core
332	TX-AZ-24	B/R C	Late 2	Non-Core
334	TX-AZ-24	B/R C	Late 2	Non-Core
374	TX-AZ-56	B/R C	Late 2	Non-Core
376	TX-AZ-56	B/R C	Late 2	Non-Core
380	TX-AZ-87	B/R C	Late 2	Non-Core
436	IX-AZ-72	B&W/R Late F	Late 2	Core

Table V.28 (continued)
Final Classification of Late Aztec Red Ware Samples

INA I.D.	Site	Type/Variant	Clay Group	Status
501	El Risco	Yellow/Red	Late 2	Core
513	Ahuitzotla	B&W/R Late Ind.	Late 2	Core
517	Sta. Clara	B&W/R Late F	Late 2	Core
521	Sta. Clara	Yellow/Red	Late 2	Core
233	CH-AZ-190	Yellow/Red	Late 3	Core
502	El Risco	B/R Late A	Late 3	Core
503	El Risco	B/R Late A	Late 3	Core
504	El Risco	B/R Late A	Late 3	Core
505	El Risco	B/R Late A	Late 3	Core
506	El Risco	B/R Late Ind.	Late 3	Core
507	El Risco	B/R Late E	Late 3	Core
508	El Risco	B/R Late E	Late 3	Core
509	El Risco	B/R Late Ind.	Late 3	Non-Core
510	El Risco	B/R Late A	Late 3	Non-Core
511	El Risco	B&W/R Late Ind.	Late 3	Core
512	El Risco	Yellow/Red	Late 3	Core
515	Sta. Clara	B/R Late A	Late 3	Core
516	Sta. Clara	B&W/R Late C	Late 3	Core
518	Sta. Clara	B&W/R Late F	Late 3	Non-Core
519	Sta. Clara	B&W/R Late F	Late 3	Core
520	Sta. Clara	Yellow/Red	Late 3	Core
524	Sta. Clara	B&W/R Late Ind.	Late 3	Core
261	XO-AZ-32	B&W/R Late C	Late 4	Core
263	CH-AZ-238	B&W/R Late C	Late 4	Core
269	CH-AZ-130	B&W/R Late F	Late 4	Core
287	TX-AZ-56	B/R Late E	Late 4	Core
290	TX-AZ-87	B/R Late E	Late 4	Core
390	IX-AZ-72	B&W/R Late AN	Late 4	Core
423	IX-AZ-72	B&W/R Late B	Late 4	Core
426	IX-AZ-72	B&W/R Late C	Late 4	Core
433	IX-AZ-72	B&W/R Late F	Late 4	Core
450	IX-AZ-72	B&W/R Late D1	Late 4	Core
291	CH-AZ-20	B/R Late E	Late 1-4	Non-Core
386	IX-AZ-72	B&W/R G	Late 1-4	Non-Core
389	TX-AZ-87	B&W/R Late AN	Late 1-4	Non-Core
391	IX-AZ-72	B&W/R Late AN	Late 1-4	Non-Core
396	IX-AZ-72	B&W/R Late AW	Late 1-4	Non-Core
422	IX-AZ-72	B&W/R Late B	Late 1-4	Non-Core
432	IX-AZ-72	B&W/R Late F	Late 1-4	Non-Core
435	IX-AZ-72	B&W/R Late F	Late 1-4	Non-Core
448	IX-AZ-72	B&W/R Late E3	Late 1-4	Non-Core
234	CH-AZ-190	Yellow/Red	Unclass.	Mixed
237	IX-AZ-26	Yellow/Red	Unclass.	Mixed

Table V.28 (continued)
Final Classification of Late Aztec Red Ware Samples

INA I.D.	Site	Type/Variant	Clay Group	Status
262	XO-AZ-66	B&W/R Late C	Unclass.	Outlier
280	TX-AZ-87	B&W/R G	Unclass.	Mixed
289	CH-AZ-192	B/R Late E	Unclass.	Mixed
292	CH-AZ-249	B/R Late E	Unclass.	Outlier
293	CH-AZ-192	B/R Late E	Unclass.	Outlier
429	IX-AZ-72	B&W/R Late C	Unclass.	Mixed
470	IX-AZ-26	B&W/R Late F	Unclass.	Mixed
329	TX-AZ-109	B/R C	Unclass.	1?
330	TX-AZ-109	B/R C	Unclass.	Outlier
333	TX-AZ-24	B/R C	Unclass.	1?
335	TX-AZ-24	B/R C	Unclass.	Mixed
373	TX-AZ-56	B/R C	Unclass.	1?
375	TX-AZ-56	B/R C	Unclass.	Outlier
377	TX-AZ-87	B/R C	Unclass.	Outlier
378	TX-AZ-87	B/R C	Unclass.	Outlier
379	TX-AZ-87	B/R C	Unclass.	Mixed
270	TX-AZ-87	B/R Basin	Unclass.	4?
271	TX-AZ-100	B/R Basin	Unclass.	Mixed
272	TX-AZ-87	B/R Basin	Unclass.	4?
273	TX-AZ-100	B/R Basin	Unclass.	Mixed

Table V.29
Core/Non-Core Composition of Late Aztec Red Ware Groups

Group	Core	Non-Core	Total
1	19	1	20
2	19	7	26
3	15	3	18
4	10	0	10
1&4	--	9	9
Uncl.	--	--	31
Total	63	16	105

Table V.30

Success Rate in Classifying Late Aztec Red Ware Sherds to Clay Group by Status Class

Classification	Ceramic Status Level						Total
	1		2		3		
Classified	7	(35%)	51	(79%)	16	(80%)	74
Unclass.	13	(65%)	14	(21%)	4	(20%)	31
Total	20		65		20		105

Table V.31

Distribution of Classified and Unclassified Late Red Ware Higher Status Vessels By Region

Survey Region	Classification Status				Total
	Class.		Unclass.		
Texcoco	16	(89%)	2	(11%)	18
Chalco/ Ixtapaluca	14	(67%)	7	(33%)	21
Xochimilco/ Ixtapalapa	16	(64%)	9	(36%)	25
W. Lake Texcoco	21	(100%)	0	(0%)	21
Total	67	(79%)	18	(21%)	85

A separate group formation analysis of all lower status vessels proved unproductive. Cluster analyses indicate that these vessels fall into a plurality of small, tight groups relatively dissimilar to other such groups (Fig. V.17). The small size of these groups precluded an assessment of group membership probabilities, and attempts to form larger groups resulted in splintering and outliers. It thus appears that multiple small-scale producers were the primary manufacturers of these utilitarian vessels, although larger-scale production centers concentrating on the output of higher class vessels were involved in their production as well. However, analyses of a substantially larger sample of these vessels will be required to verify this interpretation.

The spatial distribution of clay group members reveals a shift in Red ware ceramic production during the Late Aztec period, apparently closer to the centers of imperial power. Three of the four Late Aztec production sources identified (Late Aztec compositional Groups 1, 3, and 4) have distributions along the western and southwestern portions of the Valley (Figs. V.18, V.20, and V.21), indicating that the region near the imperial capital of Tenochtitlan became a major zone producing Red ware ceramics. The remaining production center (Group 2) appears to have been located near Texcoco, the empire's second city (Fig. V.19). In contrast, Red ware production in the relatively peripheral southern Valley (a major area of Early Aztec production) was discontinued.

Six cities in the Valley of Mexico are reported to have been major producers of ceramics in early colonial times: Cuauhtitlan, Azcapotzalco, Huitzilopochco, Xochimilco, Tlatelolco, and Texcoco (Barlow 1951; Gibson 1964:350; Branstetter-Hardesty 1978:26). It is likely that these centers represent the continuation of a late prehispanic tradition. In attempting to identify our Late Aztec clay groups with known centers of pottery production, only the association of Late Aztec Group 2 with Texcoco is fairly secure. At a more tentative level, it is likely that Late Aztec Groups 1 and 4 represent historic centers in the southwestern portion of the Valley, such as Huitzilopochco and Xochimilco. Alternatively, one of these clay groups may represent ceramics produced in the imperial capital, Tenochtitlan-Tlatelolco. Finally, Late Aztec Group 3 (the western Lake Texcoco source) may well represent Azcapotzalco (since sherds sampled from that site fall within this clay group) or perhaps the more northerly Cuauhtitlan.

Conclusions

In summary, the INA analyses indicate that a number of distinct sources were producing Aztec decorated ceramics. During the Early Aztec period, two distinct regions engaged in the production of Red ware ceramics: a prolific southern production zone located within the Chalco-Tenango-Amecameca region, and a somewhat less productive northern source identified with Huexotla and Texcoco. Within the southern zone, four possible clay groups have been identified; however, the close geochemical relationships of clays within the region make secure separation of these clay sources difficult. Two distinct sources were recognized within the northern region. Both the southern and northern regions also produced Early Aztec Orange wares, but the two Early Aztec wares are geochemically distinct, implying either specialization in ceramic technology or in clay source or both.

During the Late Aztec period, four major producers of higher status Red ware vessels were identified: one in the Texcoco region, one located to the west of Lake Texcoco, and two within the Ixtapalapa/Lake Xochimilco area. In contrast, lower status

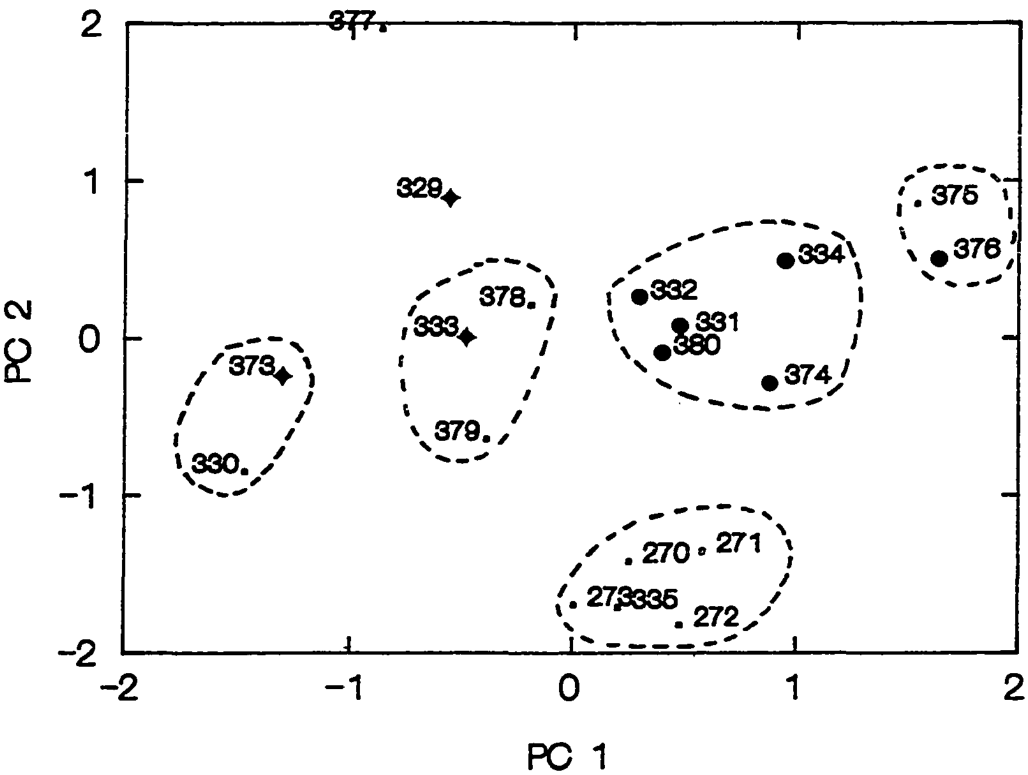


Figure V.17. Distribution of Black/Red Variant C bowls and Black/Red Basins along the first two principal components. Dashed lines encircle groups of compositionally similar sherds identified through cluster analyses and multi-dimensional scaling based on 17 elements. Sherds assigned to Group 1 are identified with a diamond and those assigned to Group 2 with a circle.

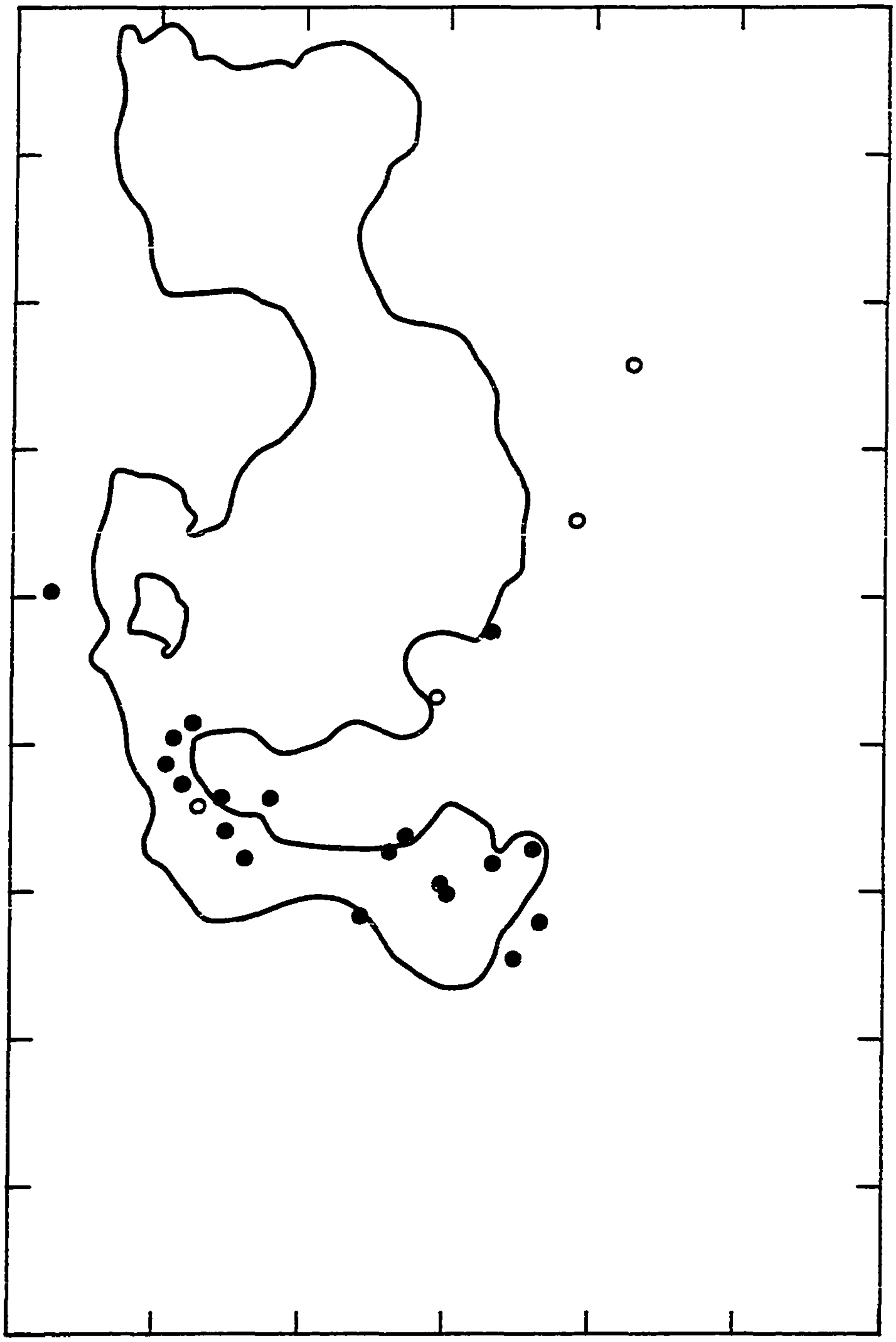


Figure V.18. Distribution of higher status vessels belonging to Late Aztec Red ware Clay Group 1 relative to the ancient lakebed margin (solid symbols equal core members, open symbols equal non-core members). Vessels show a distribution concentrated in the chinampa zone of Lake Xochimilco and Lake Chalco. (Vessel proveniences have been jittered to avoid overlap of data points.)

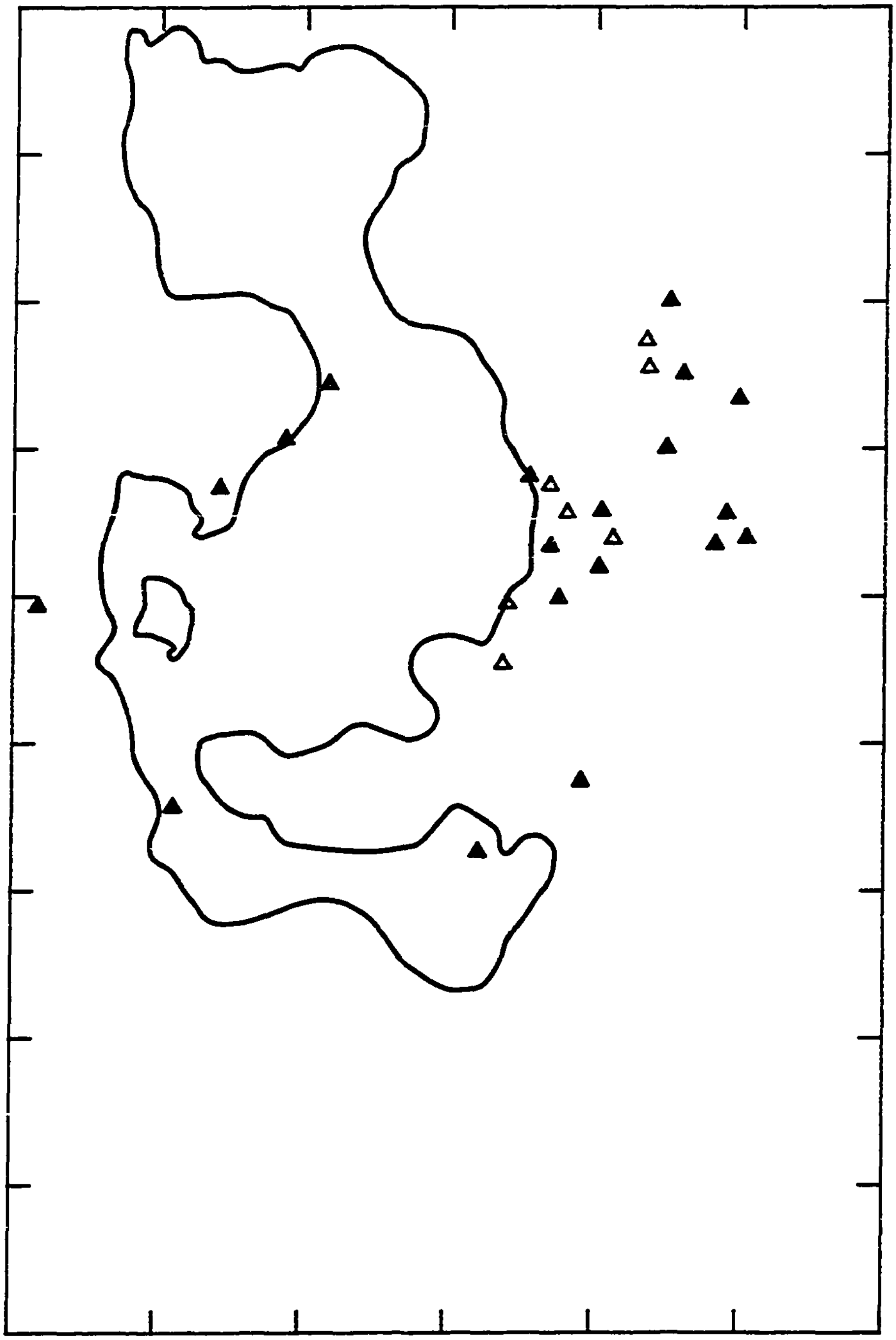


Figure V.19. Distribution of vessels belonging to Late Aztec Red ware Clay Group 2 relative to the ancient lakebed margin (solid symbols equal core members, open symbols equal non-core members). Vessels show a spatial concentration around Texcoco. (Vessel proveniences have been jittered to avoid overlap of data points.)

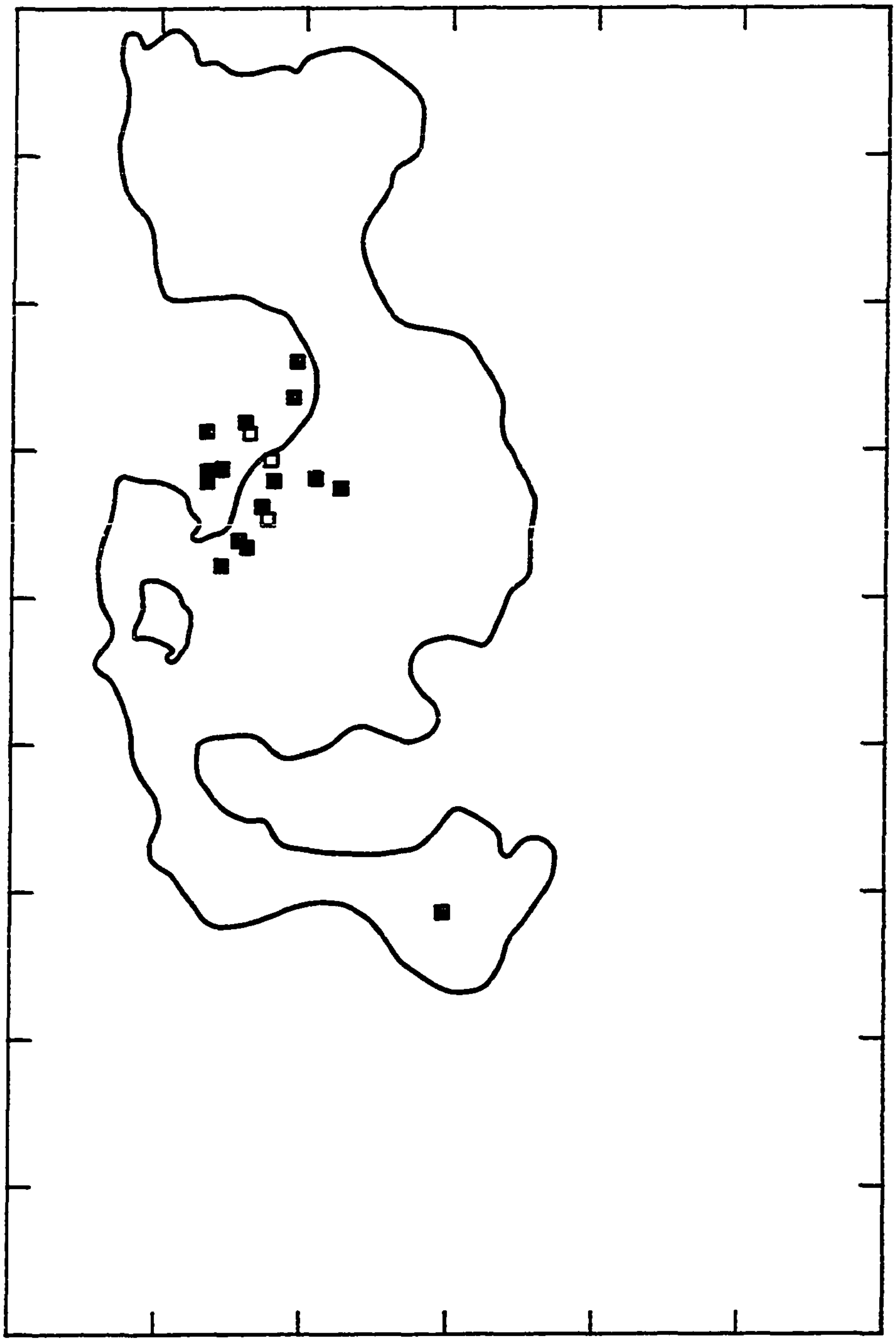


Figure V.20. Distribution of vessels belonging to Late Aztec Red ware Clay Group 3 relative to the ancient lakebed margin (solid symbols equal core members, open symbols equal non-core members). Vessels show a distribution concentrated in sites west of the lakebed, directly north of Tenochtitlan. (Vessel proveniences have been jittered to avoid overlap of data points.)

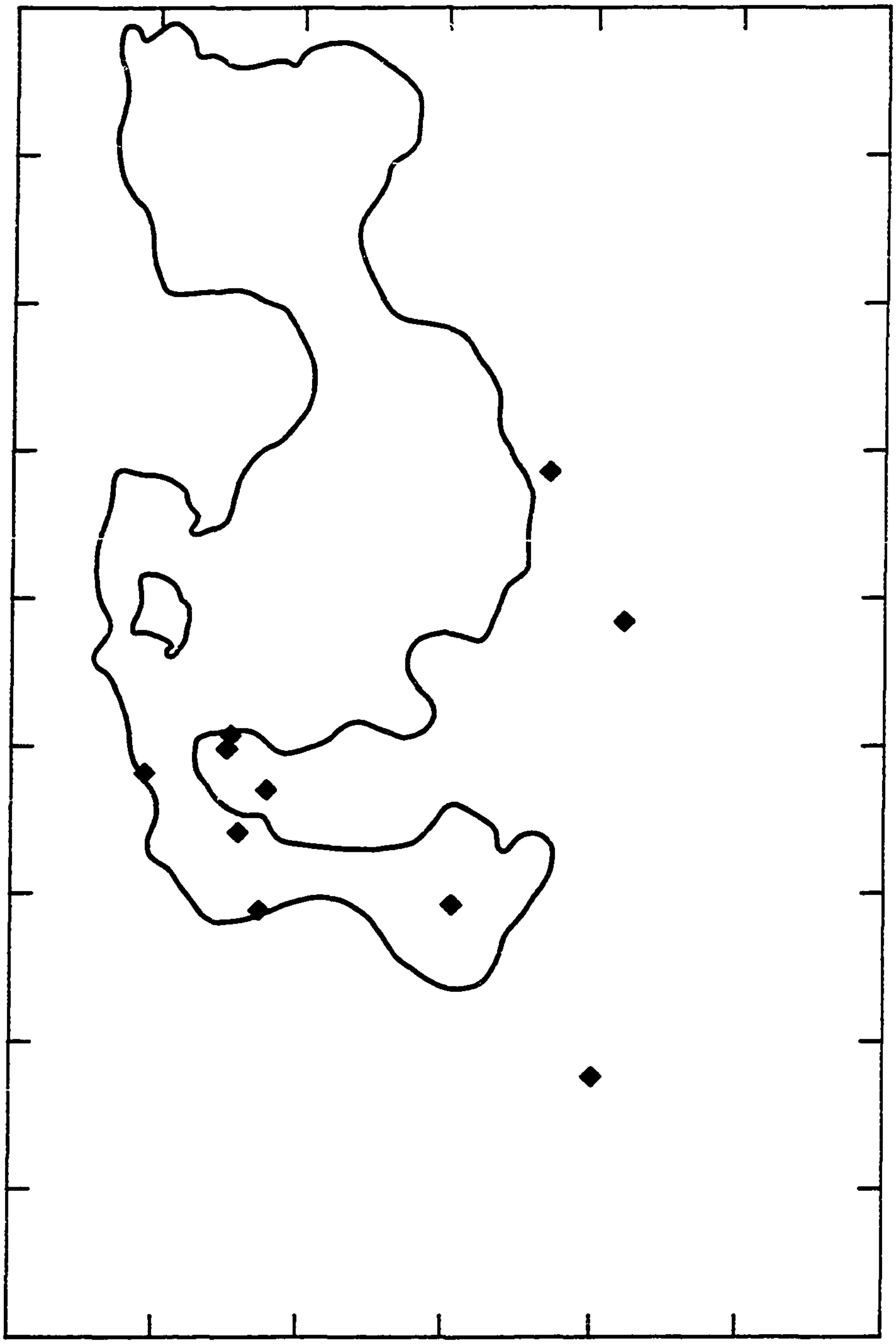


Figure V.21. Distribution of higher status vessels belonging to Late Aztec Red ware Clay Group 4 relative to the ancient lakebed margin (solid symbols equal core members, open symbols equal non-core members). Vessels show a distribution concentrated around Culhuacan, at the western end of the Ixtapalapa peninsula. (Vessel proveniences have been jittered to avoid overlap of data points.)

Red ware vessels, including the common Black/Red Variant C bowls, appear to have been produced by a number of small-scale manufacturers, although this conclusion remains tentative due to the small sample size of this class of vessels.

The analyses also revealed little continuity in the production of Red ware ceramics through time. Direct comparisons of Early and Late Aztec Red wares are hampered by technological changes that potentially altered the geochemical signature of clay sources; however, it appears that major shifts occurred in the production locations of this ware through time. Five out of six Early Aztec Red ware sources appear to have discontinued production of this ware in the Late Aztec period. Conversely, regions with no apparent history of Red ware production (e.g. the southwestern lake basin) became major producers of these vessels during the Late Aztec period.

The notable exception to this trend occurs within the Texcoco region. In spite of technological changes affecting paste texture, there is a marked similarity in the geochemical signatures of Early Group 3 and Late Group 2 when compared along a profile of the 17 most precise elements (Fig. V.22). This similarity strongly argues for continuity within the Texcoco source through time. Such similarities are not found, in contrast, within the southern Red wares. Although both Late Groups 1 and 4 appear to have a southern origin, their geochemical signatures differ substantially from the Early Aztec southern source Group 1 (Fig. V.23). This difference would be readily accounted for by the shift in the location of production from the southeastern (Chalco-Tenango-Amecameca) to the southwestern (Huitzilopochco-Xochimilco) portion of our study area through time. Nor do the southern Late Red ware sources reveal any affiliation with the southern Early Aztec Orange ware clay groups, from either the eastern (Chalco) or western (Culhuacan) sources, when compared along a profile of mean element concentrations. The precedents of the western Lake Texcoco source remain unknown due to the current lack of Early Aztec Red ware ceramic material from this area.

The lack of continuity in Red ware production is in marked contrast with Black/Orange ceramic production. Hodge et al. (1992, 1993; Hector Neff, personal communication) report substantial continuity in the production of Black/Orange ceramics during the Aztec period. All five regions identified so far as producing Black/Orange ceramics in the Early Aztec period (Chalco, Culhuacan/Ixtapalapa, Texcoco, W. Lake Texcoco, and Xaltocan) apparently continued to produce during the Late Aztec period, and the products of these sources exhibit strong continuity in the geochemical signatures of clay sources utilized. Among these, however, the output of the Chalco source appears to have been drastically reduced through time. Thus it appears that the flourishing Early Aztec ceramic industry in the Chalco region was severely affected by incorporation into the Aztec empire.

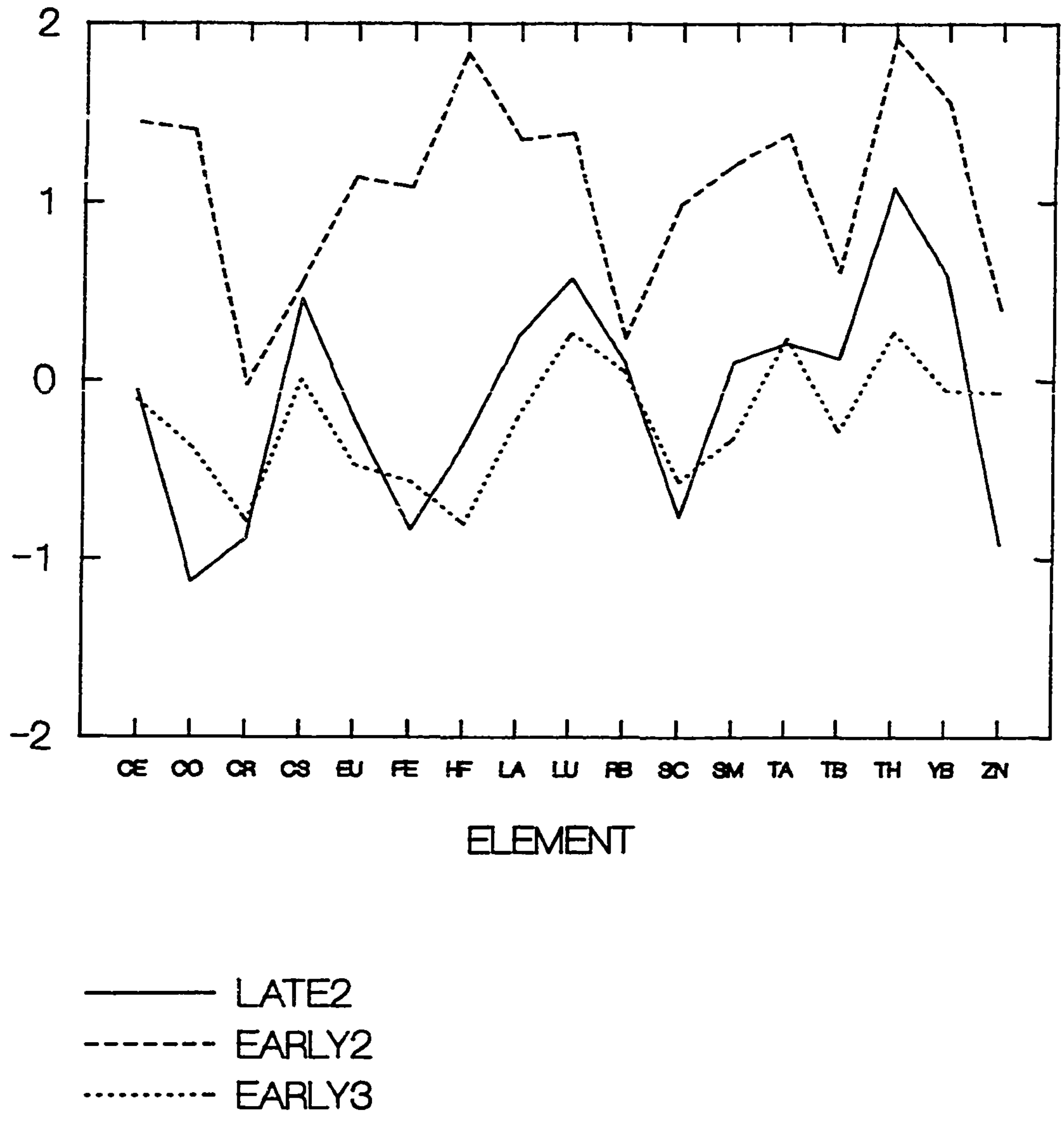


Figure V.22. Comparison of Early Aztec and Late Aztec Red ware clay groups from the Texcoco region along a profile of mean concentrations of 17 elements. Early Aztec Group 3 and Late Aztec Group 2 show strong similarities, suggesting continuity in production source at Texcoco. Both clay groups are distinct from Early Aztec Group 2, tentatively attributed to the near-by site of Huexotla.

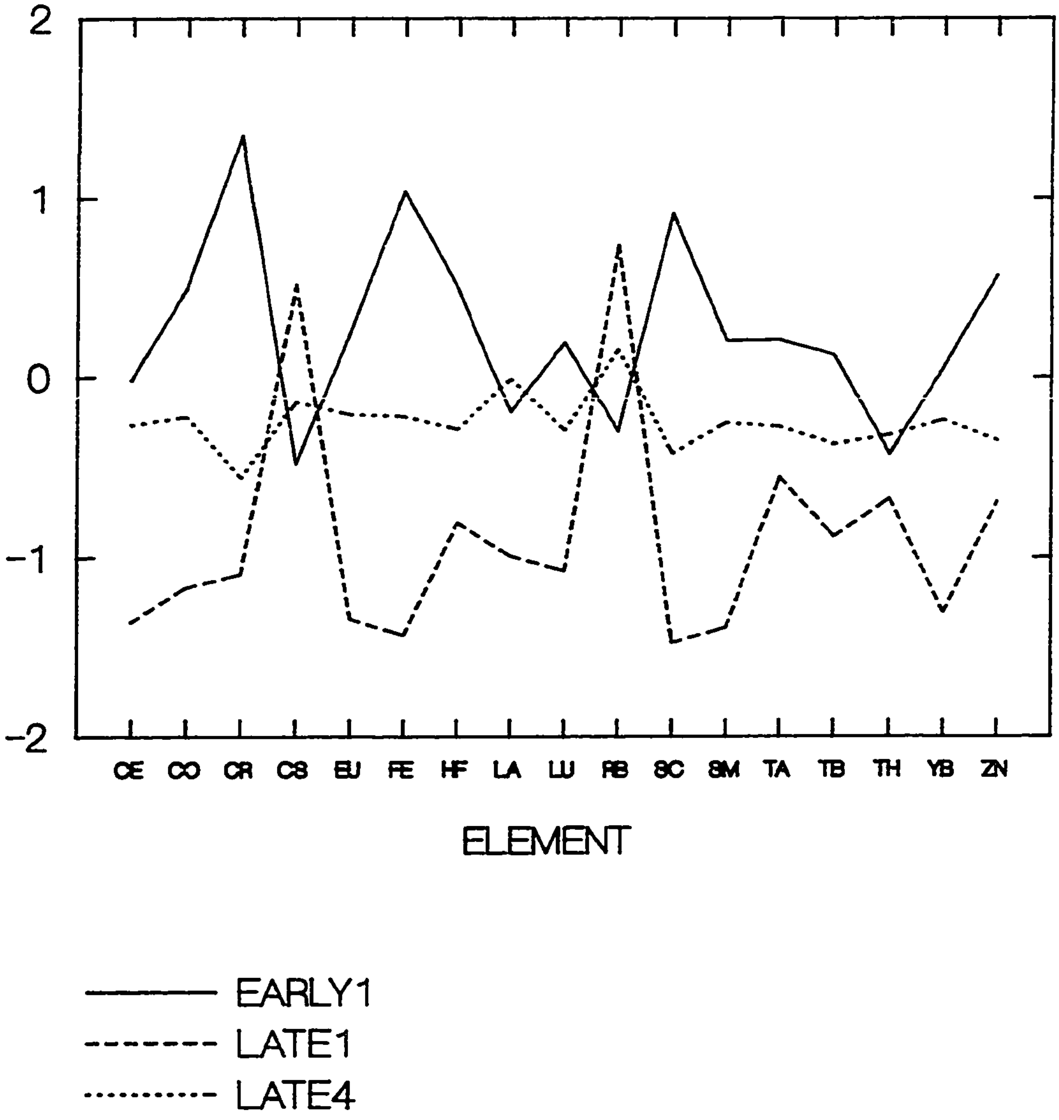


Figure V.23. Comparison of Early Aztec and Late Aztec Red ware clay groups from the southern region along a profile of mean concentrations of 17 elements. Lack of continuity in Red ware production is indicated in the southern valley, based on the strong dissimilarities between Early Aztec Group 1 (associated with the Chalco-Tenango area) and Late Aztec Groups 1 and 4 (tentatively attributed to historic production sites at Huitzilopocho and Xochimilco).

Notes to Appendix V

[1]I would like to thank Jeffrey Parsons for permission to use ceramic materials from the University of Michigan Museum of Anthropology in this analysis.

[2]The quartz tubing used in these analyses was the Clear-fused Quartz T21 Suprasil tubing (4 mm ID x 6mm OD x 1mm wall), manufactured by Heraeus-Amersil Inc., 3473 Satellite Blvd., Duluth, GA, 30136-5821. At the time of analysis (1990-1991), the quartz tubing cost $48.10/meter. The cost of this tubing was defrayed by grants from Sigma Xi, The Scientific Research Society, and from the Rackham School of Graduate Studies, University of Michigan. Their financial assistance is gratefully acknowledged.

[3]Phoenix Memorial Laboratory at the University of Michigan provided reactor time at the Ford Nuclear Reactor, as well as computer facilities, personnel assistance, and laboratory space for preparing and analyzing samples. I would like to acknowledge the support of Philip Simpson (Assistant Manager for Research) in facilitating this research, and the assistance of Edward Birdsall (Systems Manager), in all phases of sample preparation and analysis.

[4]Harbottle (1982), however, suggests that with increasing accuracy in calibrating standards to absolute concentration values, inter-lab comparisons are possible even when based on different standards and different analytical procedures.

[5]M. James Blackman provided the data for the Ohio Red Clay check standards analyzed at the Smithsonian on which inter-lab calibrations are based.

[6]The variation from andesite to basalt is continuous, with the basaltic andesites forming a transitional group. Historically, three different criteria have been utilized for the classification of andesites and basalts (Baker 1982):

1. ferromagnesian component: The term andesite was originally applied to lavas containing plagioclase and hornblende; the nature of the ferromagnesian components was at one time used in distinguishing andesites from basalts, particularly on the basis of hornblende in the former and olivine in the latter.

2. plagioclase composition: Subsequent emphasis came to be placed on the composition of the plagioclase, with that in the andesites falling within the range of An50-An30 (i.e. a modal mineralogical scheme); application was difficult since the groundmass feldspars are not readily determined by normal optical methods.

3. silica percentage: Current usage tends to restrict the term 'andesite' to intermediate calc-alkaline rocks (i.e. silica-oversaturated rocks with relatively high Al_2O_3); andesites are usually distinguished from other members of the calc-alkaline association on the basis of silica percentage, although the precise boundaries adopted vary slightly. One common division is as follows (after Peccerillo and Taylor 1976):

CLASS	% SILICA (SiO_2)
basalts	< 52%
basaltic andesites	52-56%
andesites	56-63%
dacites	63-69%
rhyolites	> 69%

These different criteria have led to conflicting characterizations of the geology of the Valley of Mexico. Thus, based on criterion (2) above, Gunn and Mooser (1971) find that there are no true basalts in the Mexico City area, while using criterion (3) above, Robin (1982:140) describes the active MVB as including the full range of basalt to acidic andesite compositions (over 60% SiO_2), with basaltic andesite (52-55% SiO_2) being the most common.

[7]The rare earth elements (REE) proper are those with atomic numbers of 57 to 71 (La to Lu); yttrium is often included with the group, and sometimes also beryllium, scandium, zirconium, hafnium, and thorium.

[8]The use of fiber temper dates back to as early as the Late Classic, suggesting substantial continuity in ceramic technology within the Valley of Mexico (Branstetter-Hardesty 1978:136).

[9]Branstetter-Hardesty reports in her analyses of clays utilized by modern Mexican potters that none of the clays naturally contained more than 20% non-plastics (1978:193), a figure that is substantially lower than the amount of aplastics recorded in petrographic analyses of both Early and Late Aztec sherds. It is unclear, however, how Branstetter-Hardesty determined that figure. If based on macroscopic or low-power microscopic analyses, this figure may well ignore the silt fraction included with the aplastics in thin-section point counts.

[10]Alternatively, preliminary groups could be defined on the basis of provenience (e.g. all samples from a given site or region) or stylistic similarities.

[11]For jack-knifed distances, each case is eliminated in turn from the computation of the group means and the covariance matrix; D^2 is then computed as the distance from the case to the group formed by the remaining cases.

[12]In addition to the potential loss of information, the use of principal components can effect a shift in element weighting. The effects are potentially most significant for sets of highly intercorrelated elements such as the REE that are generally reduced to a single dimension in PCA. If based on a correlation matrix, PCA effectively standardizes the data (i.e. each component has a mean value of 0 and a standard deviation of 1) giving each component an equal weight in the calculation of the Mahalanobis D^2 statistics. Thus, the collective weight of the REE is reduced from roughly half of the 17 elements to only 1 out of N principal components (although the Mahalanobis D^2 statistic does compensate to some degree for the redundancy represented by intercorrelated variables through weighting factors derived from the inverted covariance matrix). Conversely, a relatively autonomous element may increase drastically in importance if represented as a separate dimension or principal component.

In contrast, if the principal components are based on the variance-covariance matrix of unstandardized values, the components still have a mean of 0, but the variance decreases with each added component. The declining amount of variance subsumed by each successive component flattens out the raw component scores (Neff et al. 1992:77), increasing the relative weight of primary components and decreasing that of subsequent components. Thus, depending on whether and where the collective weight of a correlated group of elements is isolated, the effect of this group can be heightened or diminished in PCA relative to their importance as individual element concentrations.

[13]The chronological placement of basins is also less secure (see Appendix IV, this volume). Coarser pastes in these vessels may reflect both their utilitarian function as well as an earlier ceramic technology.

APPENDIX VI

SPATIAL DISTRIBUTIONS OF AZTEC RED WARES

Representations of Spatial Data

Five alternative methods for presenting and analyzing the spatial patterning of ceramic type data were considered for this study. These are presence/absence, raw counts, percentages, densities, and consumption indices. All of these approaches assume that the assemblage composition in the collection area(s) is representative of the site as a whole. Aside from this sampling problem, each of these methods present certain advantages and disadvantages which are described briefly below.

(1) **presence/absence**. This type of data is appropriate when distributional patterns are fairly strong, as when there are distinct boundaries delimiting type distributions; however, it may be too coarse to reflect subtle patterns in type distribution. In either case, this is a good option for examining the distribution of a type or variant relative to existing geographical units such as regions or polities, from the percent of sites in the geographic unit containing a specific type or variant.

(2) **raw counts**. Type or variant counts per site are affected by substantial differences in collection size between sites, arising from differences in sherd density and the number of collection areas designated within a site. Raw counts are therefore much more sensitive to differences in artifact recovery than to prehistoric patterns of distribution and consumption, and accordingly were not used in this study.

(3) **percentages**. The use of percentage data to characterize assemblage composition in terms of the relative frequency of types requires a sufficient sample size; many of the surface collections included in this study are too small for percentage data to be reliable. Percentages have the further disadvantage in that they do not provide a measure of absolute differences in quantities between sites.

(4) **densities**. Density or frequency data provide a standardized measure of quantitative differences between sites and place large and small collections on the same footing. Overall, sherd density depends on four factors: the availability of a ceramic type, the usage and discard rates for ceramics, the number of consumers or ceramic users represented within the collection area(s), and conditions for recovery of ceramics during surface collecting. Thus, although the primary interest here is in the first factor (that of ceramic availability), it is not possible to rule out differences between sites arising from the other factors. It is suggested here, however, that differences between collection areas in discard rate, population density, and recovery vary non-systematically in space whereas cultural patterns of ceramic availability and consumption are expected to display a strong spatial component. As a result, ceramic densities can provide useful information if the emphasis is placed on the overall spatial pattern of ceramic densities, rather than focusing more narrowly on densities at a specific site.

(5) **consumption index**. A measure of ceramic consumption, such as the number of sherds per consumer, can be calculated along the following lines:

$$\frac{\text{sherd density/ha} \times \text{site size in ha}}{\text{site population}} \times 100 = \text{sherds/100 consumers.}$$

This measure takes into account differences in population density between collection areas, a factor confounding simple density or frequency calculations. On the negative side, however, such a measure assumes that the population density of collection area is representative of the site as a whole and that population figures for the entire site are unbiased. Neither of these assumptions can be met with confidence. Thus, although consumption indices alleviate certain problems, they may introduce others of an equally or more serious nature.

This study paired two different methods for presenting spatial data: presence/absence plots (the most conservative approach) and density plots (a less conservative but more sensitive measure). In both approaches, similar problems of a representative sample exist, therefore the focus is on the broader patterns of spatial distribution rather than on specific inter-site comparisons.

Calculating Ceramic Densities

All ceramic count data were standardized as sherd densities per hectare of surface area collected:

$$\frac{\text{sherd type or variant counts}}{\text{collection area size(s) in m}^2} \times 10{,}000 = \text{density per hectare.}$$

If more than one collection area was designated for a site, sherd counts and collection areas were summed prior to calculating densities for the site as a whole.

Type counts were determined through tabulating the ceramics recovered through surface survey. The sizes of collection areas from which the ceramics were recovered were determined through the laborious process of reading through field notebooks, the sole place where this information was recorded. For a few sites, this information was not consistently recorded. In general, however, the field notes were surprisingly complete and I am grateful to these conscientious note-takers of 20-some years ago.

Ceramic Density Distribution Maps

The distribution and density of ceramic types throughout the study area is a major source of data for this study. Maps of these distributional patterns (and the density contour maps derived from them) are presented below (Figs. VI.1-VI.73) for all but the lowest frequency types and variants. In the density distribution maps, the size of the symbol reflects the relative ceramic type density on a logarithmic scale; the symbol is centered on site location. The same symbol size scale was utilized for all maps, permitting a comparison between types. For the contour maps, the minimum contour and contour interval are specified.

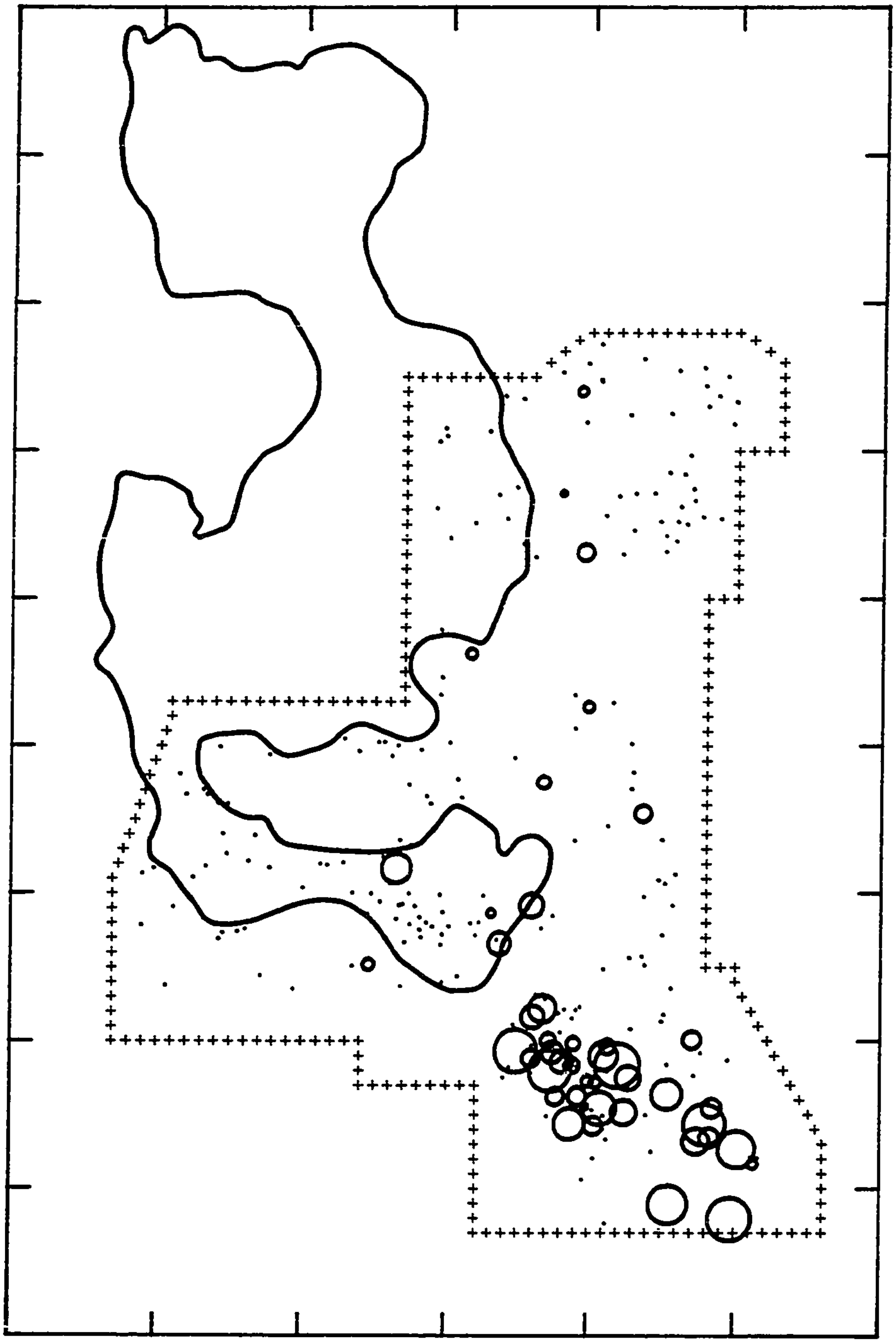


Figure VI.1. Density distribution map for Black/Red-Incised Variant A. Size of circular symbol reflects the relative density of this variant as recovered in surface collections. Dots indicate sites for which collections exist but that do not contain this variant.

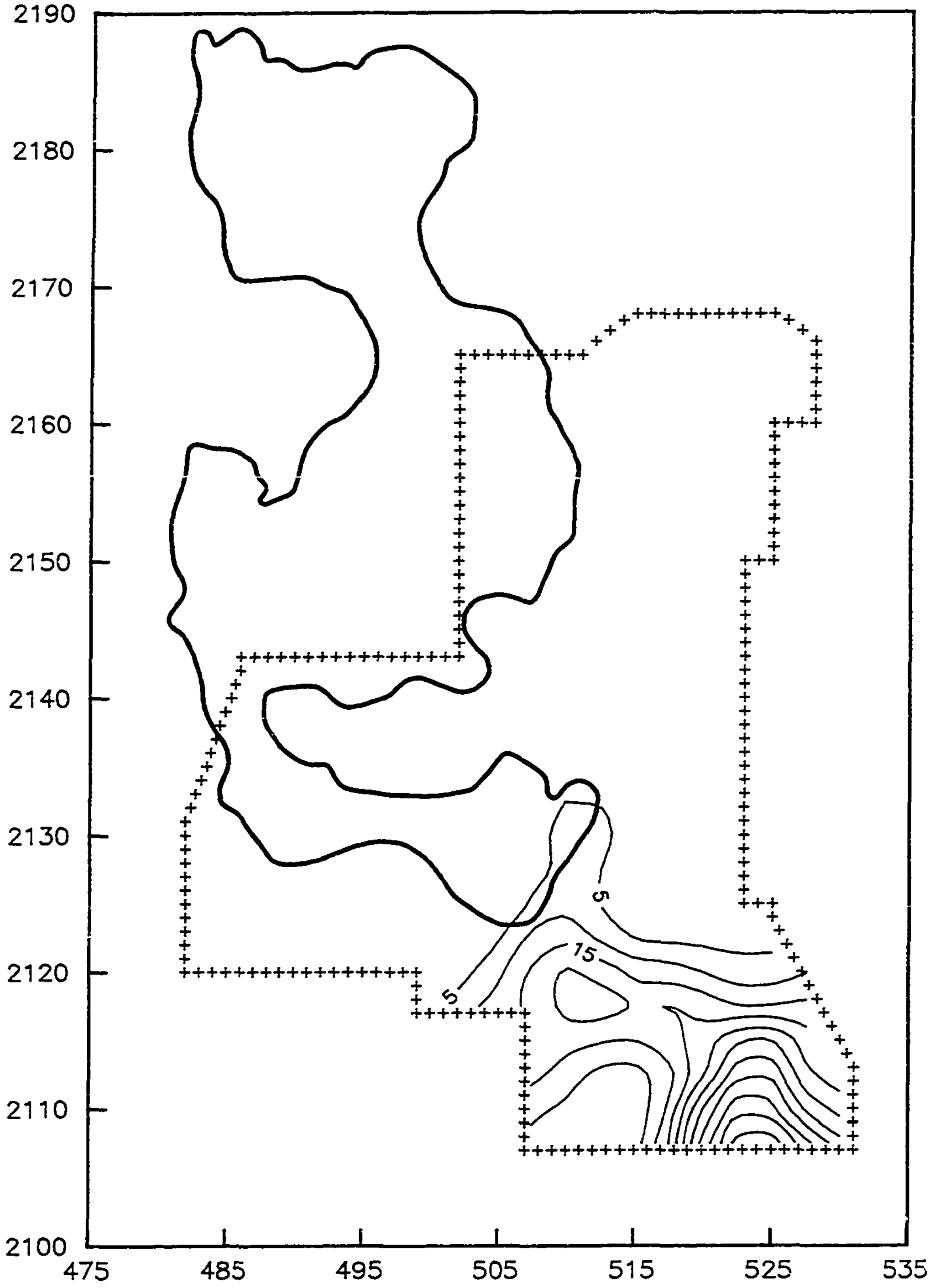


Figure VI.2. Density contour map for Black/Red-Incised Variant A. (Minimum contour = 5 sherds/ha; contour interval = 5 sherds/ha.)

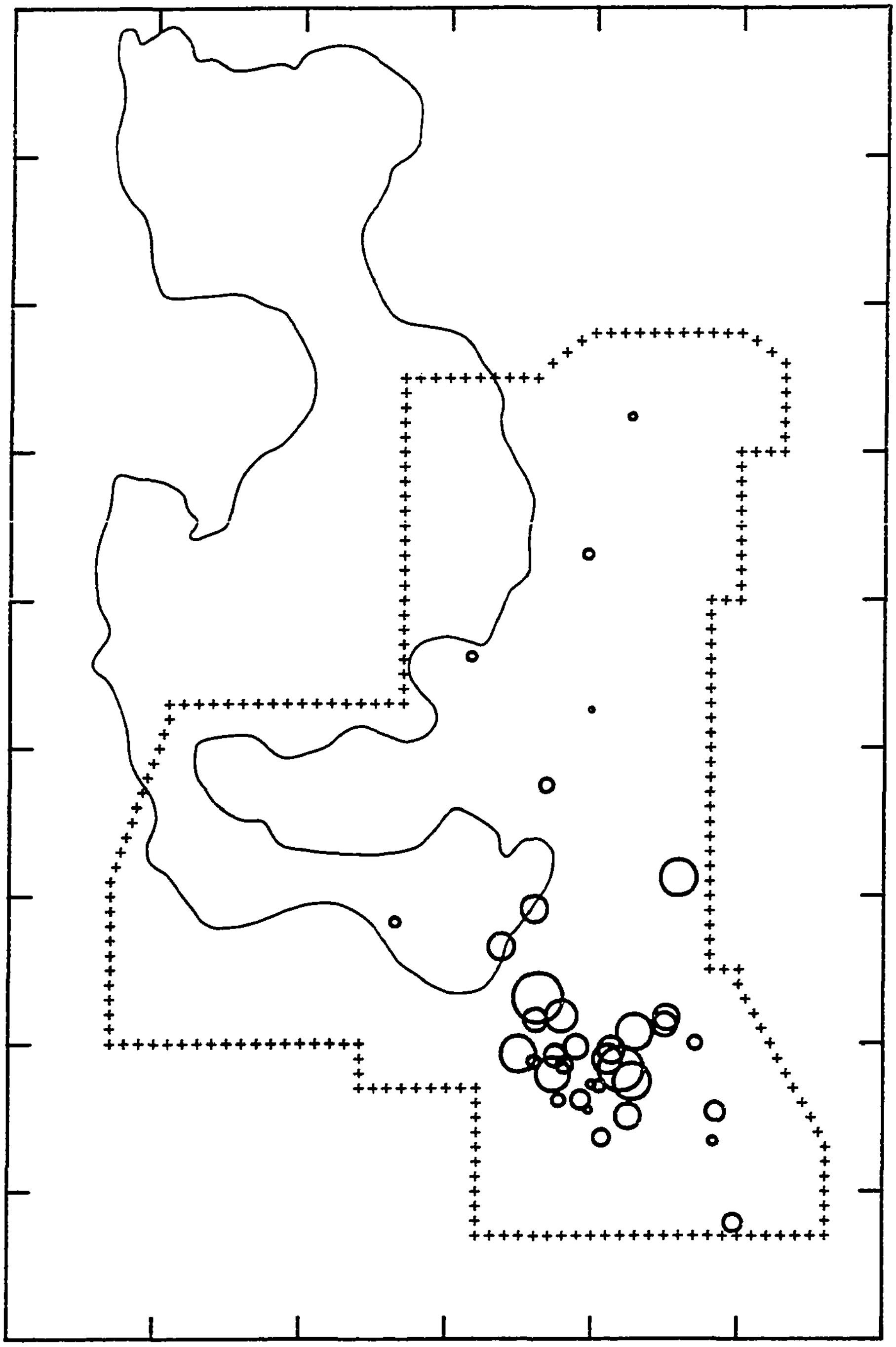


Figure VI.3. Density distribution map for Black/Red-Incised Variant B. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

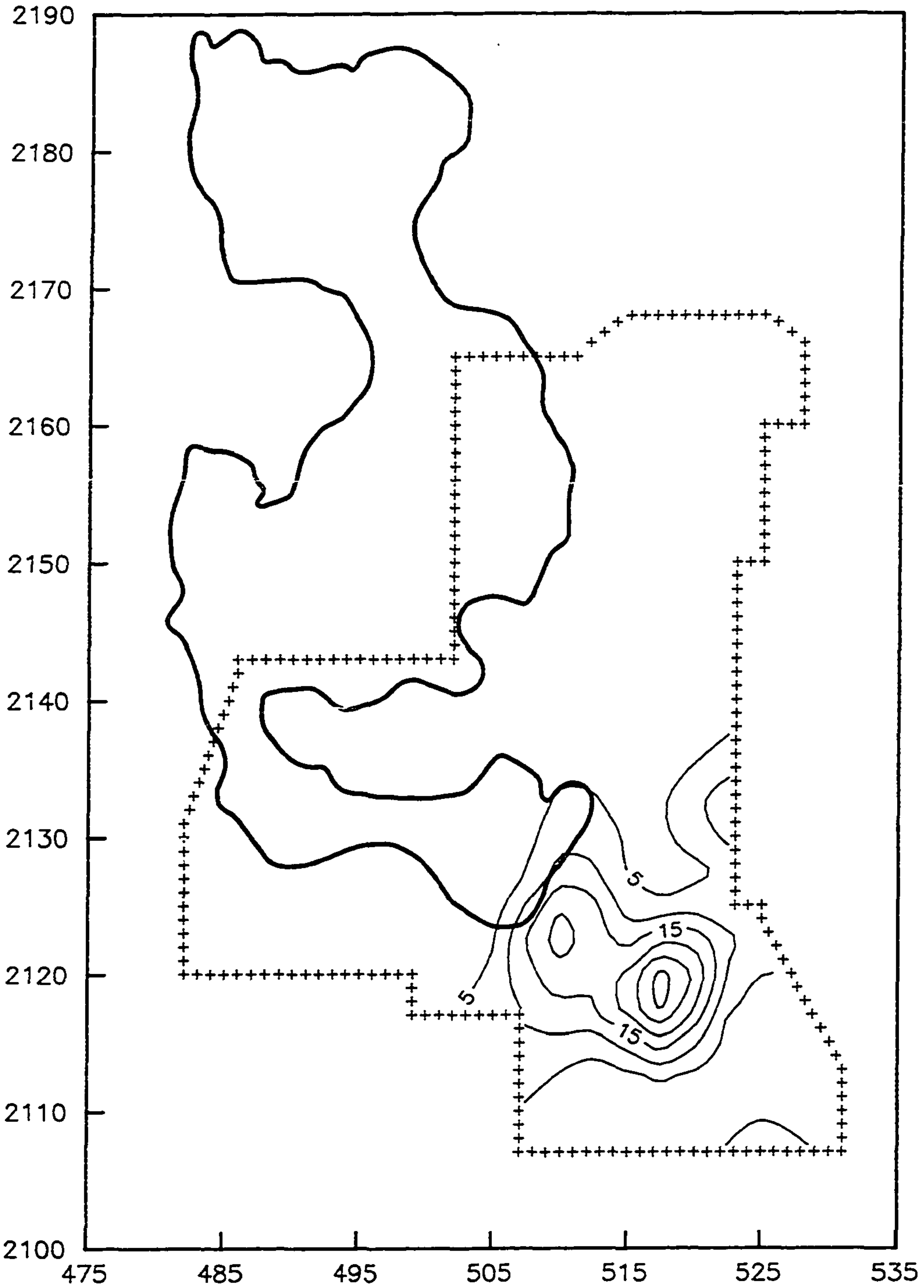


Figure VI.4. Density contour map for Black/Red-Incised Variant B. (Minimum contour = 5 sherds/ha; contour interval = 5 sherds/ha.)

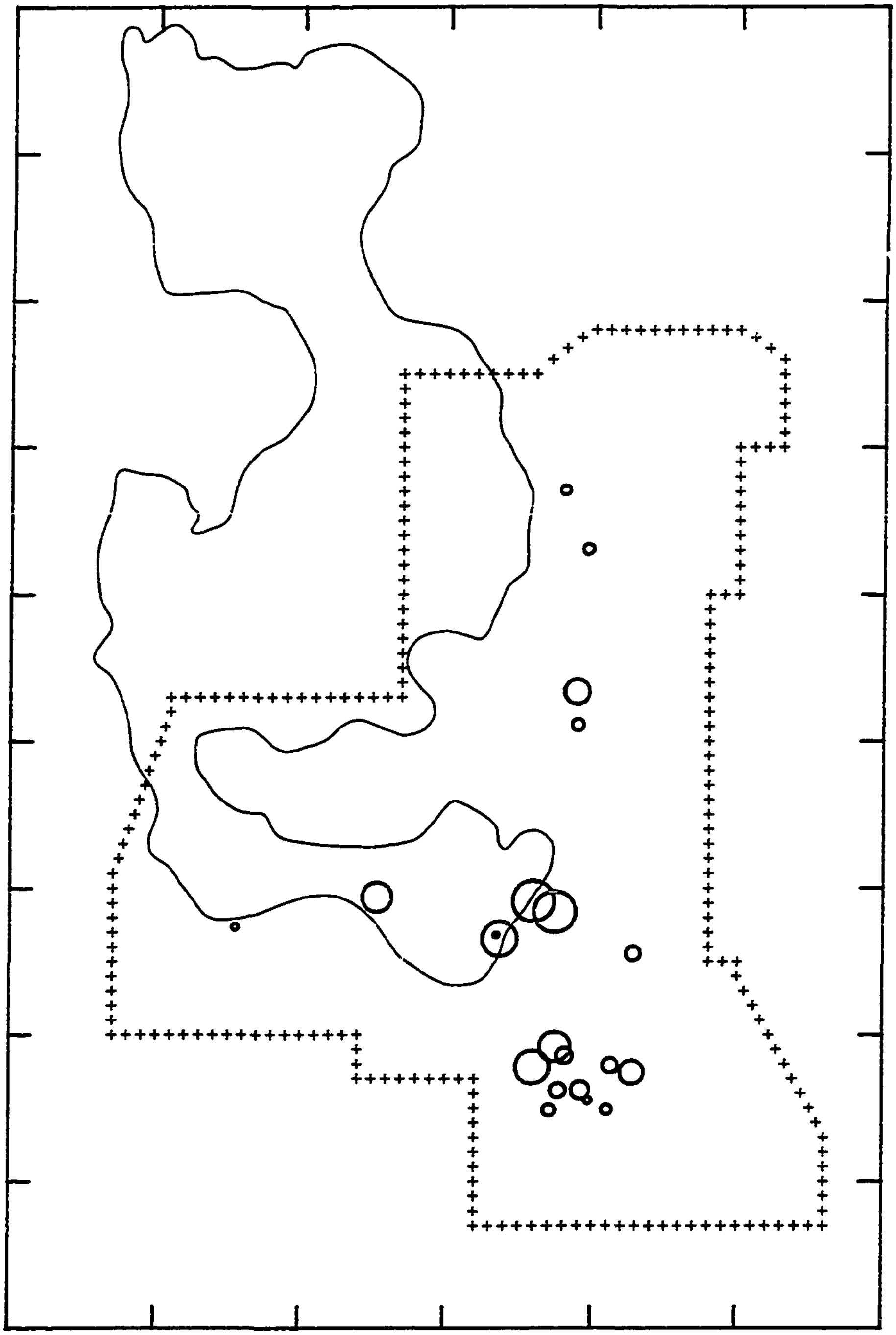


Figure VI.5. Density distribution map for Black/Red-Incised Variants C and D (i.e. the cane motifs). Size of circular symbol reflects the relative density of these variants as recovered in surface collections.

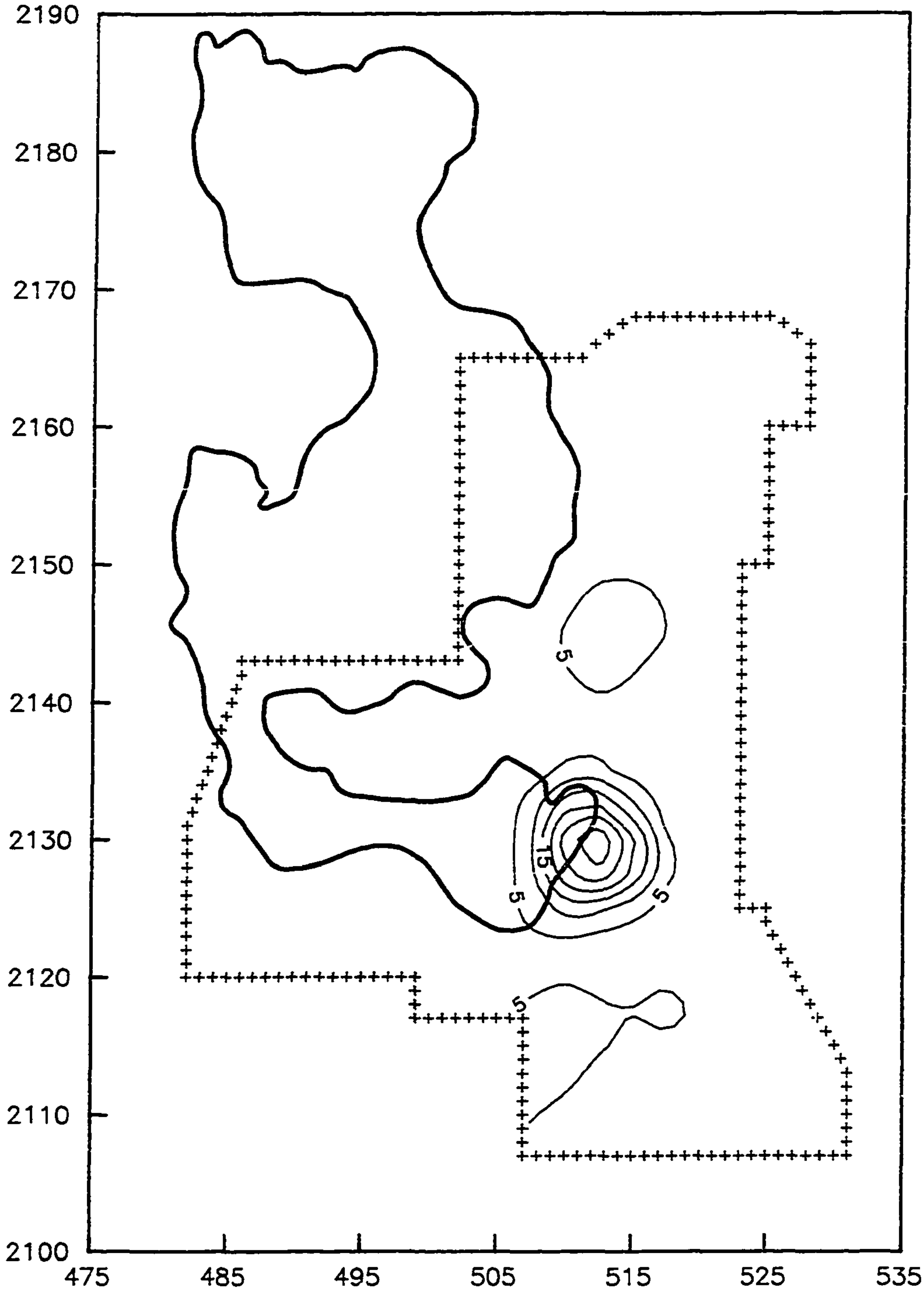


Figure VI.6. Density contour map for Black/Red-Incised Variants C and D (i.e. the cane motifs). (Minimum contour = 5 sherds/ha; contour interval = 5 sherds/ha.)

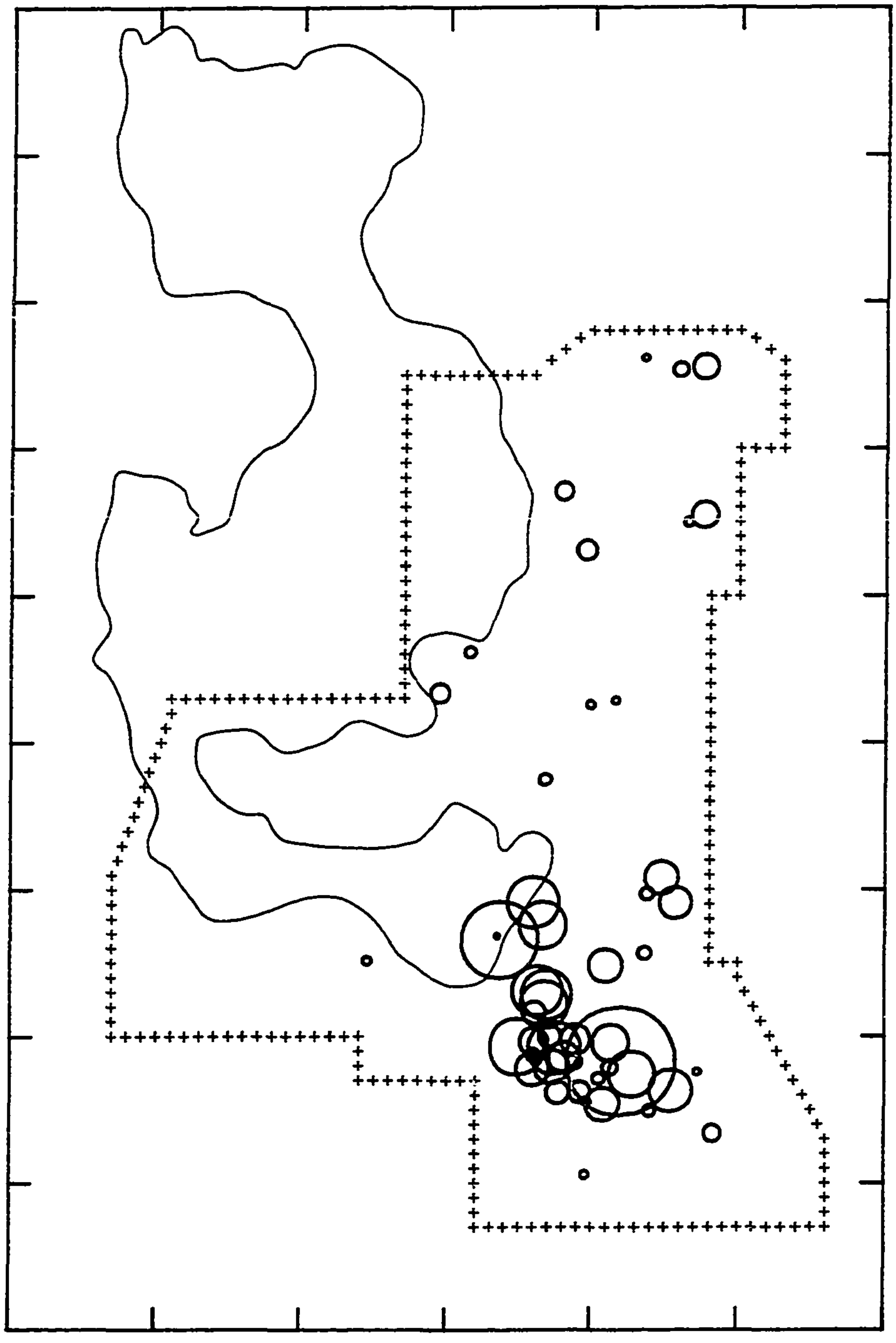


Figure VI.7. Density distribution map for Black/Red Variant A. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

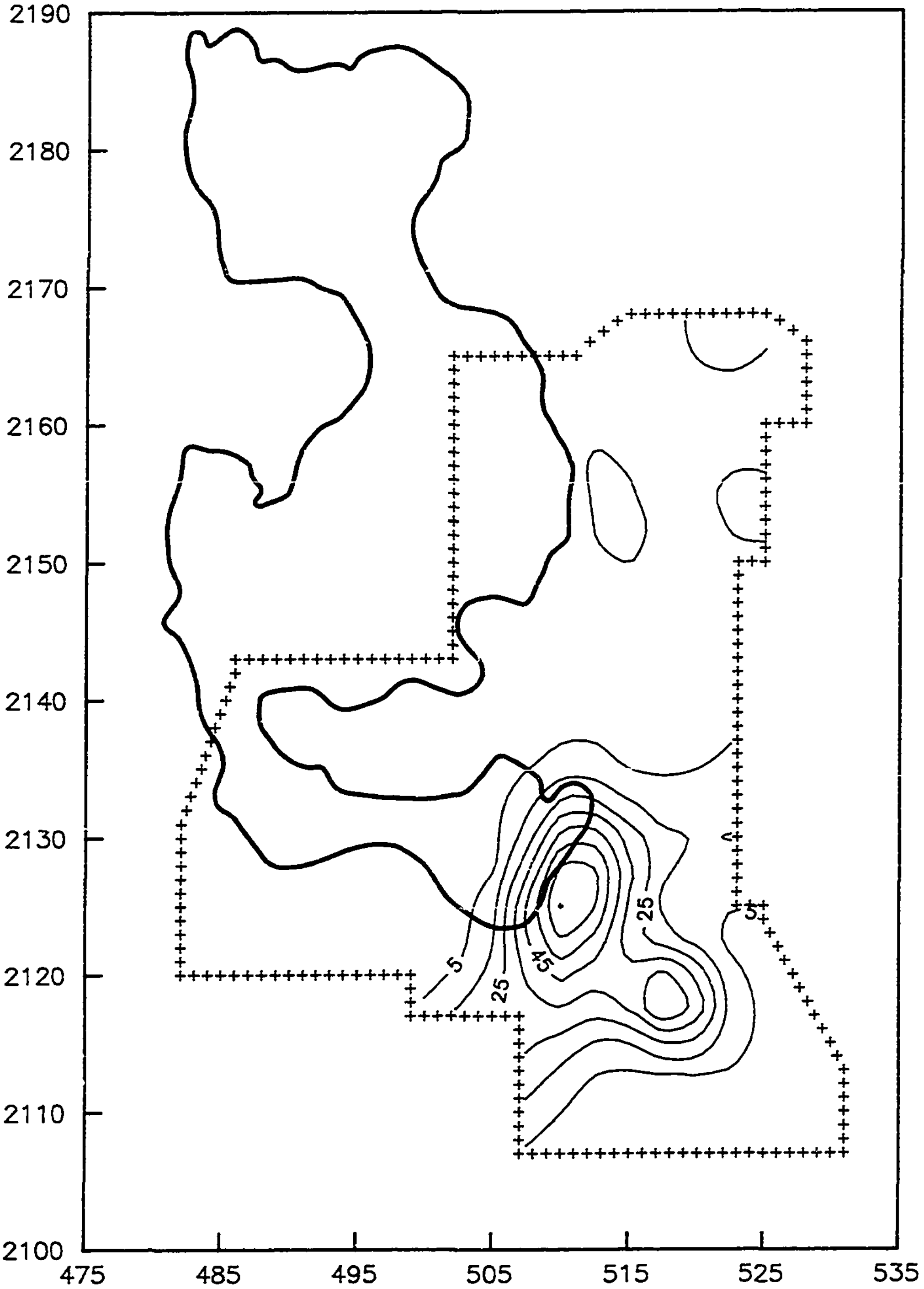


Figure VI.8. Density contour map for Black/Red Variant A. (Minimum contour = 5 sherds/ha; contour interval = 10 sherds/ha.)

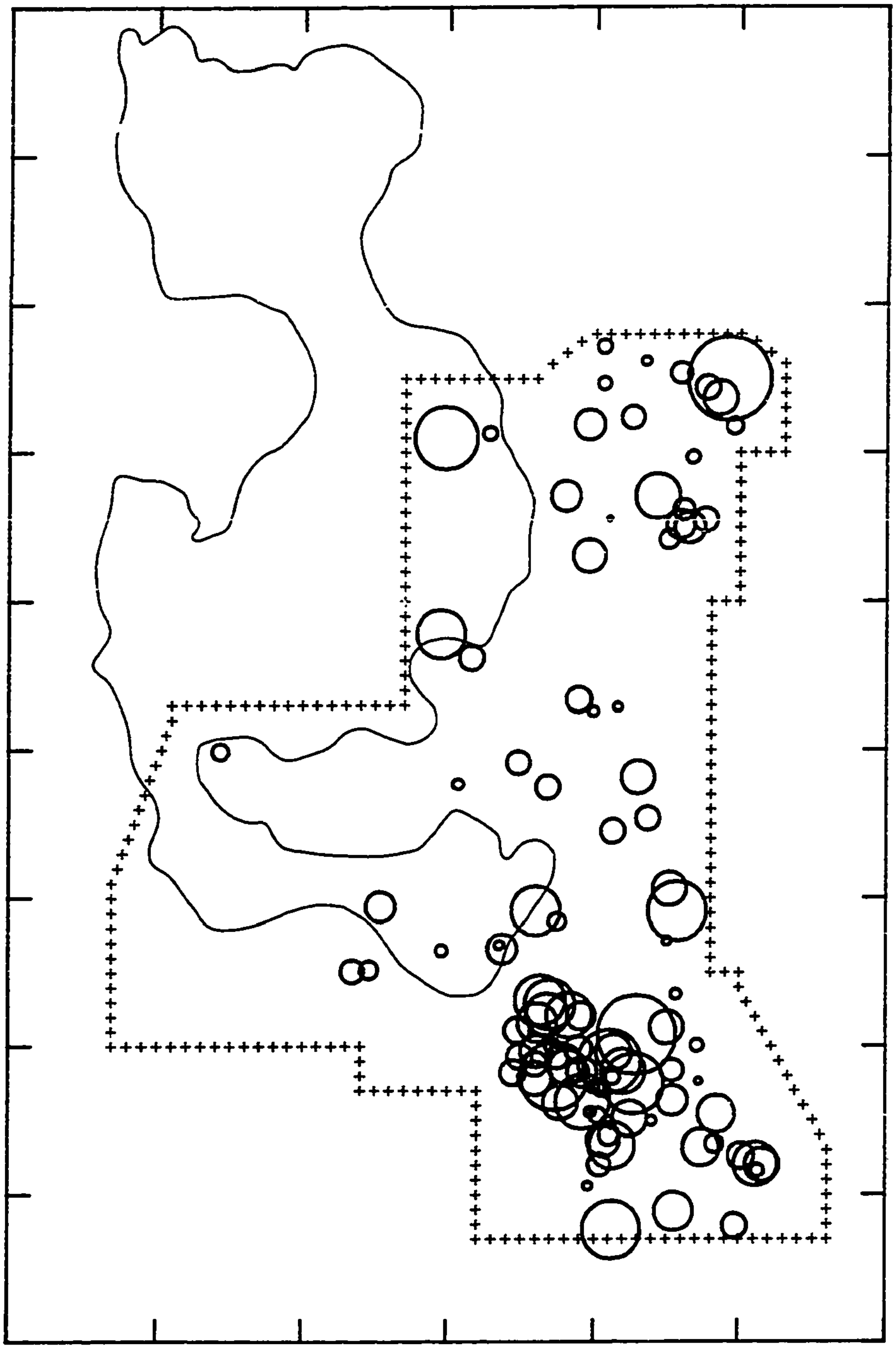


Figure VI.9. Density distribution map for Black/Red Variant B. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

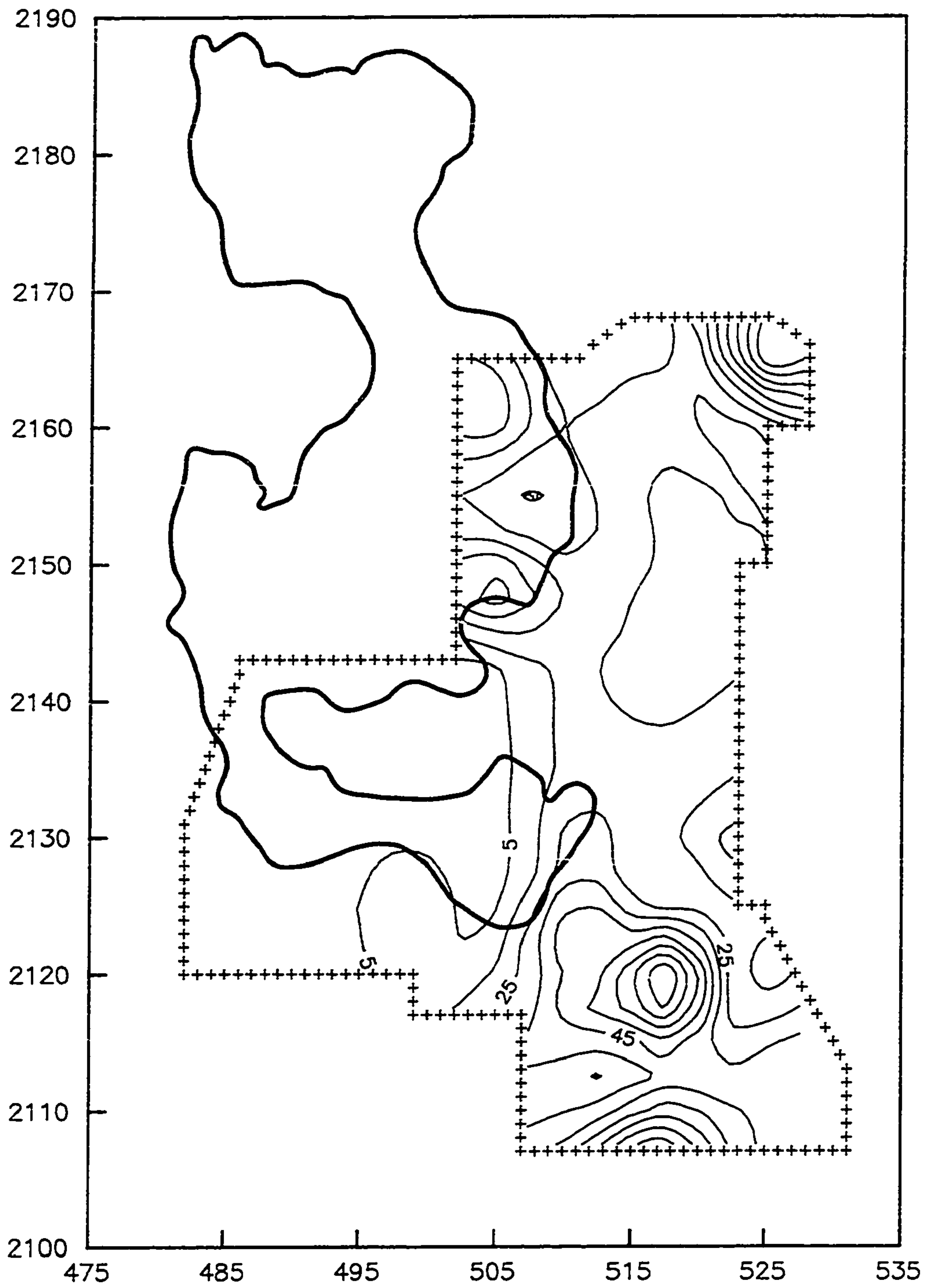


Figure VI.10. Density contour map for Black/Red Variant B. (Minimum contour = 5 sherds/ha; contour interval = 10 sherds/ha.)

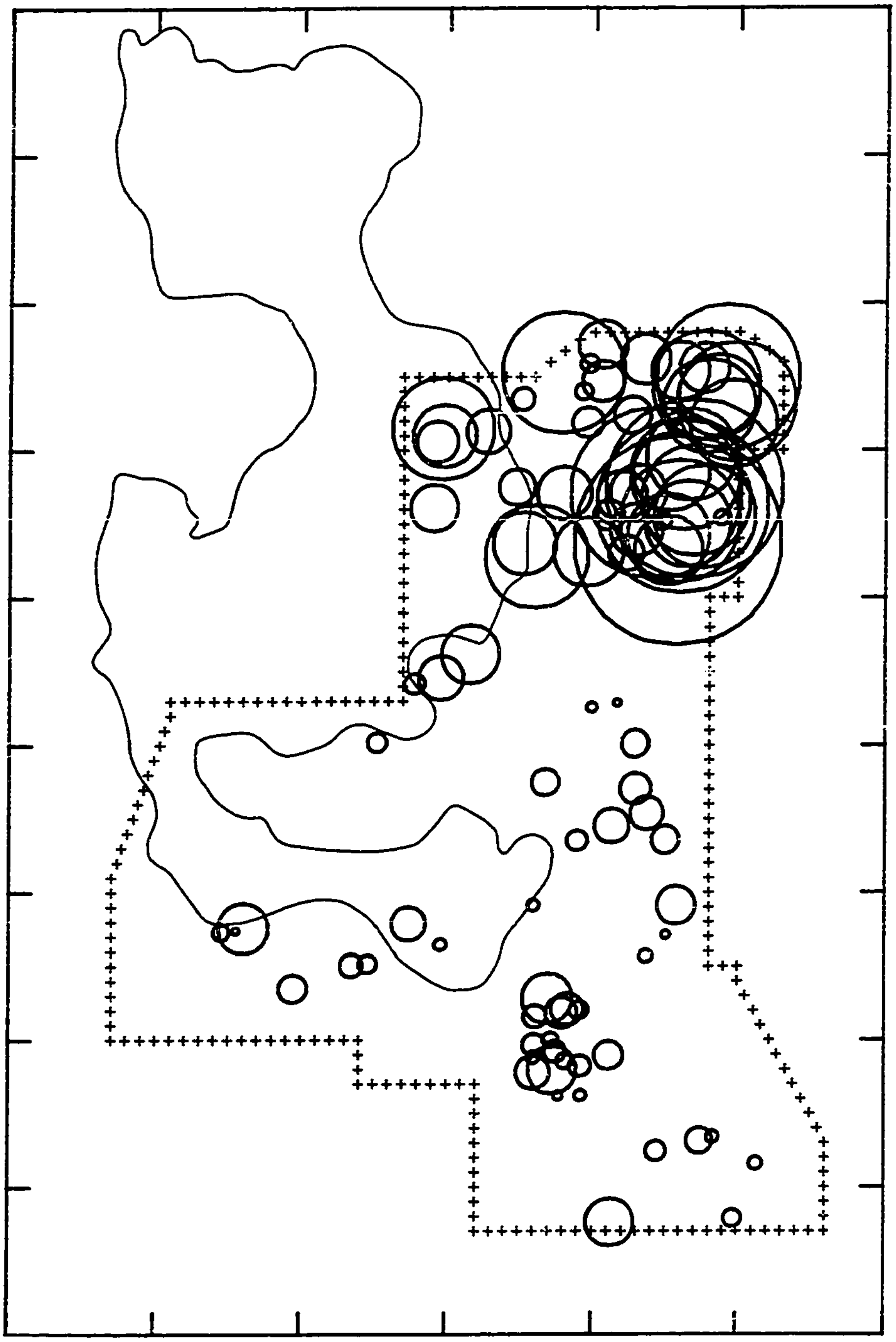


Figure VI.11. Density distribution map for Black/Red Variant C. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

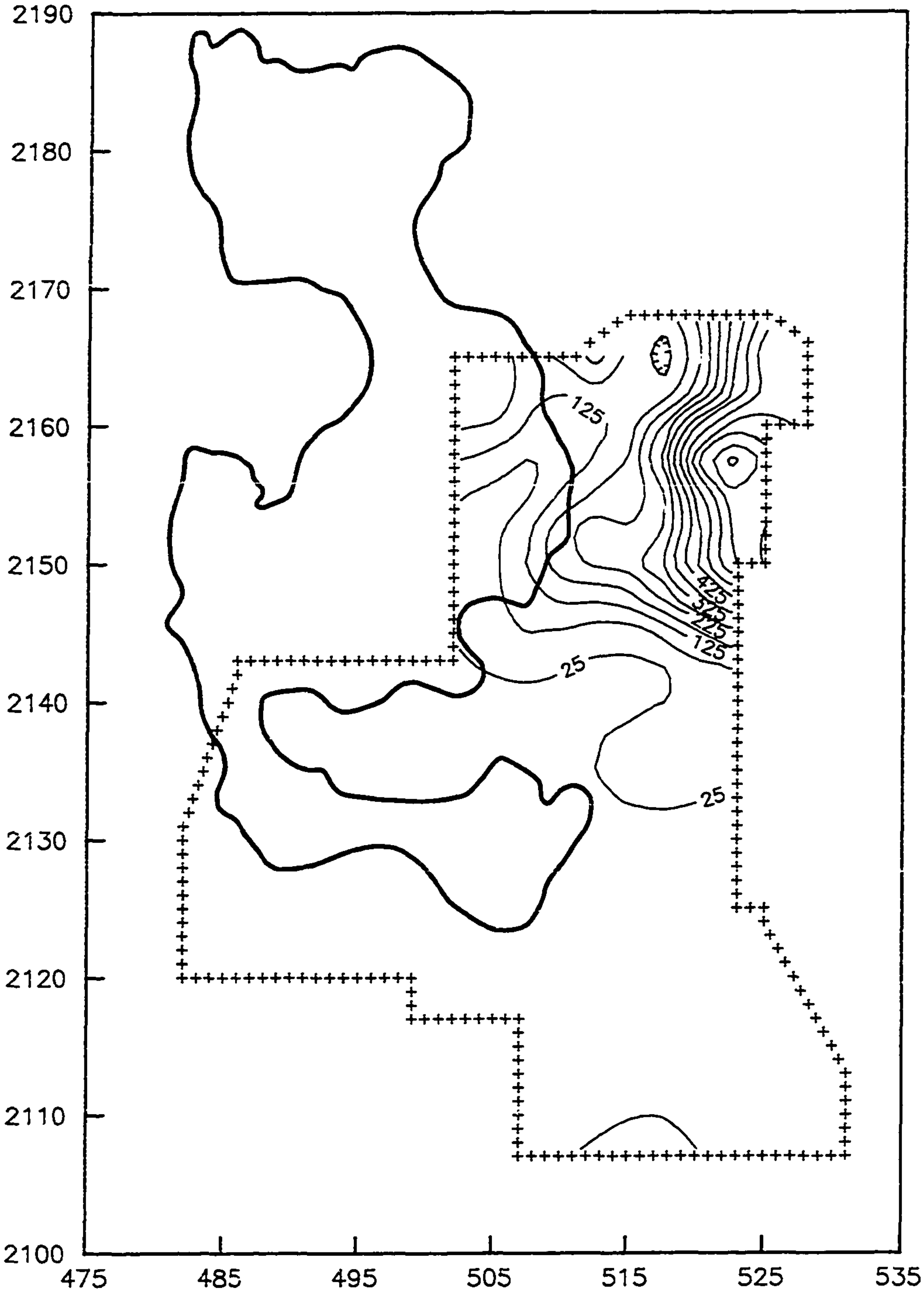


Figure VI.12. Density contour map for Black/Red Variant C. (Minimum contour = 25 sherds/ha; contour interval = 50 sherds/ha.)

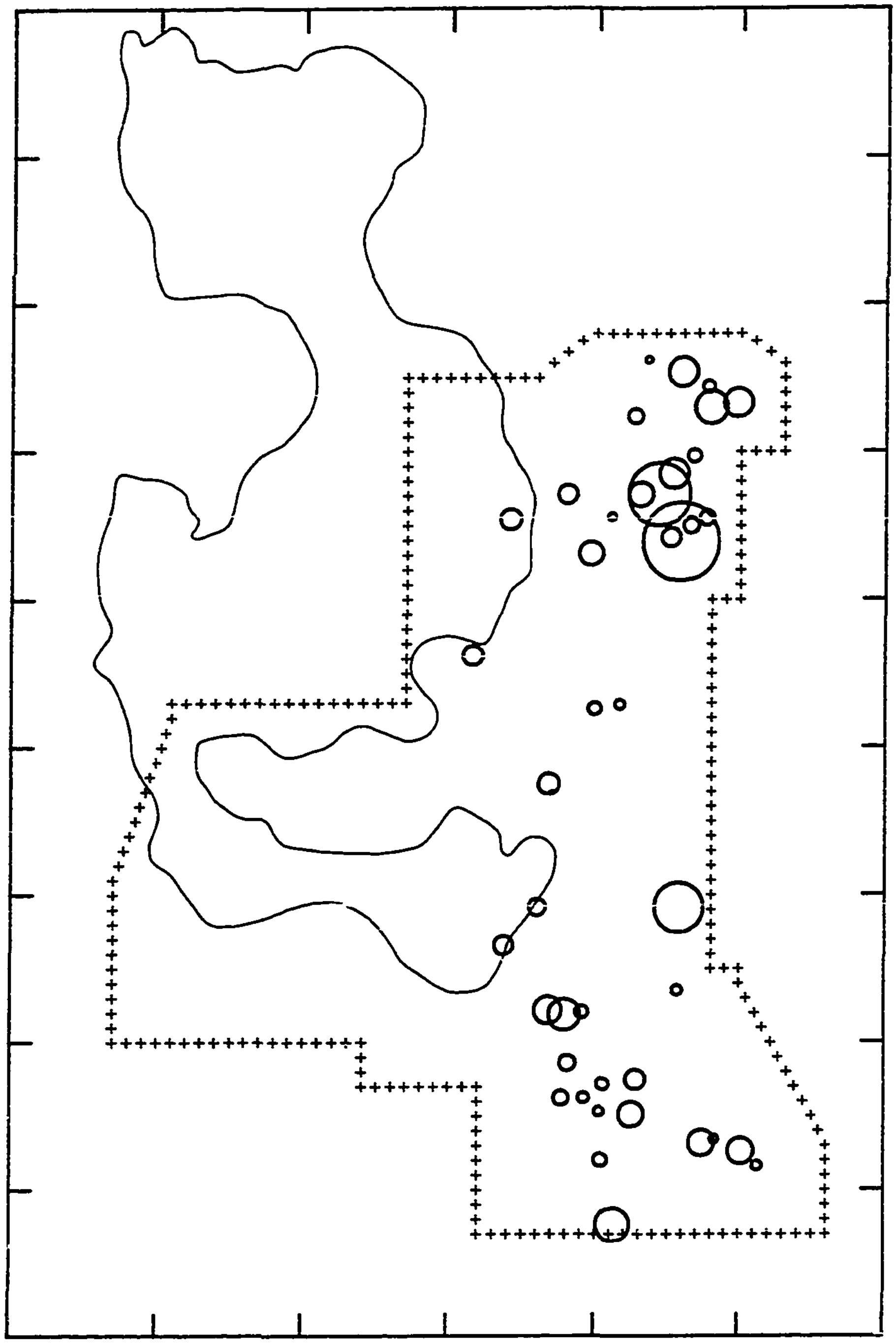


Figure VI.13. Density distribution map for Black/Red Variant D. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

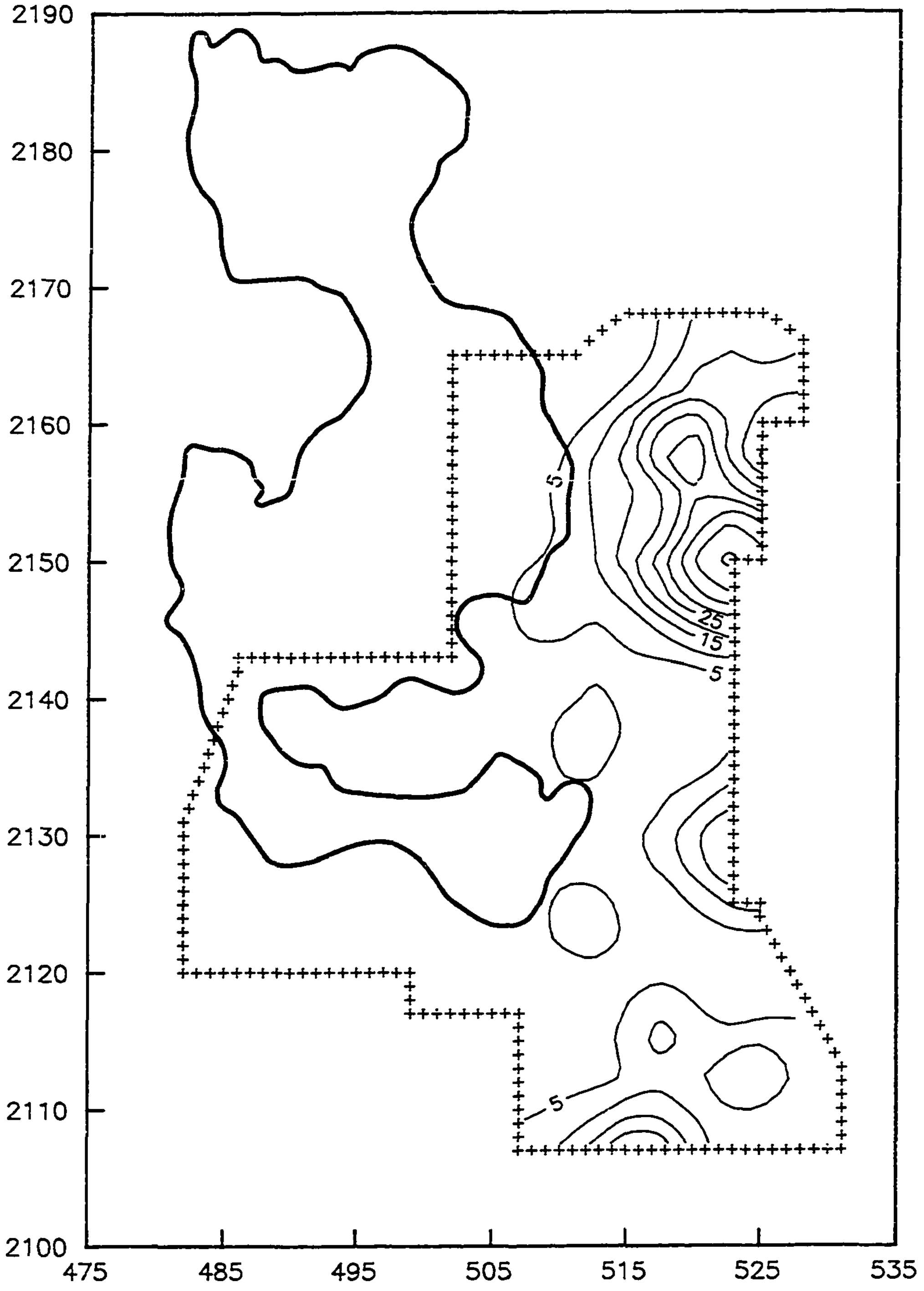


Figure VI.14. Density contour map for Black/Red Variant D. (Minimum contour = 5 sherds/ha; contour interval = 5 sherds/ha.)

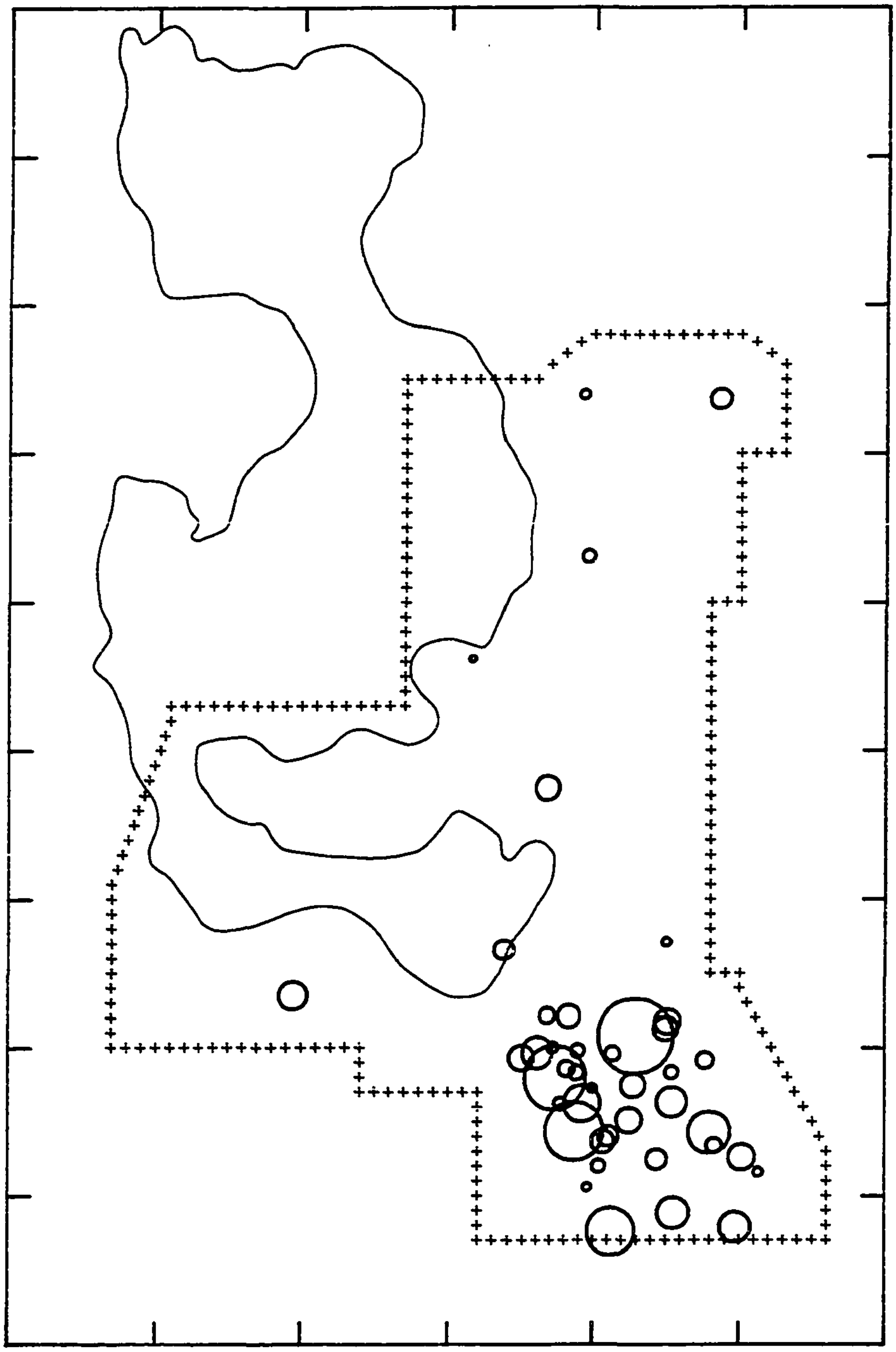


Figure VI.15. Density distribution map for Black/Red Variant E. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

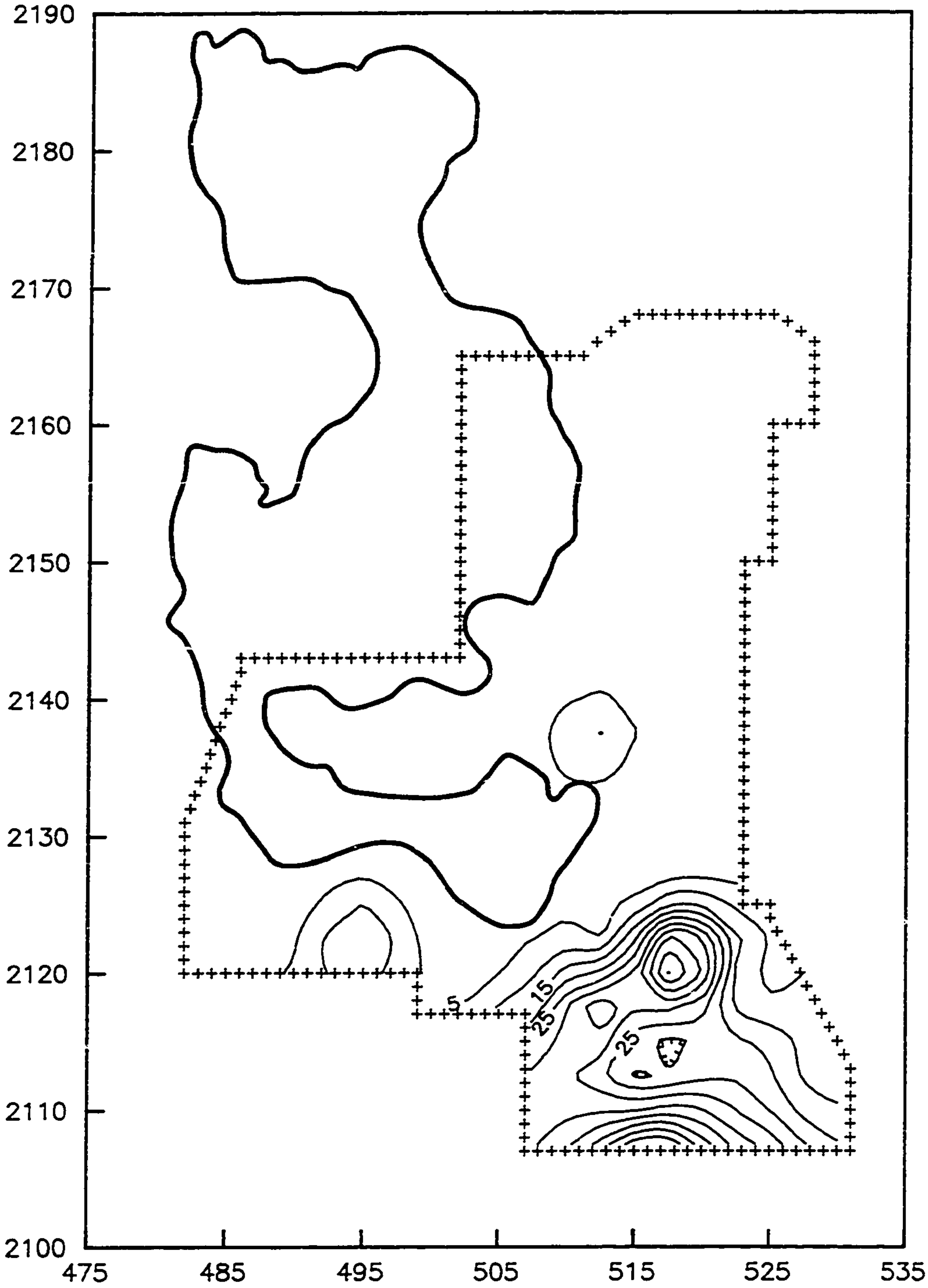


Figure VI.16. Density contour map for Black/Red Variant E. (Minimum contour = 5 sherds/ha; contour interval = 5 sherds/ha.)

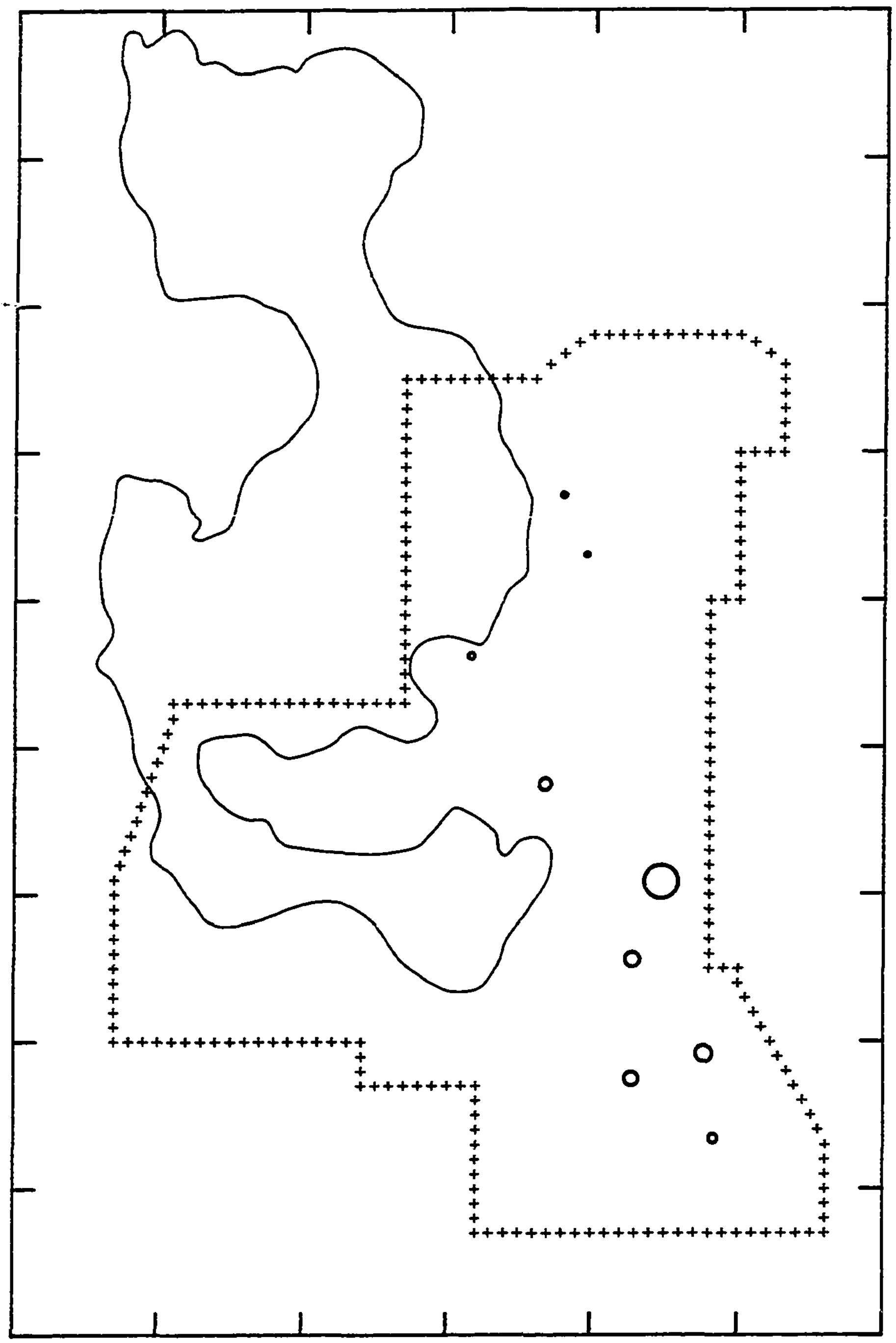


Figure VI.17. Density distribution map for Black/Red Variant F. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

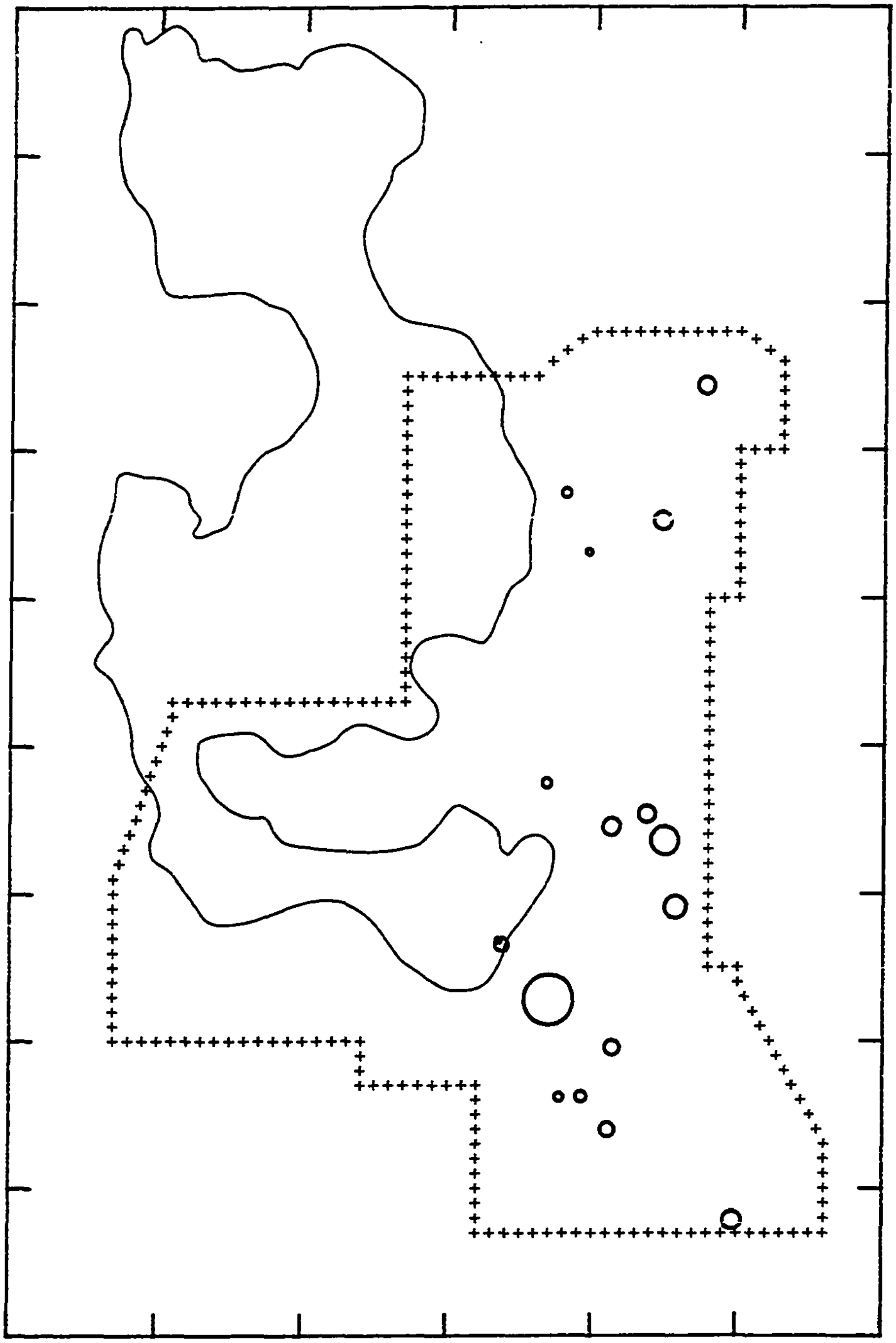


Figure VI.18. Density distribution map for Black/Red Variant G. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

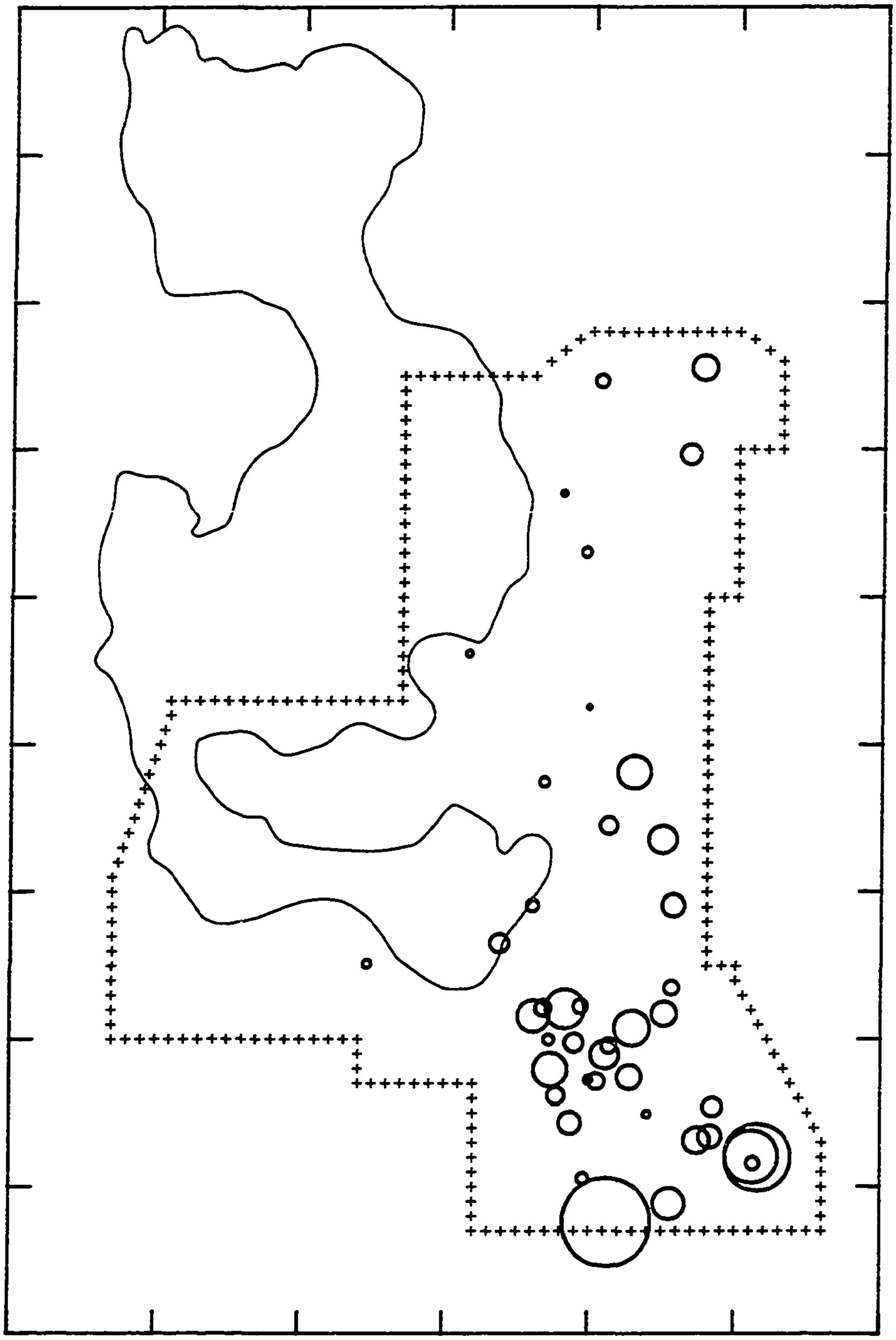


Figure VI.19. Density distribution map for Black/Red Variant H. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

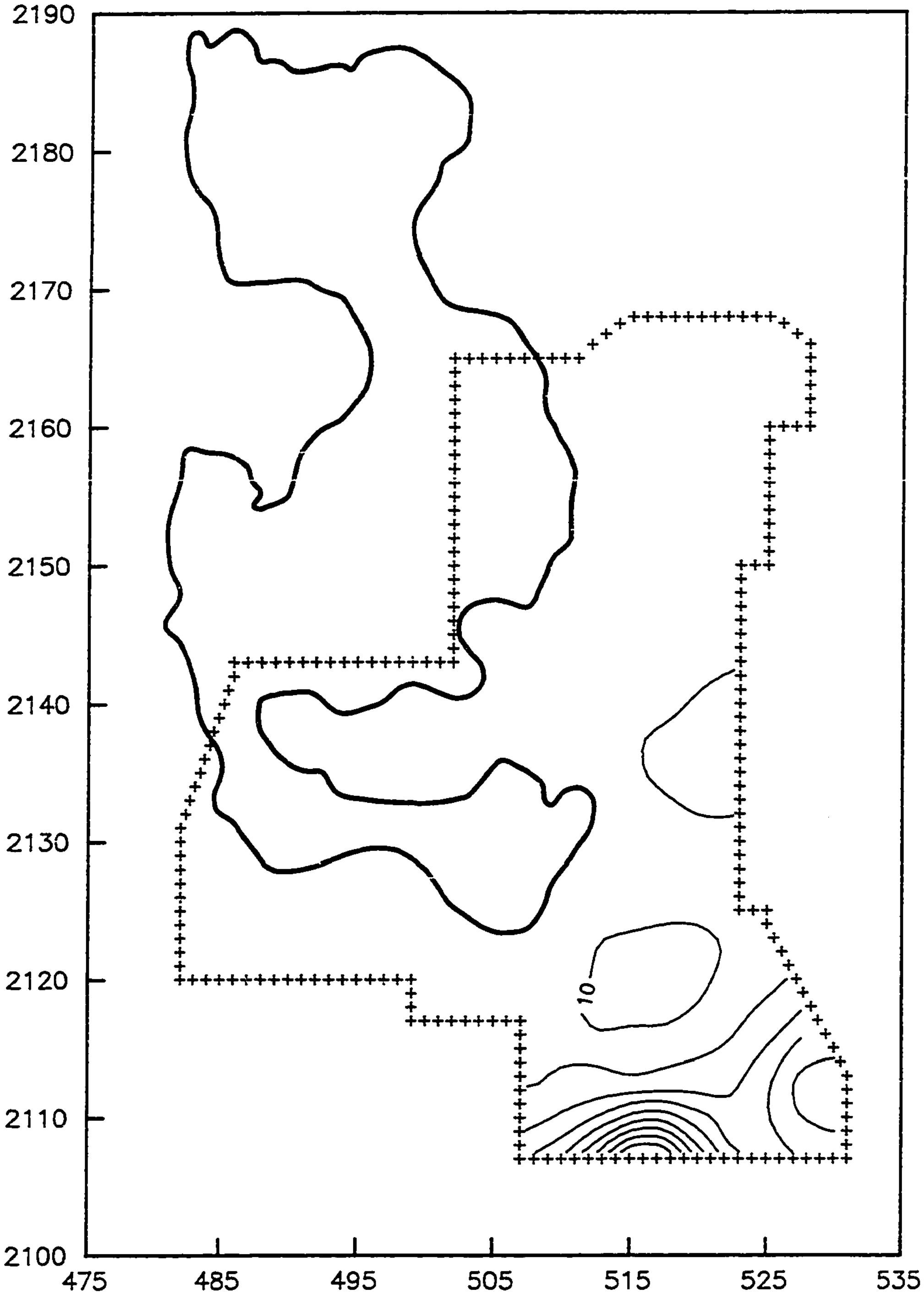


Figure VI.20. Density contour map for Black/Red Variant H. (Minimum contour = 10 sherds/ha; contour interval = 20 sherds/ha.)

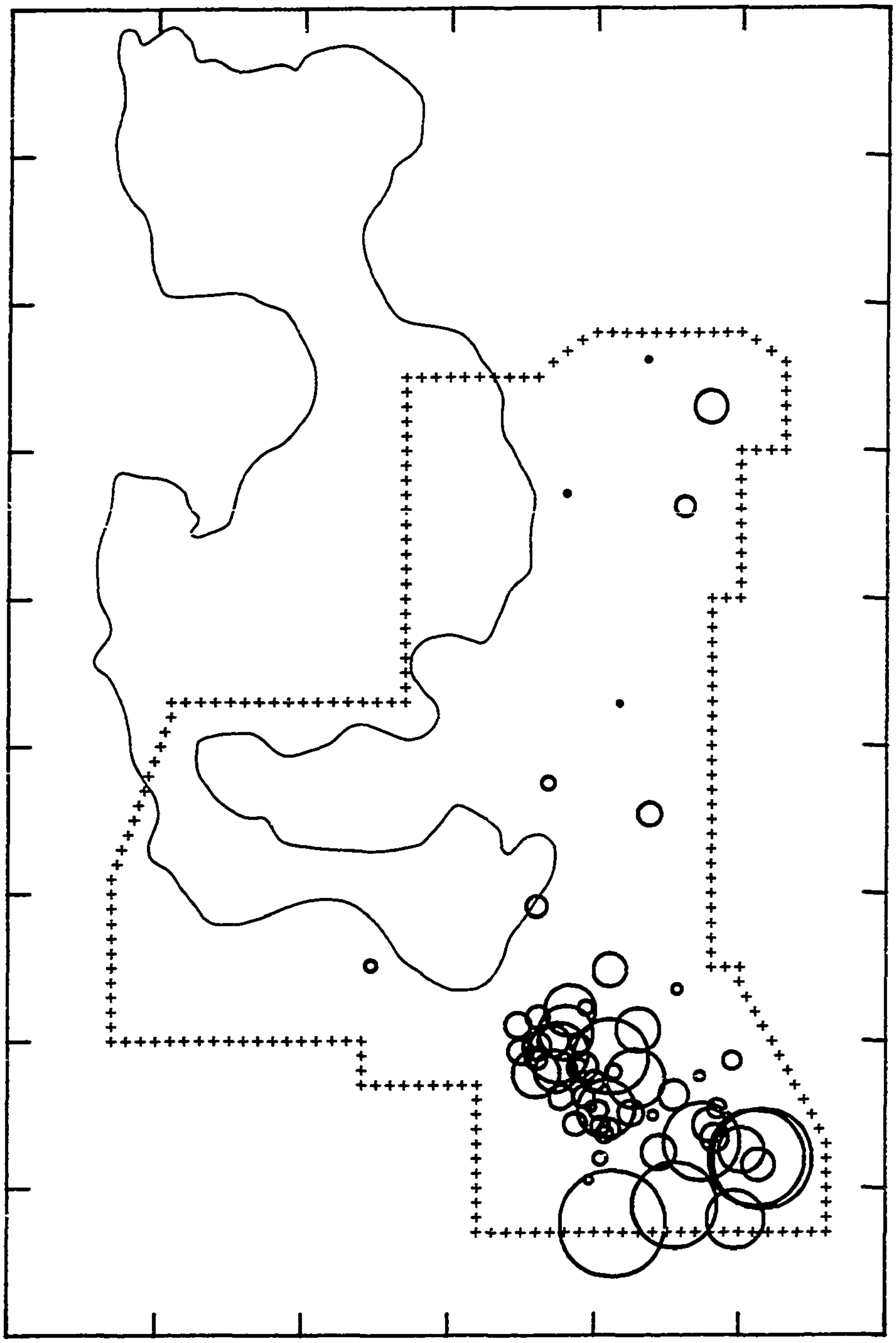


Figure VI.21. Density distribution map for Black/Red Variant I. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

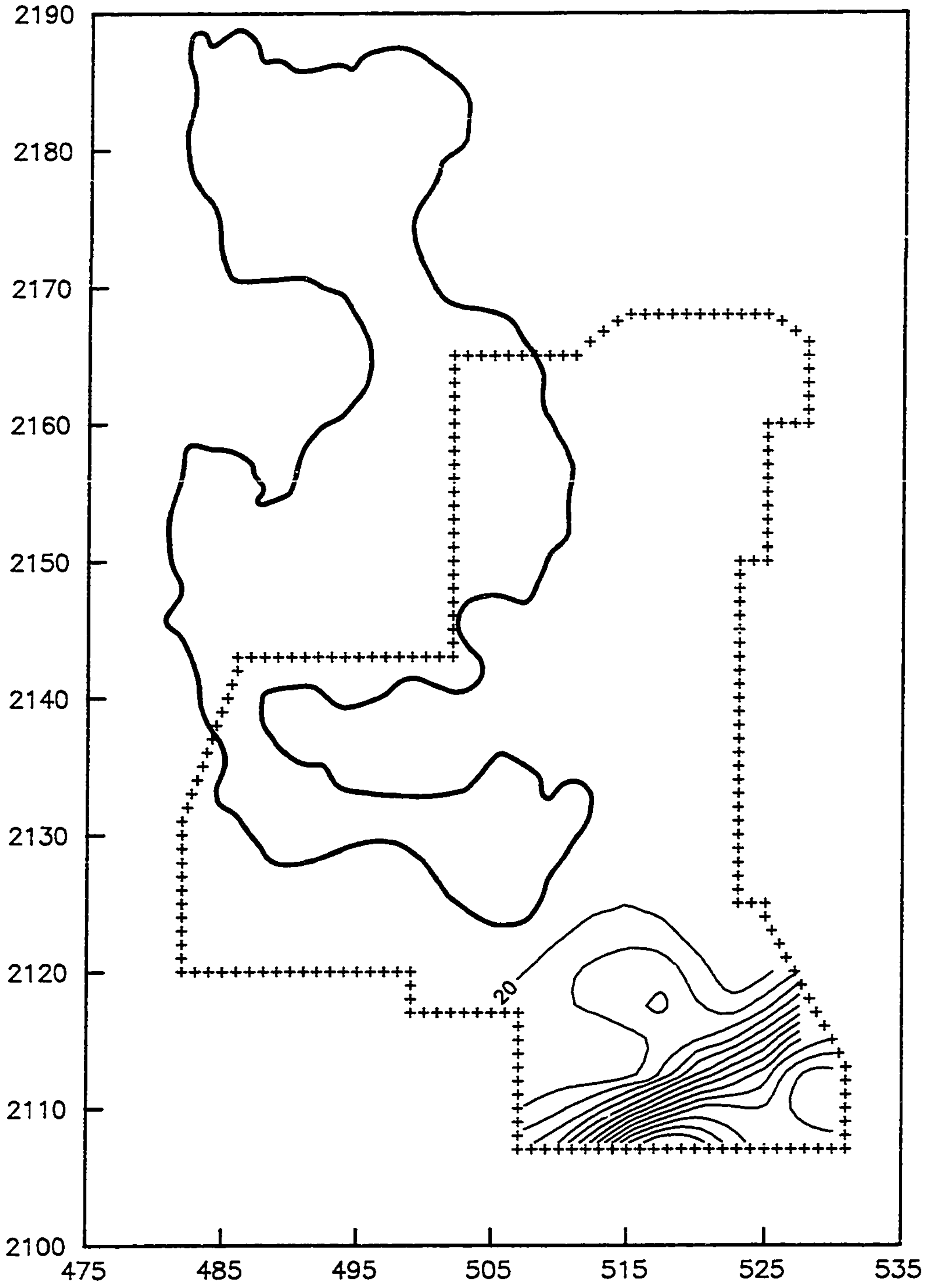


Figure VI.22. Density contour map for Black/Red Variant I. (Minimum contour = 20 sherds/ha; contour interval = 20 sherds/ha.)

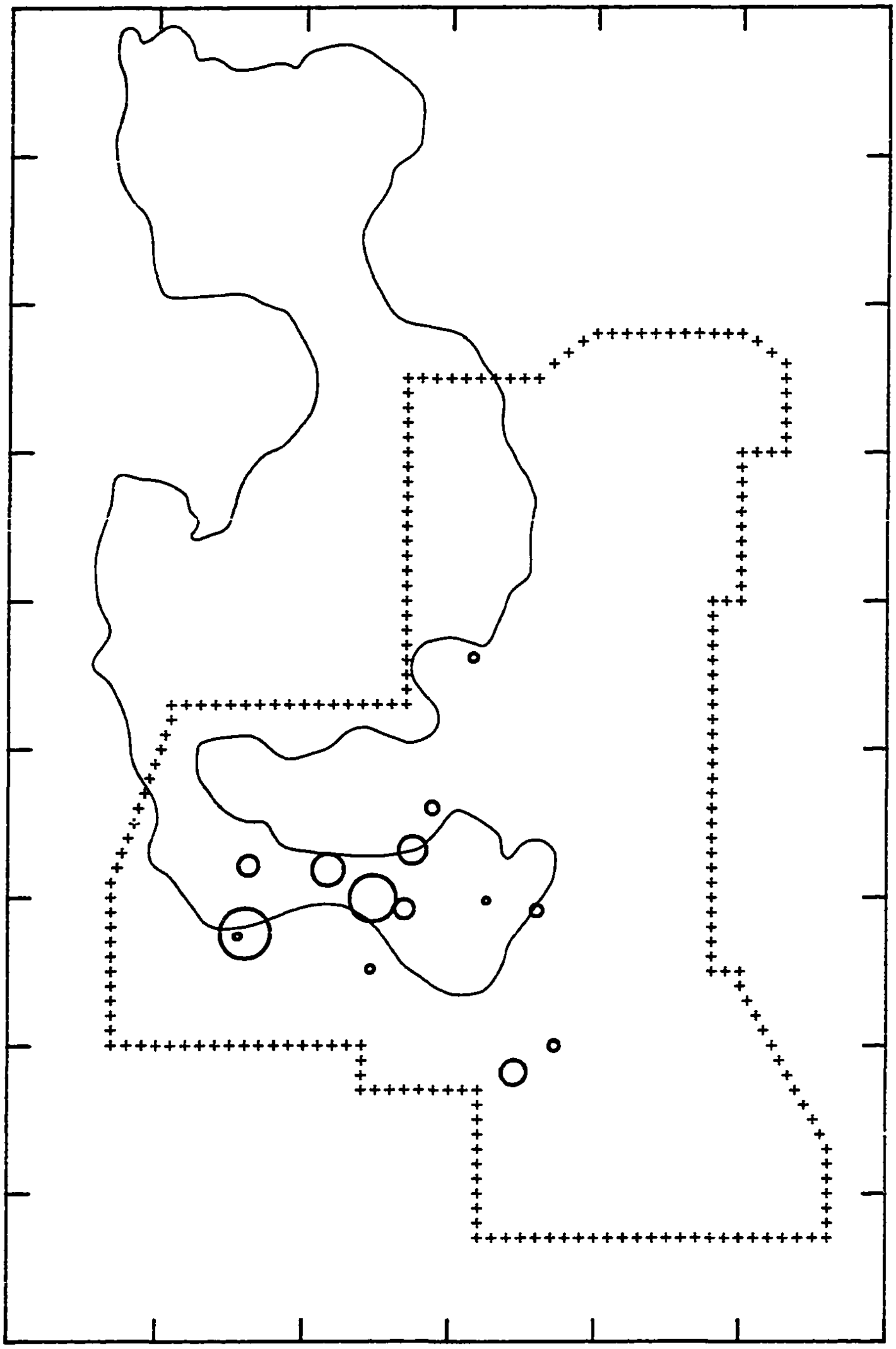


Figure VI.23. Density distribution map for Late Profile Black/Red Variant A. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

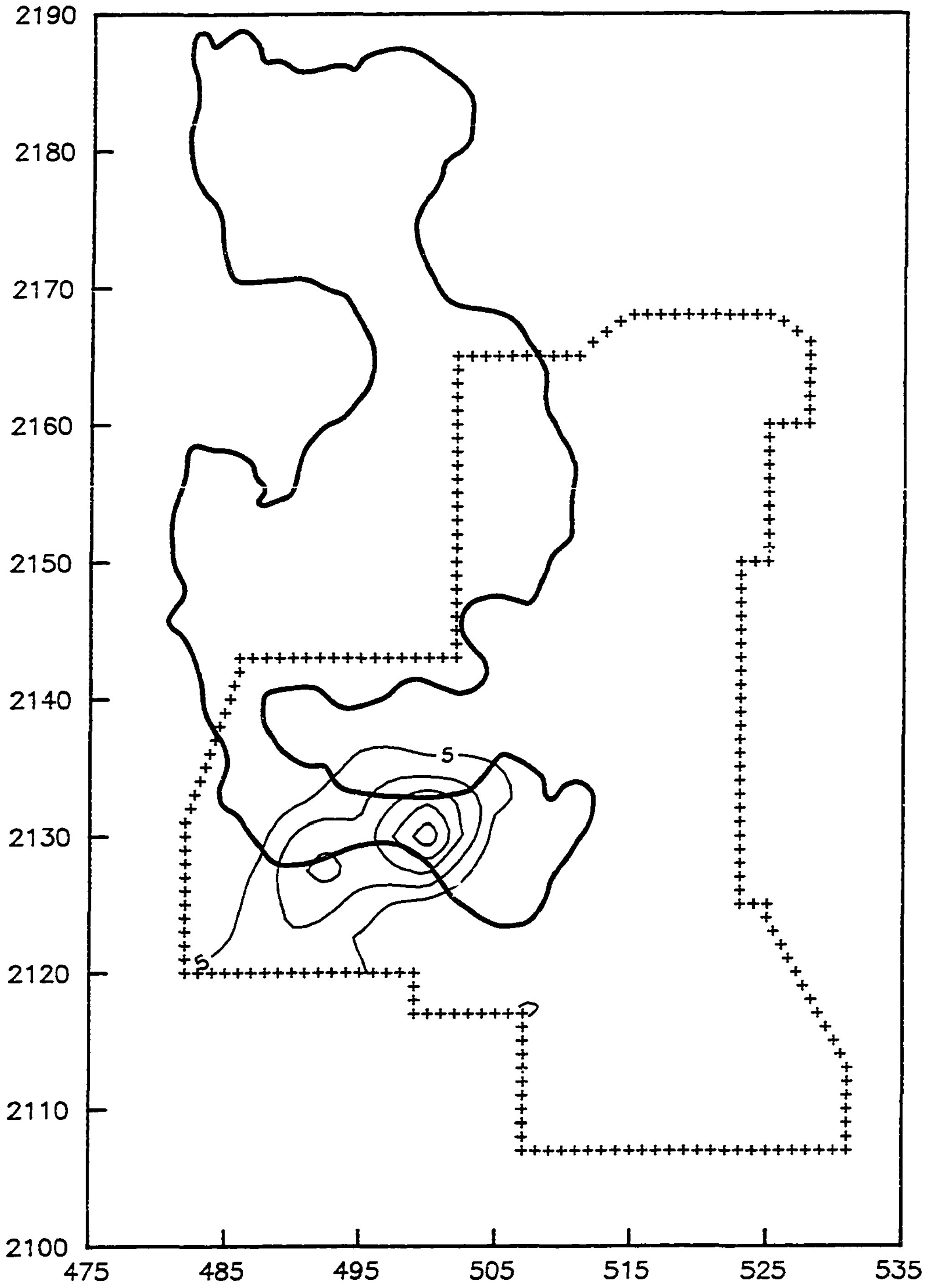


Figure VI.24. Density contour map for Late Profile Black/Red Variant A. (Minimum contour = 5 sherds/ha; contour interval = 5 sherds/ha.)

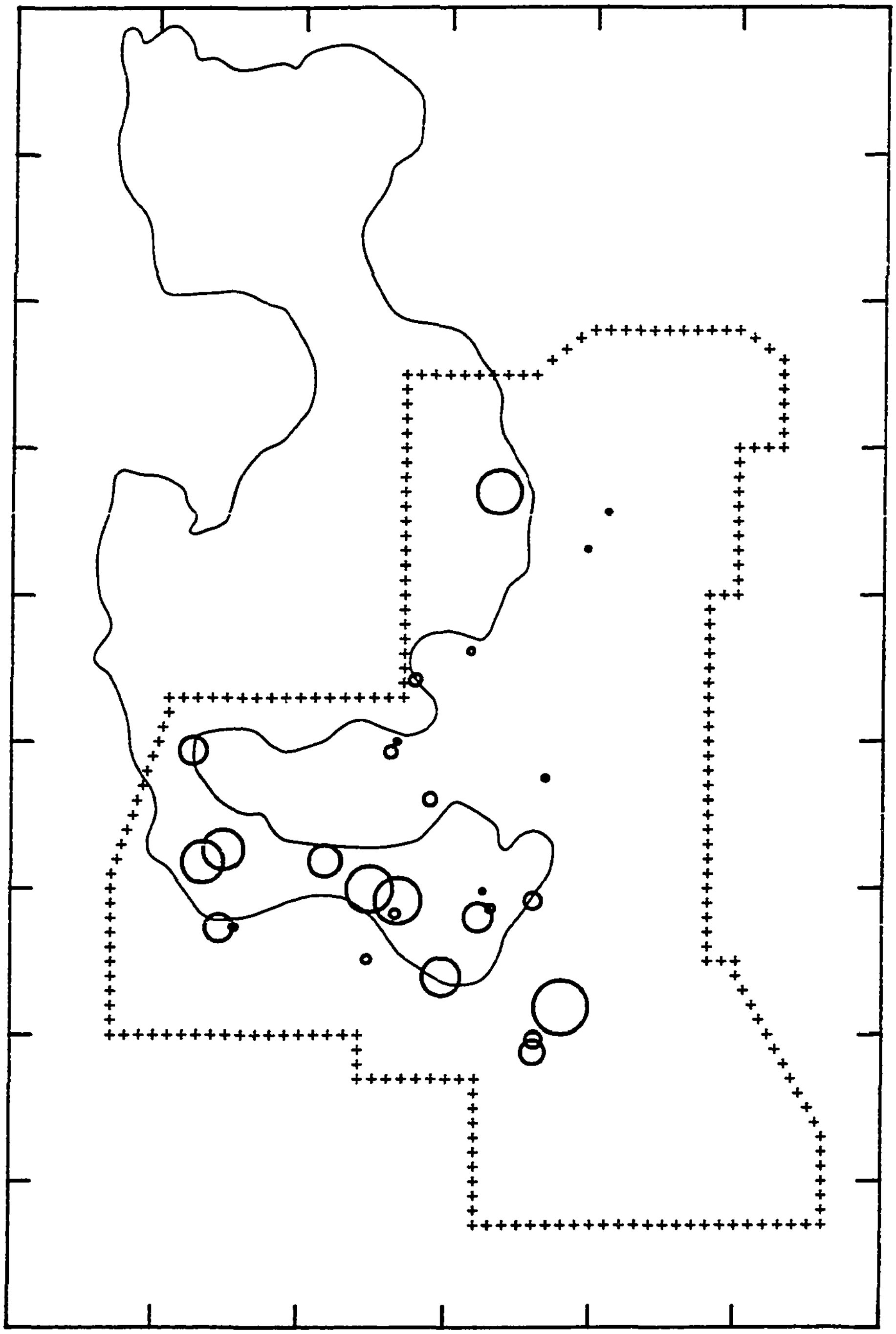


Figure VI.25. Density distribution map for Late Profile Black/Red Variant B. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

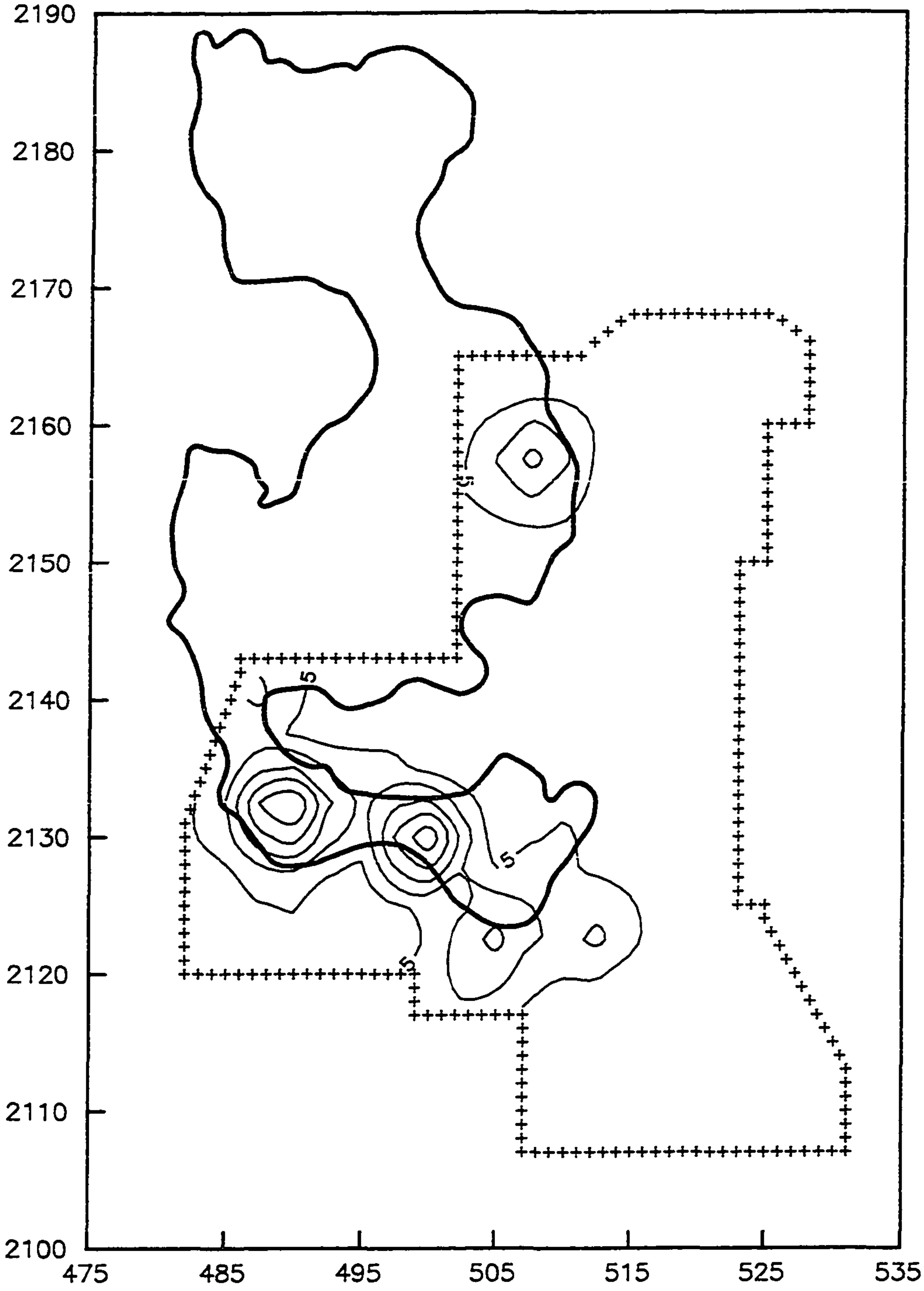


Figure VI.26. Density contour map for Late Profile Black/Red Variant B. (Minimum contour = 5 sherds/ha; contour interval = 5 sherds/ha.)

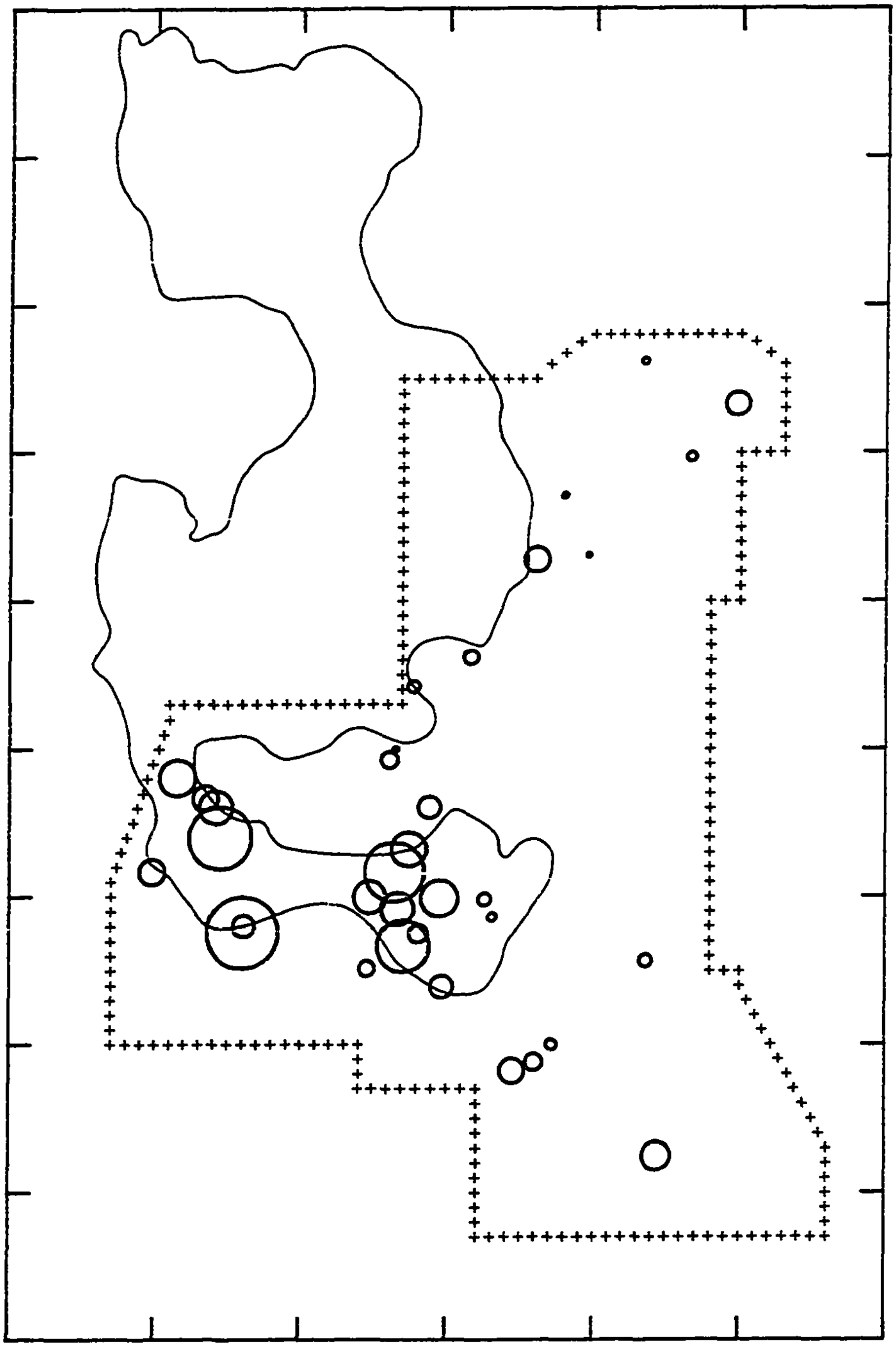


Figure VI.27. Density distribution map for Late Profile Black/Red Variant E. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

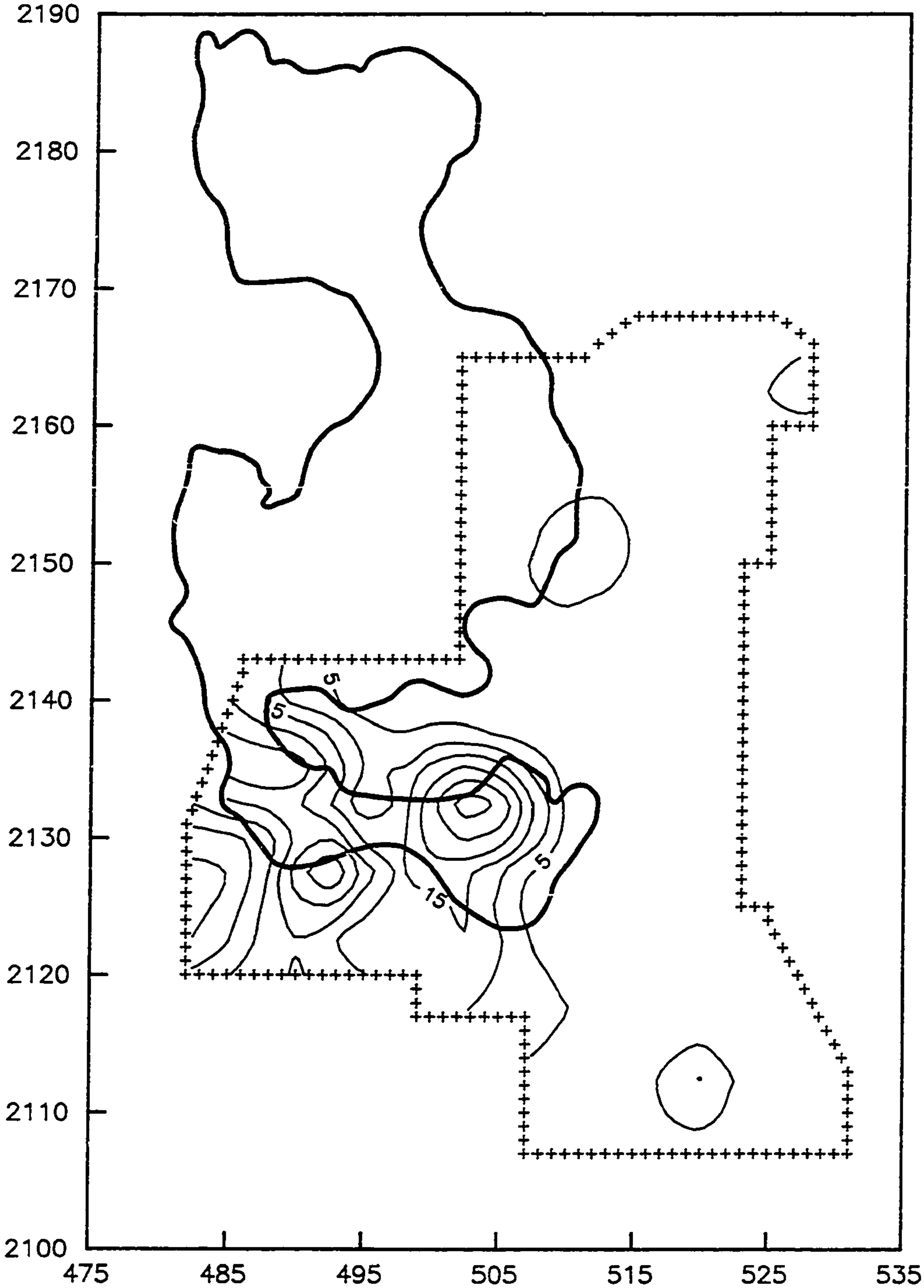


Figure VI.28. Density contour map for Late Profile Black/Red Variant E. (Minimum contour = 5 sherds/ha; contour interval = 5 sherds/ha.)

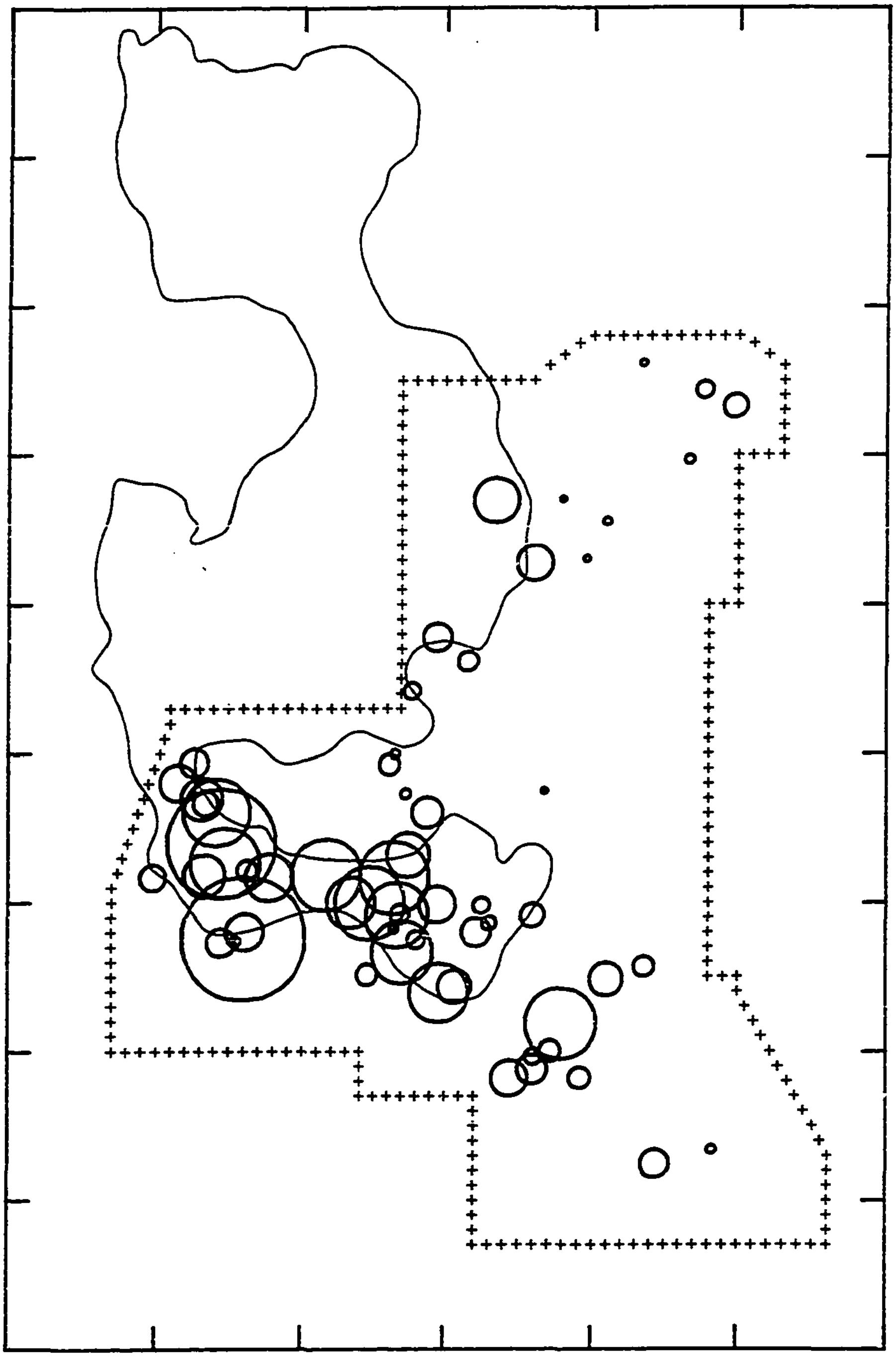


Figure VI.29. Density distribution map for Late Profile Black/Red (all variants). Size of circular symbol reflects the relative density of this type as recovered in surface collections.

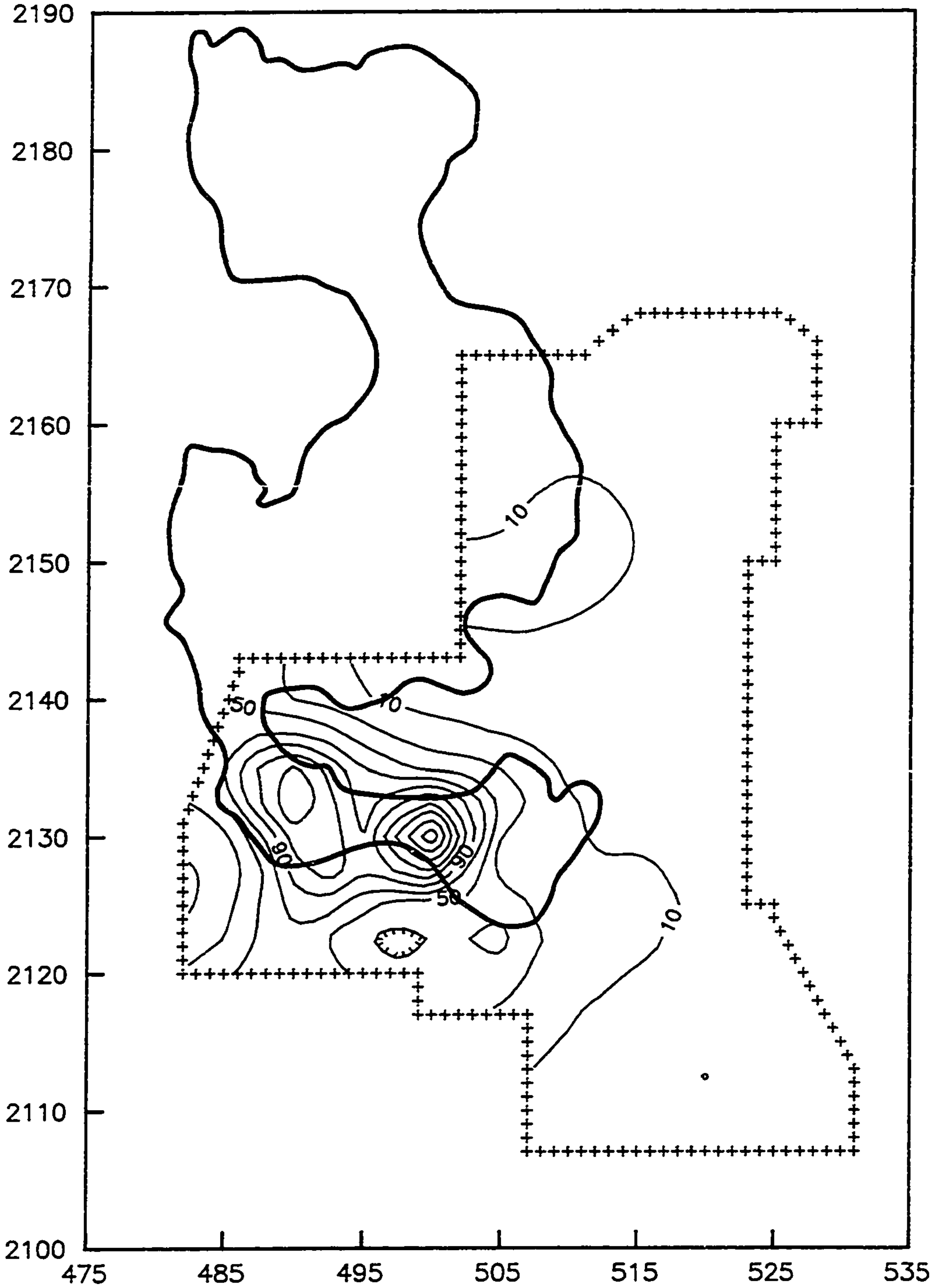


Figure VI.30. Density contour map for Late Profile Black/Red (all variants). (Minimum contour = 10 sherds/ha; contour interval = 20 sherds/ha.)

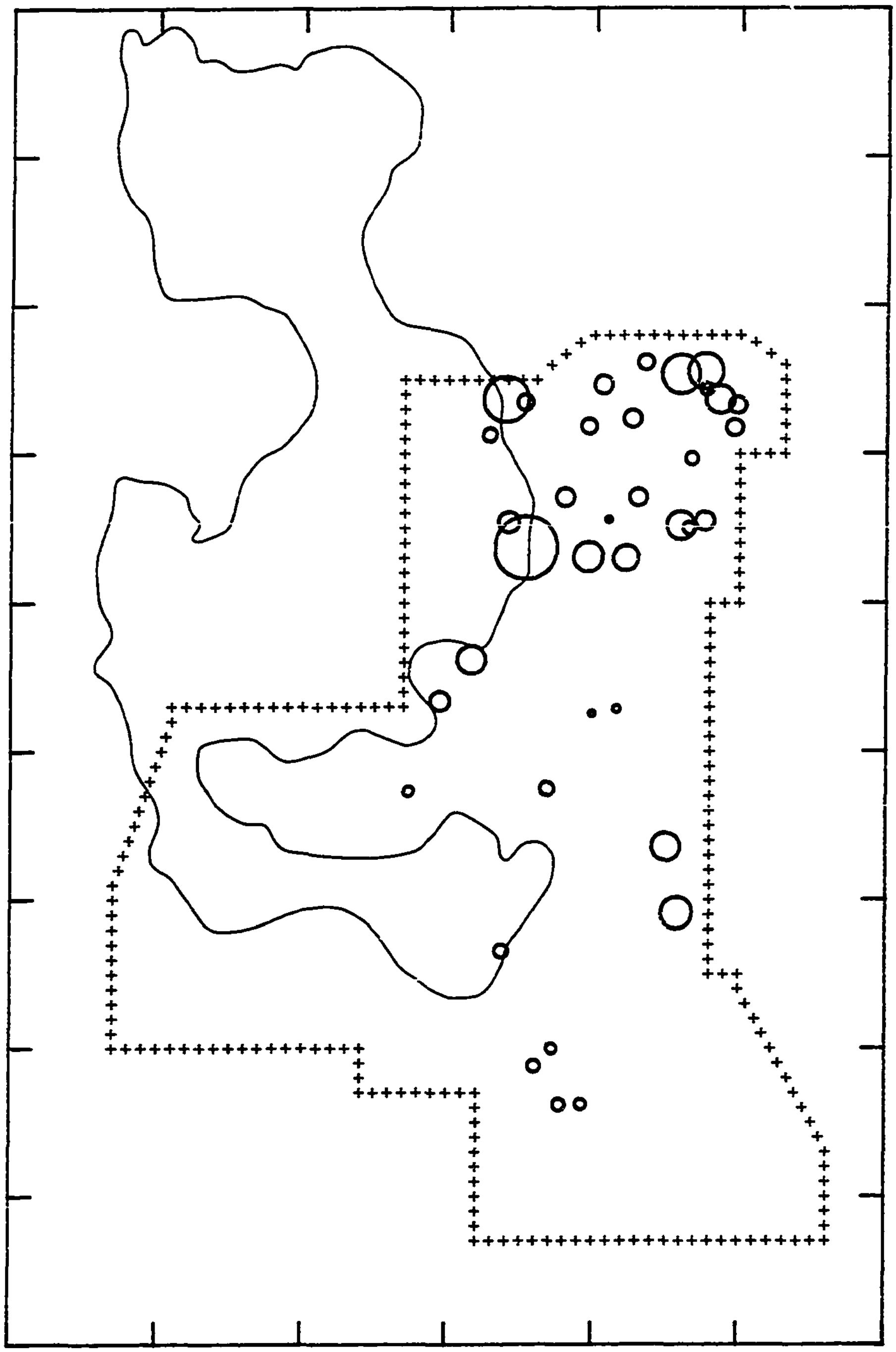


Figure VI.31. Density distribution map for Black&White/Red Subvariant AW-1. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

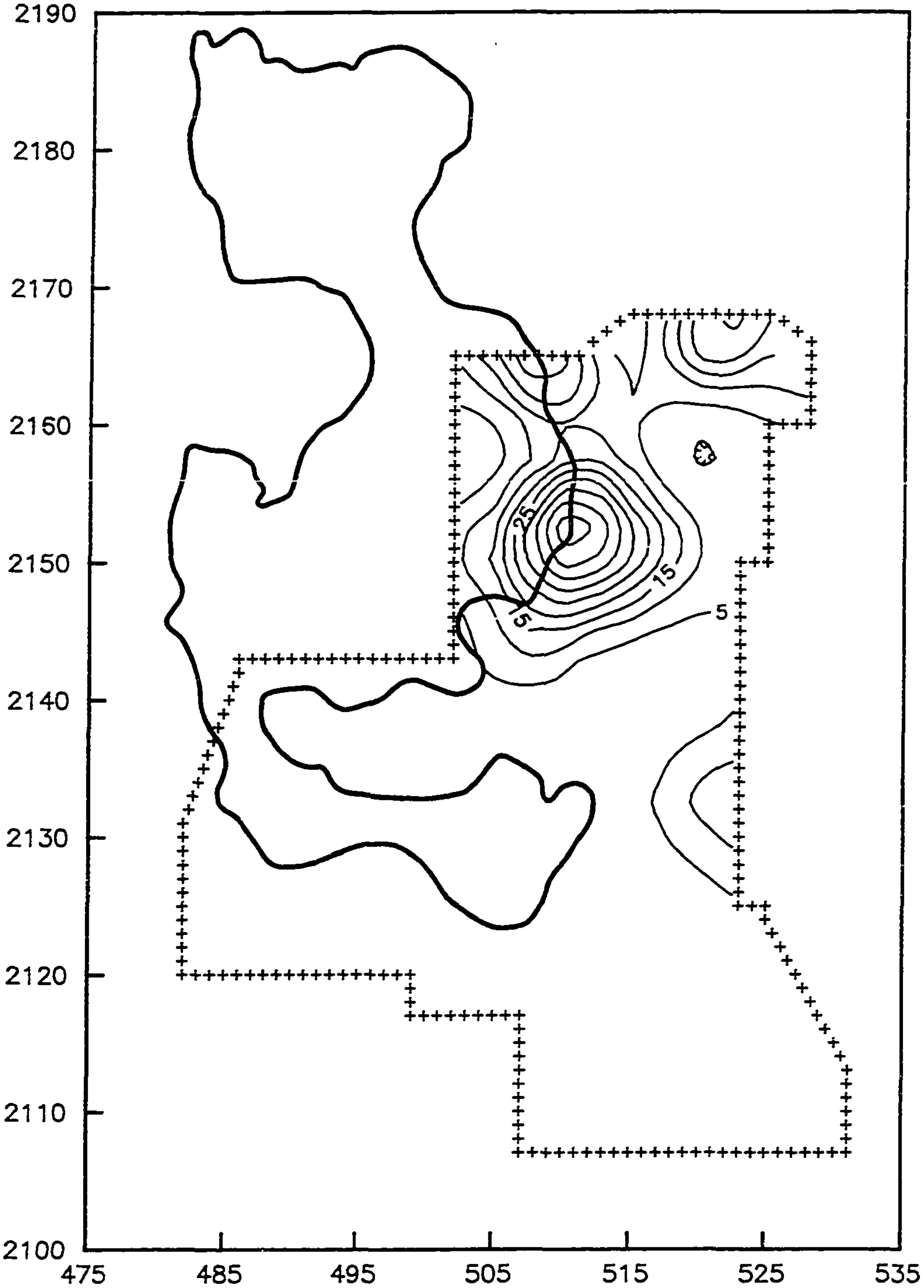


Figure VI.32. Density contour map for Black&White/Red Subvariant AW-1. (Minimum *contour = 5 sherds/ha; contour interval = 5 sherds/ha.)*

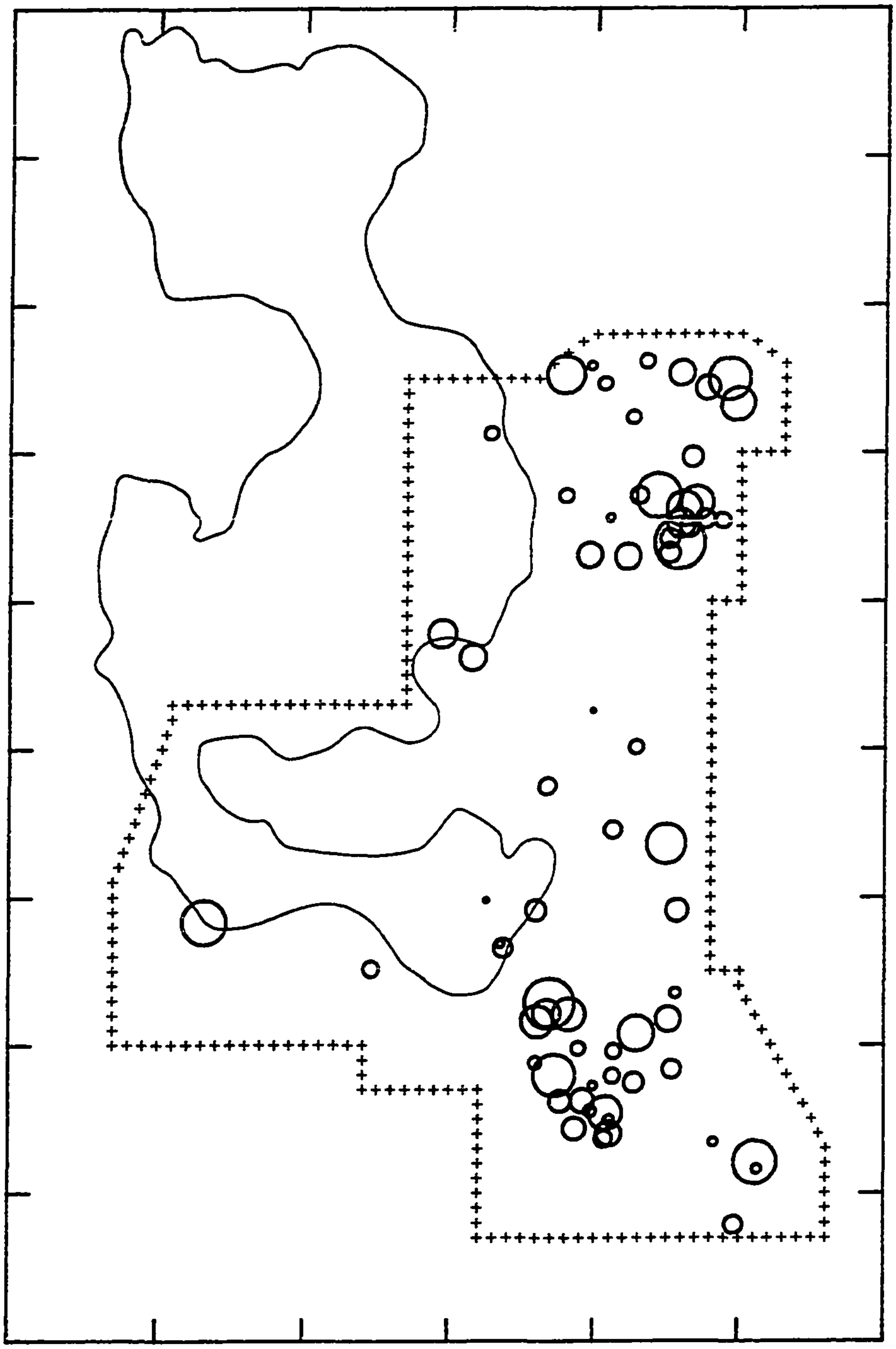


Figure VI.33. Density distribution map for Black&White/Red Subvariant AW-2. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

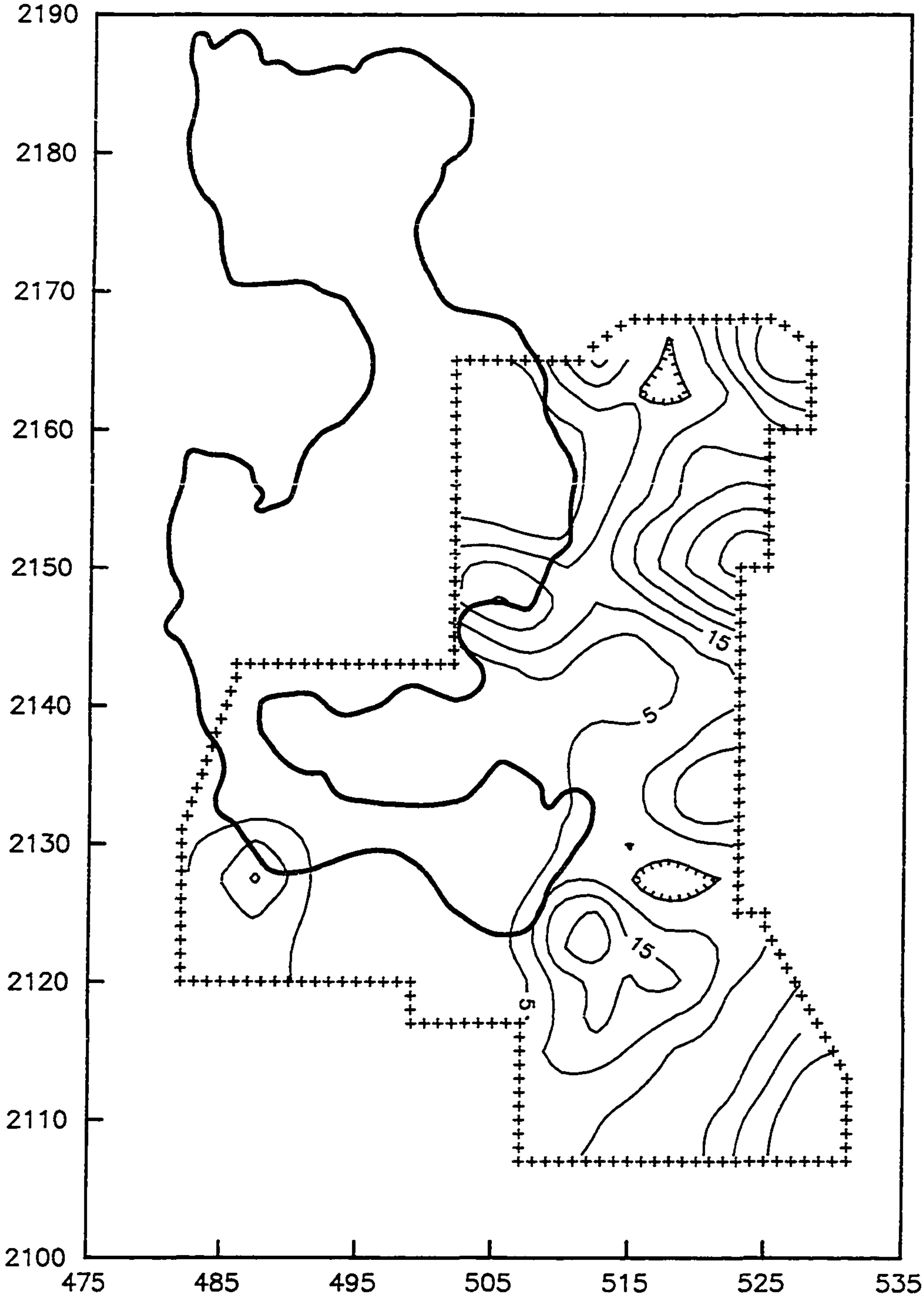


Figure VI.34. Density contour map for Black&White/Red Subvariant AW-2. (Minimum contour = 5 sherds/ha; contour interval = 5 sherds/ha.)

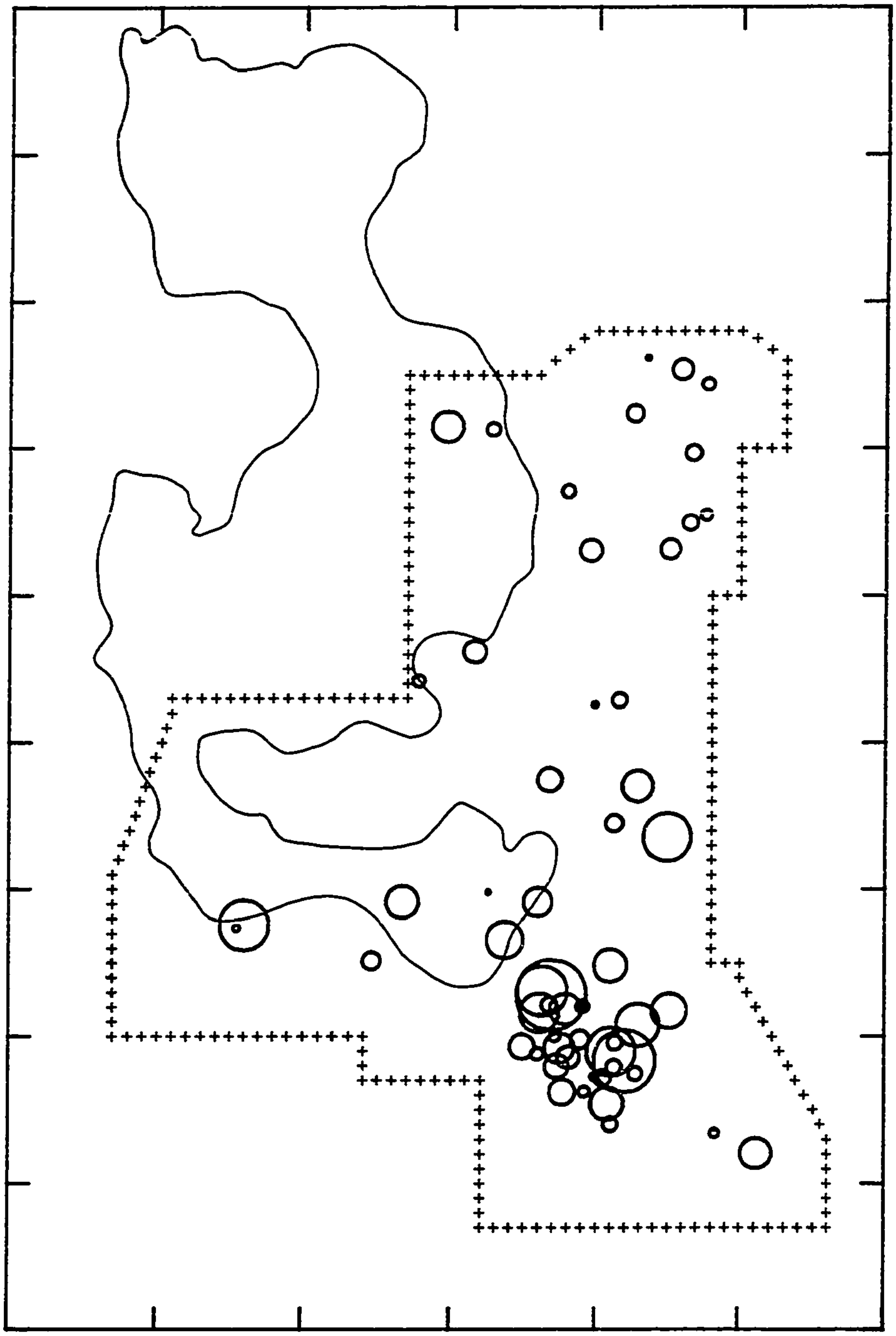


Figure VI.35. Density distribution map for Black&White/Red Variant AN. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

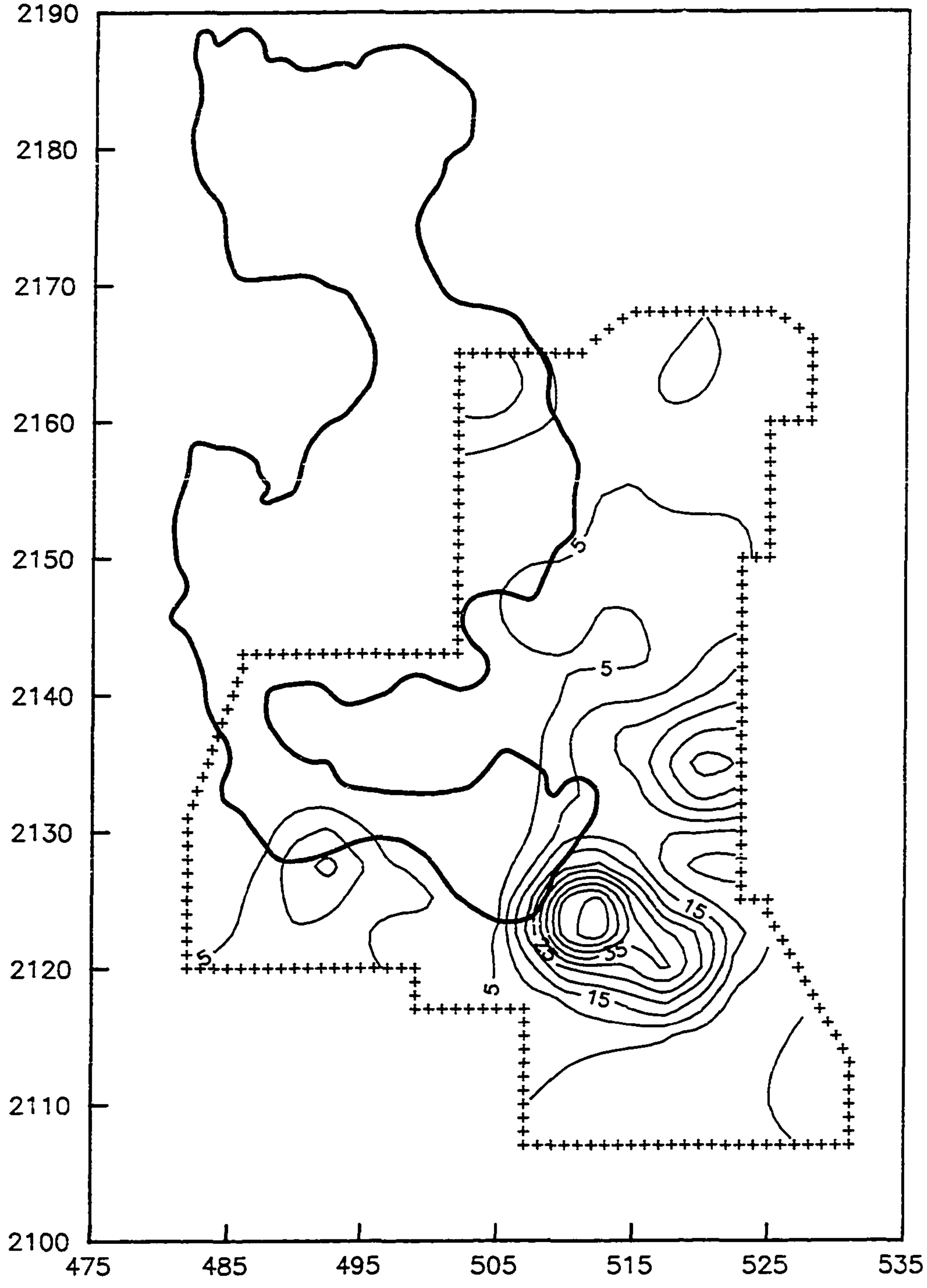


Figure VI.36. Density contour map for Black&White/Red Variant AN. (Minimum contour = 5 sherds/ha; contour interval = 5 sherds/ha.)

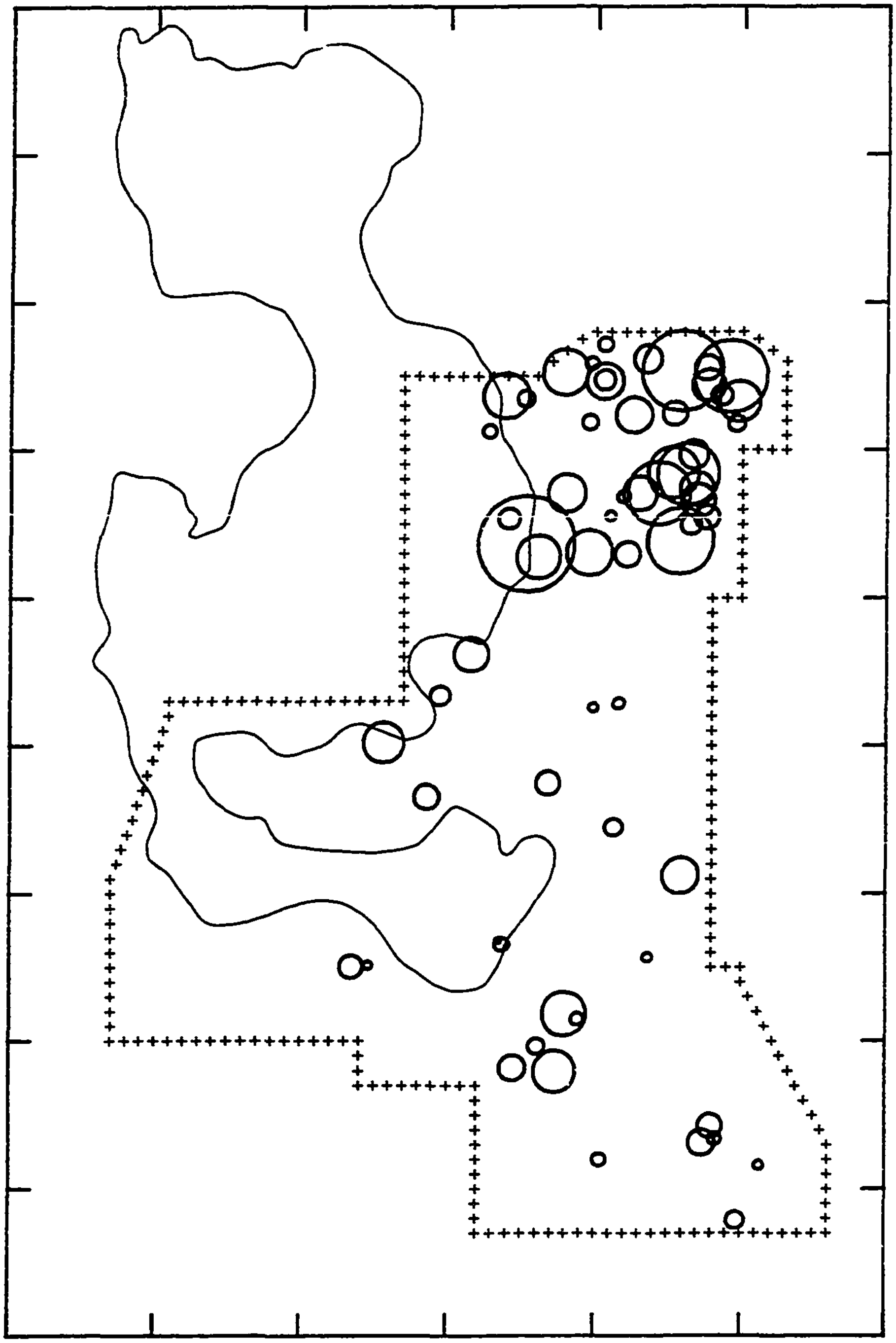


Figure VI.37. Density distribution map for Black&White/Red Variant B. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

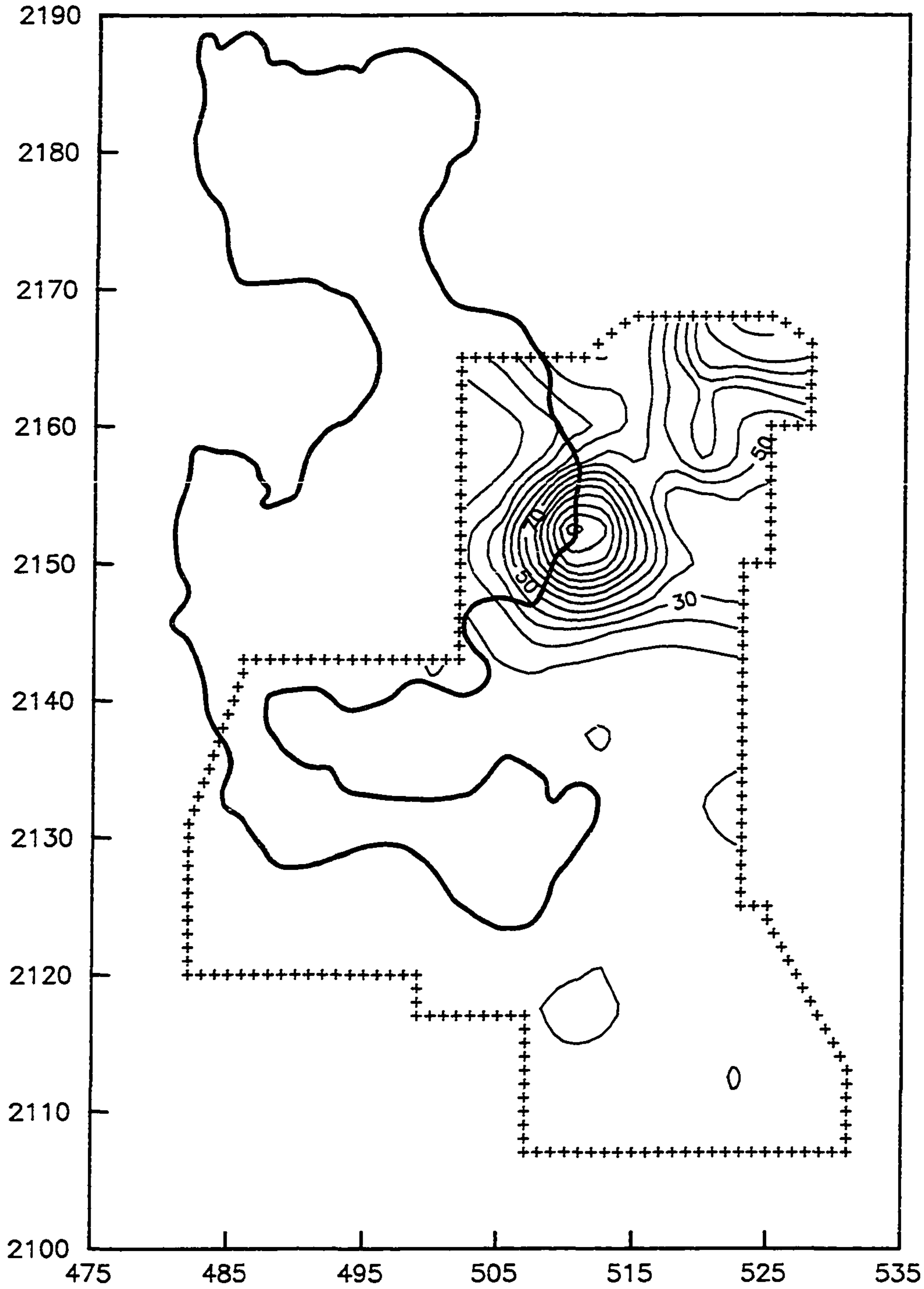


Figure VI.38. Density contour map for Black&White/Red Variant B. (Minimum contour = 10 sherds/ha; contour interval = 10 sherds/ha.)

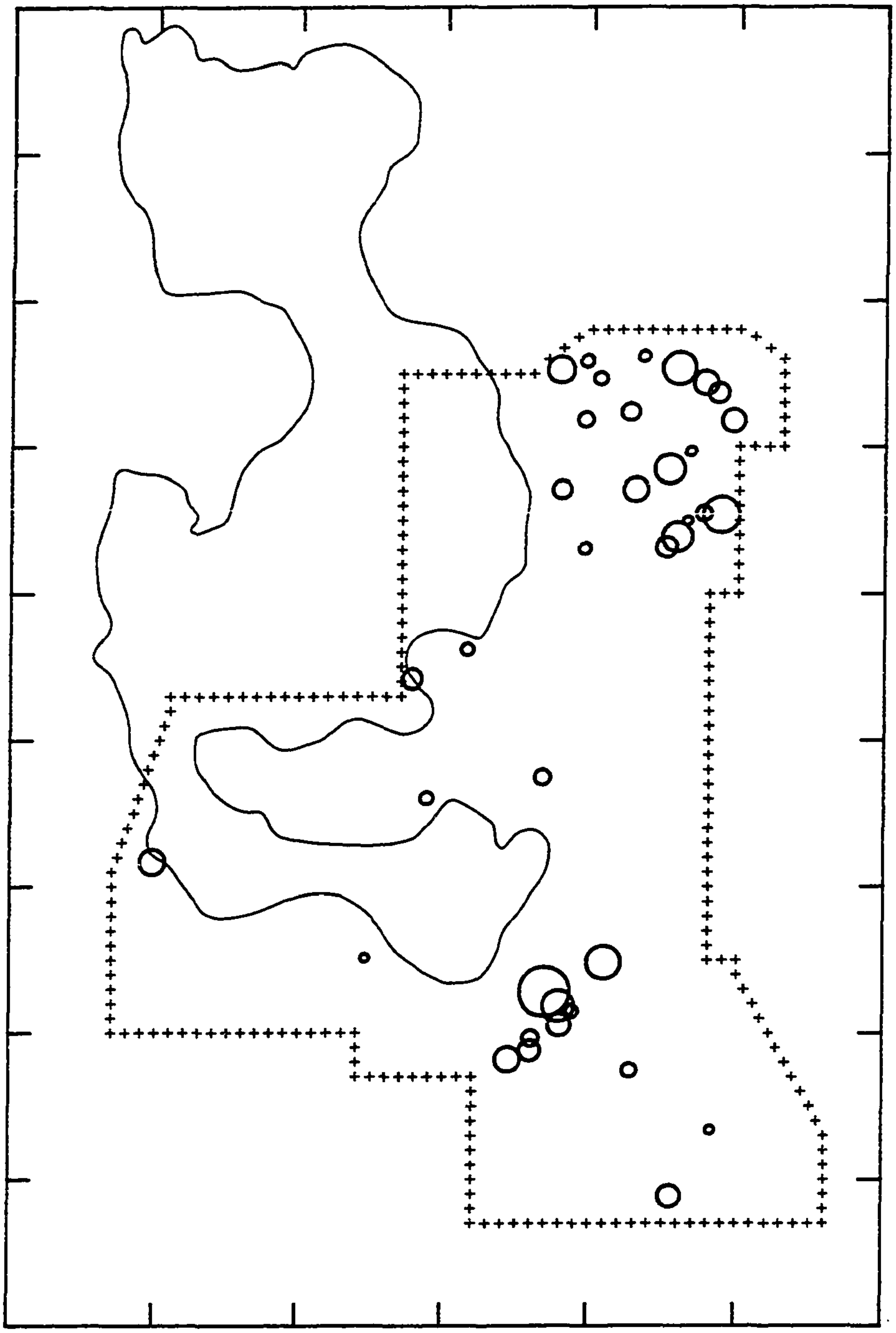


Figure VI.39. Density distribution map for Black&White/Red Variant C. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

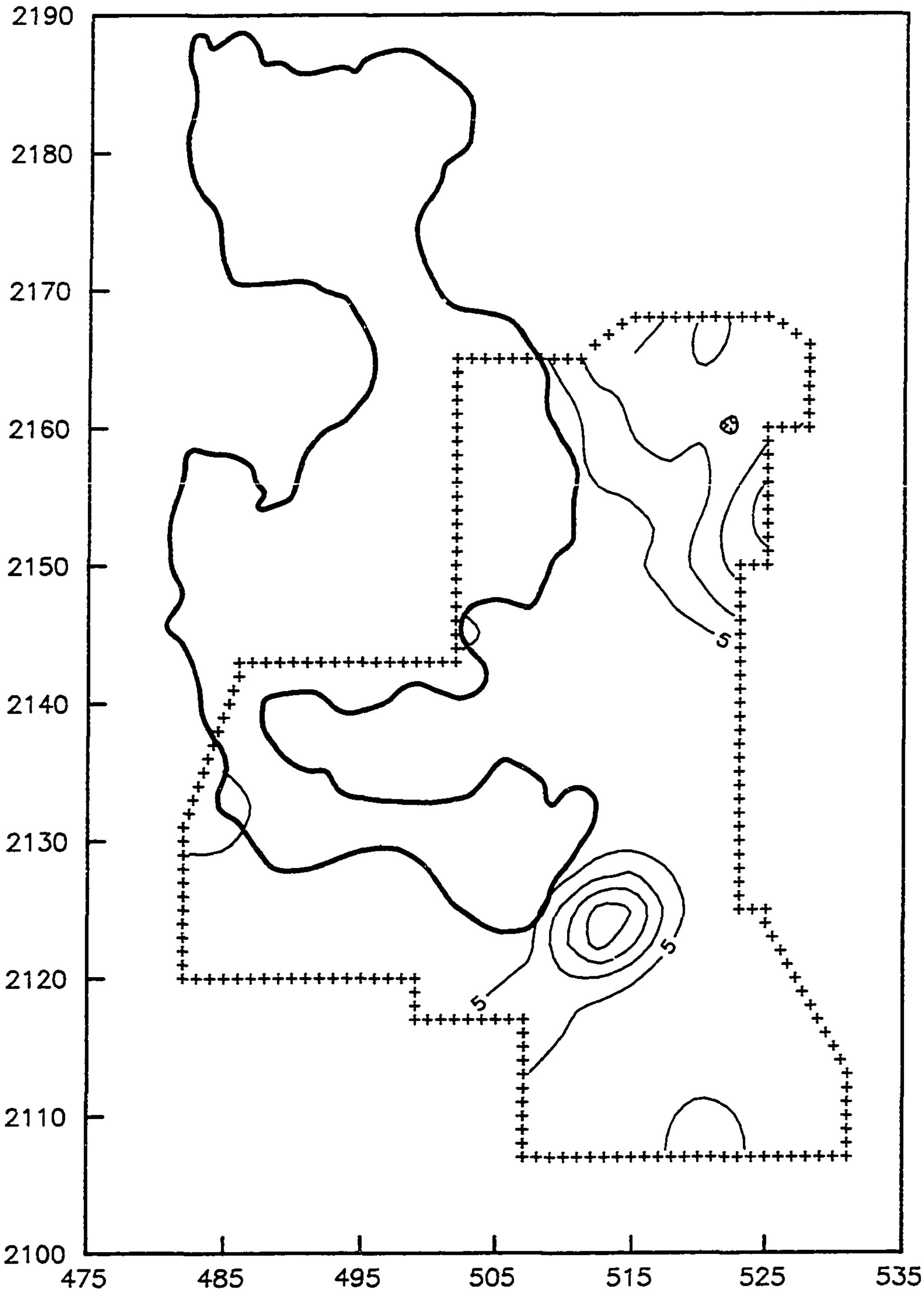


Figure VI.40. Density contour map for Black&White/Red Variant C. (Minimum contour = 5 sherds/ha; contour interval = 5 sherds/ha.)

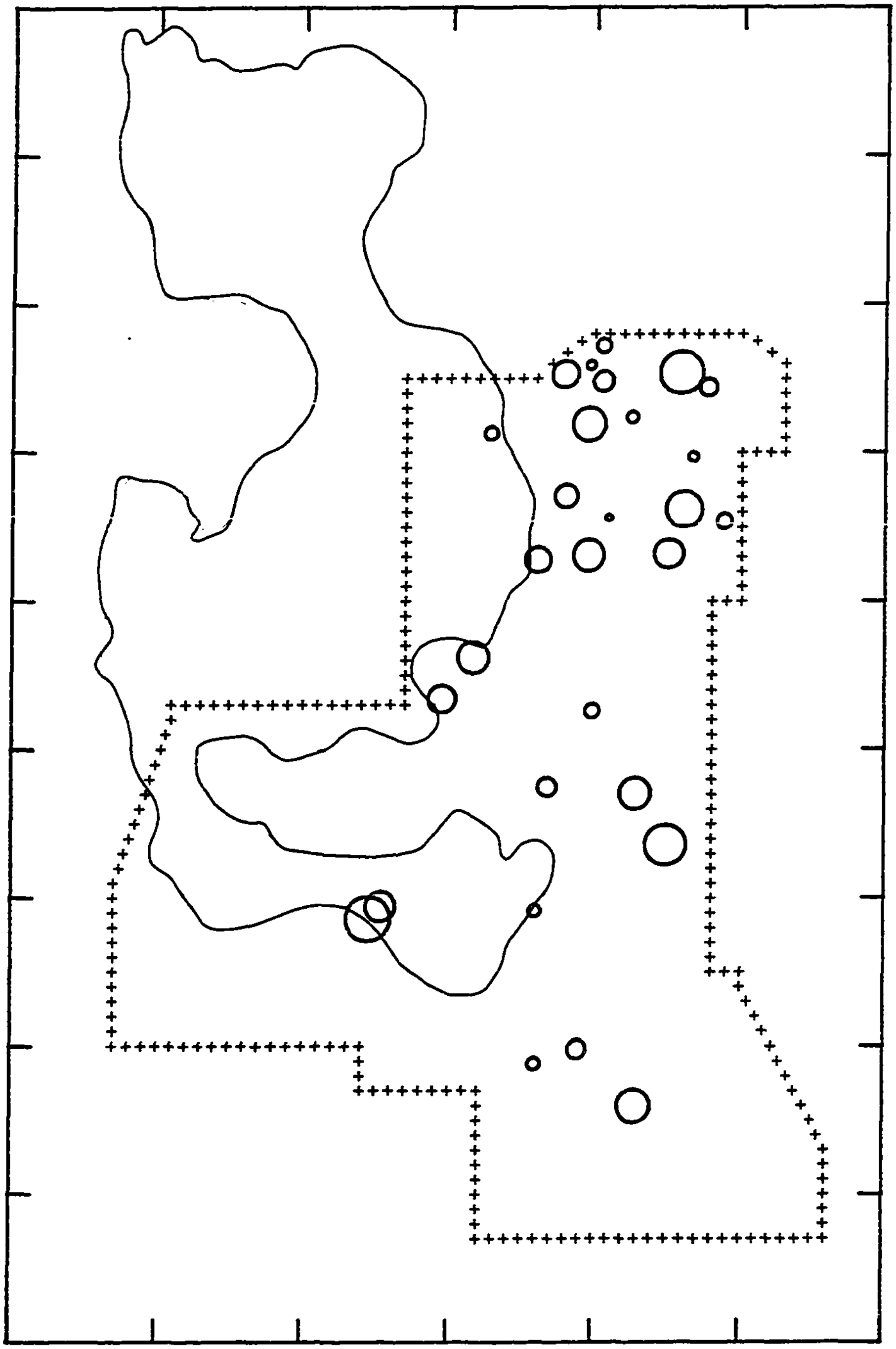


Figure VI.41. Density distribution map for Black&White/Red Subvariant D-1. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

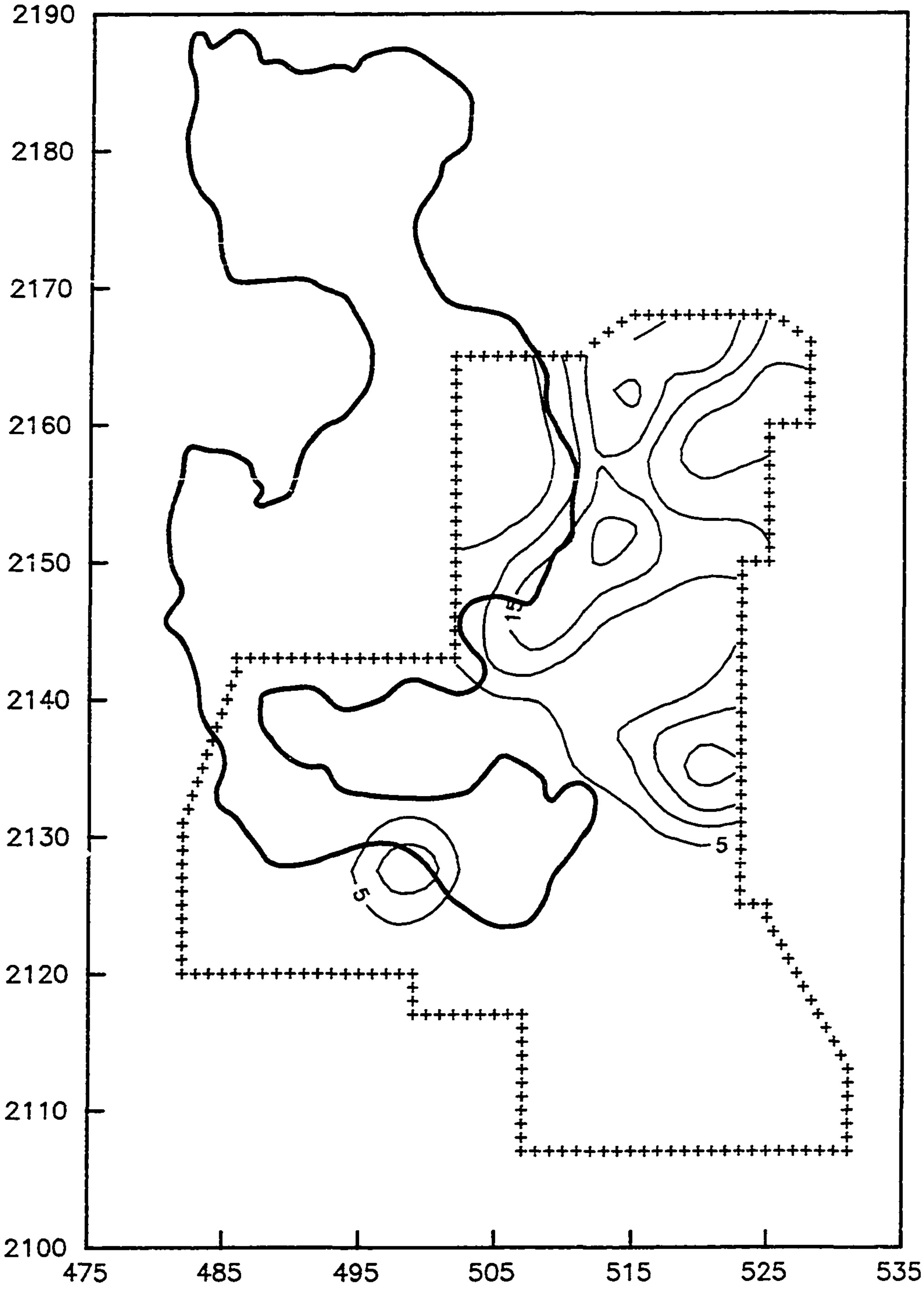


Figure VI.42. Density contour map for Black&White/Red Subvariant D-1. (Minimum contour = 5 sherds/ha; contour interval = 5 sherds/ha.)

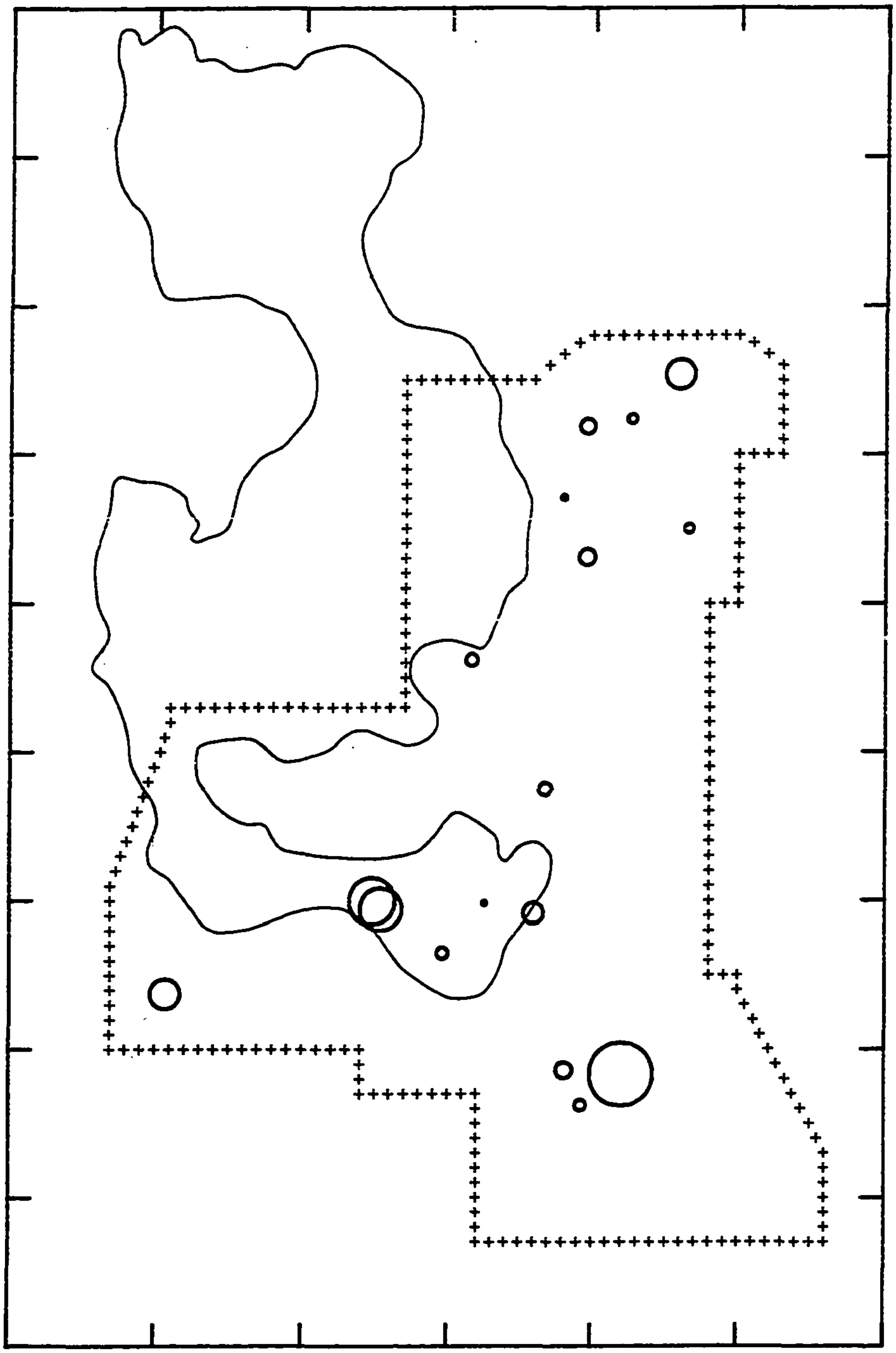


Figure VI.43. Density distribution map for Black&White/Red Subvariant D-2. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

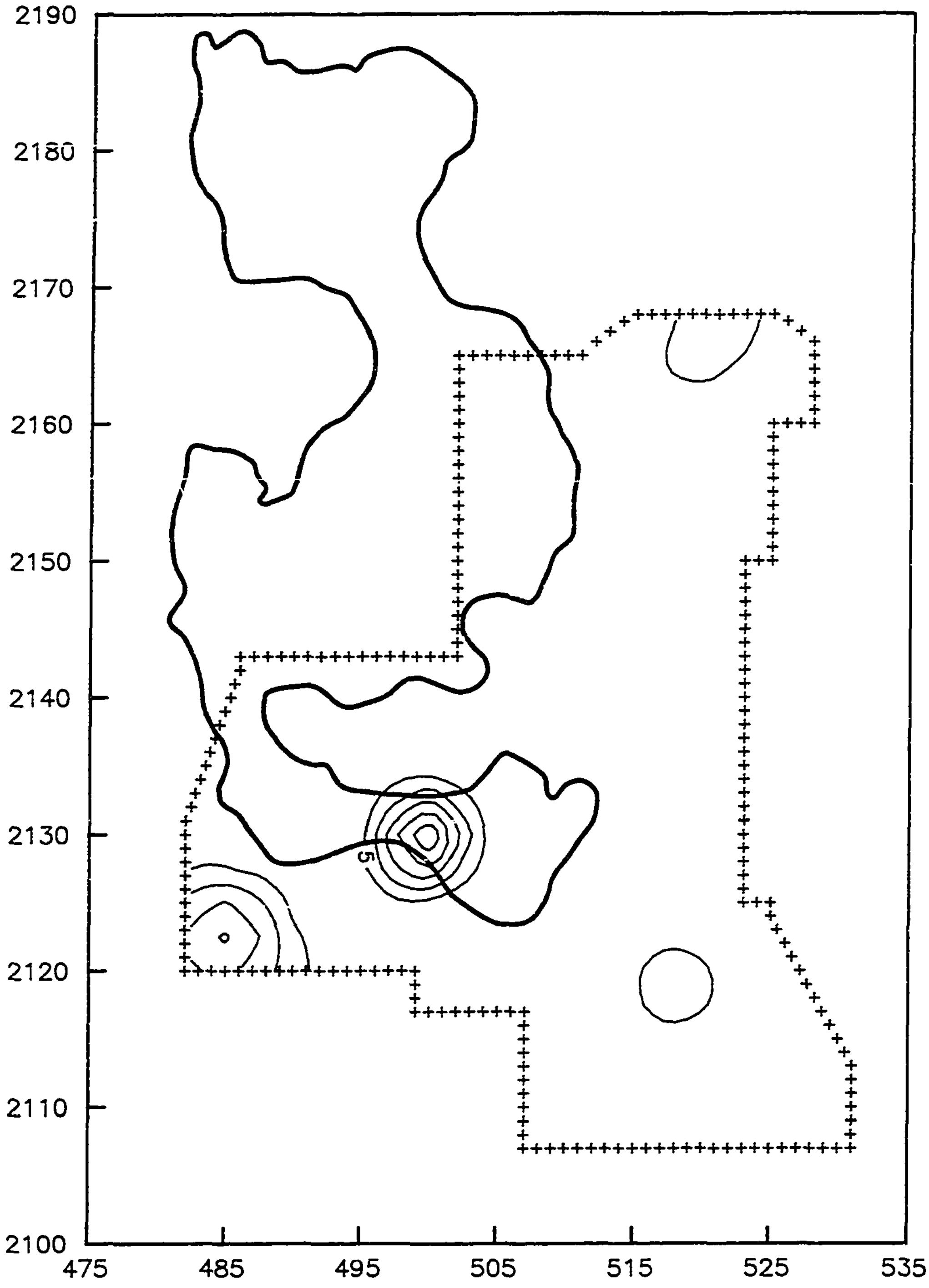


Figure VI.44. Density contour map for Black&White/Red Subvariant D-2. (Minimum contour = 5 sherds/ha; contour interval = 5 sherds/ha.)

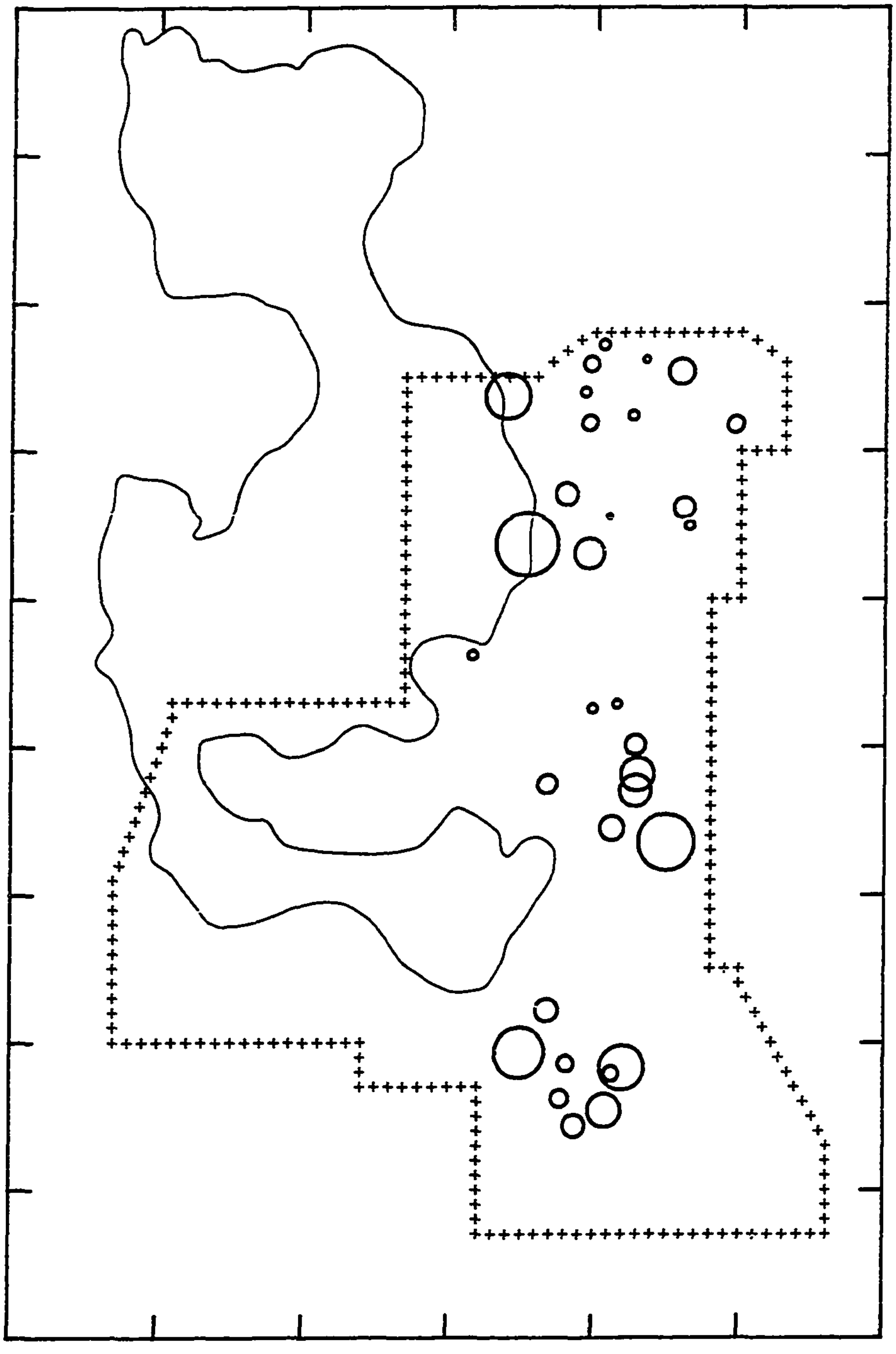


Figure VI.45. Density distribution map for Black&White/Red Subvariant D-3. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

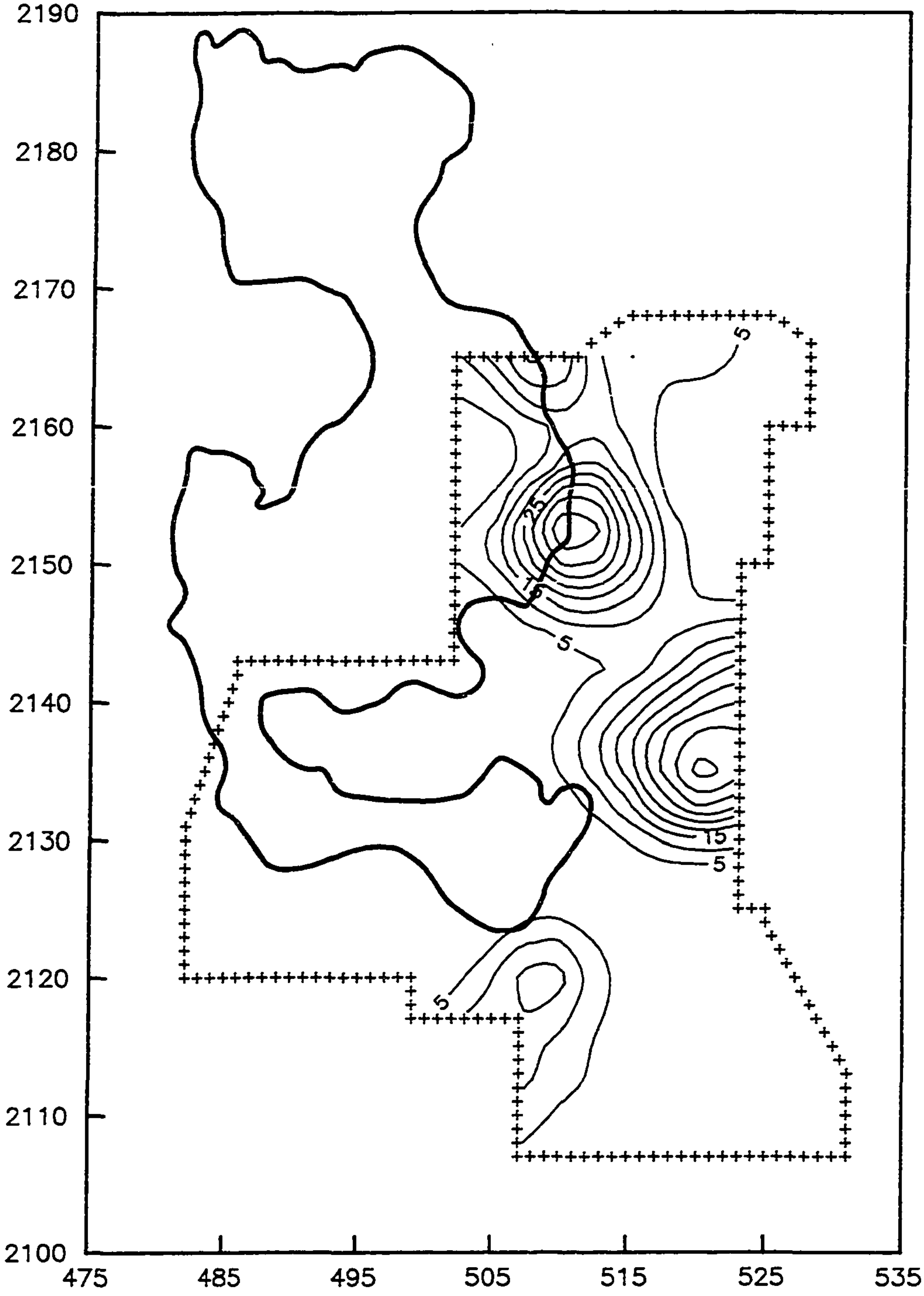


Figure VI.46. Density contour map for Black&White/Red Subvariant D-3. (Minimum contour = 5 sherds/ha; contour interval = 5 sherds/ha.)

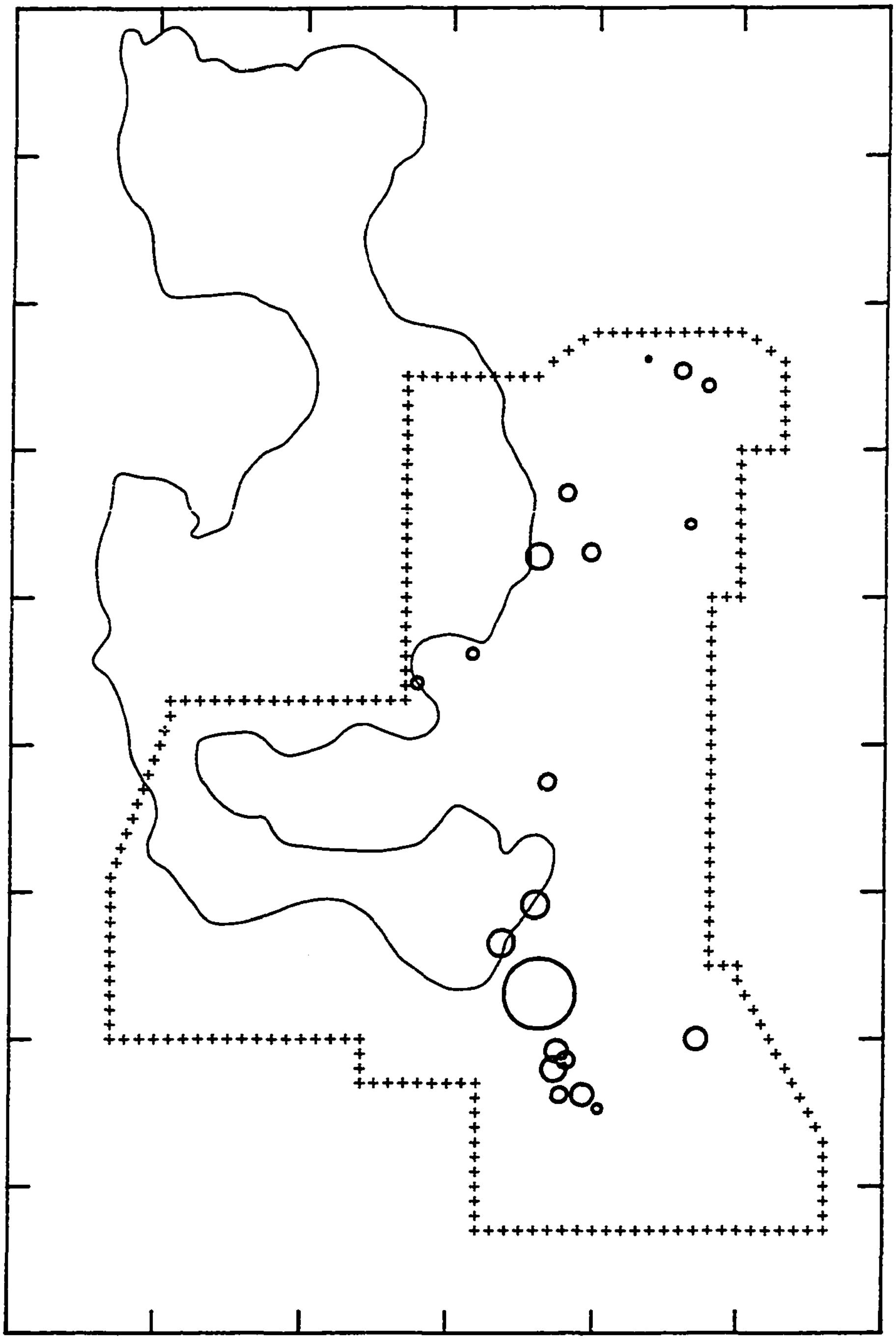


Figure VI.47. Density distribution map for Black&White/Red Subvariant E-1. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

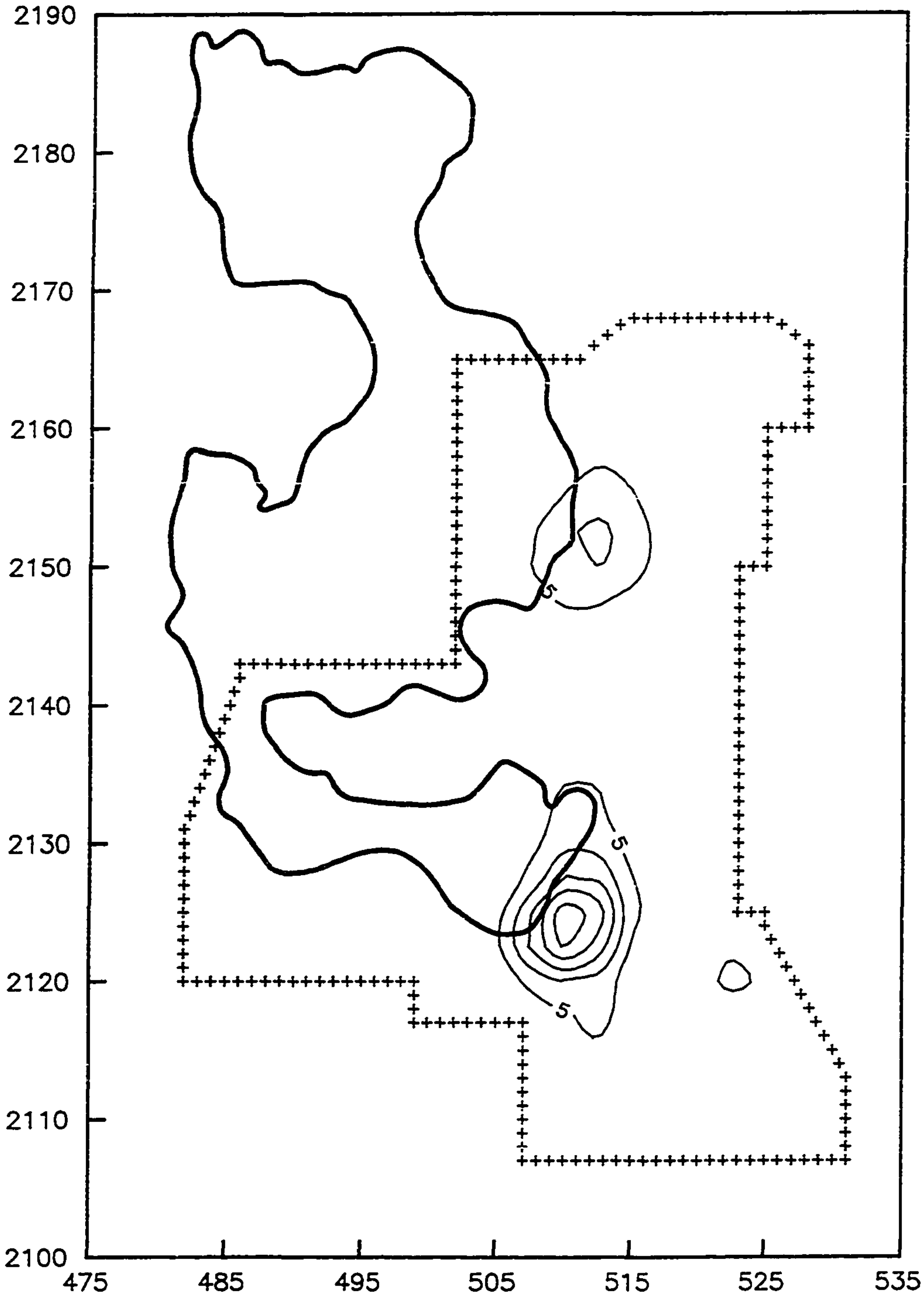


Figure VI.48. Density contour map for Black&White/Red Subvariant E-1. (Minimum contour = 5 sherds/ha; contour interval = 5 sherds/ha.)

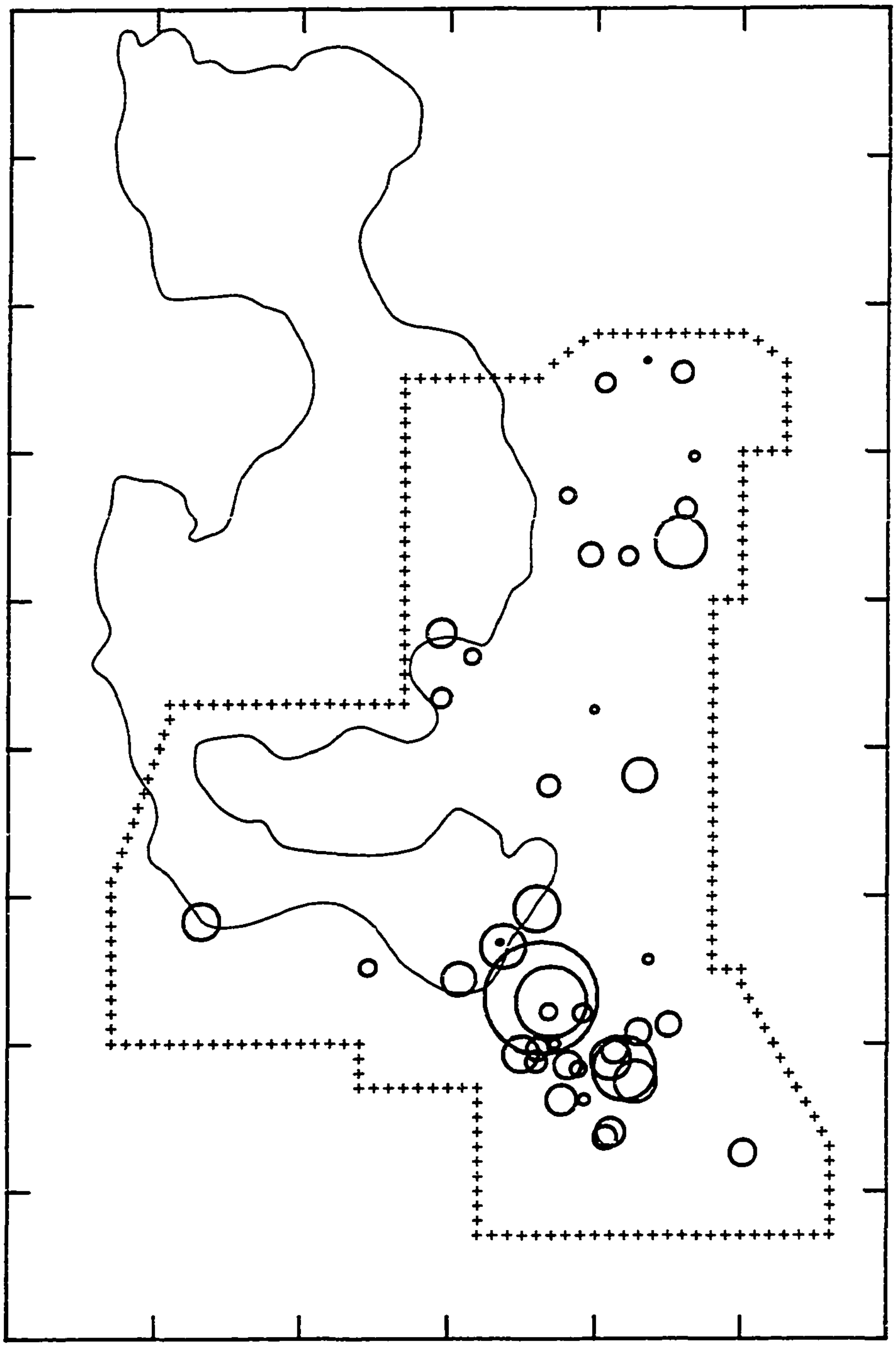


Figure VI.49. Density distribution map for Black&White/Red Subvariant E-2. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

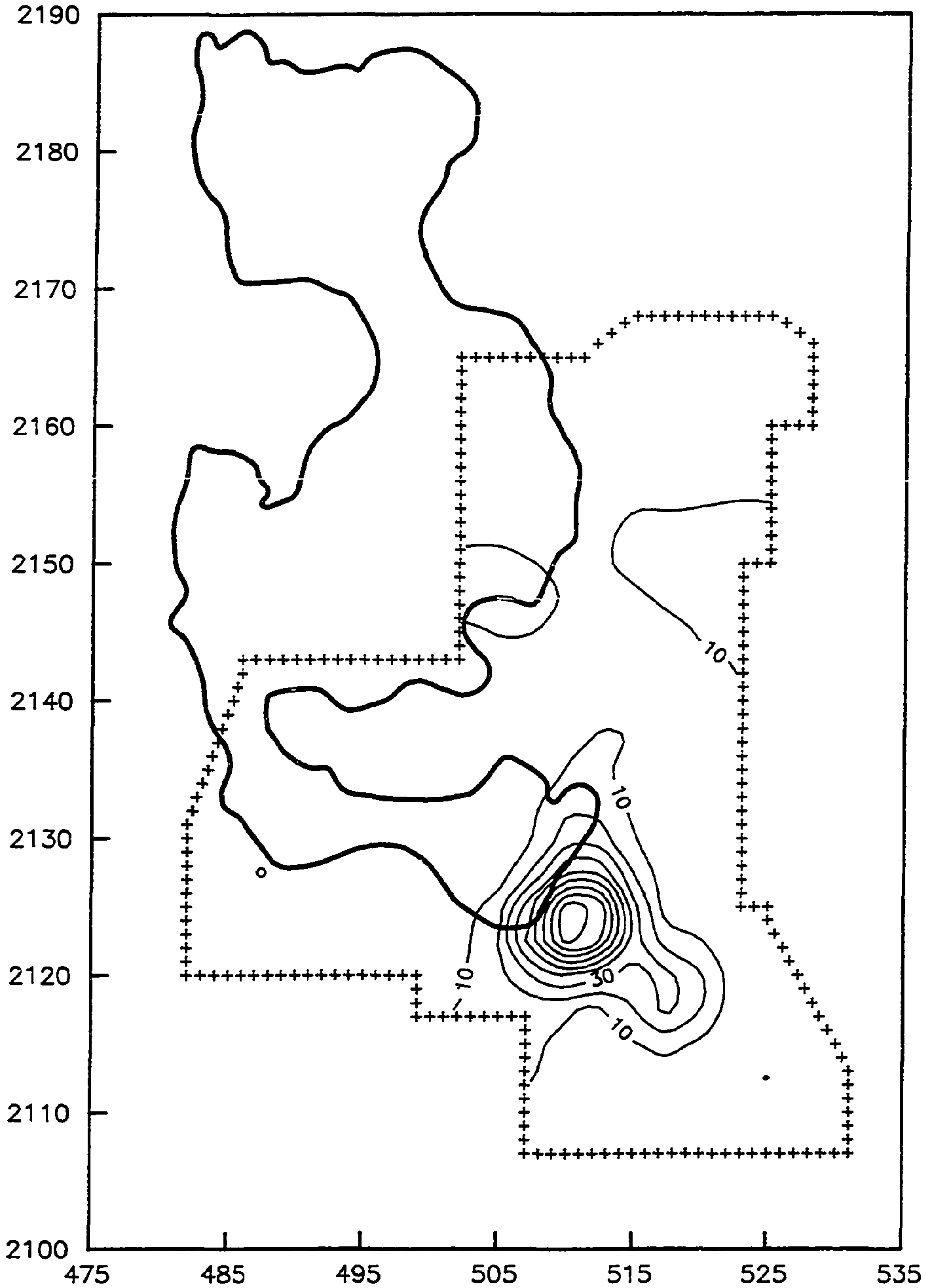


Figure VI.50. Density contour map for Black&White/Red Subvariant E-2. (Minimum contour = 10 sherds/ha; contour interval = 10 sherds/ha.)

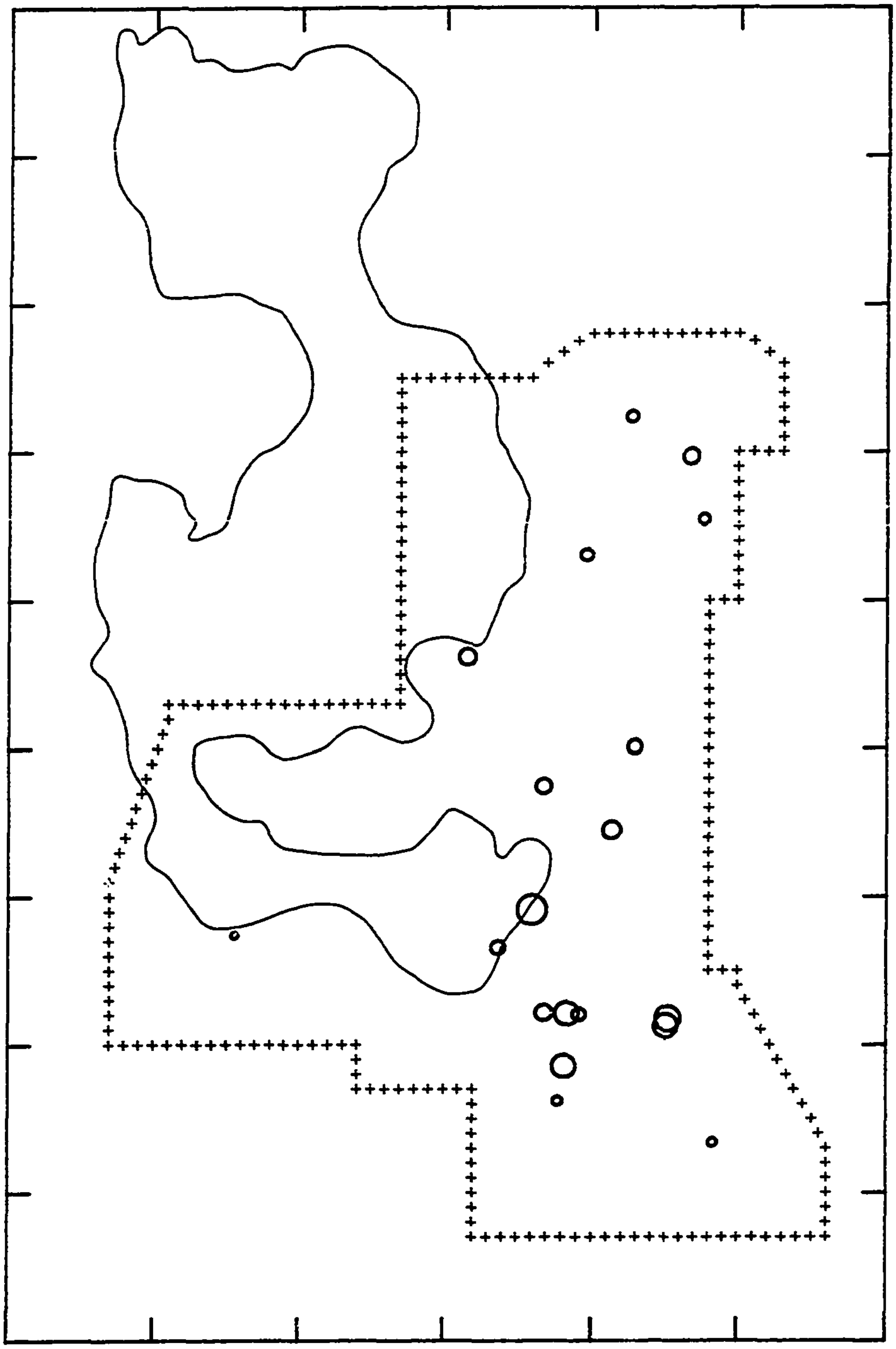


Figure VI.51. Density distribution map for Black&White/Red Subvariant E-3. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

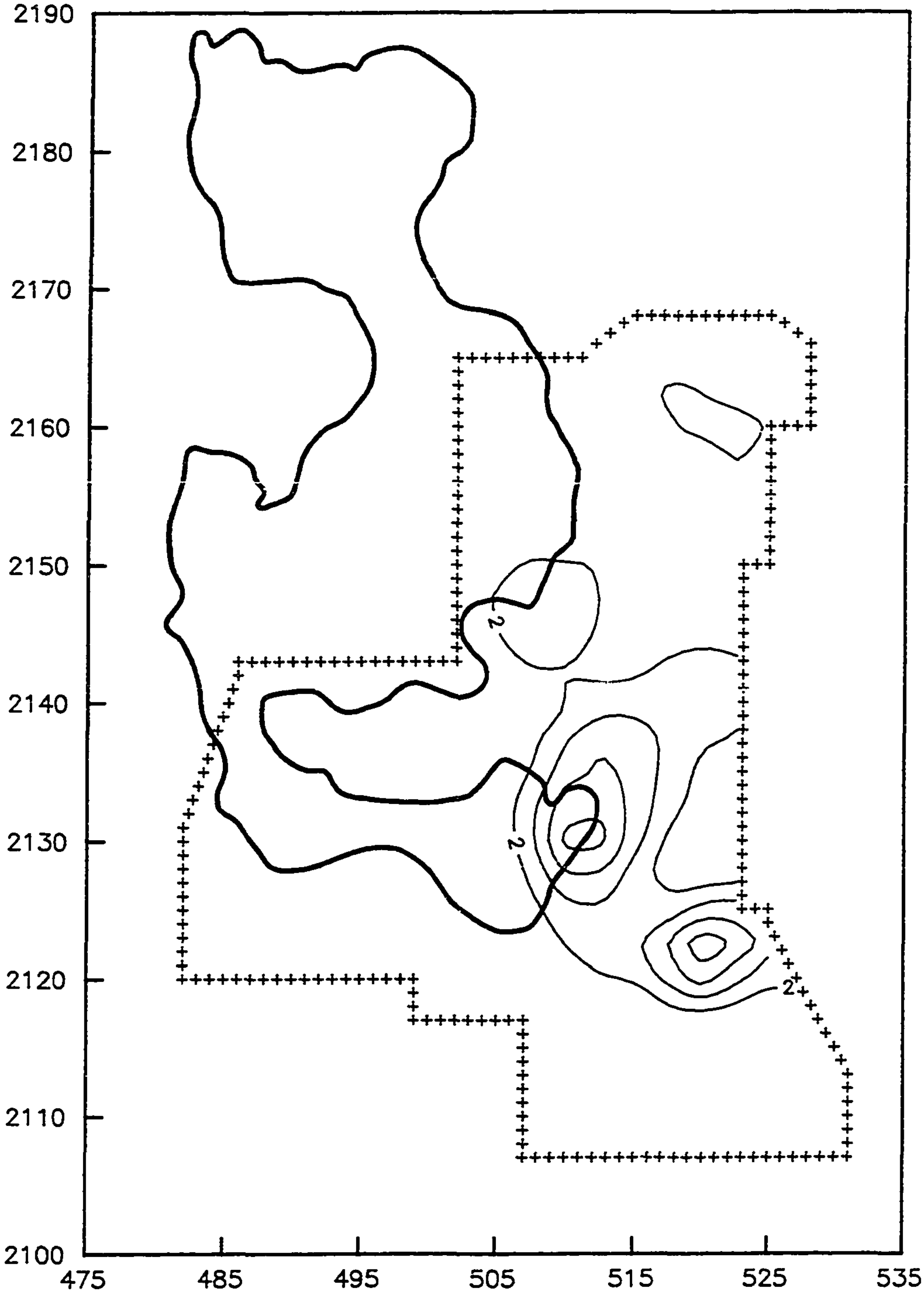


Figure VI.52. Density contour map for Black&White/Red Subvariant E-3. (Minimum contour = 2 sherds/ha; contour interval = 2 sherds/ha.)

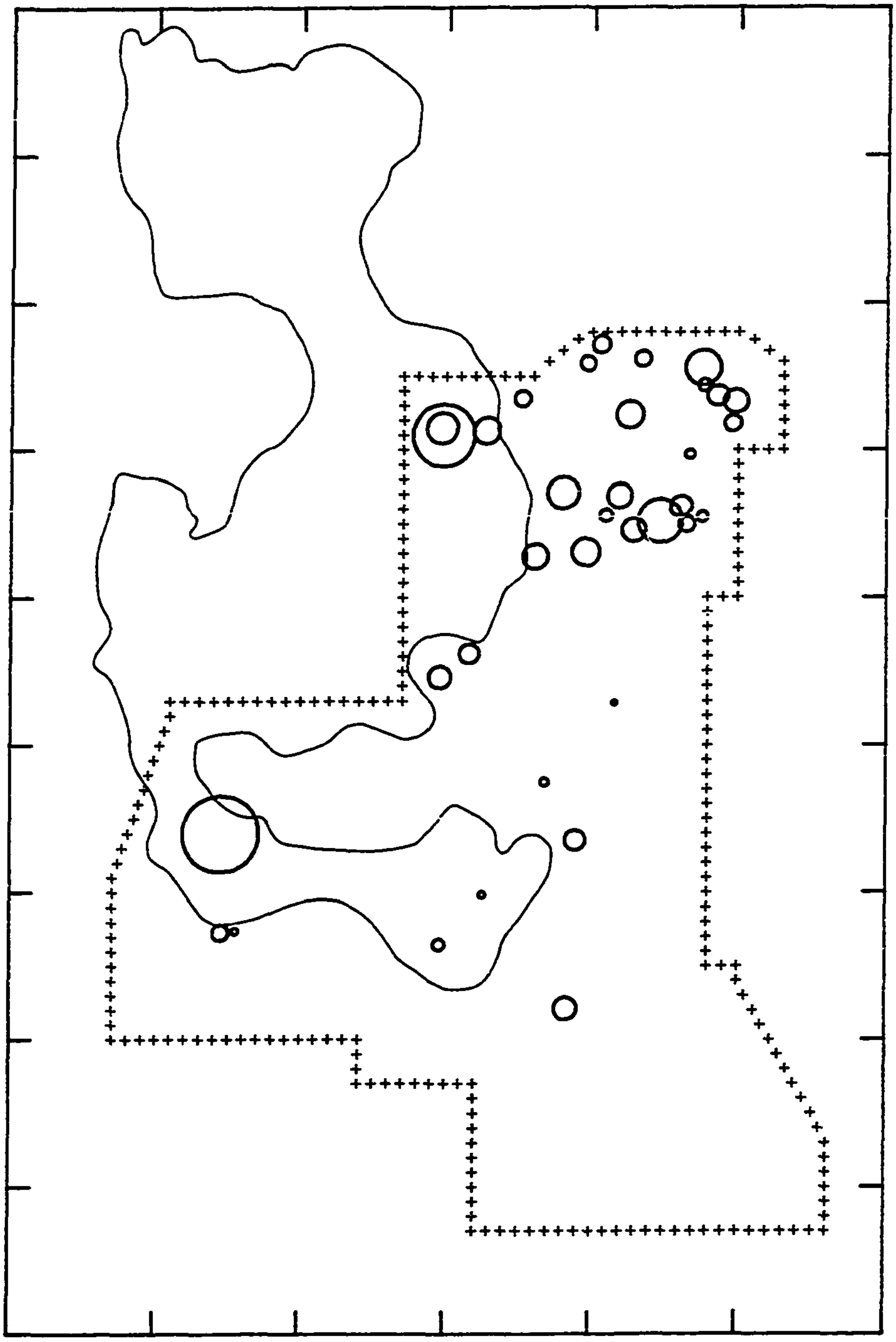


Figure VI.53. Density distribution map for Black&White/Red Variant G. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

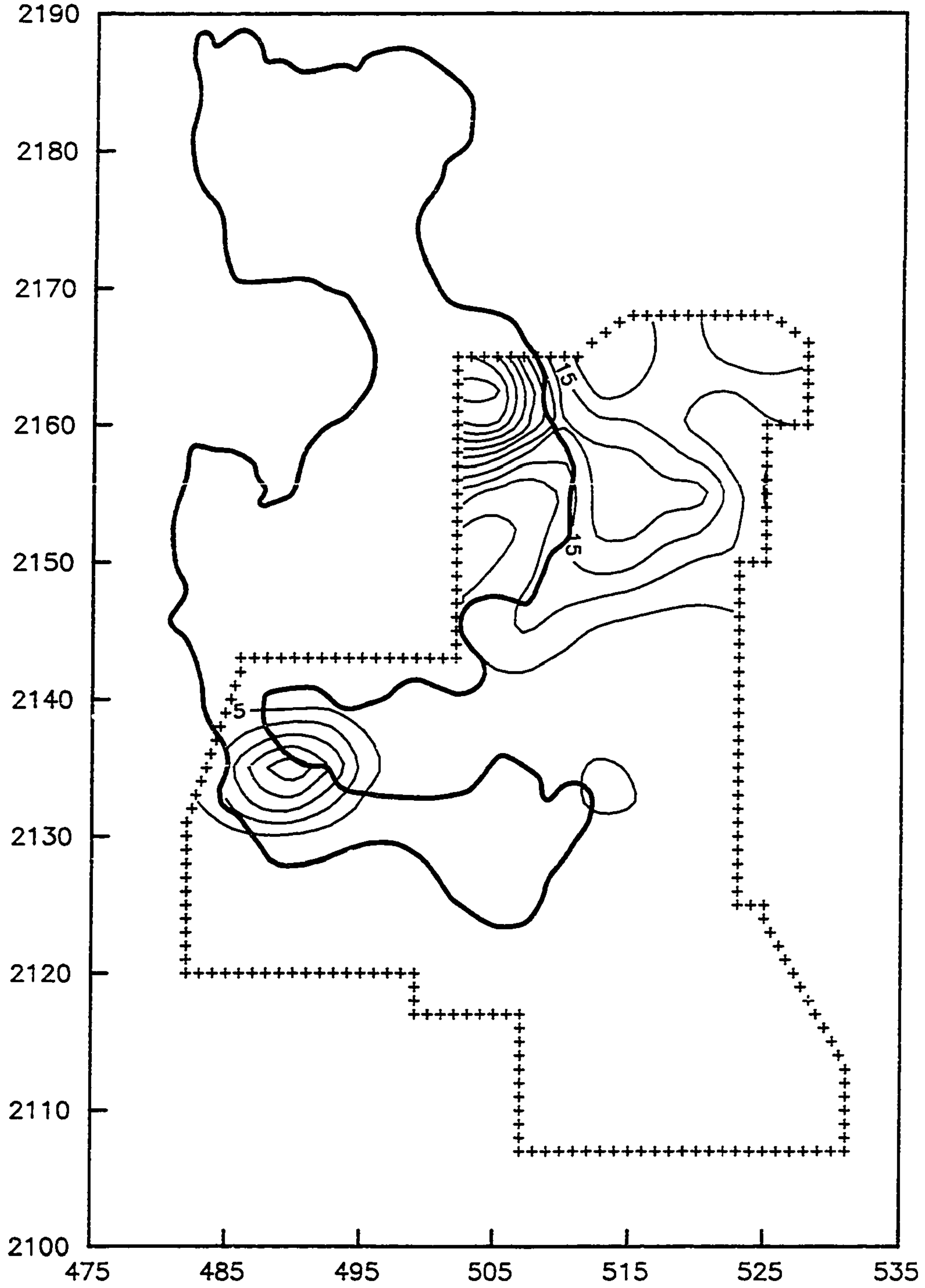


Figure VI.54. Density contour map for Black&White/Red Variant G. (Minimum contour = 5 sherds/ha; contour interval = 5 sherds/ha.)

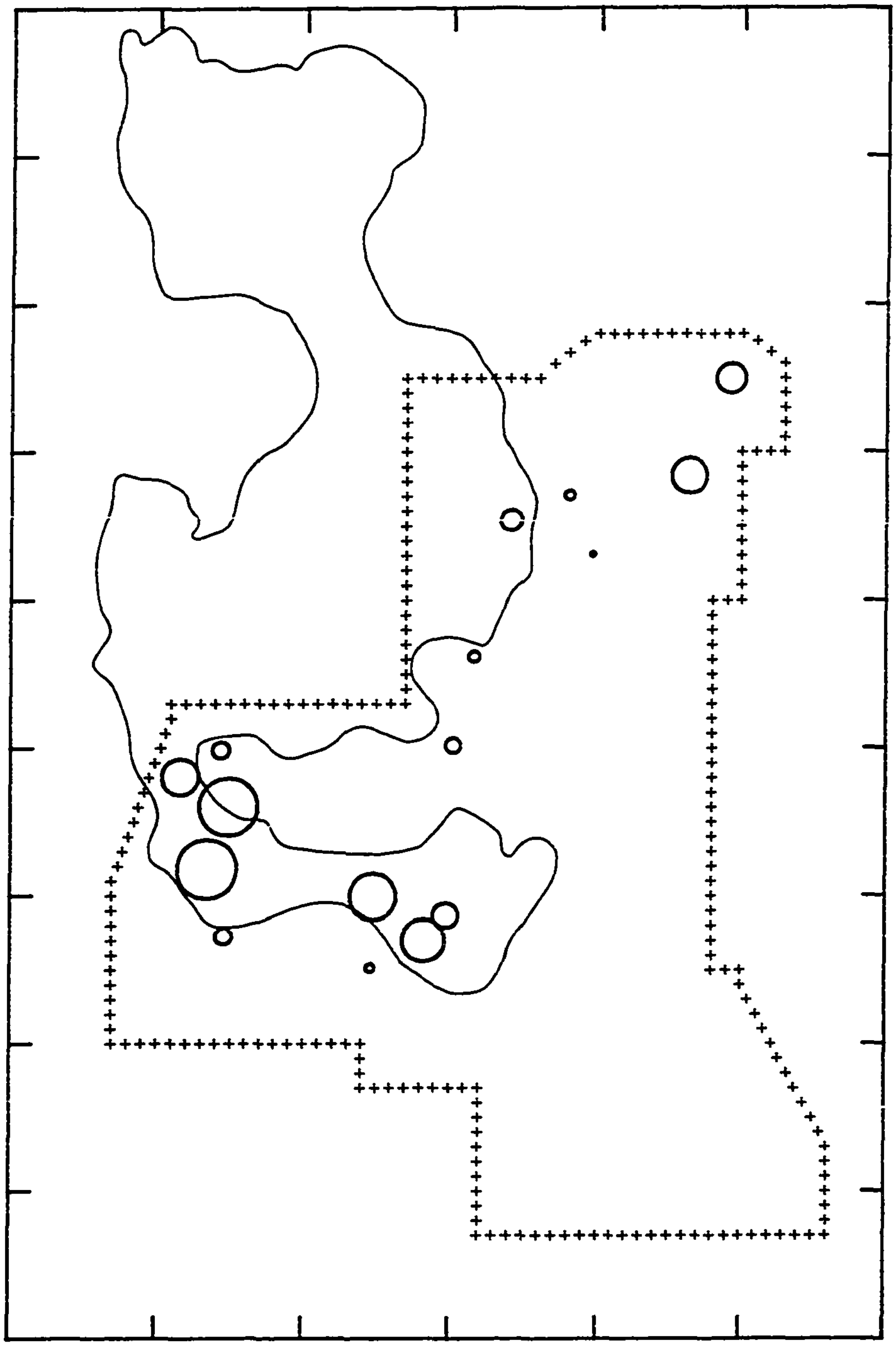


Figure VI.55. Density distribution map for Late Profile Black&White/Red Variant AW. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

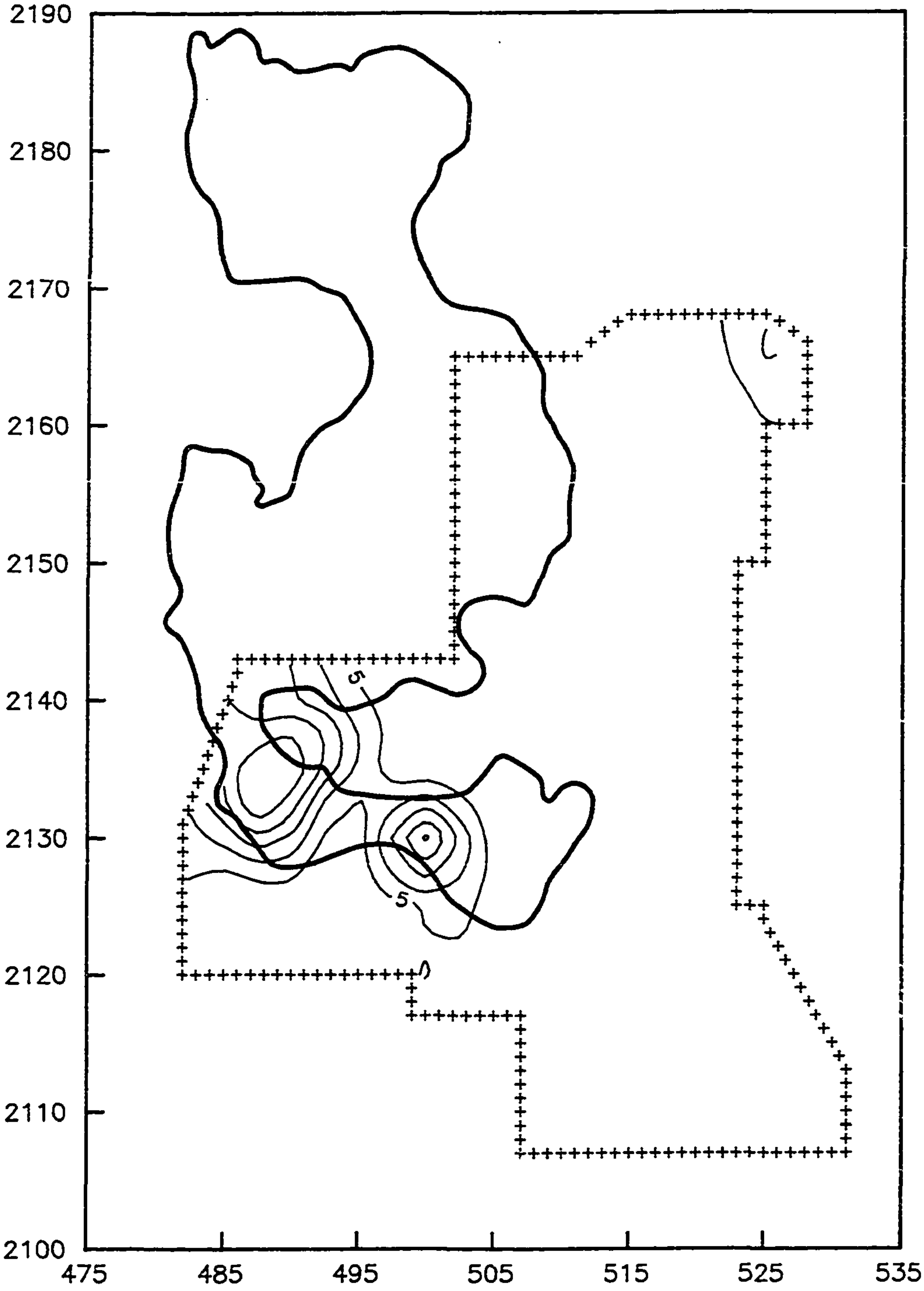


Figure VI.56. Density contour map for Late Profile Black&White/Red Variant AW. (Minimum contour = 5 sherds/ha; contour interval = 5 sherds/ha.)

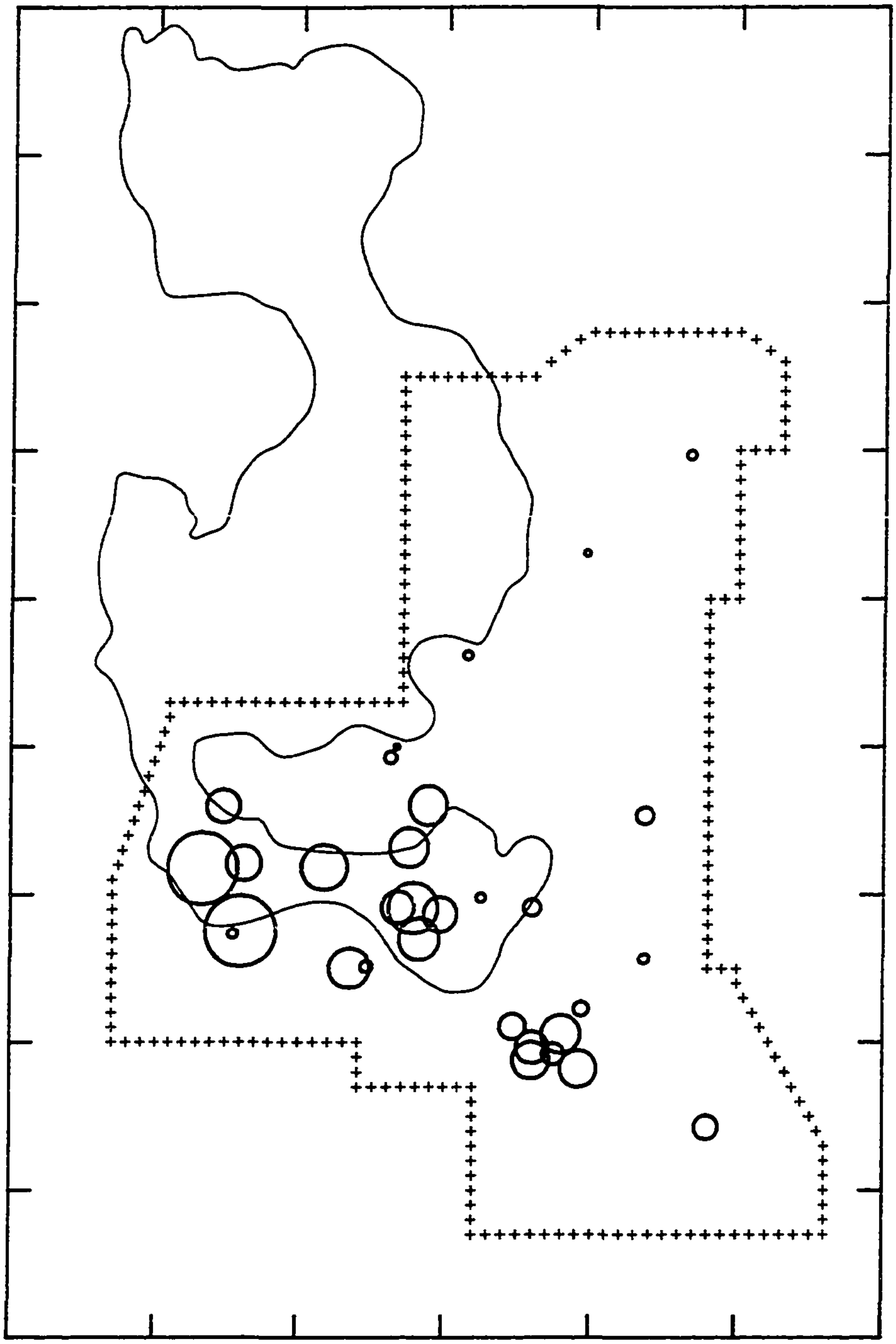


Figure VI.57. Density distribution map for Late Profile Black&White/Red Variant C. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

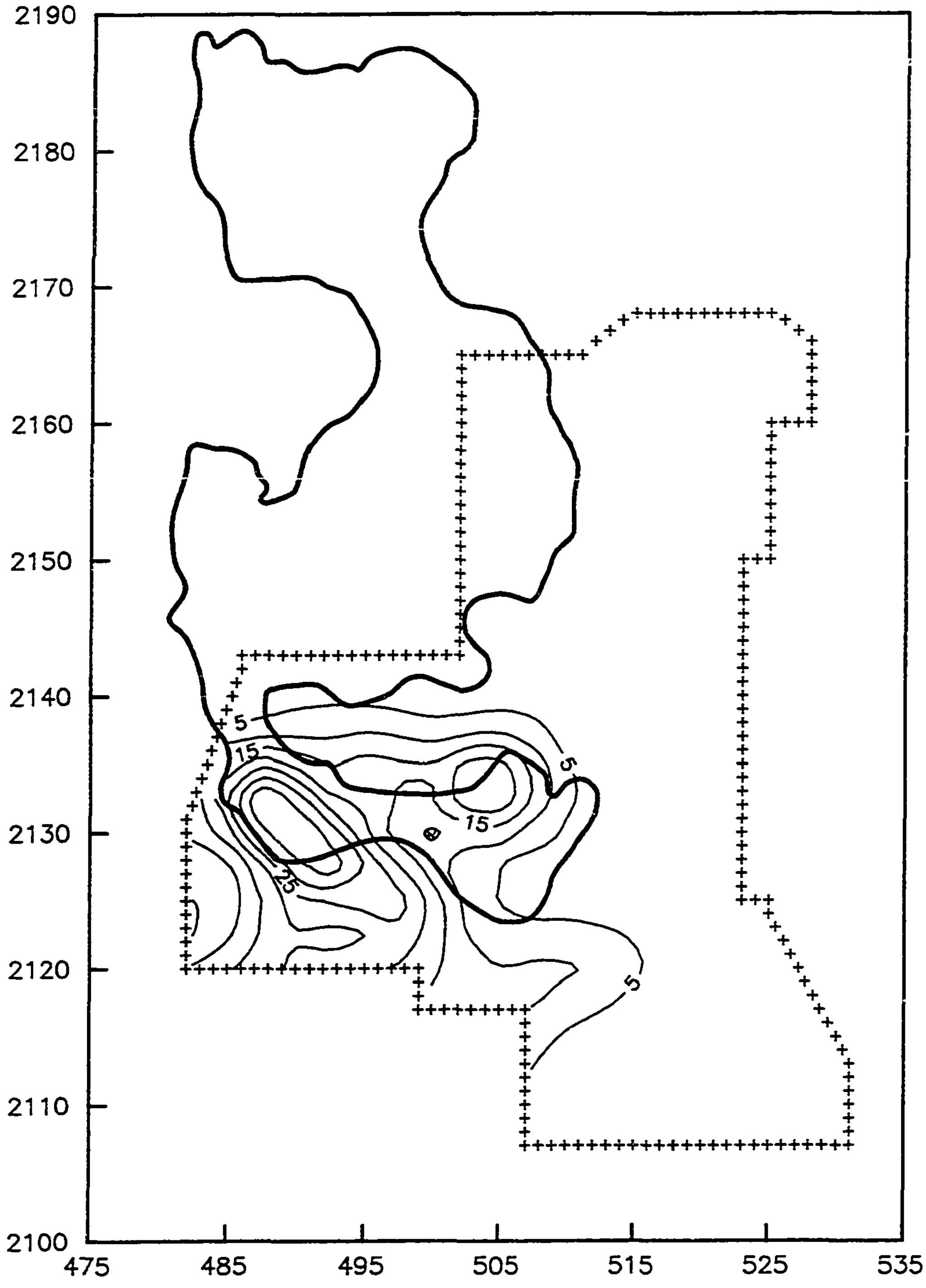


Figure VI.58. Density contour map for Late Profile Black&White/Red Variant C. (Minimum contour = 5 sherds/ha; contour interval = 5 sherds/ha.)

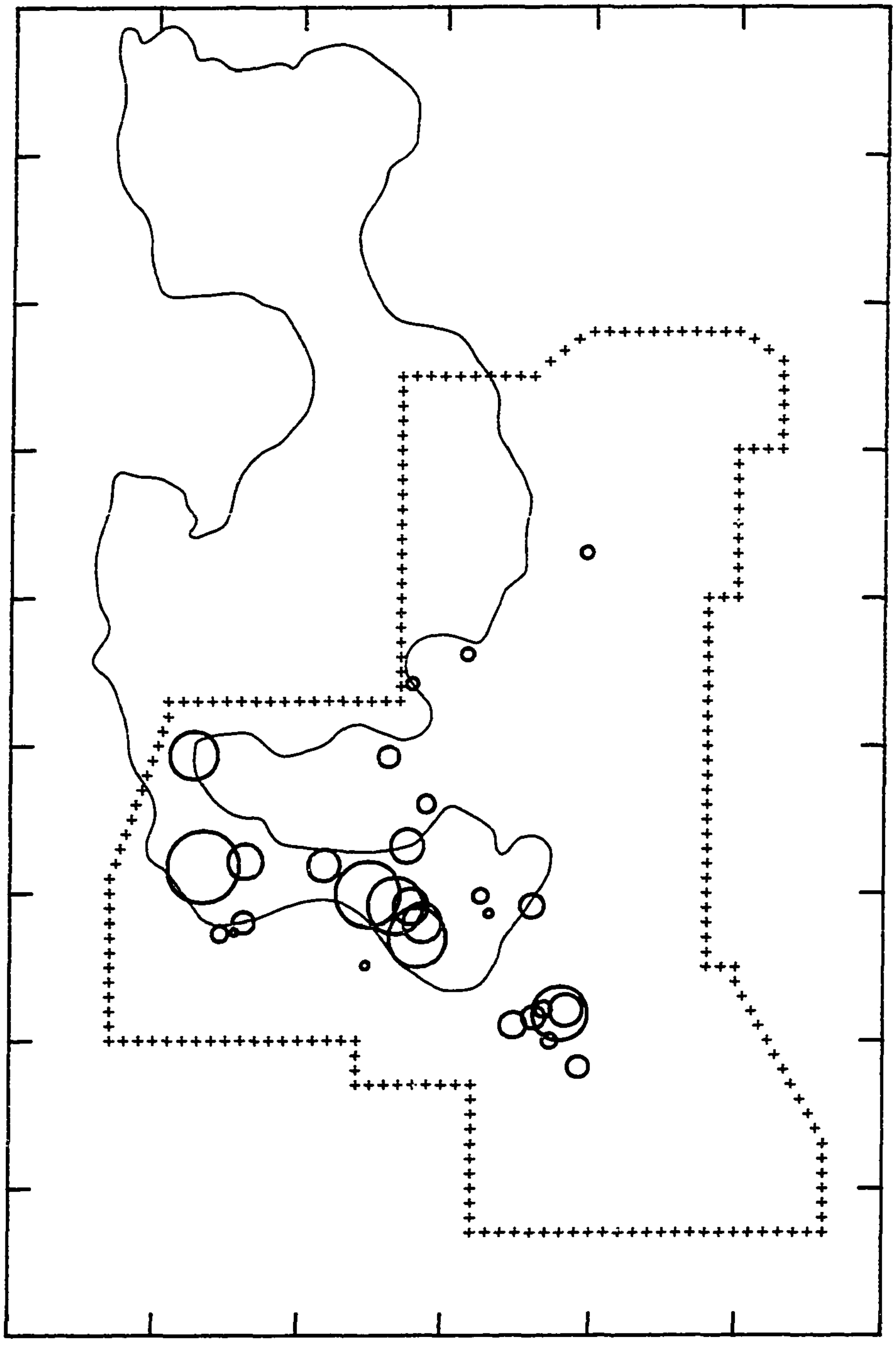


Figure VI.59. Density distribution map for Late Profile Black&White/Red Variant F. Size of circular symbol reflects the relative density of this variant as recovered in surface collections.

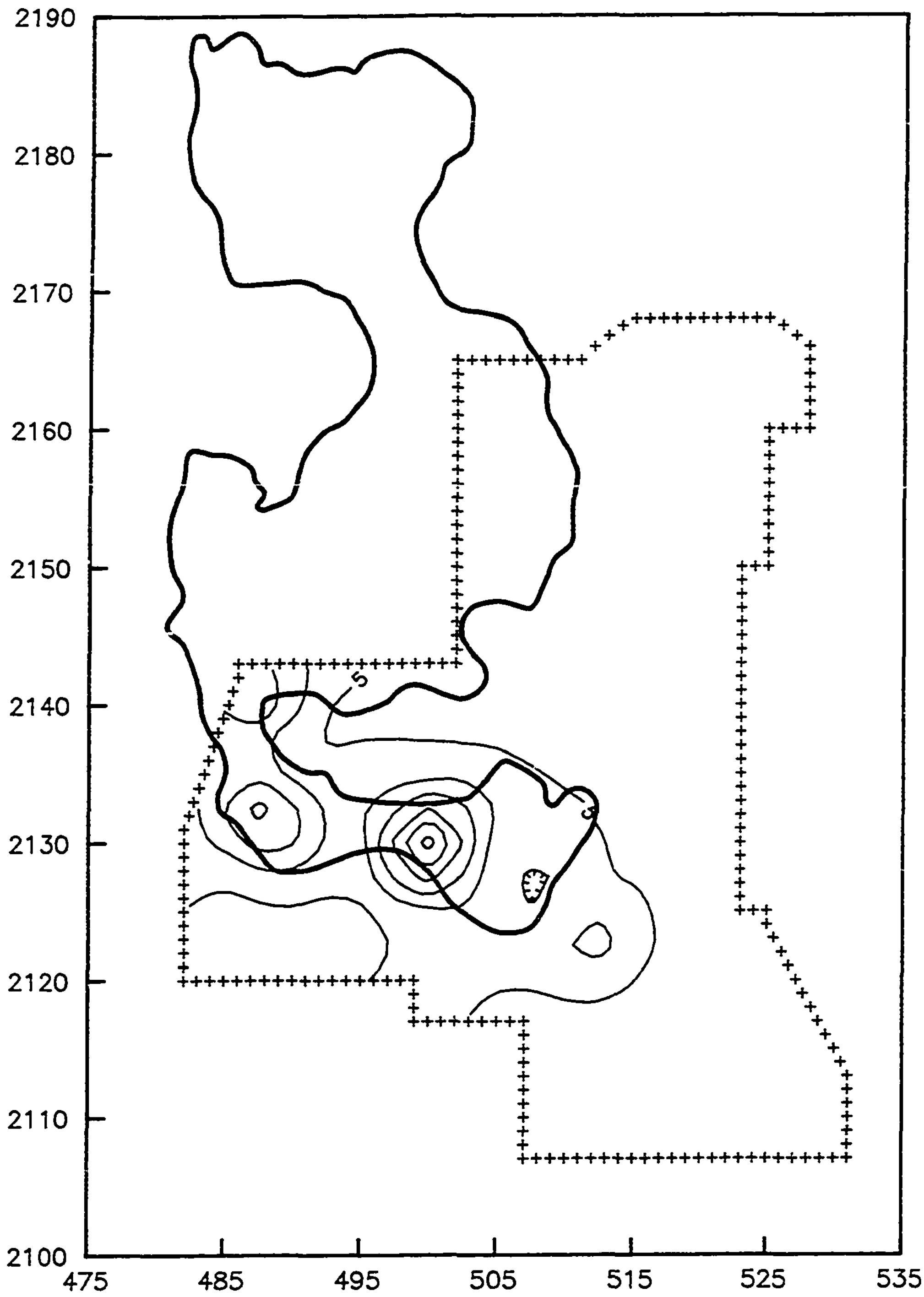


Figure VI.60. Density contour map for Late Profile Black&White/Red Variant F. (Minimum contour = 5 sherds/ha; contour interval = 10 sherds/ha.)

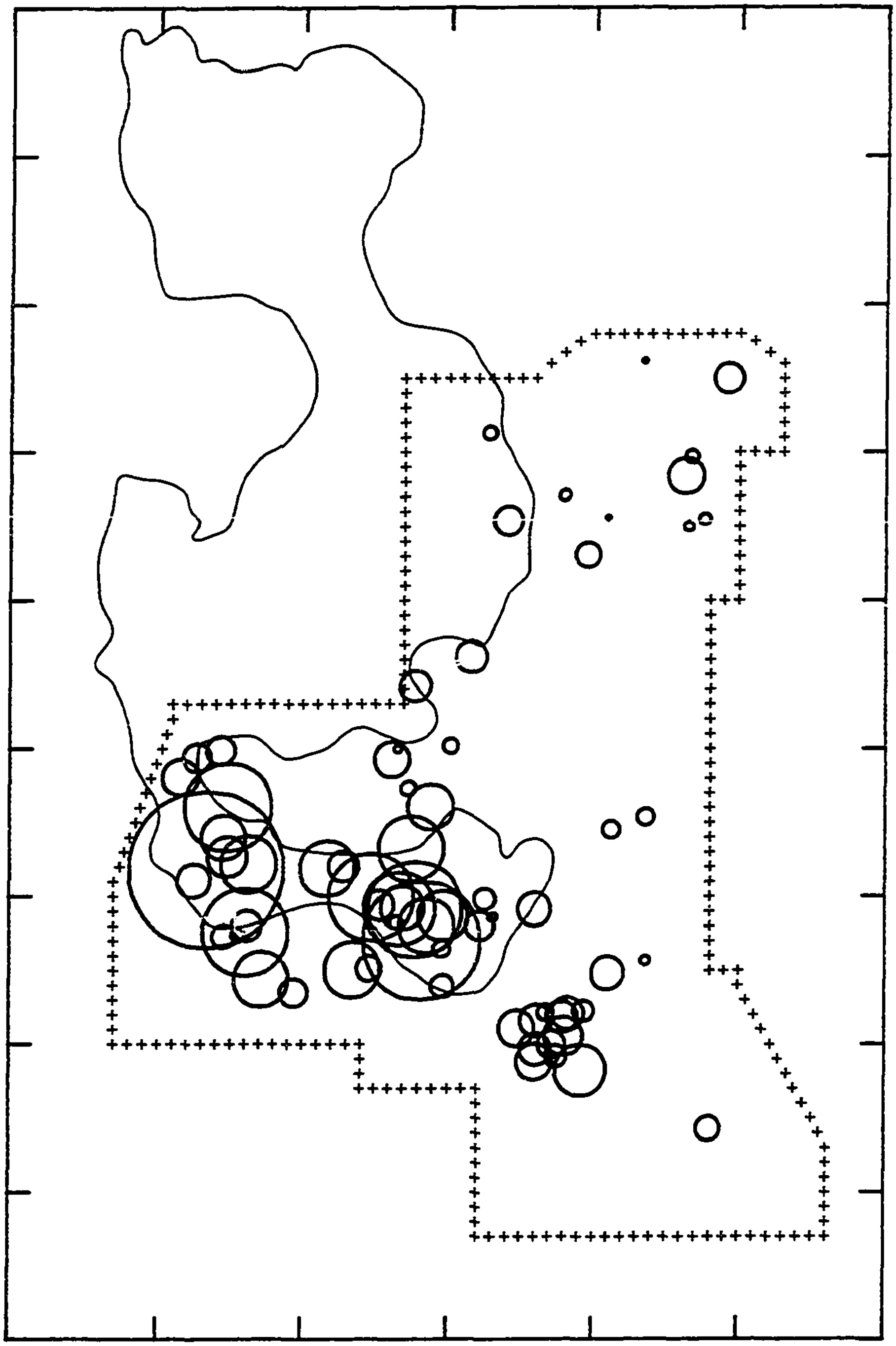


Figure VI.61. Density distribution map for Late Profile Black&White/Red (all variants). Size of circular symbol reflects the relative density of this type as recovered in surface collections.

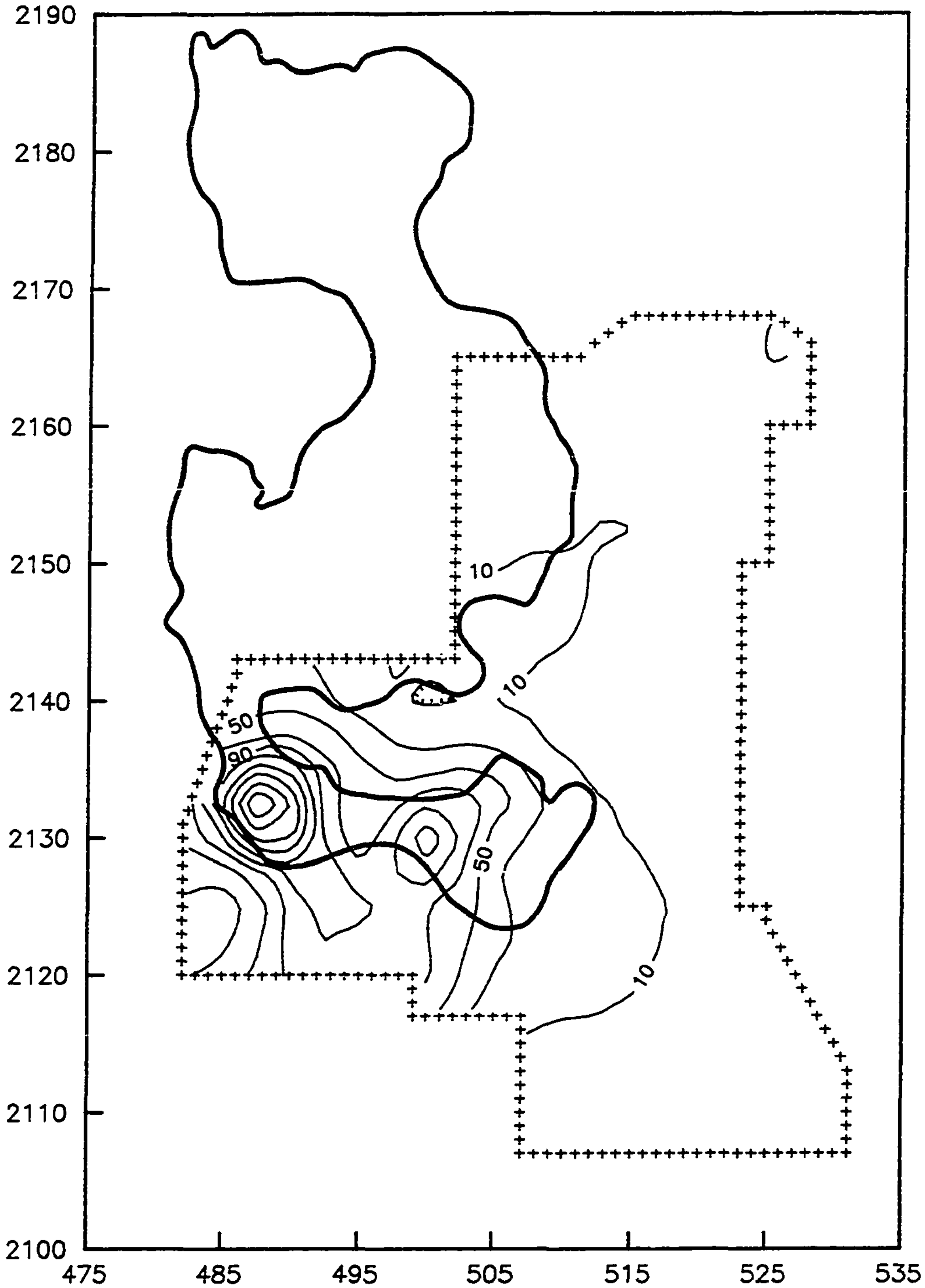


Figure VI.62. Density contour map for Late Profile Black&White/Red (all variants). (Minimum contour = 10 sherds/ha; contour interval = 20 sherds/ha.)

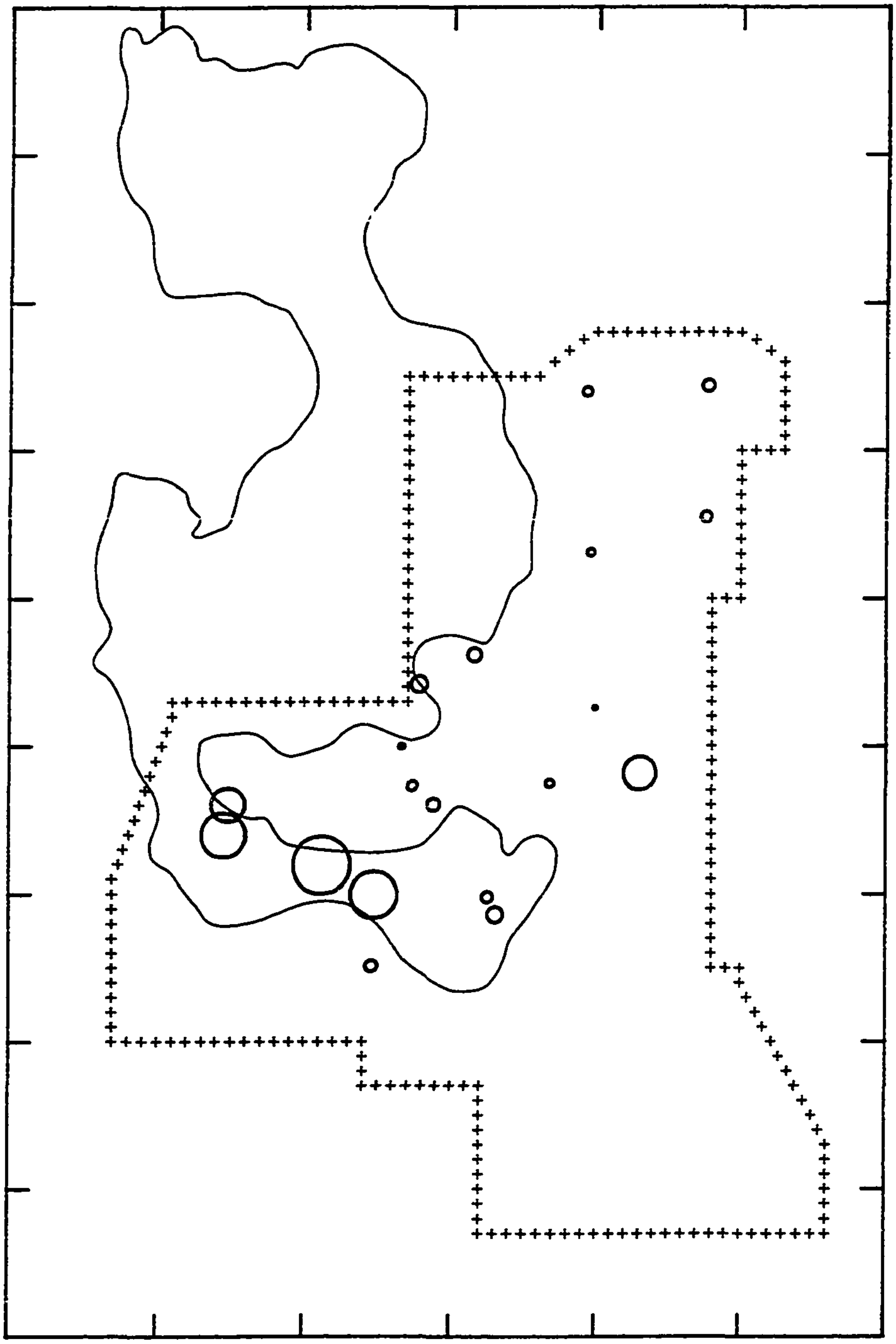


Figure VI.63. Density distribution map for Yellow/Red. Size of circular symbol reflects the relative density of this type as recovered in surface collections.

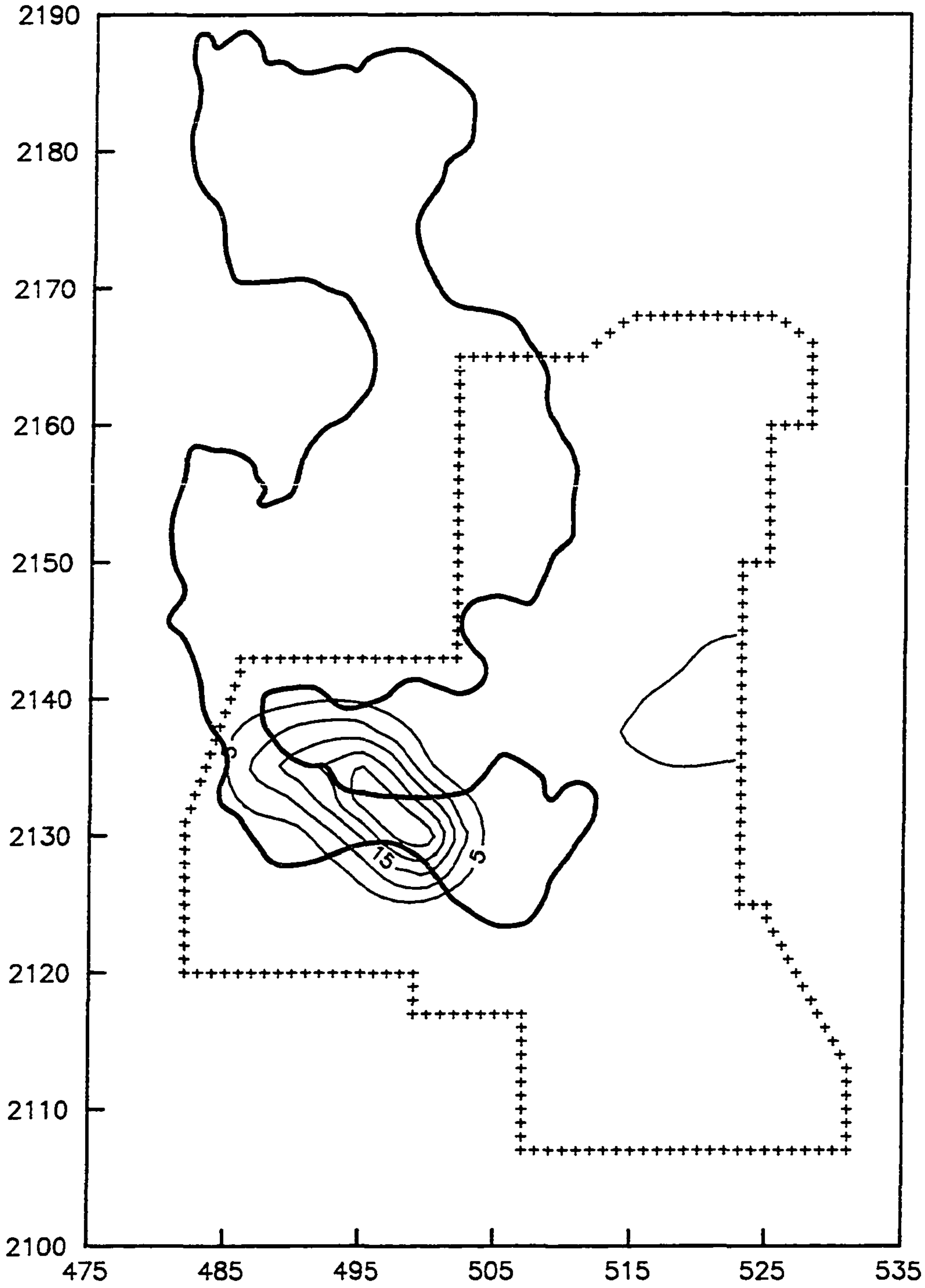


Figure VI.64. Density contour map for Yellow/Red. (Minimum contour = 5 sherds/ha; contour interval = 5 sherds/ha.)

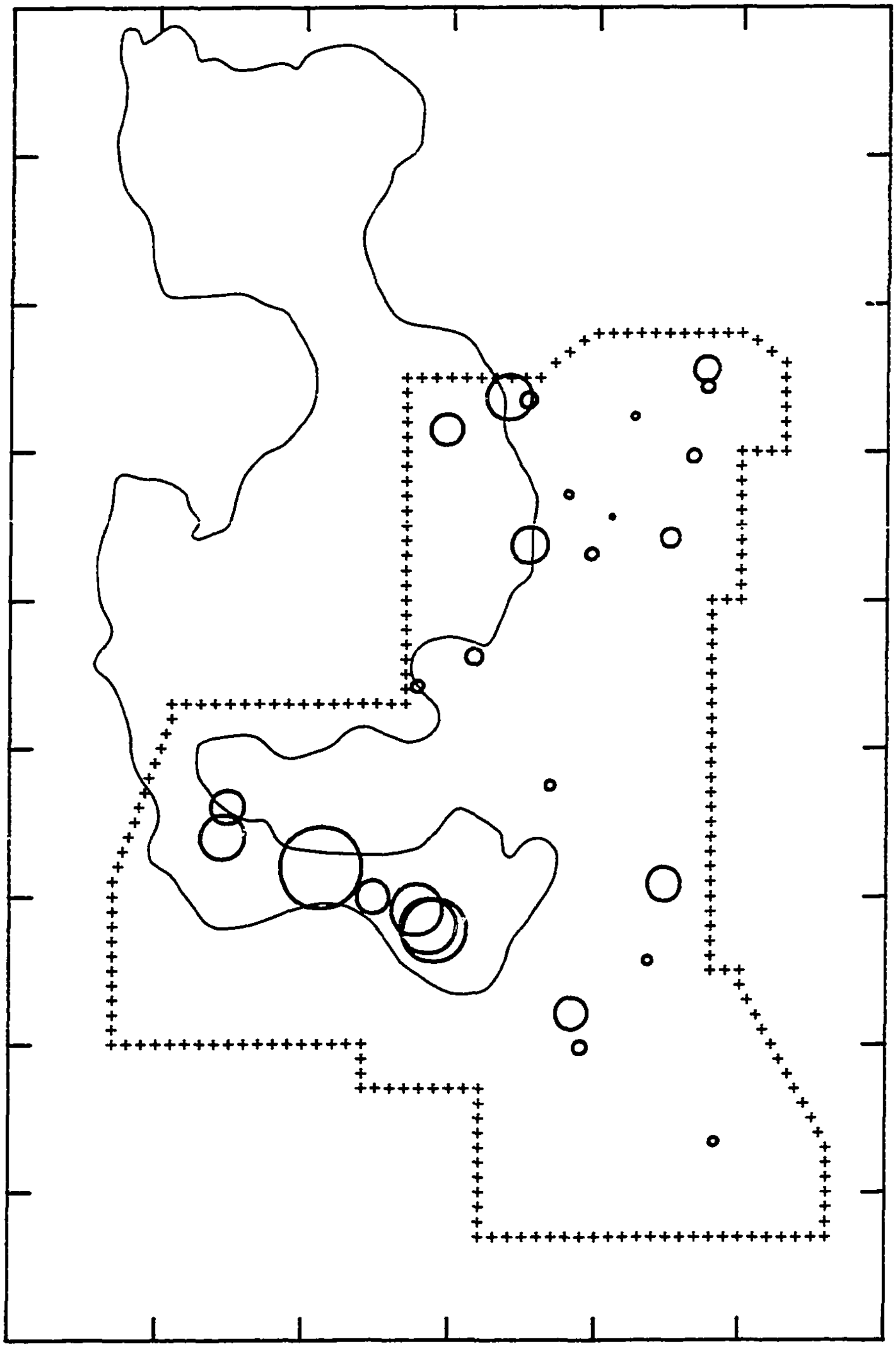


Figure VI.65. Density distribution map for Black&White&Yellow/Red. Size of circular symbol reflects the relative density of this type as recovered in surface collections.

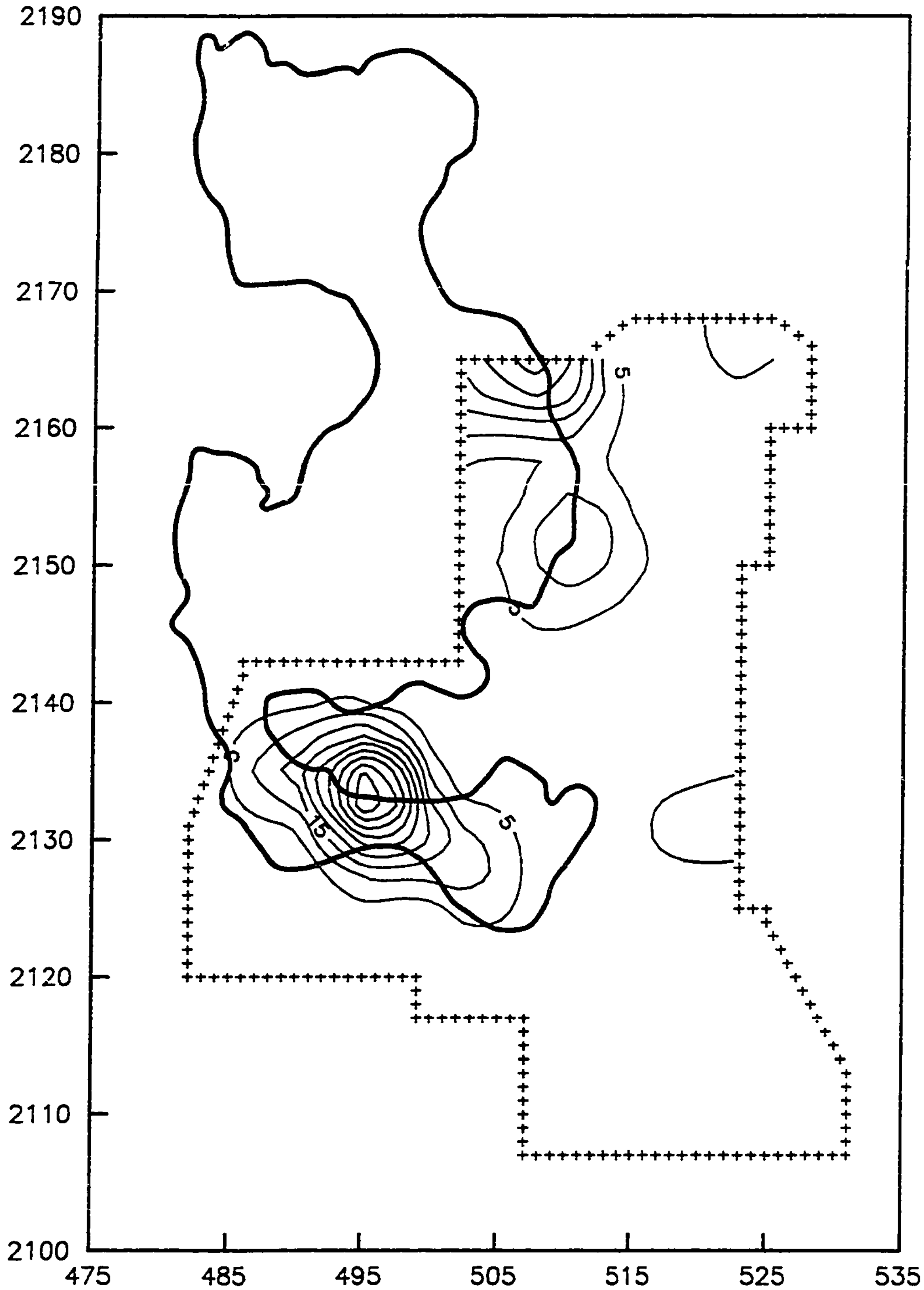


Figure VI.66. Density contour map for Black&White&Yellow/Red. (Minimum contour = 5 sherds/ha; contour interval = 5 sherds/ha.)

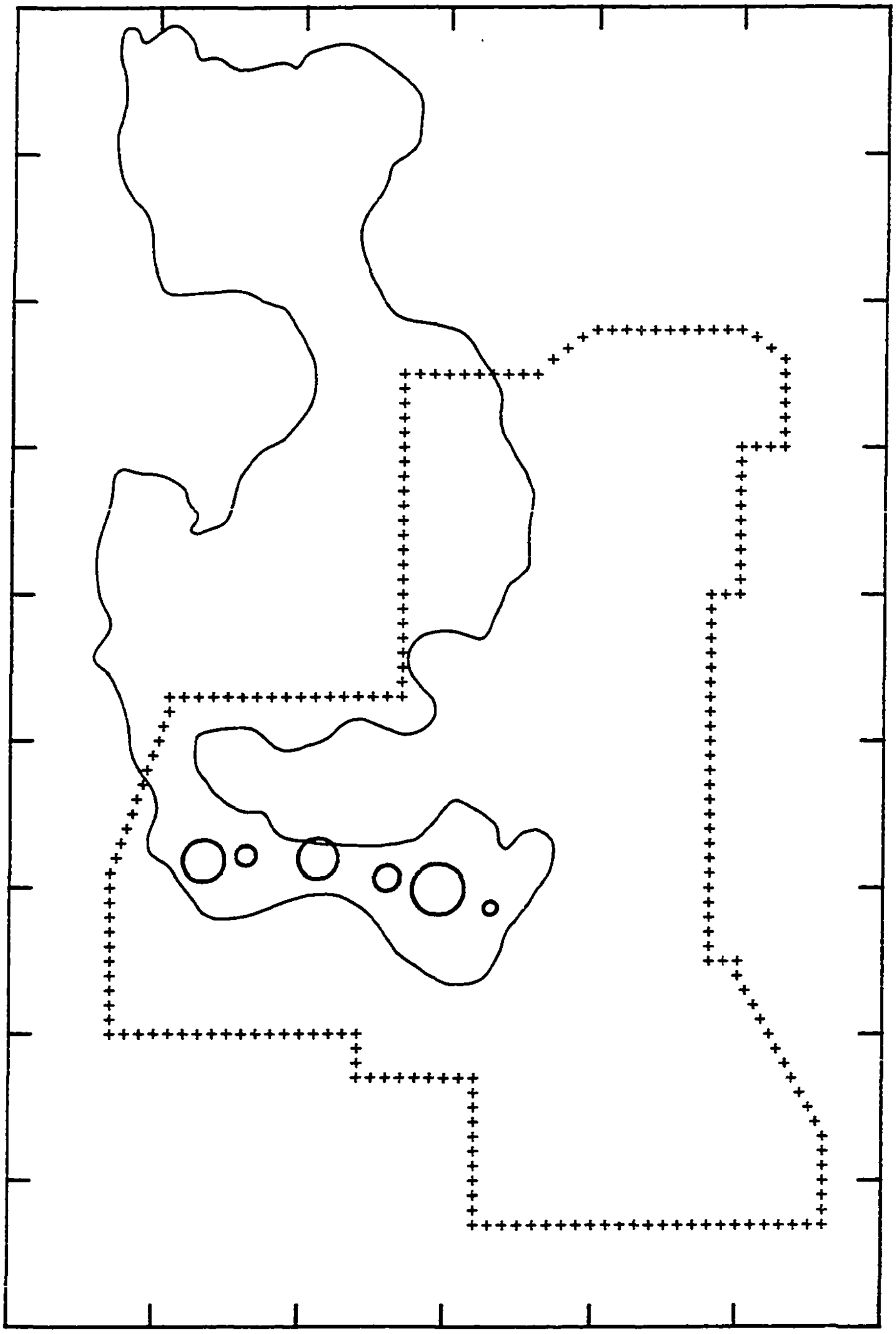


Figure VI.67. Density distribution map for White/Red. Size of circular symbol reflects the relative density of this type as recovered in surface collections.

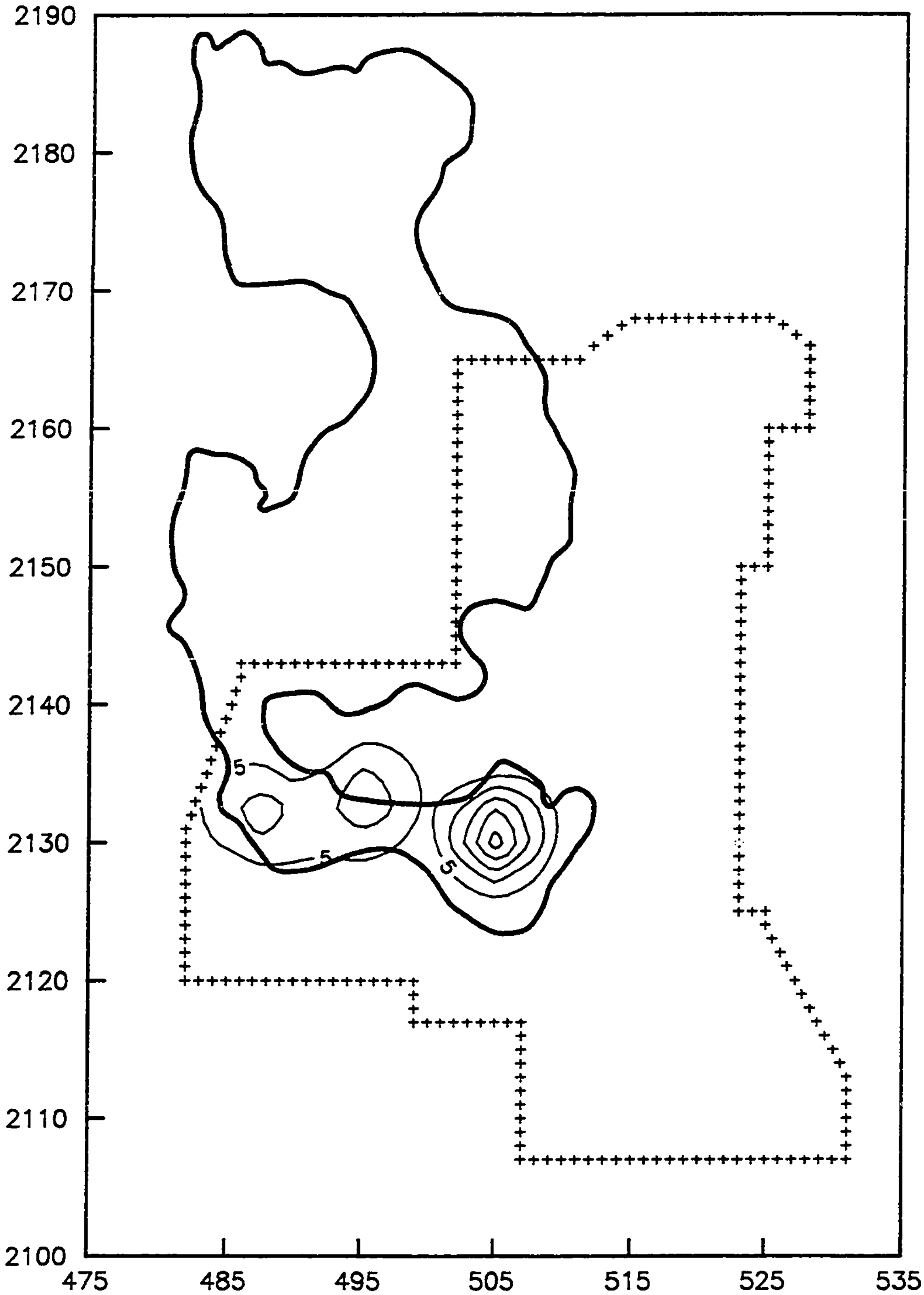


Figure VI.68. Density contour map for White/Red. (Minimum contour = 5 sherds/ha; contour interval = 5 sherds/ha.)

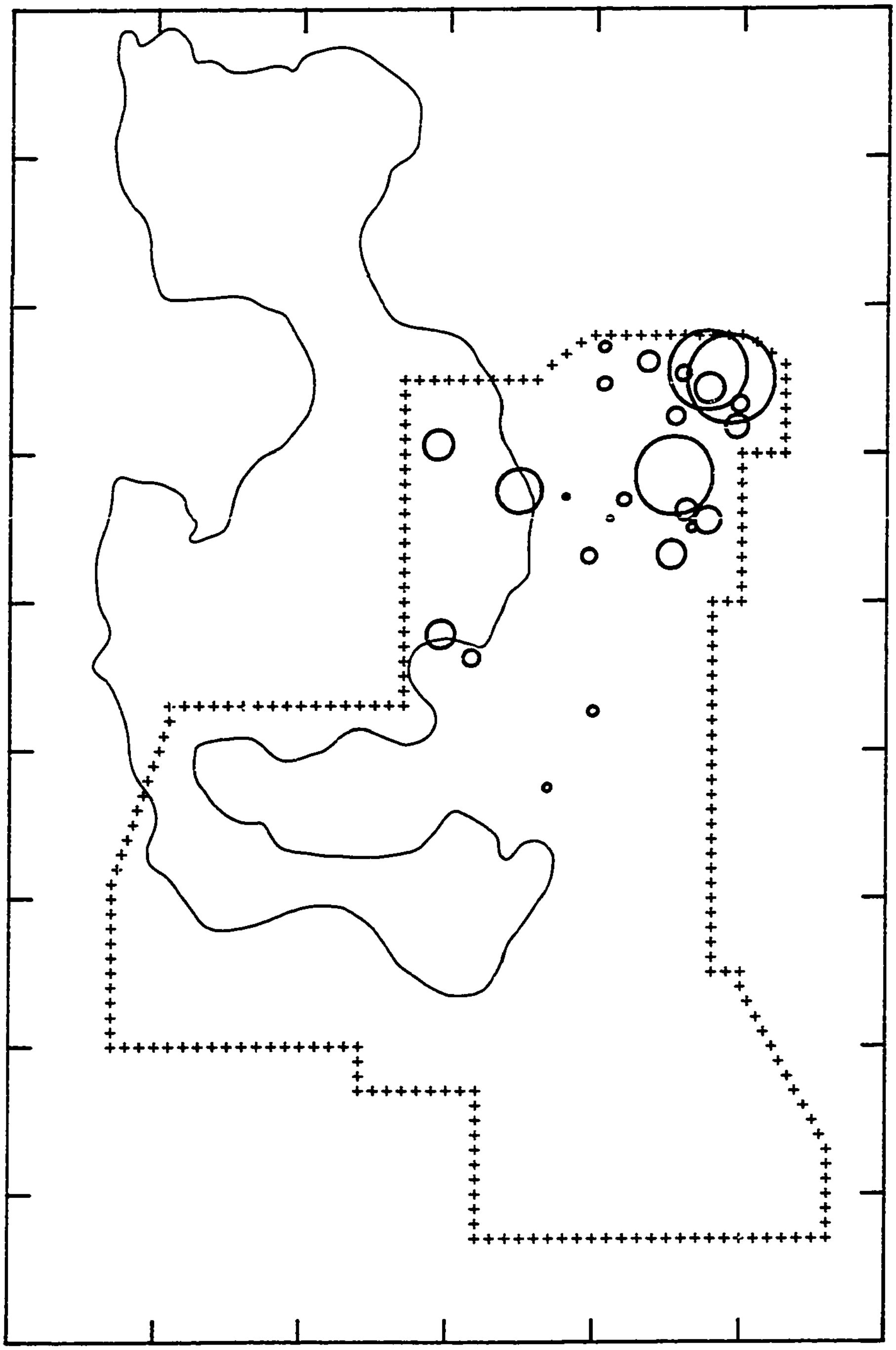


Figure VI.69. Density distribution map for Black&Red/Tan. Size of circular symbol reflects the relative density of this type as recovered in surface collections.

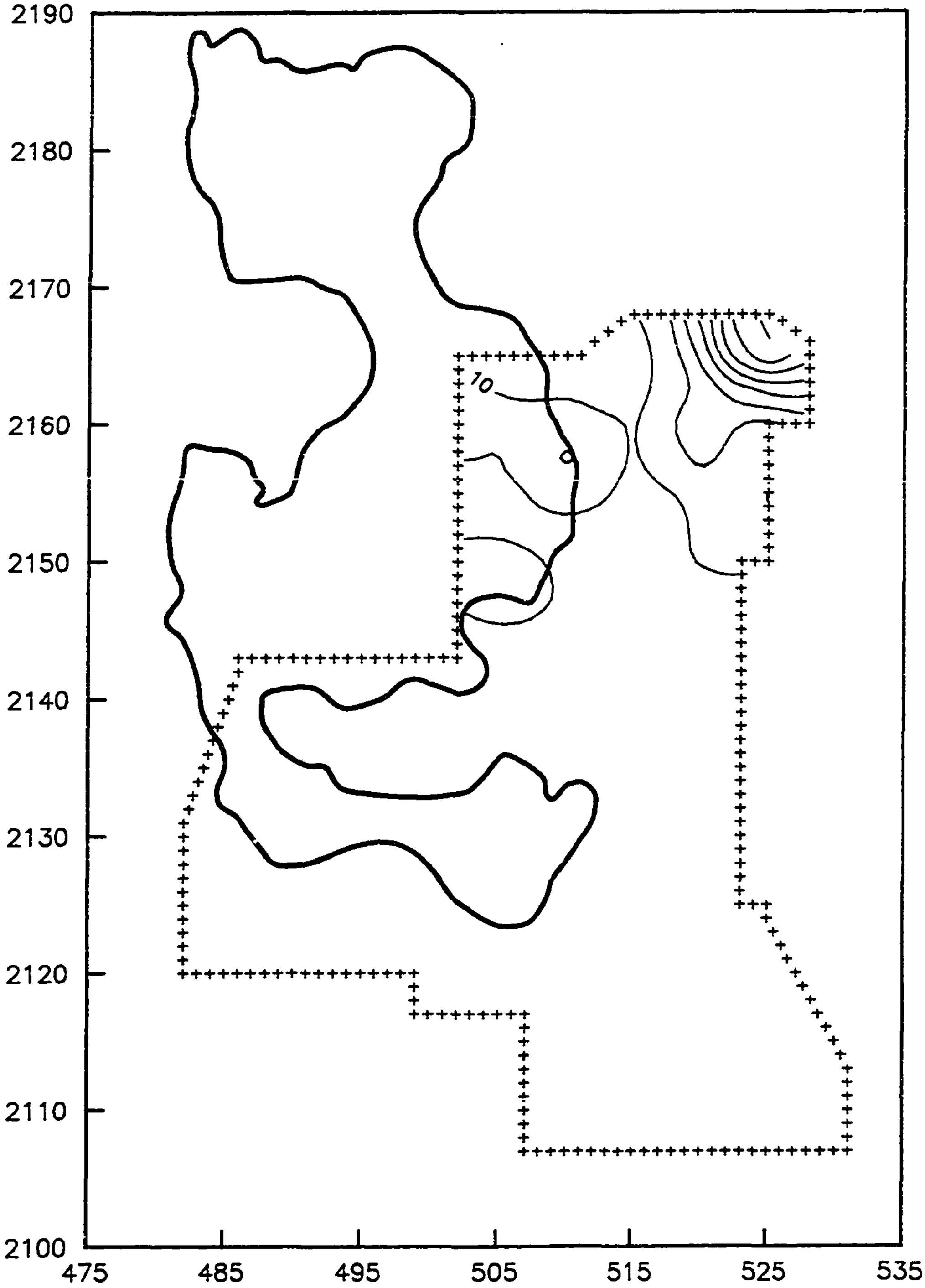


Figure VI.70. Density contour map for Black&Red/Tan. (Minimum contour = 10 sherds/ha; contour interval = 20 sherds/ha.)

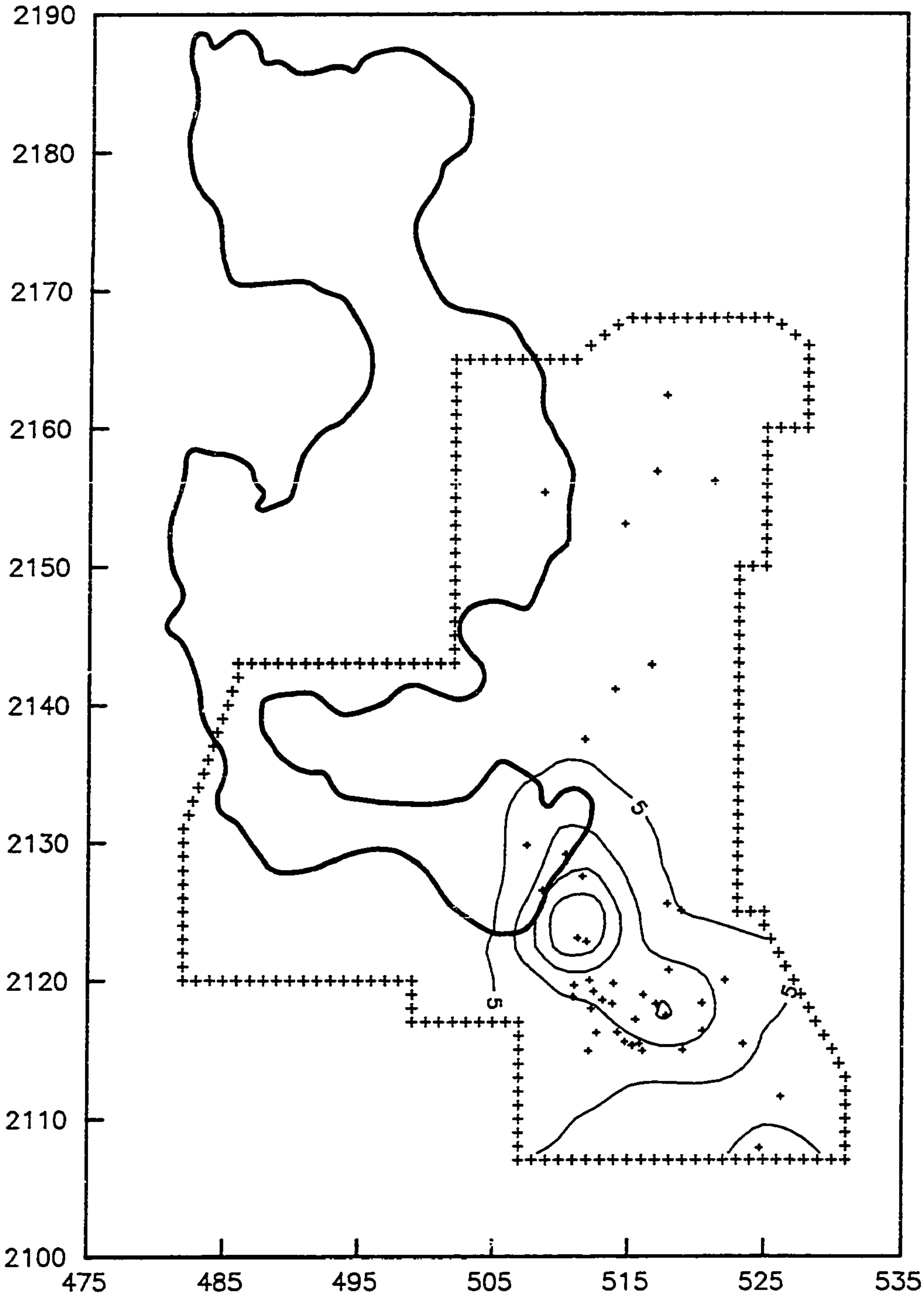


Figure VI.71. Density contour map for Early Aztec Chalco Black/Orange. (Minimum contour = 5 sherds/ha; contour interval = 20 sherds/ha.) Site locations where this type was recovered are marked with a plus sign.

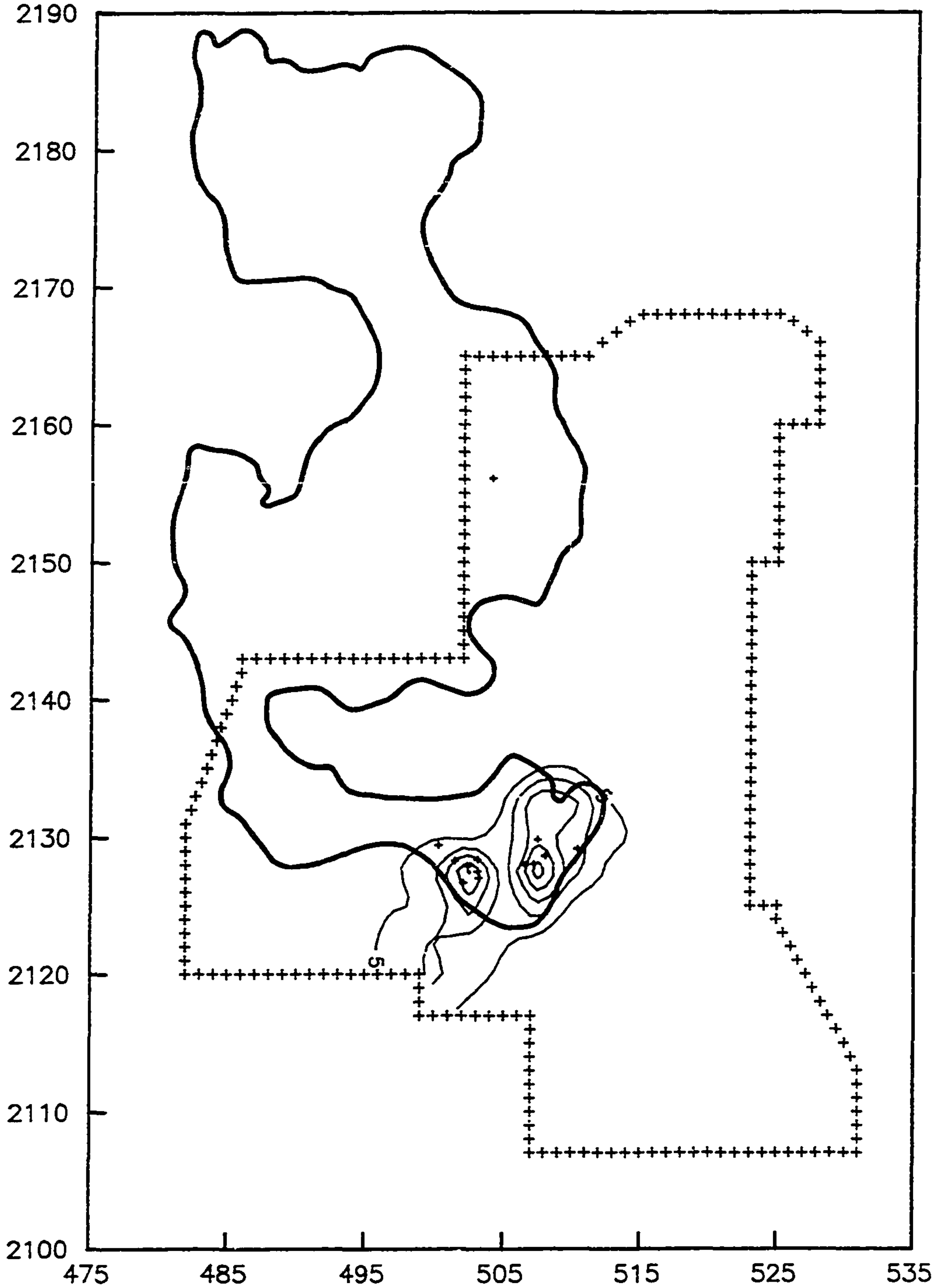


Figure VI.72. Density contour map for Early Aztec Mixquic Black/Orange. (Minimum contour = 5 sherds/ha; contour interval = 20 sherds/ha.) Site locations where this type was recovered are marked with a plus sign.

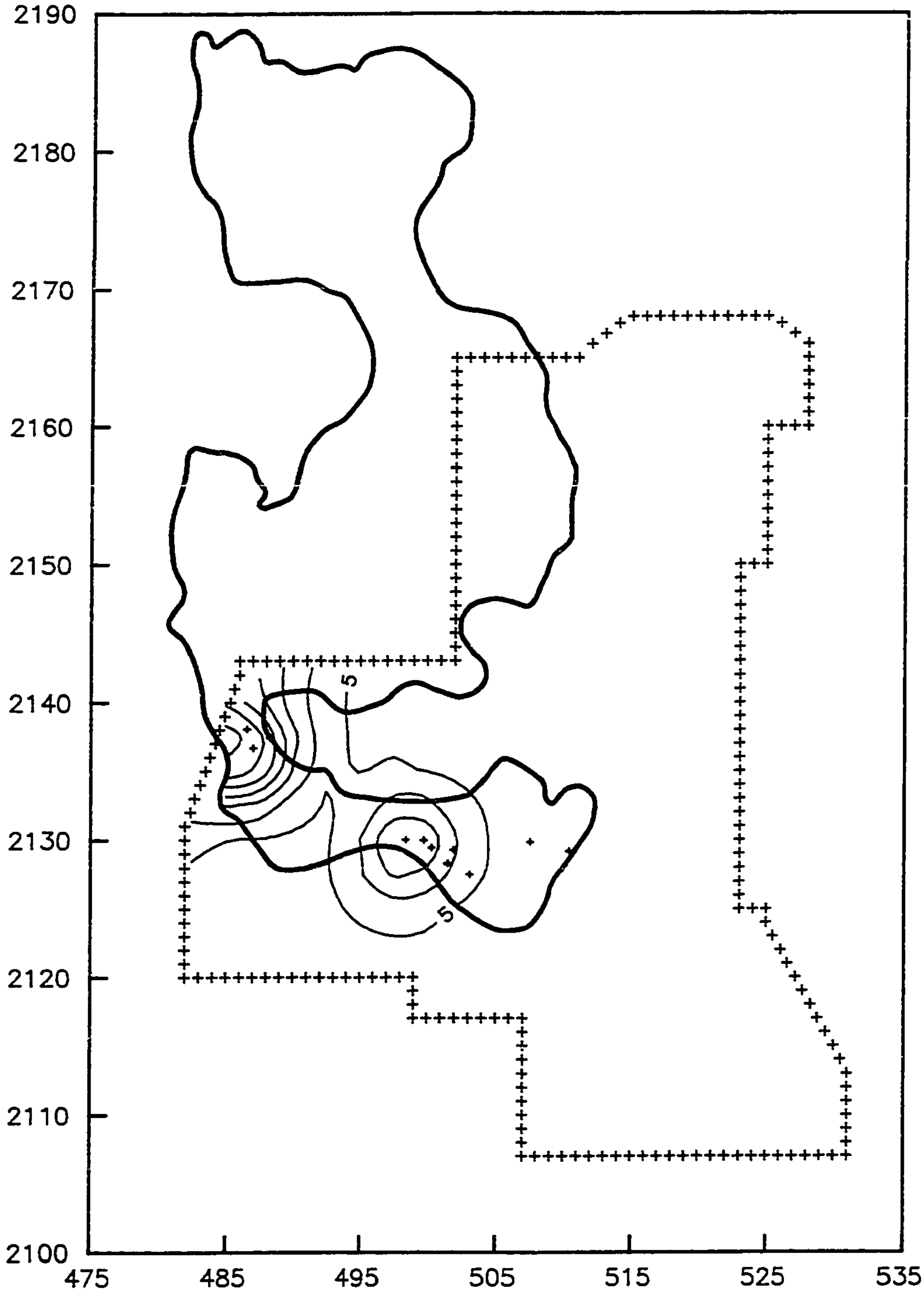


Figure VI.73. Density contour map for Early Aztec Culhuacan Black/Orange. (Minimum contour = 5 sherds/ha; contour interval = 20 sherds/ha.) Site locations where this type was recovered are marked with a plus sign.

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