

chapters, the student is led into lucid accounts of carbonate precipitation and chemical weathering; after some elementary crystal chemistry and a brush with surface chemistry, he is presented with clay mineralogy; several chapters on the chemistry of sedimentation follow, including one of the most readable short discussions on evaporites available to date. The foregoing represents over half the book. The major part of the balance treats phase relations in melts, magmatic volatiles, and an introduction to metamorphic facies. Only the final two chapters deal with elemental distribution as such, although a good deal of analytical data is presented in the previous chapters.

As a consequence of its emphasis, this book will probably not replace MASON's *Principles of Geochemistry* in undergraduate courses of the descriptive survey type. Although the book is addressed to undergraduate juniors and seniors it is appropriate for use in a first graduate course in geochemistry; and indeed, few juniors, particularly in "classical" geology departments, will have had the training in physical chemistry necessary to obtain the full benefit of this presentation.

The introductory treatment of a solution in equilibrium with two solids is valid only in the limiting case of the two solids being mutually immiscible. The example, $\text{CaSO}_4\text{-BaSO}_4$, was well chosen in that there is negligible solid solution in this system, but the limitation of the treatment is never indicated. The statement regarding the laboratory preparation of dolomite became invalid with the publication of LIEBERMANN'S work (*Nature* **213**, 241-245, 1967), no doubt too late to be included. The book, one of the publishers' series in earth and planetary sciences, contains the usual first edition production errors; Appendix 10 bears the title for Appendix 11. But these are quite minor flaws and in general the writing is lucid and the exposition coherent.

Of special interest to geochemistry instructors are the collateral reading suggestions and numerical problems at the end of nearly every chapter. Every teacher who has agonized over the creation of geochemical problems which are both valid and soluble will consider the problems alone worth the price of this book.

In summary, the book is a successful demonstration of the uses of chemistry in geology and serves as a unique introduction to modern geochemical research for the well-prepared undergraduate or first year graduate student. The chemical emphasis complements, rather than competes with, other introductory texts.

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K. A. VLASOV, M. Z. KUZ'MENKO and E. M. ES'KOVA: **The Lovozero Alkali Massif**, (translated by D. G. Fry and K. Syers; editors S. I. Tomkeieff and M. H. Battey), Hafner Publishing Co., New York, 1966. 627 + xvi pp., 255 figs, 200 tables, \$39.50.

THE LOVOZERO massif is one of the two major alkalic-apatitic massifs of the Kola Peninsula, U.S.S.R.—the other is the Khibina. These have been the subject of geological and mineralogical studies since 1887, and the mouth-watering published results have left petrologists and mineralogists intellectually drooling and bemoaning their inability to examine this, one of the classic rock and mineral localities of the world.

This monograph is not only a summary of the published research but adds many new data. It is divided into four parts, which are:

Part I: Geological structure and the petrology.

Part II: The pegmatites.

Part III: Systematic mineralogy.

Part IV: Geochemistry and origin.

The structure of the massif is that of a stacked pile of saucers (stromoconolith of Tomkeieff) with four participating "complexes": (1) an upper complex of eudialytic lujavrites, (2) a layered differentiated complex at the bottom (fayalites, urtites, etc.), (3) a complex of poikilitic syenites and (4) a suite of dikes.

In terms of their mechanism of development the pegmatites are grouped into three categories: (1) facies pegmatites (by U.S. terminology accumulation or segregation, i.e. non-injected pegmatites); (2) phase pegmatites (i.e. intruded pegmatites); and (3) facies-phase pegmatites (transitional) between (1) and (2).

Pegmatites are genetically related to three of the complexes: those of the eudialytic lujavrite complex, those of the differentiated complex, and those of the poikilitic syenite complex; in addition a fourth group of *hybrid* pegmatites was formed as the result of assimilation of country rocks by injected pegmatite fluid.

All minerals in the pegmatites fall into six paragenetic associations:

1. Nepheline-aegirine I-microcline-eudialyte.
2. Nepheline-aegirine I-microcline with eudialyte.
3. Sodalite-nepheline-aegirine I-microcline-eudialyte with Zr, Ti, Nb and RE minerals.
4. Feldspar-aegirine II with Zr, Ti and Nb minerals.
5. Hackmanite-natrolite with RE and Th minerals.
6. Natrolite-analcite-ussingite-albite with late microcline and Li and Be minerals.

A wealth of paragenetic information is provided, and the descriptions of the internal structure (chiefly zoning) are unique for pegmatites of the alkalic-subsilicic group.

Part III describes 108 minerals, seventy more than previous lists and eleven new species. These are grouped into three categories: (1) principal rockforming minerals; (2) rare-metal minerals (Zr, Nb and Ti, RE and Th, Li, Be); and (3) secondary and accessory minerals. In addition to the usual mineralogical data, much information is presented on genetic relationships, distribution patterns and paragenesis. For some of the rarer and more recently described species X-ray powder diffraction data are provided; for some species DTA data also appear.

A discussion of the geochemistry of individual elements begins Part IV. In addition to the surprising concentrations of Li and Be, another discovery is the relative abundance and widespread distribution of Ga which occurs in more than forty minerals, reaching 0.02–0.04% in hackmanite, natrolite and ussingite.

The authors conclude that the massif was formed largely as the result of a single injection of magma which differentiated *in situ* and parts of which were hybridized by syntexis (with granite gneiss and mafic volcanics).

Although this is a monumental piece of work it is in many respects an unsatisfactory one. There is a great deal of repetition, and the text could have been markedly reduced in volume without any loss of quality. In the sections dealing with geology of the massif and its genesis the exposition is poorly organized and fuzzy. The regional geologic setting is barely mentioned; nor is there any mention of the relation of this marvellous body to the other alkalic intrusions of the peninsula.

Although the chemical composition of the parent magma has been worked out in great detail, the magma remains petrologically undefined. Indeed, the section on origin is largely a non-informative rehash of information previously encountered. The occurrence of hydrocarbon gases is not mentioned. Most of the illustrations are good, but the quality is variable and some might better have been omitted (especially those of some mineral hand specimens). The authors have persisted in retaining varietal and trivial mineralogical names.

Despite these faults, this is a good and worthwhile book; a small amount of editing and a few well-written additions would have easily made it a much better one.

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