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MAMMALIAN AND OTHER FOSSILS, EARLY EOCENE PASS PEAK FORMATION, CENTRAL WESTERN WYOMING

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VOLUME 22

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6. A redescription of the Middle Silurian compound rugose coral *Grabauphyllum johnstoni* Foerste, by Erwin C. Stumm. Pages 71–73, with 1 plate.
7. Systematics and faunal analysis of a Lower Pliocene vertebrate assemblage from Trego County, Kansas, by Richard L. Wilson. Pages 75–126, with 17 text-figures.
8. *Gennaeocrinus chilmanae,* a new crinoid from the Middle Devonian Silica Formation in southeastern Michigan, by Robert V. Kesling. Pages 127–131, with 1 plate and 1 text-figure.
9. Note on ontogeny of the Middle Devonian crinoid *Proctothylacocrinus esseri* Kesling, by Robert V. Kesling. Pages 133–138, with 2 plates and 4 text-figures.
10. *Archaeosperma arnoldii*—a cupulate seed from the Upper Devonian of North America, by John M. Pettitt and Charles B. Beck. Pages 139–154, with 6 plates and 3 text-figures.
11. *Ameliacrinus benderi,* a new dicyclic camerate crinoid from the Middle Devonian Silica Formation in northwestern Ohio, by Robert V. Kesling. Pages 155–162, with 3 plates and 2 text-figures.
12. *Logocrinus conicus,* a simple new Middle Devonian inadunate crinoid from Michigan, by Robert V. Kesling. Pages 163–167, with 1 plate and 1 text-figure.
13. Copulatory adaptations in ostracods, Part I. Hemipenes of *Candona,* by Don L. McGregor and Robert V. Kesling. Pages 169–191, with 3 plates and 16 text-figures.
14. A fossil carabid beetle from the Miocene of Montana, by P. J. Darlington, Jr. Pages 193–197, with 2 plates.
15. Two new crinoids from the Middle Devonian Silica Formation, by Robert V. Kesling. Pages 199–206, with 2 plates.

MAMMALIAN AND OTHER FOSSILS, EARLY EOCENE PASS PEAK FORMATION, CENTRAL WESTERN WYOMING

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ABSTRACT—A few mammalian fossils from several levels in the Pass Peak Formation, central western Wyoming, indicate the age of the formation is *not* Middle Eocene as previously supposed. Instead, a "transition zone" between the underlying Hoback Formation and the Pass Peak is Graybullian, probably Late Graybullian (late Early Wasatchian, late earliest Eocene). A slightly higher faunule in the Pass Peak Formation most probably is Lysitean (mid-Wasatchian, middle Early Eocene) in age. A still higher faunule, near the top of what remains of the formation, is Lysitean? or Early Lostcabinian (early Late Wasatchian). No level as young as Bridgerian (Middle Eocene) was found. Fossils were found in a well-exposed stratigraphic section along U.S. Highway 187–189, whereas the relatively inaccessible type locality of the Pass Peak Formation has yielded none. Strata exposed along the highway include fine clastics of a mid-basin facies in contrast to coarse conglomerates which dominate at the type locality of Pass Peak itself. At least the upper part of the Pass Peak Formation interfingers southward with the Lysitean? and/or Early Lostcabinian age LaBarge (= Knight equivalent) tongue of the Wasatch Formation.

INTRODUCTION

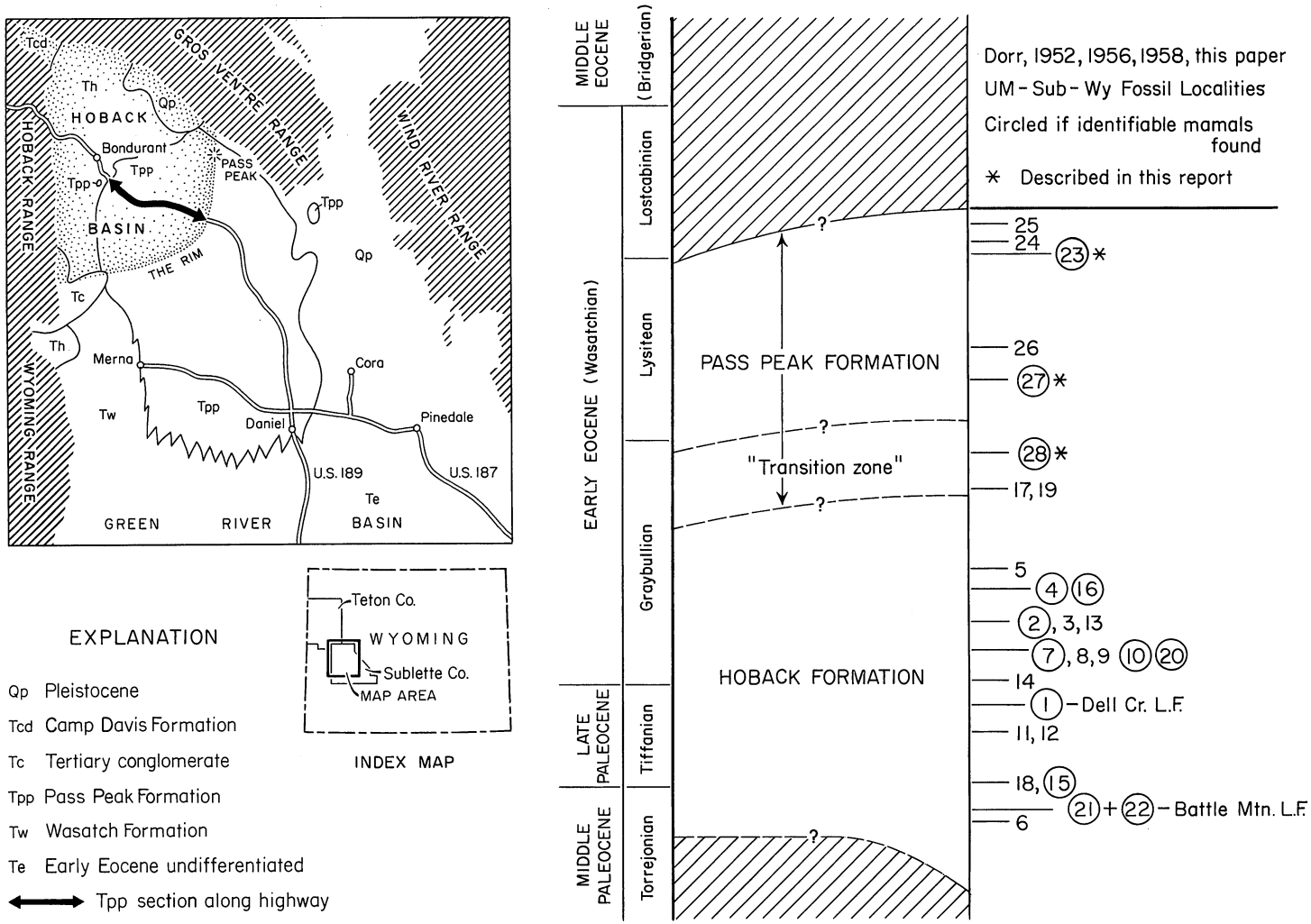
THIS PAPER DEALS with the geologic age, stratigraphic relationships, and fossil content of the Pass Peak Formation, providing a preliminary complement to a forthcoming publication on extensive studies of the Early Tertiary sedimentary and tectonic history of the Hoback Basin, Northern Green River Basin, and adjoining mountain ranges in central Western Wyoming (Dorr, Spearing, & Steidtmann, manuscript in preparation).

LOCATION

The Pass Peak Formation occurs in the northwestern corner of Sublette County in central Western Wyoming (text-fig. 1). It extends from the southwestern flank of the Gros Ventre Range, southward across U.S. Highway 187–189 and westward toward the Hoback and Wyoming ranges. The area of outcrop occurs along both sides of the Hoback Basin "Rim" which is the drainage divide between the north-flowing Hoback River (tributary to the Snake) and the south-flowing Green River (tributary to the Colorado). The formation is exposed at the surface throughout most of this area except for local patches of Pleistocene or Recent cover. Within the Hoback Basin, along the northern and northwestern edge of its outcrop, the Pass Peak Formation can be seen to overlie the Hoback Formation of Middle Paleocene to earliest Eocene age. Their contact is transitional. The Pass Peak Formation extends southward from the Hoback Basin Rim, but exposures are poor. A few miles south of Daniel Junction, sandstones of Pass Peak type interfinger with strata of the LaBarge Tongue (Oriel, 1962; = Knight equivalent of Gazin, 1952, 1955, 1962) of the Wasatch Formation. The LaBarge Tongue is considered Lysitean? and/or Early Lostcabinian in age. The zone of interfingering lies mainly south of Merna and Daniel, between Horse Creek on the north and Cottonwood Creek on the south. South of the Rim, the formation lies mainly west of U.S. 187–189. Although earlier reports (Eardley *et al.*, 1944; Eardley, 1951, 1962; Dorr, 1952, 1958; and others) have indicated that the formation extends westward to the flanks of the Hoback and Wyoming Ranges, this now is open to question. Conglomeratic deposits previously identified as Pass Peak Formation there are of a markedly different facies, their age is yet unknown, and intertonguing with the Pass Peak Formation remains to be clearly demonstrated. Our recent studies suggest, but do not yet prove, that at least some of the conglomerates on the west more probably are related to the so-called "Main Body of the Wasatch" of Oriel (1962).

TYPE LOCALITY OF THE PASS PEAK FORMATION

The type locality of the Pass Peak Formation, although never specifically designated, has been established by usage as being a hill called Pass Peak (altitude 9910 feet) on the Hoback Basin Rim. Pass Peak lies 12 miles due east of the town of Bondurant (from whence it is



TEXT-FIG. 1—Location, general geologic relationships, and time range of the Pass Peak Formation.

visible as a high point on the skyline, with a prominent erosion scar at its apex). Pass Peak lies about 6 miles due north of the point where U.S. 187–189 crosses the Rim. At the type locality, the Pass Peak Formation consists almost entirely of conglomerates representing a basin-edge facies. These conglomerates are very coarse and composed almost entirely of roundstones of Precambrian metaquartzite of the same type found in the geologically older Harebell Conglomerate (latest Cretaceous) and Pinyon Conglomerate (Paleocene) to the north (Love, 1956). The provenance of the metaquartzite clasts in these latter two formations is still in doubt. Likewise, the source which provided similar material to the Pass Peak is yet to be determined with certainty, although reworking from the Pinyon, the Harebell, or both has been suggested (Love, 1956, 1960; Antweiler & Love, 1967; Dorr, 1956, 1958).

MID-BASIN FACIES AND HIGHWAY SECTION

The best and most completely exposed stratigraphic section of the Pass Peak Formation occurs in road cuts along U.S. 187–189, and in the valley sides along Fisherman (Fish) Creek and its tributaries, between the Upper Hoback River steel highway bridge and the Rim (text-figs. 1, 2; pl. 1). This section of the highway falls entirely within Township 37 North, Ranges 111, 112, and 113, in Sublette County, Wyoming. The roadcuts resulted from recent, extensive reconstruction of that section of the highway. By 1964, sufficient weathering and erosion of the cuts had occurred to bring some mammalian fossil bone fragments to the surface, thus enhancing the possibility for discovery of fossils. As mentioned above, the type locality of the formation is quite inaccessible and consists of a basin-edge conglomerate facies in which preservation of fossils is unlikely; as yet none have been found there. An added advantage of the highway section stems from the fact that in the course of construction small (2 feet high) concrete distance markers were placed at intervals along the outer edge of the right-of-way. Each monument is clearly marked to record the distance from the highway zero point near Jackson, Wyoming. The figures on the markers are meaningless in themselves, but record distances which can be found, to scale, on the detailed Plan and Profile drawings of the highway. These drawings also show elevations above sea level at the centerline of the "as constructed" highway. The drawings may be obtained from the U. S. Department of Commerce—Bureau of Public Roads (see references). Thus the location and elevation of fossil localities and important sedimentary horizons close to the highway can be determined with greater than ordinary accuracy (text-fig. 2). Since the dip of the formation along the highway is nearly everywhere zero and nowhere exceeds 4 degrees, the stratigraphic positions of horizons within the formation also can be determined fairly accurately.

UM-Sub-Wy Locality 28 (text-fig. 2), from which datable fossils have come, occurs near the top of a "transition zone" where lithologies typical of the Hoback Formation and Pass Peak Formation alternate. This locality (pl. 1, fig. A) is in a meander scar on the north side of Fisherman Creek, just north of the highway, near the new home of Mr. and Mrs. Albert Fuez (pronounced "fates"). Taking the elevation of this locality as zero, the stratigraphic levels of higher localities along the highway in the Pass Peak Formation were determined as shown on text-figure 2. Measured in this manner, the total thickness of the formation, from Locality 28 near the base, to the top of the road cut at UM-Sub-Wy Locality 25 at the crest of the Hoback Basin Rim, is about 1146 feet. Strata within the formation crop out at a much higher elevation (9910 feet) six miles to the north on Pass Peak itself. This at first suggested that strata at the Rim originally lay well below the depositional top of the formation, being exposed now as a result of considerable erosion of overlying beds. This in turn seemed to imply that the original total thickness of the formation in the area along the highway once was greater and that deposition of the Pass Peak Formation must have continued into a time later than any represented by fossils along the highway. However, the angle of slope (about 4 degrees) and geomorphologic character of the Rim between Pass Peak and the highway, the 4 degree southward dip of the strata in the formation there, and the change in sedimentary facies from very coarse to fine southward from Pass Peak to the highway, all suggest that the surface slope of the Rim, as it exists today, is close to that of an original depositional surface on a steep fan which spread southward from the vicinity of Pass Peak to points well south of the present location of the highway. If this latter interpretation, which I now favor, is correct, then time horizons within the formation along the highway may rise geographically northward so that the ages of sediments high on Pass Peak are little if any younger than those determined for beds along the highway. I therefore believe that sediments at the type locality at Pass Peak accumulated during about the same time span as those along the highway.

An especially important sedimentary horizon crops out in a road cut on the north side of the highway 4.28 miles east of the steel highway bridge over the Upper Hoback River. This outcrop is at distance marker 1280 on the highway plan (text-fig. 2). The lowermost "in place" Pass Peak conglomerate lens occurs here, about 325 feet stratigraphically above Locality 28. This conglomerate is composed of the typical "Pass Peak type" or "Pinyon type," pressure-marked and fractured, highly rounded, varicolored, Precambrian metaquartzites. Although similar conglomerate horizons occur above, the significance of this particular one stems from the fact that past authors have placed the contact between the Pass Peak and underlying Hoback formation differently. In the 1940's Eardley and some of his students from nearby University of Michigan Camp Davis mapped the contact along the base of the lowest yellow Pass Peak type sandstone. Dorr (1952, 1958) placed it somewhat higher at the lowest horizon of typical Pass Peak conglomerate. Hoback and Pass Peak types of sandstones now can be distinguished on the basis of their heavy mineral content as well as their gross field aspects and our studies in progress now incline us to shift the contact back down, placing it at the lowest well-developed Pass Peak type sandstone within the so-called "transition zone." The advantage of this latter course is that it draws attention to the time of acceleration of Pass Peak type sedimentation and thus to whatever tectonic events may have been the cause of a change in provenance. Other alternatives are possible but would not be as useful in regional history. Conclusions regarding the tectonic significance of the shift in provenance will be presented in a subsequent paper.

Regardless of which criterion is used to define the base of the Pass Peak Formation, the lowest conglomerate horizon along the highway occurs low but well within the formation. Moreover, Fossil Locality UM-Sub-Wy 27, a horizon dated in this paper as Lysitean in age, occurs only about 98 feet stratigraphically above this conglomerate. This faunule is, by any definition, within the Pass Peak Formation and about 423 feet stratigraphically above the faunule found in the "transition zone" at Locality 28. Since the total thickness of the formation exposed along the highway, from Locality 28 to the Rim, is about 1146 feet, nearly two thirds (about 723 feet) of the formation must be Lysitean or younger in age, as discussed below. Since the beds at Locality 28 are Graybullian (probably Late Graybullian) in age, and there is no stratigraphic evidence for a significant sedimentational gap above, it is probable that the Graybulian-Lysitean Land Mammal Provincial Subage time boundary lies somewhere between Localities 28 and 27. Future fossil discoveries at levels between may establish the position of that boundary more closely.

GENERAL CHARACTERISTICS OF THE FORMATION

Above the basal "transition zone," the Pass Peak Formation consists of somewhat variable but recurring sequences of yellow sandstone, gray to blue-gray and brown claystones and shales, and conglomerates. Some of the coarser

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EXPLANATION OF PLATE 1

Exposures of the Pass Peak Formation along U.S. Highway 187–189, Sublette County, Wyoming.

A—View ENE from steel highway bridge over Upper Hoback River to UM-Sub-Wy Locality 28. Albert Fuez home, concealed from view by bridge, lies short distance to right of the locality. Exposure is a meander scar along Fisherman (Fish) Creek. Fossil mammals and snails occur here. Conspicuous sandstone outcrops in distance are in Pass Peak Formation.

B—UM-Sub-Wy Locality 27 near small, vertical concrete highway marker numbered 1330. Man sits in small quarry in productive horizon. Fossil mammals and snails occur here.

C—UM-Sub-Wy Locality 24. Aquatic snails occur here in thinly and regularly bedded lacustrine shales. Note channel-scoured contact between shales and overlying, strongly cross-bedded, fluviatile sandstone.

D—UM-Sub-Wy Locality 23. University of Michigan students ranged along productive horizon in blocky, floodplain claystones beneath stream channel sandstone. Fossil mammals, and snails (*Oreoconus*) retaining distinct color markings, occur here.

E—Two prominent stream sand lenses cut diagonally by Pass Peak conglomerate.

F—UM-Sub-Wy Locality 25 at Hoback Basin Rim. Prominent stream channel lens pinches out within claystones and shales. Fossil snails, leaves, wood, fragments of mammal bones and teeth and fish bone found here. Sign in extreme upper right marks Teton National Forest boundary.

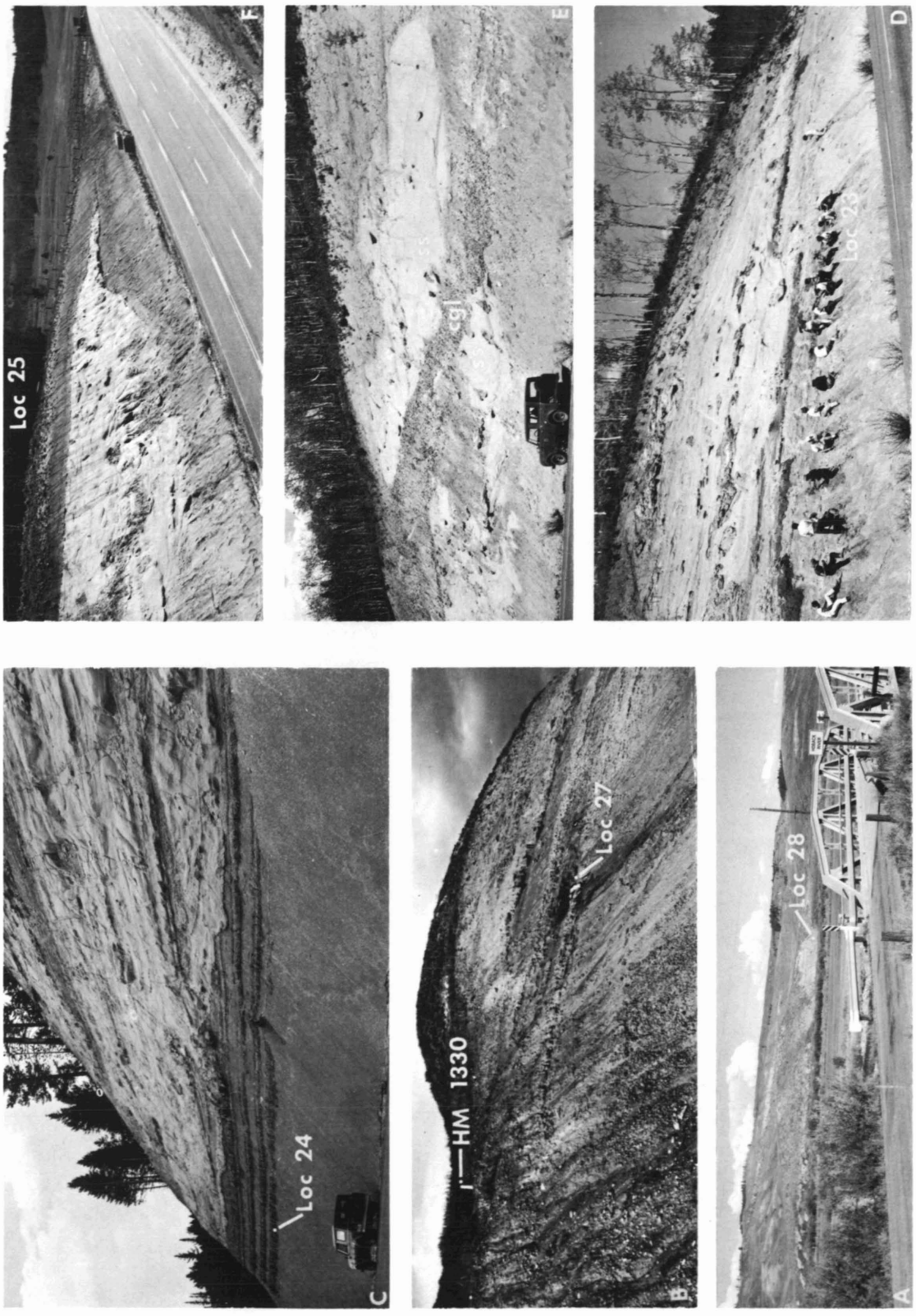
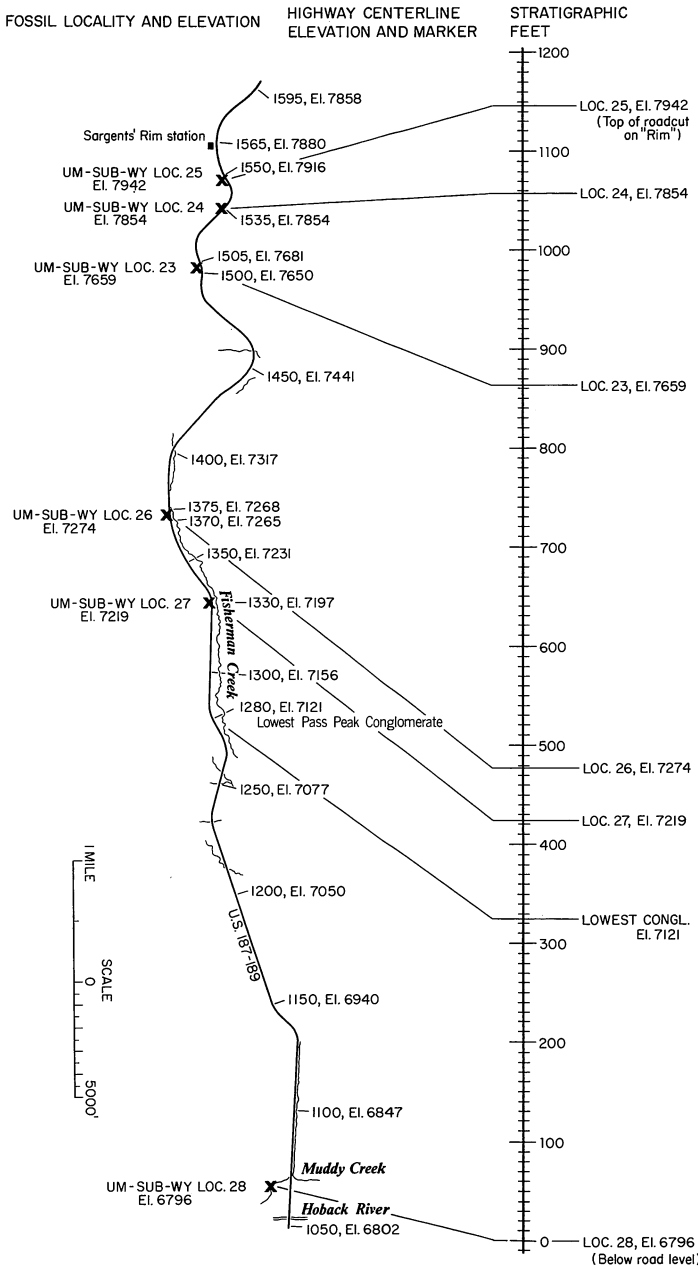


PLATE 1

sandstones are strongly arkosic. The sandstones are, for the most part, markedly lensatic stream deposits, as are the conglomerates. The claystones originated as overbank deposits adjacent to the streams. The thinly and regularly laminated shales were deposited in ponded water and are locally rich in fossil remains of aquatic snails. Many of the roundstones in the conglomerate lenses are pressure-marked and fractured. The physical nature and origin of the



TEXT-FIG. 2—Plan and cross section along U.S. 187–189, where the Pass Peak Formation crops out. Modified and reduced from detailed, "as constructed" highway plan and profile obtained from the U. S. Department of Commerce—Bureau of Public Roads. Regularly spaced cross-marks on plan represent 5000 foot intervals along highway. Many concrete distance markers are located along edge of highway. Those near fossil localities are shown on the plan. Elevations, in feet above sea level, are for highway centerline opposite the markers; elevations of fossil horizons were measured from those points. Dip of the formation is nearly everywhere zero, and nowhere greater than 4 degrees.

formation will be discussed more thoroughly in a forthcoming publication based on studies still in progress. Until then, however, more complete descriptions of the formation may be found in the literature cited below.

GEOLOGICAL RELATIONSHIPS

On the northeastern edge of the depositional basin, along the flank of the Gros Ventre Range, the Pass Peak Formation terminates against Mesozoic rocks near the Cache Fault (Eardley *et al.*, 1944; Horberg, Nelson & Church, 1949; Dorr, 1952, 1956, 1958). Toward the western edge of the basin, along the Hoback Basin Rim, its relationships to other formations become obscure, due in part to the lack of well-exposed sections. The previous authors just listed considered that the formation extended across the basin of deposition, grading into a red and gray conglomerate facies, and terminating against the eastern flank of the Hoback Range where the formation was laid down over the trace of the Cliff Creek (Prospect) Thrust and then cut by subsequent younger thrusts. Present studies cast doubt on this interpretation. I am not satisfied that the exact relationship between the main body of the Pass Peak Formation and the conglomerates along the western edge of the basin is known. The western conglomerates are not clearly seen to interfinger with the Pass Peak Formation, no age significant fossils have been found in them, and hence they cannot yet be proven to be the same age as any part of the Pass Peak Formation. Moreover, the composition of the western conglomerates is so different as to suggest that they might best be set off as a separate lithic unit, perhaps correlatable with other deposits of similar provenance farther south at the western edge of the Green River Basin. Structural and historical interpretations are deferred until completion of field studies in progress.

AGE OF THE FORMATION

The geologic age of the Pass Peak Formation should be known as exactly as possible if conclusions concerning the origin of the formation are to be related to the complex geologic history of the northern part of the Green River Basin. When the present study was undertaken, no fossil vertebrates had been reported from the formation. Previous conclusions about its age were based on its stratigraphic position above the Hoback Formation, and on oral reports of unpublished and inexact evidence from scanty fossil remains of molluscs and land plants. Most authors relied upon statements of predecessors. A chronological resume of principal literature references to the formation follows:

1. Schultz (1914, p. 77) considered the deposits correlative with the Almy conglomerates of Southwestern Wyoming, applying that name.
2. Blackwelder (1915, p. 204) considered the conglomerates in the formation lithologically correlative with the Pinyon conglomerate but was uncertain of age of either.
3. Nelson & Church (1943) following Schultz (1914) correlated the formation with the Almy and used that name.
4. Eardley, Horberg, Nelson, & Church (1944) in stratigraphic column, listed "Pass Peak conglomerate, Middle Eocene, 1000–5000 feet." Type locality not specified but Pass Peak implied. Formation described as, "Coarse red and grey conglomerates that grade into sandstone and shale toward basin."
5. Horberg, Nelson, & Church (1949, p. 190) considered Pass Peak deposits including conglomerates as Middle Eocene, following Eardley, *et al.* (1944).
6. Eardley (1951, explanation of figure 203) showed "Tp, Pass Peak (middle Eocene)." Correlation chart figure 179 shows Pass Peak about age equivalent to Knight in the Eocene. On p. 325 said Pass Peak formation is "middle (?) Eocene."
7. Dorr (1952, pl. 2) failed to show Pass Peak Formation in Early Eocene at top of correlation chart, considering it Middle Eocene.
8. Wanless, Belknap, & Foster (1955) offered no new evidence but ascribed to "Eardley (1942; 1944)" the view that Pass Peak is "later Early Eocene or Middle Eocene" in age. This turns out to have been a very good judgment *not* based on good evidence. Actually, Eardley in 1942 made no reference to the formation and in 1944 gave its age as Middle Eocene.
9. Love, Weitz, & Hose (1955) placed the symbol "Tep" on their map in the area where the formation occurs. The contact with "Tw" (Wasatch) to the south is left undefined. "Tep" is described as, "Lower Eocene and Paleocene rocks, undivided. Dully variegated claystone, shales, and sandstone interbedded with conglomerates of highly rounded quartzite fragments; includes Pass Peak formation of Eardley." "Tep" is shown in the map explanation as being older than the Green River, Wasatch, Willwood, Wind River, or Indian Meadows formations, and as lying on the Paleocene-Eocene boundary. Thus the description fits the Pass Peak formation but the age assignment and correlations are incorrect.
10. Love (1956, p. 144) stated that uplift and southward tilting of the northern part of

Teton County caused streams to strip off a cover of the Paleocene Pinyon Conglomerate, reworking and transporting the debris southward to be redeposited as the Pass Peak Formation at the northern end of the Green River Basin. He referred to an oral communication from the late Dr. Roland W. Brown, paleobotanist, to the effect that the fragmentary fossil plant remains indicate the Pass Peak Formation to be of Early Eocene age.

11. Dorr (1956, correlation chart on p. 104) showed the Pass Peak Formation as questionably ranging from Late Lysitean through Lostcabinian into Middle Eocene time, thus equivalent to the upper Knight, the LaBarge Local Fauna, the lower part of the Green River Formation, the Late Wasatchian in general, and Bridgerian (Middle Eocene) as well. He stated (p. 106), "The formation is certainly no older than early Eocene, and is probably younger than early Wasatchian because it overlies beds of that age in the Hoback formation." There was then no direct fossil evidence to support those conclusions.
12. Dorr (1958, p. 1239) in an outline of orogenic events, stated, "Deposition of Pass Peak, in part during mid Eocene Bridgerian time, may have begun in latest early Eocene (Lostcabinian) time." The suggestion of a pre-Middle Eocene age was based on tectonic and stratigraphic considerations, not fossil evidence.
13. Love (1960, p. 208–209) altered his stand of 1956 slightly, speaking of uplift, probably at the beginning of Middle Eocene time, causing stripping and southward transport of the Pinyon Conglomerate, then redeposition (in Middle Eocene time by implication) as a 2000 foot thick fan in the northern Green River Basin.
14. Eardley (1962, explanation for figure 24.2) listed "Tp, Pass Peak (middle Eocene)." On p. 337–338 he discussed the formation as accumulating in the Eocene phase of the Laramide Orogeny (Late Laramide). In his explanation of figure 22.9 he stated, ". . . the Grizzly thrust is late middle Eocene (post-Pass Peak conglomerate)." Figure 22.6 shows the Pass Peak accumulating along the eastern edge of the Snake River Range salient of the Central Rockies in Eocene time. Figure 22.2 shows the Pass Peak as Middle Eocene, younger than the Knight Formation, and about equivalent to the Wind River Formation.
15. Antweiller & Love (1967, p. 7) mentioned "Pass Peak of Eardley and others" and stated, "The age is uncertain but is probably middle Eocene." They believed the deposits were reworked southward from the Late Cretaceous-Harebell Formation and the Paleocene-Pinyon Conglomerate.

Thus the Pass Peak Formation has been assigned ages ranging from Paleocene through Middle Eocene, and most commonly and recently Middle Eocene.

The present study, based more firmly on evidence from fossil mammals, leads to the conclusion that the age of the Pass Peak Formation ranges from Late Graybullian (late Early Wasatchian) through Lysitean (Middle Wasatchian; i.e., middle Early Eocene), into Early Lostcabinian (early Late Wasatchian). Contrary to most previous reports, there is no evidence that any part of the formation is as young as Bridgerian (Middle Eocene). These conclusions are shown graphically on text-figure 1. For a general discussion of North America Land Mammal Provincial Ages see Evernden, *et al.* (1964).

FOSSILS FROM THE FORMATION

Concentrated search for fossils in the Pass Peak Formation, conducted during parts of the field seasons of 1964–67, produced far less material than desired, but specimens of a few mammals, some other vertebrates, and associated molluscs and plants were found. Identifiable mammal material proved extremely rare and hard to find, largely because of heavy grass and forest cover, and poor exposures over most of the area. Moreover, the highly lensatic character of the strata makes it virtually impossible to trace specific horizons for more than short distances. It seemed best to spend what little prospecting time was available mainly on the better exposed and more nearly complete section along the highway, thus enhancing chances of fossil discovery and correlation.

The fossil locality numbers listed below and shown on text-figure 2 are prefixed by UM-Sub-Wy, meaning The University of Michigan-Sublette County-Wyoming. They continue the sequence of numbered localities in this county reported by me in earlier papers (1952, 1956, 1958) dealing with Paleocene and earliest Eocene vertebrates from the underlying Hoback Formation. All specimens are catalogued and stored in The University of Michigan Museum of Paleontology in Ann Arbor. The listing begins with UM-Sub-Wy Locality 28 in the "transition zone" between Hoback and Pass Peak Formations, and continues, through successively higher and younger levels, to UM-Sub-Wy Locality 25 in the roadcut along U.S. 187–189 on the crest of the Hoback Basin Rim just west of Sargents' Rim (gas) Station. Not all localities are datable.

UM-Sub-Wy Locality 28.—Graybullian and probably Late Graybullian age. About 10 feet

above water level at east end of meander scar on north side of Fisherman (Fish) Creek, north of U.S. 187–189; about 1500 feet N72°E of a point on the highway 100 feet east of the Hoback River bridge; just west of the newly built (1967) home of Mr. and Mrs. Albert Fuez, sec. 24, T 37 N, R 113 W, Sublette County, Wyoming (pl. 1, fig. A). Stratigraphic level: "transition zone" of interstratified Hoback and Pass Peak lithologies. Geologic age may be *Late* Graybullian because other localities of Graybullian age (Dorr, 1952, 1956, 1958) occur well below this level in the underlying Hoback Formation (text-fig. 1). This locality is fortunately located so as to date the approximate time of cessation of Hoback and beginning of Pass Peak sedimentation. Fossils found here so far are:

1. *Hyracotherium angustidens*. Horse. The University of Michigan Museum of Paleontology (UMMP) catalogued specimens: V55131, associated left M^1-M^2, and premolar fragment; V55132, left P^3-M^3, and right M^3; V55133, right lower jaw with canine alveolus, roots of P_2-P_3, and P_4-M_3; V55134, right lower jaw with fragment of canine, roots of P_1-P_2, and complete P_3-P_4; V55135, anterior fragment of jaw and left lower jaw with P_2-M_1; V55136, right M_3 fragment; V55137, right M_3 fragment; V55138, right lower molar fragment.

   The combination of characters shown in the available material provide the following reasons for the specific identification shown. (A) The space between the roots and alveoli of P_1-P_2, is so short that if crowns were still present no diastema would be present; P_1 is double-rooted. Kitts (1956) listed a short diastema between those teeth as a characteristic of the species. Of special note, Kitts placed into synonymy with *Hyracotherium angustidens etsagicum* a species described by Wortman (1896, p. 103) as *H. (Pliolophus) montanum*. Wortman figured American Museum of Natural History specimen 4593 for this latter species and it turns out that this figured specimen apparently also lacks the P_1-P_2 diastema. This is not taken to support a subspecific identification but does support that of the species. McKenna (1960) named and described the Four Mile Fauna of Early Graybullian age from Colorado. AMNH specimen 80050 (discovered later and not described by McKenna) from the East Alheit Pocket locality, which also provided other material to that fauna, is identified on the tray label at the American Museum as being *H. angustidens*. In this specimen the diastema between the first two lower premolars also is lacking. (B) the specimens are too small for *H. craspedotum*, as that species was defined by Kitts. (C) P^3 and P^4 are simple, triangular teeth, fitting Kitts' definition of *H. angustidens* not *H. craspedotum* nor *H. vasacciense*.
2. *Oreoconus*, terrestrial snail, original color pattern preserved on some specimens.
3. Other, unidentified, small species of snails, including many isolated snail columellae.

The species of horse identified above is, so far as known, restricted to deposits of Graybullian age. The snail *Oreoconus* (Taylor, 1962) occurs in the Eocene.

UM-Sub-Wy Locality 27.—Lysitean age. About 22 feet above pavement level, in road cut on north side of U.S. 187–189, 42 feet east-northeast of concrete highway marker 1330 (text-fig. 2), and about 4.3 miles west of entrance to U.S. Forest Service picnic ground at crest of Hoback Basin Rim, NE ¼, sec. 27, T 37 N, R 112 W, Sublette County, Wyoming. Fossils occur in blocky claystone about 11 feet below prominent, cross-bedded, yellow sandstone (pl. 1, fig. B). Fossils found here so far are:

1. Adapisoricid insectivore, genus and species indeterminate (Order Insectivora, Family Adapisoricidae). UMMP specimens: V-55143, lower jaw fragment with single tooth; V55144, lower jaw fragment with single molar; V55145, maxillary fragment with 2 premolars. An Early Tertiary type, but no further determinable geochronologic significance.
2. *Paramys copei* (Order Rodentia, Family Ischyromyidae) small, primitive rodent. UMMP specimens: V55141, left lower jaw fragment with posterior half of M_1 and M_2-M_3; V55146, isolated incisor; V55147, isolated left M_1. This species occurs throughout the Wasatchian, in faunas of Graybullian, Lysitean and Lostcabinian age. However, Dr. D. A. Guthrie, who is more knowledgeable about these rodents than I, points out (letter, January, 1967) that there is considerable morphological variation within the species through its time range. He suggests that my specimens, which he has examined, on morphology alone may be as old as Graybullian but are no younger than Lysitean.
3. *Hyopsodus* cf. *H. wortmani* (Order Condylarthra, Family Hyopsodontidae). UMMP specimens of this small, primitive mammal are: V55139, palate with right M^1-M^3 and left P^3-M^2; V55140; M^1-M^2. Dr. C. L. Gazin of the U. S. National Museum has examined these specimens for me. He currently is engaged in a thorough study of Early Tertiary *Hyopsodus* and on the basis of this suggested (oral communication, Dec. 1966) that the Pass Peak specimens are

too advanced for Graybullian time because of the fusion of para- and metaconids, but too primitive for Bridgerian time because the internal cusp on P^3 is low and the tooth is triangular, not molariform. Thus these specimens would indicate either a Lysitean or Lostcabinian age, and are not as young as Middle Eocene.

4. *Diacodexis* cf. *D. metsiacus* (Order Artiodactyla, Family Dichobunidae). UMMP specimen is: V55142, right lower jaw fragment with P_4-M_1. The genus *Diacodexis,* as presently defined, occurs throughout the Early Eocene but *not* in the Middle Eocene. The species *D. metsiacus* occurs most commonly in the Graybullian but has been reported from younger beds, perhaps because the taxonomic concept of the species is too broadly defined. The Pass Peak specimen compares closely with a U.S. National Museum specimen from Graybullian beds in the Big Horn Basin of Wyoming, but also is nearly identical with another U. S. N. M. specimen from the Knight Fauna of Lostcabinian age from the Fossil Basin, Wyoming. Gazin (1962, p. 81) states that a small form of this species may be represented in the LaBarge Local Fauna amongst specimens found 12 miles north of Big Piney, Wyoming. Rohrer and Gazin (1965, figure 1, and p. D137) record a specimen of this species on the Graybull-Lysite boundary, from their Locality 50 in the Big Horn Basin southeast of the east end of Tatman Mountain.
5. Snails, poorly preserved, including *Viviparus?* and *Holospira?* No geochronologic significance.

The uncertainty of identification of specimens from this locality, the limited number of specimens and taxa, and the unusually great length and uncertainty of the time ranges of the taxa, make it difficult to reach conclusions regarding the age of beds at UM-Sub-Wy Locality 27. However, it is clear that the faunule is Wasatchian and *not* Bridgerian in age. If the stages of morphological development of *Paramys copei* and *Hyopsodus* cf. *wortmani* are correctly interpreted, their range of common overlap in time makes the age of the faunule Lysitean, a conclusion I accept for the present.

UM-Sub-Wy Locality 26.—Age indeterminate from available fossils, but Lysitean or Lostcabinian by stratigraphic position between Localities 27 (below) and 23 (above). Finely conglomeratic, strongly cross-bedded, yellow sandstone about 7 feet above pavement, north side of U.S. 187–189, 346 feet east of concrete highway marker 1370, 3.5 miles west of entrance to U.S.F.S. picnic ground at Hoback Basin Rim. Fossils found here so far are:

Mammalian tooth fragments; terrestrial and aquatic, nonmarine snails, including *Oreoconus* and *Viviparus;* and unidentified deciduous land plant leaf fragments.

UM-Sub-Wy Locality 23.—Lysitean? or Early Lostcabinian age. Blocky, gray, blue-gray, and brown claystones, about 6½ feet above pavement edge and 4 feet below base of a buff, strongly cross-bedded sandstone, in center of roadcut, north side of U.S. 187–189, 225 feet east of concrete highway marker 1500, about 0.9 miles west of entrance to U.S.F.S. picnic ground at crest of Hoback Basin Rim, NE ¼, sec. 31, T 37 N, R 111 W, Sublette County, Wyoming (pl. 1, fig. D). Fossils found here so far are:

1. *"Nyctitherium"* cf. *"N." celatum* (Order Insectivora, Family Adapisoricidae, Subfamily Creotarsinae). UMMP specimen is V55154, an isolated M^2. My comparisons and those of Dr. Peter Robinson (letter, Jan. 24, 1967), who also examined the specimen, indicate that this specimen has its closest resemblance to specimens which Matthew referred to the above genus and species. McKenna (1960, p. 53–55) pointed out, however, that Matthew's reference of material to the genus is open to question. Moreover, the type specimen of the species is non-diagnostic. Van Valen (1967, p. 262) tentatively classifies "the genus called *'Nycthitherium'* by McKenna, 1960" in the adapisoricid insectivores but in a separate subfamily, Creotarsinae, from the genus *Nyctitherium* itself, placing the latter in the Nyctitheriinae. Whatever may be the ultimate taxonomic fate of *"N." celatum,* specimens previously referred to that species have come from beds of Wasatchian *not* Bridgerian age.
2. *Hyracotherium* cf. *H. vasacciense* (Order Perissodactyla, Family Equidae). UMMP specimens are: V55151, right lower jaw fragment with M_1-M_3; V55153, isolated left M^2; V55155, right P_4 or deciduous molar; V55156, right M_3. A relatively small horse, morphologically close to specimens of this species in the collections of the U. S. National Museum from localities of both Lysitean and Lostcabinian age. Too small to be *H. craspedotum.* In absence of upper premolars, and on size alone, I cannot rule out the possibility of *H. angustidens* (of Graybullian age), but the stratigraphic position of these specimens, well above the Lysitean level of underlying Locality 27, suggests the small, post-Graybullian, *H. vasacciense.* The circularity of this reasoning is mitigated somewhat by the presence of *Hyopsodus wortmani,* a post-Graybullian species, at this locality (see below).

3. *Hyopsodus* cf. *H. wortmani* (Order Condylarthra, Family Hyopsodontidae). UMMP specimens are: V55148, lower jaw fragment with deciduous P_4 and permanent M_1-M_2 of immature animal; V55149, lower jaw fragment with P_4-M_3; V55159, isolated M_2. As mentioned earlier, in the discussion of Locality 28, *H. wortmani* is largely a Lostcabinian species but has been recorded (Rohrer & Gazin, 1965) from the Graybullian-Lysitean boundary. Gazin, who has examined these species, considers them (oral communication, Dec. 1966) too primitive for a Bridgerian but too advanced for a Graybullian hyopsodontid, for the same reasons as cited above under the discussion of *H. wortmani* from Locality 27. Again these specimens, on morphology, appear to indicate either a Lysitean or Lostcabinian age.
4. Unidentified mammal teeth. V55150, lower jaw fragment with two worn teeth; V55157, isolated canine tooth. No geochronologic significance.
5. Unidentified bird bone. No geochronologic significance.
6. Anguid lizard. V55152, lower jaw fragment with teeth and attached scutes; V55160, several isolated scutes. No geochronologic significance.
7. *Oreoconus*. Abundant snails of this genus occur at this locality, many specimens clearly showing color pattern. No particular geochronologic significance.
8. Abundant snails of other genera including *Holospira?, Anisus,* and *Viviparus* (see Taylor, 1962). No particular geochronologic significance.
9. Hackberry seeds. Very abundant. No geochronologic significance.

Again with this faunule both the specimens and taxa are too few to support as firm a geochronologic conclusion as desired. The evidence is sufficient, however, to rule out a Bridgerian age for this level and locality. The identifiable mammals would allow either a Lysitean or Lostcabinian age, and this conclusion is supported by the fact that this locality occurs well above Locality 27 where the beds are most probably Lysitean in age. Turning further to stratigraphic evidence, I note that Locality 23 occurs relatively high in the Pass Peak Formation (text-fig. 2). We have traced sandstone beds high in the formation southward to a point just south of Daniel where they begin to interfinger physically with other beds identified by Oriel (1962; and oral communication in the field, 1967) as the LaBarge Tongue of the Wasatch in the northwestern part of the Green River Basin. Gazin (1955, 1962) prefers a different terminology to that of Oriel, considering these same beds equivalent to the Knight Formation. Gazin (op. cit.) considers fossil mammals from these beds, about 12 miles north of Big Piney, Wyoming, as part of the LaBarge Local Fauna which he has determined to be Early Lostcabinian in age. On the basis of both fossils and intertonguing relationships, I consider it most probable that the age of beds in the upper part of the Pass Peak Formation at Locality 23 is Early Lostcabinian, although the possibility of a Lysitean age cannot be ruled out entirely.

UM-Sub-Wy Locality 24.—Geologic age indeterminate from available fossils; older than Bridgerian, probably Early Lostcabinian, but possibly Lysitean, on stratigraphic evidence discussed for Locality 23. Thin, uniformly bedded, argillaceous layers of alternating shale and silty shale in lower half of west end of roadcut on north side of U.S. 187–189, about 75 feet west of concrete highway marker 1535, 0.3 miles west of entrance to U. S. Forest Service picnic ground at crest of Hoback Basin Rim (pl. 1, fig. C). Fossils found here so far are:

Poorly preserved aquatic snails and fragmentary deciduous leaves. I have determined no geochronologic significance for materials I have found here, but this may be about the level from which were taken the leaves examined by R. W. Brown (see Love, 1956).

UM-Sub-Wy Locality 25.—Geologic age indeterminate from available fossils; older than Bridgerian, probably Early Lostcabinian, but possibly as old as Lysitean, on basis of stratigraphic evidence discussed for Locality 23. Argillaceous beds with an intercalated channel sandstone, the latter of markedly lensatic shape. Roadcuts on both sides of U.S. 187–189, extending about 800 feet westward from concrete highway marker 1550, opposite entrance to U.S.F.S. picnic ground on crest of Hoback Basin Rim, and a short distance west of Sargents' Rim (gas) Station, SW ¼, sec. 32, T 37 N, R 111 W, Sublette County, Wyoming (pl. 1, fig. F). Fossils found here so far are:

1. Mammalian bone and tooth fragments. V55162.
2. *Lepisosteus,* Gar pike, scales.
3. Crocodilian (Order Crocodilia, Suborder Eusuchia), genus and species indeterminate. V55161, jaw fragment and associate bone fragments.
4. Aquatic and terrestrial, nonmarine snails, poorly preserved.
5. Fragments of coalified wood and wood impressions.
6. Leaf fragments.

CONCLUSIONS

1. Exposures of the Pass Peak Formation along U.S. Highway 187–189 between the Upper Hoback River and the Hoback Basin Rim comprise the best and most nearly continuous section available, are a mid-basin facies, interfinger northward with a basin-edge facies composed almost entirely of conglomerate at the type locality at Pass Peak, and probably were deposited during a time span of about the same length as that represented by deposits remaining at the type locality.

2. A change in character of sedimentation from that of the Paleocene and earliest Eocene-Hoback Formation to that of the Pass Peak Formation occurred as a result of tectonic uplift to the north and east, and a shift in sedimentary provenance.

3. The contact between the Hoback and Pass Peak Formations is transitional vertically in mid-basin, thus indicating that tectonism and change in provenance did not interrupt sedimentation.

4. The age of the beds near the top of the "transition zone," and hence the approximate time of sedimentation change, is probably Late Graybullian.

5. The lower third of the Pass Peak Formation, above the "transition zone" is not yet dated, but the upper two thirds were deposited during Lysitean and probably Early Lostcabinian time.

6. In contrast with statements of previous authors, no part of the Pass Peak Formation is yet known to be as young as Middle Eocene.

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