

Revised Tertiary Stratigraphy
and Paleontology of the
Western Beaver Divide,
Fremont County, Wyoming

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ABSTRACT

Emry, Robert J. Revised Tertiary Stratigraphy and Paleontology of the Western Beaver Divide, Fremont County, Wyoming. *Smithsonian Contributions to Paleobiology*, number 25, 20 pages, 6 figures, 1975.—In the western Beaver Divide area in west-central Wyoming, a lens of coarse Tertiary volcanic conglomerate and tuff disconformably overlies Uintan rocks of the Wagon Bed Formation. The coarse volcanoclastic rocks were previously regarded as a facies of the Beaver Divide Conglomerate Member of the Chadronian White River Formation, although fossil mammals from the volcanoclastic unit are species known otherwise only from Uintan rocks. Reexamination of field relations has shown that the White River Formation disconformably overlies the volcanoclastic unit. The "lower Uinta C" temporal equivalence indicated by the fossils from the volcanoclastic unit is no longer anomalous; the underlying Wagon Bed Formation has fossil mammals indicating "Uinta B" equivalence, and the overlying White River Formation has a fairly diverse Chadronian fauna. The Uintan volcanoclastic unit is assigned to the Wiggins Formation. The Beaver Divide Conglomerate Member is restricted to conglomerate in the lower part of the White River Formation. It is composed predominantly of clasts of locally derived Precambrian crystalline rocks.

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Revised Tertiary Stratigraphy and Paleontology of the Western Beaver Divide, Fremont County, Wyoming

Robert J. Emry

Introduction

The highly disconformable relationship between Uintan and Chadronian strata along the western Beaver Divide, near Wagon Bed Spring (sec 34, T 32 N, R 95 W), Fremont County, Wyoming, has led to an incorrect interpretation of the stratigraphic sequence. A coarse volcanic conglomerate disconformably overlying Uintan rocks of the Wagon Bed Formation was believed by Sinclair and Granger (1911) to also overlie Chadronian deposits filling a valley cut into the Wagon Bed Formation. But they mistook a coarse conglomerate of Precambrian crystalline rock clasts that does overlie the valley fill deposits for the volcanic conglomerate. The valley fill deposits and overlying strata, which Granger (1910) dated paleontologically as Oligocene, were assigned to the White River Formation. Consequently, the volcanic conglomerate, mistakenly thought to overlie the valley fill, was also assigned to the White River Formation. The error was perpetuated by later workers (Bauer, 1934; Nace, 1939; Van Houten, 1954; Love, 1970).

Fossil mammals from the volcanic conglomerate indicate a Uintan ("late Eocene") age, while those from the valley fill deposits, believed by earlier authors to underlie the volcanic conglomerate, are

clearly Chadronian ("early Oligocene"). This conflict between paleontologic age and stratigraphic position had never been adequately resolved. The fossil mammals from the volcanic conglomerate have simply been cited as anomalously late occurrences for the species, questioned as to identifications or localities, or grouped with other specimens from both the underlying Wagon Bed Formation and overlying White River Formation to form an artificial composite fauna that was then promoted as evidence for the presence of the intermediate Duchesnean "stage" in the Beaver Divide sequence.

This report demonstrates that the volcanic conglomerate is not part of the White River Formation. The White River Formation, including the valley fill deposits and the crystalline rock conglomerate, rests on a substantial erosional unconformity cut on and through the volcanic conglomerate. When the rock units are correctly ordered stratigraphically, the fossil occurrences are not anomalous but fit predictably into the stratigraphic framework.

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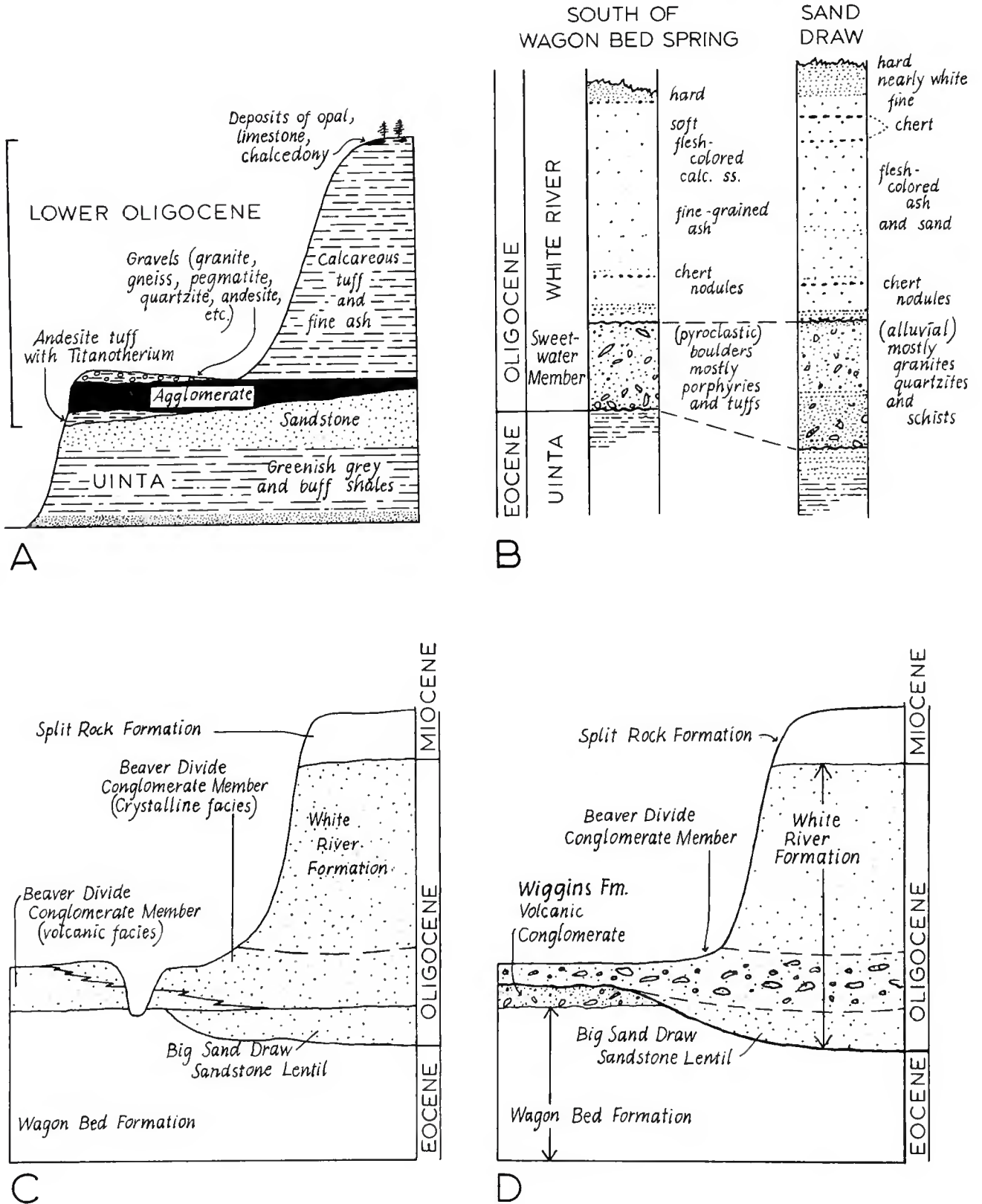


FIGURE 1.—Diagrammatic profiles and sections showing stratigraphic interpretations of previous authors compared to present interpretation: A, after Sinclair and Granger (1911, fig. 2A); B, after Bauer (1934, pl. 96); C, after Van Houten (1964, pl. 6, profile A); D, present interpretation.

(CM) and Dr. Malcolm C. McKenna of the American Museum of Natural History (AMNH). Field work support was provided by the Smithsonian Research Foundation. The abbreviation USNM refers to the old United States National Museum catalog numbers of specimens in the National Museum of Natural History at the Smithsonian Institution.

Geographic and Geologic Setting

The Tertiary sequence here discussed is exposed in central Wyoming, along the western part of Beaver Divide (Beaver Rim of some authors), an escarpment forming the northern margin of the Sweetwater Plateau, near the southern margin of the Wind River structural and topographic basin. The section discussed in most detail is about six and one-half kilometers (four miles) south of Sand Draw oil and gas field, in the vicinity of Wagon Bed Spring, in sec 34, T 32 N, R 95 W, Fremont County, Wyoming.

The Tertiary sequence includes, from oldest to youngest, the following: (1) Wind River Formation (Wasatchian); (2) Wagon Bed Formation (Bridgerian to Uintan); (3) a sequence of coarse volcanoclastic rock (Uintan), previously considered part of the Beaver Divide Conglomerate Member of the White River Formation, and assigned here to the Wiggins Formation; (4) White River Formation (Chadronian); (5) Split Rock Formation (Miocene) (Arikaree Formation of Denson, 1964).

Previous Investigations and Interpretations

The Tertiary deposits of the western Beaver Divide were mentioned by Hayden (1869, 1871) and Endlich (1879, 1883). The first detailed study of the sequence reviewed here was by Granger (1910), who collected and described the first mammalian fossils from these strata and demonstrated that they represent one of the most complete Tertiary sections in the Rocky Mountain region.

Granger (1910) measured and described a section near Green Cove (sec 35, T 31 N, R 96 W), about 13 kilometers (8 miles) southwest of Wagon Bed Spring, and characterized the "White River Group" as "buff colored marls, very uniform in nature except the lower 50 feet where the marls are inter-

bedded with coarse sandy layers from an inch to two feet in thickness." He also noted (1910:239) another "exception to the uniformity of the lower Oligocene" near Wagon Bed Spring, this being a "five foot bed of volcanic material not observed at Green Cove where the section was taken." He described this material as "gray ash, in which is imbedded in places numerous smooth, rounded masses of pumice an inch or two in diameter," and noted that "this bed is well shown near the top of the exposures in Plates XXI and XXII." Thus began the confusion that has continued for more than 60 years; the bed near the top of the exposures in Granger's plate XXI is not the same bed as that near the top of the exposures in plate XXII. The bed shown in the upper part of Granger's plate XXI (1910), on which the word "zone" (of Titanotherium zone) is written, is the coarse volcanic conglomerate disconformably overlying the Wagon Bed Formation (*Diplacodon* zone of Granger). What Granger regarded as the same bed in his plate XXII: figure 1 is the coarse, tuffaceous, arkosic sandstone and crystalline rock conglomerate conformably overlying deposits filling a valley that had been cut through, and had removed, the volcanic conglomerate shown in Granger's plate XXI. That the bed overlying the valley fill in Granger's plate XXII is the one he equated with the volcanic conglomerate is confirmed by Sinclair and Granger (1911, pl. IV; fig. 1), who again mistook it for the "agglomerate" (compare Granger, 1910, pl. XXII: fig. 1; Sinclair and Granger, 1911, pl. IV: fig. 1; and Figures 3 and 4 of this report).

Sinclair and Granger (1911, fig. 2A) presented a diagrammatic section of the sequence near Wagon Bed Spring, which shows a unit of "andesitic tuff with Titanotherium" overlain by "agglomerate," which is overlain in turn by "Gravels (granite, gneiss, pegmatite, quartzite, andesite, etc.," (see Figure 1A, this report). Sinclair and Granger (1911: 100-101) described the distribution of these "gravels" as "on the great terrace above the agglomerate flow and extending for perhaps a mile north of the spring."

Sinclair and Granger recognized three distinct units: the valley fill deposits ("andesitic tuff"), the volcanic conglomerate ("agglomerate"), and the crystalline rock conglomerates ("gravels"). The error, made first by Granger (1910) and then by Sinclair and Granger (1911), was in misidentifying

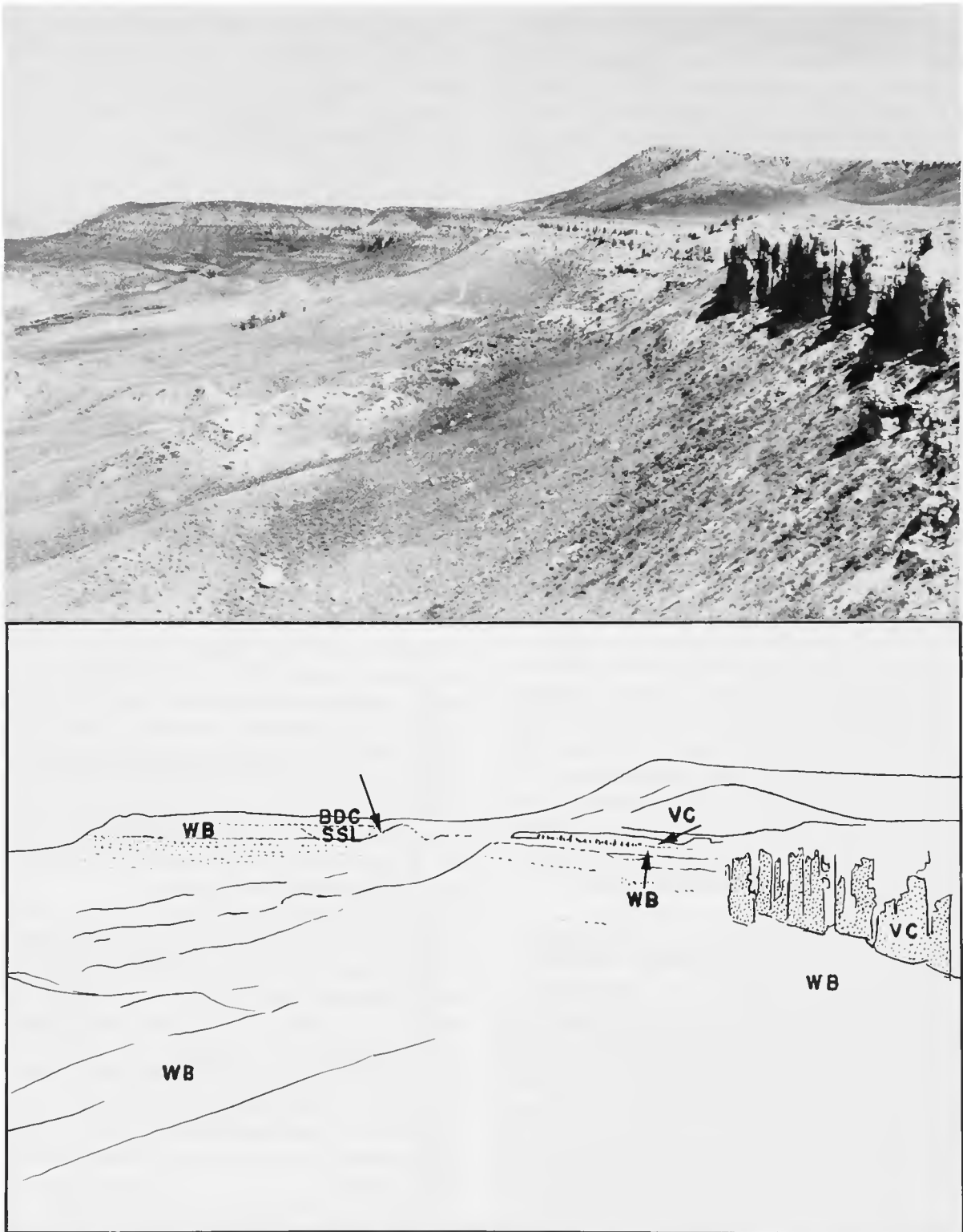


FIGURE 2.—View northward along Beaver Divide from about 2½ kilometers (1½ miles) south of Wagon Bed Spring (indicated by arrow). (WB=Wagon Bed Formation; VC=coarse volcanic conglomerate (Wiggins Formation); SSL=Big Sand Draw Sandstone Lenticle of White River Formation; BDC=Beaver Divide Conglomerate Member of White River Formation.) (Figures 3 and 4 are closer views of hill in upper left center, showing stratigraphic relationships in more detail.)

the cemented part of the tuffaceous, arkosic, sandstone, and crystalline rock conglomerate overlying the valley fill as "agglomerate," and consequently including the actual volcanic conglomerate in the White River Formation.

The coarse conglomerates near the base of the White River Formation in the western Beaver Divide area were named the Sweetwater Member by Bauer (1934:678-680). He included in this member the volcanic conglomerate as well as the crystalline rock conglomerate. Figure 1B shows Bauer's correlation (1934, pl. 96) of the volcanic conglomerate ("(pyroclastic) boulders mostly porphyries and tuffs") of his "south of Wagon-Bed Spring" section with the crystalline rock conglomerate ("(alluvial) mostly granites quartzites and schists") of his "Sand Draw" section. Unlike Sinclair and Granger, who had stated that the "gravels" overlay the "agglomerate flow," Bauer (1934:680) wrote that "interfingering into this pyroclastic lens on either side are the boulder beds of alluvial origin." Bauer apparently did not recognize the valley fill deposits from which Granger had recovered the titanotheres, as he incorrectly stated (1934:680) that Granger had found the specimen in the boulder beds, and did not show the valley fill on his sections (see Figure 1B).

Because Bauer's name "Sweetwater Member" was preempted, Nace (1939:32) proposed a new name, Beaver Divide Conglomerate Member, for the "basal conglomerate of the Chadron formation in the Beaver Divide region."

Prior to Bauer's and Nace's reports, no fossils had been recorded from the volcanic conglomerate, so there was no paleontological evidence to conflict with the assignment of this unit to the Oligocene White River Formation. Two protoreodont specimens had been found previously in the volcanic conglomerate (see paleontology section following), but these were not described until later by Scott (1945), whose interpretation only added to the confusion.

Scott (1945:211-212) included a paragraph from a letter from John Clark, who stated that the Uinta

is overlain by a series of tan and white agglomerates and tuffs, from the lower part of which Granger collected Chadron titanotheres. At this point there is some confusion, since the Carnegie Museum recently collected a skull of *Protoreodon* from one of the agglomerates. Naturally enough, Granger placed the boundary between the Uinta and Chad-

ron at the base of the agglomerates; occurrence of so definitely Eocene a form as *Protoreodon* within the agglomerates demonstrates that the contact lies higher, somewhere within the agglomerate series, and has not yet been accurately determined.

Clark apparently used the term "agglomerate" rather loosely to include both the volcanic and crystalline conglomerates. And though he did not accurately establish the position of the Uintan-Chadronian boundary, he correctly concluded that the confusion was due to its inaccurate placement. But Clark's conclusion was not accepted by Scott (1945:212), who also rejected Clark's opinion that *Protoreodon* indicated an Eocene age for the containing beds. Scott concluded that "in the Beaver Divide section are to be found at least three stages above the Wind River Eocene. In descending order these are: (1) The Chadron substage of the White River; (2) Duchesne River; (3) Uinta." Scott wrote that H. E. Wood had examined an *Amyndodon* skull (collected by Granger near the top of the Wagon Bed Formation), and had concluded that it is "definitely referable to the Uinta species, *A. advenus*, and that it lay below the levels at which the supposedly Duchesne River fossils were found, *Brachyhyops*, *Protoreodon*, and *Mesagriochoerus*." Scott therefore excluded the *Amyndodon* from his Duchesne River Fauna, but inexplicably included *Camelodon arapahovius*, which came from the same unit as the *Amyndodon*. The *Brachyhyops* was from the Big Sand Draw Sandstone Lentil of the White River Formation (Oligocene), but had been erroneously reported as from the "Uinta" by Colbert (1938). Scott's evidence for the presence of the "Duchesne River Stage" in the Beaver Divide sequence consisted of four specimens: two from the volcanic conglomerate, one from the underlying Wagon Bed Formation, and one from the overlying White River Formation.

Wood (1948:39) considered the "Beaver Divide Conglomerate of Nace," as developed at Beaver Divide, to be "Duchesnean??" but for somewhat different reasons than Scott (for further details see the discussion in the following paleontology section, under *Menodus heloceras*).

Gazin (1955:7) observed that "much confusion exists as to the relative ages of horizons represented in the sequence exposed along Beaver Divide at the southern rim of the Wind River Basin." After reviewing the fossil materials and occurrences,

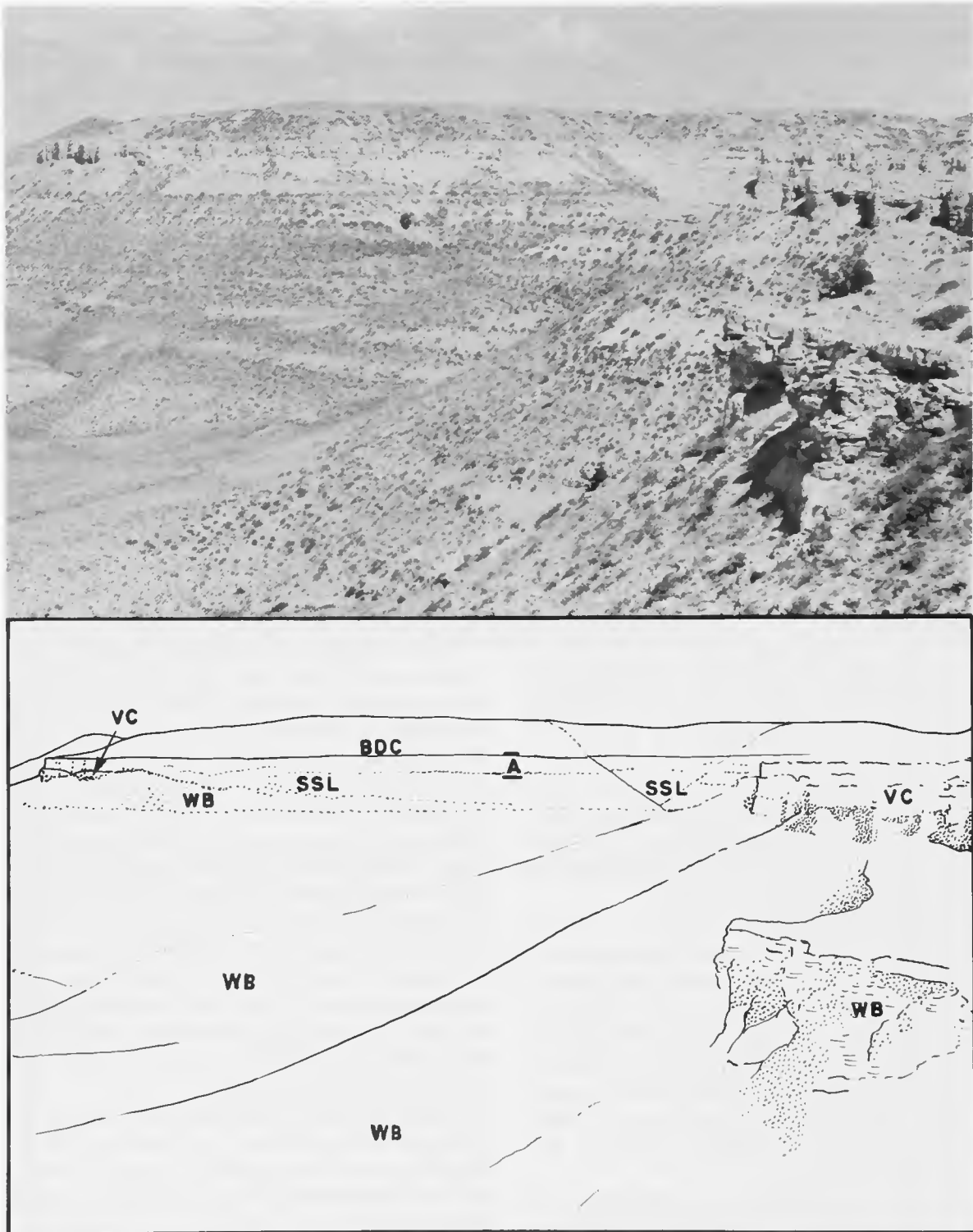


FIGURE 3.—South face of ridge immediately north of Wagon Bed Spring, which is to right of view. (WB=Wagon Bed Formation; VC=coarse volcanic conglomerate (Wiggins Formation); SSL=Big Sand Draw Sandstone Lenticle of White River Formation; BDC=Beaver Divide Conglomerate Member of White River Formation; A=cemented part of coarse, tuffaceous, sandstone and crystalline rock conglomerate mistaken for volcanic "agglomerate" by Sinclair and Granger (1911). Edge of channel containing the Big Sand Draw Sandstone Lenticle is defined by thin, cemented zone between WB and SSL in upper left center of view.)

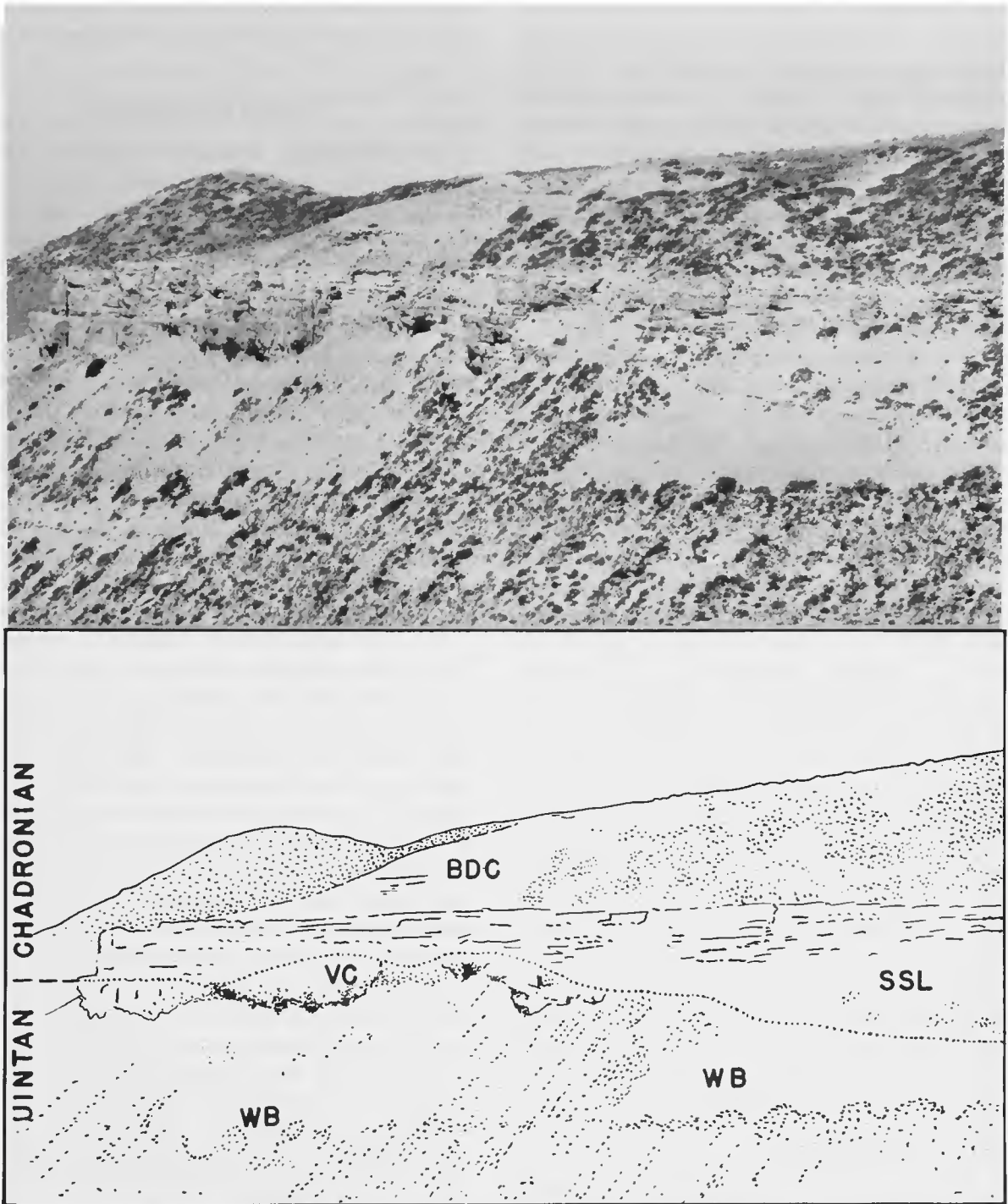


FIGURE 4.—Photo of disconformity (dotted line) between Uintan rocks (Wagon Bed Formation=WB; volcanic conglomerate=VC) and Chadronian rocks (Big Sand Draw Sandstone Lentil of White River Formation=SSL; Beaver Divide Conglomerate Member of White River Formation=BDC). (This view is enlargement of part of area shown in Figures 2 and 3.)

along with field information furnished him by Van Houten and others, Gazin concluded (1955:8) that "the Duchesnean Interval is not represented by sediments at the Beaver Divide." The materials of Eocene aspect attributed to the "Beaver Divide Conglomerate" he regarded as "not as late as Duchesnean," and appealed to the "highly disconformable relationship between the Eocene and Oligocene strata" to explain the uncertain stratigraphic assignments.

Van Houten (1964) came closer to the present interpretation by apparently recognizing that the volcanic conglomerate does not directly overlie the Big Sand Draw Sandstone Lentil. At least this is implicit in his statement (1964:57) that "the lower part of the conglomerate member overlying the Big Sand Draw Sandstone Lentil and the upper part of the member east of the lentil has been designated the crystalline facies of the Beaver Divide Conglomerate Member." This statement conflicts, however, with some of his sections (1964, pls. 3, 4) in which he shows the "volcanic facies" as the lower part of the conglomerate member overlying the Big Sand Draw Sandstone Lentil. Van Houten (1954, 1964) termed the volcanic conglomerate and crystalline conglomerate the "volcanic facies" and "crystalline facies," respectively, of the Beaver Divide Conglomerate Member, and on his profiles (1964, pls. 6, A,B) shows the two facies interfingering over the edges of the Big Sand Draw Sandstone Lentil. Elsewhere in the text, Van Houten (1964) does not specifically mention an interfingering relationship. In fact, the relationship he describes would seem to argue against a facies relationship. He comments (1964:72) that the "crystalline facies" accumulated in the same general drainage system that had deposited the underlying Big Sand Draw Sandstone Lentil, and that "along the course of this old valley, the volcanic facies was eroded and part of it incorporated into the crystalline facies." This implies that the volcanic conglomerate was in place before deposition of the crystalline conglomerate.

Van Houten (1964:68) observed that mammals from the Beaver Divide Conglomerate anomalously suggest an Eocene (Uintan) age, and fossil snails from the volcanic facies are also forms that occur in the upper part of the Wagon Bed (upper Eocene) Formation.

Love (1970) followed Bauer's and Van Houten's

interpretation, stating that "the Beaver Divide Conglomerate Member consists of a facies of volcanic rock fragments that grades laterally into a facies of crystalline Precambrian rock fragments."

Present Interpretation

The foregoing discussion indicates that the paleontologic evidence did not agree with the stratigraphic interpretations of the Eocene-Oligocene succession of the western Beaver Divide. My study of the fossil material from the volcanic conglomerate confirmed that identifications were correct; they are clearly assignable to species otherwise known only from Uinta "C" and its equivalents. A careful examination of the contact relationships of the volcanic conglomerate was undertaken in an attempt to resolve the discrepancy.

The volcanic conglomerate sequence overlies an erosional unconformity cut on rocks of the Wagon Bed Formation. After deposition of the coarse volcanic conglomerate, erosion excavated a broad valley through it into the underlying Wagon Bed Formation. White River sedimentation began locally with deposition of tuffaceous arkosic sandstone, siltstone, and mudstone in this valley. This channel fill (the Big Sand Draw Sandstone Lentil of Van Houten) nearly filled the paleovalley, resting directly on the Wagon Bed Formation over most of its areal extent, but also overlapping the eroded edges of the volcanic conglomerate (see Figures 1D and 4). The Big Sand Draw Sandstone Lentil grades upward into tuffaceous sandstone and coarse conglomerate composed of pebbles, cobbles, and boulders of Precambrian crystalline rock, derived locally from the Granite Mountains to the southeast, and rare pebbles of Tertiary volcanic rock, almost certainly reworked from the older volcanic conglomerate that bordered the valley. Where the Big Sand Draw Sandstone Lentil is not present, the crystalline conglomerate rests disconformably on the volcanic conglomerate over broad areas both northeast and southwest of the paleovalley. The crystalline conglomerate grades upward into the massive white to grayish-orange, fine-grained, tuffaceous, silty sandstone, siltstone, and claystone typical of most of the White River Formation in this area.

Across the top of the Big Sand Draw Sandstone Lentil the coarse tuffaceous sandstone and crystal-

line conglomerate is well cemented and resistant relative to the overlying and underlying strata, and forms a low scarp (Figures 3-4, unit A). It is this unit that Sinclair and Granger (1911, pl. IV: fig. 1, unit 0.2) identified as "agglomerate." This error was probably due to the deceptive spatial relationship between this unit and the volcanic conglomerate, which occurs nearby at about the same topographic, but not the same stratigraphic, level. Together the two units appear to form a single, continuous scarp (Figure 4) that extends across the top of the Big Sand Draw Sandstone Lentil. But careful inspection shows that only the unit forming the upper part of the scarp lateral to the channel is continuous above the channel fill. The volcanic conglomerate, which forms the lower part of the scarp lateral to the channel, is eroded off at the edges of the channel and overlapped by the channel fill.

This overlapping relationship can be observed at several places along the escarpment within a half mile south of Wagon Bed Spring, particularly at the west end, and along the south side, of the ridge immediately south of the spring, in the N $\frac{1}{2}$, SE $\frac{1}{4}$, SW $\frac{1}{4}$, sec 34, T 32 N, R 95 W. Here the edge of the Big Sand Draw Sandstone Lentil laps up onto the eroded edge of the volcanic conglomerate. Immediately above the well-defined contact are occasional lenses and pockets of pebbles, predominately of Precambrian crystalline rocks, but also including occasional fragments of volcanic rock reworked from the underlying unit. At this locality fragments of bone and teeth, mainly of large titanotheres, are commonly seen in the basal coarse strata of the Big Sand Draw Sandstone Lentil, immediately overlying the volcanic conglomerate.

The overlapping relationship can be observed again near the west end of the ridge immediately north of Wagon Red Spring, in the NW $\frac{1}{4}$, SW $\frac{1}{4}$, sec 34, T 32 N, R 95 W (Figures 3, 4). Here a wedge-shaped remnant of volcanic conglomerate underlies the southwest edge of the Big Sand Draw Sandstone Lentil. This is the locality of Van Houten's measured section 27 (1964, pls. 2, 4), which correctly illustrates the volcanic conglomerate directly overlain by the cemented crystalline conglomerates, as it appears in the left center of Figure 4, where the distinct change in lithology

can be seen midway up the vertical face. But Van Houten incorrectly indicated in his correlation of measured sections 26 and 27 (1964, pl. 4) that the Big Sand Draw Sandstone Lentil wedges out beneath the volcanic conglomerate. As indicated in Figure 4, the sandstone lentil wedges out above the eroded edge of the volcanic conglomerate and is conformably overlain by the cemented crystalline conglomerate which, lateral to the channel, disconformably overlies the volcanic conglomerate.

The same relationship can be observed along the northeast side of the Big Sand Draw Sandstone Lentil, in the E $\frac{1}{2}$, sec 26, T 32 N, R 95 W, in the vicinity of Van Houten's measured section 28 (1964, pls. 2, 4). Again, Van Houten correctly illustrates the volcanic conglomerate overlain by the crystalline conglomerate, but shows the Big Sand Draw Sandstone Lentil wedging out beneath rather than above the volcanic conglomerate.

As previously mentioned, Van Houten (1964:57) wrote that "the lower part of the conglomerate member overlying the Big Sand Draw Sandstone Lentil and the upper part of the member east of the lentil has been designated the crystalline facies of the Beaver Divide Conglomerate Member." This statement is not consistent with his measured sections 25 (1964, pl. 3) and 28 (1964, pl. 4), in which he shows the "volcanic facies" as the lower part of the conglomerate member overlying the Big Sand Draw Sandstone Lentil. The statement is correct, the sections are not. Van Houten (1964:60) commented that the "volcanic facies" of sections 25 and 28 "contains only a few volcanic cobbles as much as 8 inches in diameter; these are scattered through very pale, grayish-orange tuffaceous sandstone." This is not the volcanic conglomerate unit in situ, but clasts of it reworked into the White River Formation, either into the upper part of the Big Sand Draw Sandstone Lentil or the lower part of the crystalline conglomerates, depending on where one wishes to divide this gradational sequence. Sections 25 and 28 of Van Houten have none of the volcanic conglomerate unit in place, either above or below the Big Sand Draw Sandstone Lentil; it had been removed by erosion that excavated the valley in which the Big Sand Draw Sandstone Lentil was deposited. Sections 25 and 28 have the same sequence shown in Van Houten's section 26 (1964, pl. 4), the sandstone lentil directly over-

lying the Wagon Bed Formation, and overlain by the tuffaceous, arkosic sandstone and crystalline rock conglomerate.

Because the volcanic conglomerate and the crystalline conglomerate are demonstrably two distinct units of different ages, separated by a substantial erosional unconformity, they can no longer be regarded as different "facies" of the Beaver Divide Conglomerate Member of the White River Formation. The question naturally arises as to what now constitutes the Beaver Divide Conglomerate Member. The name Sweetwater Member of the White River Group was given by Bauer (1934:678) to the very coarse conglomerates lying "unconformably on the Uinta formation, from the head of Sand Draw southwestward to the south end of the Wind River Range." Bauer included the conglomerate composed of locally derived Precambrian crystalline rocks, which he considered to be the most extensive part of the member, as well as the volcanic conglomerate, which he described as "one lens of material, extending from Wagonbed Spring southwestward for about two miles." Nace (1939:32), after establishing that Bauer's name was not available for use, proposed a new name, "Beaver Divide conglomerate member of the Chadron formation," for "The basal conglomerate of the Chadron formation in the Beaver Divide region." It is evident that Nace proposed the new name for the same deposits Bauer had called the Sweetwater Member. Van Houten (1964:57) wrote that Nace "proposed a new name, Beaver Divide Conglomerate Member, for the conglomerate 40 miles to the south at Oregon Buttes, 7 miles west of Continental Peak on the northwest flank of the Great Divide Basin." But the conglomerates at Oregon Buttes were assigned to the Beaver Divide Conglomerate Member by Nace (1939:32) because he had "traced them from the mapped area into the outcrops in the southern portion of the 'Sweetwater Plateau' which are continuous with those of the Beaver Divide." Nace added that at Oregon Buttes "the conglomerate is in the base of the Chadron," and "there is little doubt that this is the Beaver Divide conglomerate." It is clear that Nace assigned the conglomerate at Oregon Buttes to the Beaver Divide Conglomerate by correlation, not by definition as implied by Van Houten (1964:57).

The Beaver Divide Conglomerate has always been considered a member of the White River

Formation (called White River Group by Bauer, Chadron Formation by Nace). The coarse volcanic conglomerate on the western Beaver Divide was never the only basis for the name, but was included in the member because it was believed to inter-finger with the crystalline rock conglomerate that Bauer (1934:692) described as much more widespread. Because the volcanic conglomerate is now known to be older, disconformably underlying the White River Formation, it is excluded from the Beaver Divide Conglomerate Member of the White River Formation. The Beaver Divide Conglomerate Member is then restricted to the coarse conglomerate composed predominantly of clasts of locally derived Precambrian crystalline rock types, occasional clasts of Paleozoic sedimentary rocks, and rare clasts of Tertiary volcanic rock. It occurs in the lower part of the White River Formation over much of the Beaver Divide region, but is not separated by distinct boundaries from other parts of the formation, and does not necessarily everywhere represent the same stratigraphic interval within the formation. As the Beaver Divide Conglomerate Member is designated solely by lithology the usage is informal, in accordance with article 7 (a) of the *Code of Stratigraphic Nomenclature* (1970).

The volcanic conglomerate is Uintan ("late Eocene"), and is tentatively assigned to the Wiggins Formation (further discussion follows under "Ages and Correlations"). Northeast of the Big Sand Draw Sandstone Lentil it underlies the Beaver Divide Conglomerate Member of the White River Formation in outcrops in the N 1/2, sec 25 and E 1/2, sec 26, T 32 N, R 95 W. It is exposed from the southwest edge of the Big Sand Draw Sandstone Lentil in the SW 1/4, sec 34, T 32 N, R 95 W, southwestward to the vicinity of Green Cove in sec 32, T 31 N, R 96 W. In some places it is overlain by the Beaver Divide Conglomerate Member of the White River Formation and in other places by the finer grained undivided upper part of the White River Formation. Van Houten (1964:60, pl. 3) reported 5 to 10 feet of volcanic conglomerate as far south as old U.S. Highway 287, in secs 3 and 10, T 30 N, R 96 W. From the area of Green Cove southwestward the unit that Van Houten called the volcanic conglomerate "consists predominantly of lenticular deposits of sandstone and pebble conglomerate; it contains a few fragments 3 to 6 inches in diameter" (Van Houten,

1964:60). Van Houten (1964:61) also observed that in this area the volcanic conglomerate grades upward into the White River Formation, and that the lower 30 feet of the White River has scattered lenses of volcanic conglomerate. If any of the volcanic conglomerate actually exists, in place, from Green Cove southwestward, any sharp upper contact has been obliterated by extensive reworking of volcanic material into the White River Formation. This reworking probably occurred during the same erosion cycle that excavated the valley occupied by the Big Sand Draw Sandstone Lentil 11 to 13 kilometers (7 to 8 miles) to the northeast.

The Uintan fossils from the volcanic conglomerate no longer appear anomalous; they indicate a Uintan age for the rock unit. Recognition of the volcanic conglomerate as Uintan rather than Chadronian has little effect on the interpretation of its regional significance. Sinclair and Granger (1911:99) concluded that it is the result of "extremely violent" Oligocene volcanism somewhere in the vicinity, but the vents from which the material came had not been located. Van Houten (1964) and Love (1970) regarded the volcanic conglomerate as, for the most part, coarse debris transported by streams, or as mud flows, from a source in the Absaroka volcanic field 80 to 90 miles northwest. Their identification of the source is undoubtedly correct, and their Oligocene age assignment, while now known to be incorrect, was reconcilable with the probable source, which at that time was also thought to be Oligocene. Until recently, the Wiggins Formation, a coarse volcanoclastic sequence along the southern margin of the Absaroka Range, was considered Oligocene, but Smedes and Prostka (1972:32) and Love, McKenna, and Dawson (in press) have recently demonstrated that the Wiggins Formation is older, probably late middle Eocene or late Eocene, which again brings it into approximate temporal equivalence with the volcanic conglomerate on Beaver Divide.

Paleontology

The known vertebrate fauna of the Uintan Wagon Bed Formation and overlying volcanic conglomerate in the western Beaver Divide area consists of only about a dozen specimens. Most of these are, however, sufficiently diagnostic to pro-

vide reliable age assignments for the enclosing rocks. Compared with the known Uintan fauna, that of the Chadronian White River Formation is considerably more diverse taxonomically and, while specimens are not abundant, they are much more common than in the underlying Uintan rocks.

Van Houten (1964) listed the known fossil material, with specimen numbers where available. Several additional specimens were collected from the Big Sand Draw Sandstone Lentil of the White River Formation during the summers of 1971-1972 by Smithsonian Institution parties, and other specimens may have been collected at other times by parties from other institutions. But so far as known, these additional specimens add no taxa not listed by Van Houten. The identifications and stratigraphic assignments of most of the specimens have never been questioned. The following discussion is therefore restricted to the specimens that have been misidentified, referred to the wrong stratigraphic units, or have played some other part in the confusion of the stratigraphy and paleontology of this sequence. Other specimens are mentioned, but only as they relate to the specimens that have been in some way controversial.

MOLLUSKS

Van Houten (1964:68-69) reported fossil gastropods from two localities in what he regarded as White River Formation ("Oligocene"). One of these is USGS Cenozoic Locality 20031 (Locality 12 of Van Houten, 1964, pl. 2), which he recorded as "10 feet above the base of the Beaver Divide Conglomerate Member (volcanic facies)." Van Houten listed *Lymnaea* aff. *L. similis* Meek, *Planorbina pseudoammonius* (Schlothheim), *Aplexa?*, and *Oreoconus*, and commented (1964:68) that "the fossil snails from locality 12 are forms that also occur in the upper part of the Wagon Bed (upper Eocene) Formation (D. W. Taylor, written communication, April 1962)." Love (1970:71-72) also cited Taylor's report, which stated that "this assemblage is indistinguishable from that of the underlying Eocene rocks. It is in marked contrast to other known Oligocene assemblages, admittedly few in number. This occurrence is the youngest known for all of the species." The apparent late occurrence was due to their being from the vol-

canic conglomerate, which was then mistakenly considered part of the Chadronian White River Formation.

Lohman and Andrew (1968) described a well-preserved diatom assemblage from material filling the snail shells from Van Houten's locality 12. These diatoms, like the snails, appear to be identical to others found in the upper part of the Wagon Bed Formation. On the basis of their field studies, Lohman and Andrews determined that the diatoms and gastropods from locality 12 are from limestone originally deposited in the Wagon Bed Formation and later reworked into the volcanic conglomerate and, on this basis, assigned the gastropods and diatoms to the Wagon Bed Formation of Uintan age. The volcanic conglomerate is now shown to disconformably underlie the White River Formation, which does not affect the conclusions of Lohman and Andrews.

The second gastropod occurrence is Van Houten's locality 17. It is "¼ mile north of Findlay (Chalk) Springs; 40 to 50 feet above the base of the White River Formation" (Van Houten, 1964:69). This locality is about 11 kilometers (7 miles) east of Van Houten's locality 12, on the east side of Conant Creek Anticline, and has no direct bearing on the age of the volcanic conglomerate, but nevertheless requires comment. The gastropods listed from this locality (Van Houten, 1964:69) are *Lymnaeidae*, *Planorbina pseudoammonius* (Schlotheim), and *Aplexa?*, again, species that are typical of the upper Eocene. Lohman and Andrews (1968:8) noted that this collection had been lost and that they were unable to compare the lithology or gastropods with those of Van Houten's locality 12. They also mentioned (1968:8) that Van Houten "did not state whether the limestone occurs here in place or as slump blocks." In examining this locality I found abundant gastropods in a bed of light-colored cherty limestone, apparently the source of Van Houten's collection. Except for this ledge of white limestone, the formations are not well exposed here and the Wagon Bed-White River contact is difficult to determine on a physical stratigraphic basis, but several other lines of evidence indicate that the contact is higher here than indicated by Van Houten, and that the limestone is in the Wagon Bed rather than the White River Formation. No limestone is known in the White River Formation elsewhere in the Beaver Divide region,

but lithologically similar limestone is known in the upper part of the Wagon Bed Formation a few miles to the west on the opposite side of the Conant Creek anticline, and also in the eastern end of the Beaver Divide area (Van Houten, 1964:36, 63). Furthermore, the gastropod species at locality 17 are not known from Oligocene strata, of any other lithology, anywhere else, but they are common in the upper part of the Wagon Bed Formation in nearby areas. The White River Formation is known to lie on a surface with considerable relief cut on the Wagon Bed Formation throughout the Beaver Divide region. Van Houten (1964:54) explained the limestones in the upper part of the Wagon Bed Formation west of Conant Creek Anticline, as lime muds derived from Paleozoic limestones on the Conant Creek Anticline, which accumulated in a local lake and were diagenetically replaced by silica derived from altered volcanic debris. The limestone at Van Houten's locality 17, on the east flank of the Conant Creek Anticline, probably formed at the same time in the same manner.

MAMMALS

Hyopsodus cf. *H. uintensis*

FIGURE 5

A single right M² of *Hyopsodus* (USNM 181389) was collected by Van Houten, who listed the specimen (1964:67) as "*Hyopsodus* sp. (USGS specimen)" from "15 feet below top of Beaver Divide Conglomerate Member (volcanic facies)." Gazin (1956:10) had previously mentioned the specimen and remarked on its similarity to another tooth from the Badwater upper Eocene in the northeast part of the Wind River Basin. Gazin explained the apparent anomalous age of the Beaver Divide specimen with the statement that "the locality is some distance away from the critical Wagonbed Springs section and Van Houten (personal communication) has since doubted the correlation so that the tooth may well have originated in the Uinta equivalent present in the sequence." There is no longer reason to doubt that the tooth is from the volcanic conglomerate, as Van Houten had indicated, and that it is Uintan. On the basis of this specimen and others, the volcanic conglomerate is itself a Uinta equivalent.

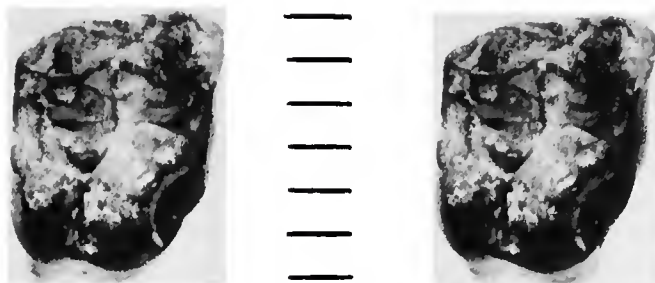


FIGURE 5.—*Hyopsodus* cf. *H. uintensis*, right M², USNM 181389, from 15 feet (4.6 meters) below top of volcanic conglomerate unit, in SE ¼, sec 24, T 31 N, R 96 W, near Devil's Gap about 5 miles (8 kilometers) southwest of Wagon Bed Spring (see Van Houten, 1964:67, pl. 2). (Stereogram; scale in millimeters.)

Gazin (1968), in his study of *Hyopsodus*, assigned the specimens from the Badwater upper Eocene in the northeast part of the Wind River Basin to *H. uintensis*. He reported that 10 M²'s in the Carnegie Museum collections from this locality range in length from 4.1 to 5 mm, that the type of *H. uintensis*, from Uinta "C" is 4.3 mm in length, and that these measurements are somewhat larger than those of specimens from Uinta "B." The Beaver Divide specimen is 4.5 mm in length, and has a width of 6.1 mm, compared with a width of 6.2 mm in the type.

Gazin (1968:47) pointed out that in the early and middle Eocene species of *Hyopsodus*, the metaconule is a small isolated cusp about midway between the protocone and metacone, but in the late Eocene the metaconule had become more aligned with the hypocone, and the latter cusp is relatively larger and more widely and deeply separated from the protocone, giving the first and second molars a more lophodont appearance. The Badwater specimens exhibit this condition, as does the Beaver Divide specimen. This, together with the size of the Beaver Divide tooth, while hardly constituting compelling evidence, is nevertheless suggestive of a Uinta "C" age for the volcanic conglomerate on Beaver Divide.

Protoreodon pumilus

Three specimens, apparently all from the volcanic conglomerate overlying the Wagon Bed Formation near Wagon Bed Spring, can be assigned to *Protoreodon pumilus*. Several authors have, at

various times, assigned these specimens to several different species, which indicated several different ages for one rock unit in the Beaver Divide sequence.

P. pumilus, AMNH 22558

Dentition illustrated by Scott (1945, pl. IV: figs. 1, 2).

The first of the three Beaver Divide protoreodont specimens was found by Mrs. N. H. Brown, a resident of Lander, Wyoming, who presented it to the American Museum of Natural History in 1928. It consists of the middle part of a skull of a young individual with left dP⁴, M¹–M², right M¹–M², and part of unerupted M³, and an associated fragmentary right mandible with dP₃–dP₄, M₁–M₂. There is some doubt as to the precise locality, although it is almost certainly from near the edge of the rim within a mile south of Wagon Bed Spring. Van Houten (1964:68) assigned it to his "volcanic facies" of the Beaver Divide Conglomerate. The matrix adhering to the specimen, and its similarity in preservation and morphology to other specimens from the volcanic conglomerate, support Van Houten's assignment. Scott (1945:233) referred the specimen to *Mesagriochoerus primus* and included it in his Duchesne River Fauna. Gazin (1955:47) placed the genus *Mesagriochoerus* in synonymy with *Protoreodon*, and considered the Beaver Divide specimen to be closer to *P. pumilus* than to *P. primus*. Its closest comparison is to specimens of *P. pumilus* from Leland Bench draw in the Uinta basin, which Gazin regarded as earlier in Uinta "C" than Myton Pocket. Specimens of *P. pumilus* from Myton Pocket are slightly larger and perceptibly more selenodont, and were assigned by Gazin to a distinct subspecies, *P. pumilus annexens* (Gazin, 1955:51).

P. pumilus, CM 12049

Illustrated by Scott (1945, pl. II: fig. 1).

A second specimen of *Protoreodon*, consisting of the major part of a skull, was collected by the Carnegie Museum expedition of 1934, under the leadership of J. LeRoy Kay. Colbert (1938:87) referred to this specimen when he mentioned that the skull of *Brachyhyops* "was found in association

with a primitive type of oreodont." The collector's data for the protoreodont specimen indicate, however, that it was not associated with the skull of *Brachyhyops*, but "ca 1/2 mile south of Wagon Bed Springs, Wyoming" from "sandstone 40 feet above conglomerate which Sinclair and Granger determined to be top of Uinta." This would place the locality for CM 12049 about a mile from that of *Brachyhyops*, which, as noted elsewhere, was about a half mile north of Wagon Bed Spring. Sinclair and Granger (1911) called the top of the "Uinta" here a sandstone, although they did describe it as being very coarse locally, and Van Houten (1964: 43) described it as arkosic sandstone and conglomerate. If the specimen were from 40 feet above the top of the Wagon Bed Formation (Sinclair and Granger's "Uinta") it would be from the volcanic conglomerate sequence, which does have lenses of sandy material in the middle at this locality (see Van Houten's section 23, 1964, pl. 3). The matrix adhering to the specimen is a coarse tuffaceous sandstone like that seen in the lenses of finer material within the volcanoclastic sequence, and like that adhering to other specimens that are surely from this unit. Van Houten (1964:68) assigned the specimen to the upper 25 feet of the crystalline rock conglomerate, and shows the locality (no. 8) at approximately "road level" in his section 25 (pl. 3). On his map (pl. 2) he indicates the locality about one-fourth mile east of Wagon Bed Spring, and this point, if plotted on a topographic map (USGS 7.5 minute series, Dishpan Butte Quadrangle), is 100 feet or more above the level of the road, well above the crystalline conglomerate, which does not agree with his section 25. And neither of these agrees with the information supplied by Kay at the time he collected the specimen. If the specimen is, as the collector indicated, from about one-half mile south of Wagon Bed Spring, it is almost certainly from one of the lenses of finer material within the volcanic conglomerate, as the matrix adhering to it suggests. It is the same species as other specimens from the volcanic conglomerate. If it came from the Chadronian crystalline conglomerate, as Van Houten indicated, it would be indeed an anomalous occurrence, the only known specimen of this species from rocks younger than Uintan age.

CM 12049 was made the type of a new species, *Protoreodon tardus*, by Scott (1945:236) and was

included in his Duchesne River Fauna. Scott mentioned differences, that he considered to be progressive, between this specimen and earlier protoreodonts, but none of these are apparent to me, and obviously were not apparent to Gazin (1955:50), who, on the basis of the transverse width of the premolars, size, and degree of selenodonty, tentatively assigned the specimen to *P. pumilus* and suggested that it may even be "a trifle less progressive than in most referred material of *P. pumilus*." Gazin's hesitation to assign the specimen unequivocally to *P. pumilus* was probably due, at least in part, to its apparent, but incorrect, late date. As he explained (1955:50), "*Protoreodon tardus* is stated to be from the Beaver Divide conglomerate, in which case it is as late as, or later than, *Protoreodon primus*," which is in turn later than *P. pumilus*. The specimen compares most favorably, in size and dental morphology, with material from Leland Bench draw referred to *P. pumilus*. As noted above, Gazin regards the Leland Bench draw fossil levels as early in Uinta "C" time.

P. pumilus, USNM 181391

FIGURE 6

A third specimen of *Protoreodon*, collected by Van Houten, consists of a fragmentary left mandibular ramus with M_1 - M_2 . Gazin (1955:8) commented that "an immature jaw-fragment collected by Van Houten from beds undoubtedly a part of the Beaver Divide conglomerate resembles *Protoreodon*, but the two lower teeth preserved are not truly diagnostic so that a small species of *Agricochoerus* may well be represented." Van Houten (1964:67) listed the specimen as "*Protoreodon* sp. or *Agricochoerus* sp. (USGS specimen)," from "Beaver Divide Conglomerate Member (volcanic facies)." The volcanic conglomerate is now shown to disconformally underlie the White River Formation, including the Beaver Divide Conglomerate Member. The teeth of this specimen, whether "truly diagnostic" or not, are virtually identical to those of specimens referred to *P. pumilus* from Leland Bench draw in the Uinta Basin. For comparison, the specimen is shown in Figure 6 with a specimen from Leland Bench draw. The specimen further confirms the "Uinta C" age of the volcanic conglomerate.

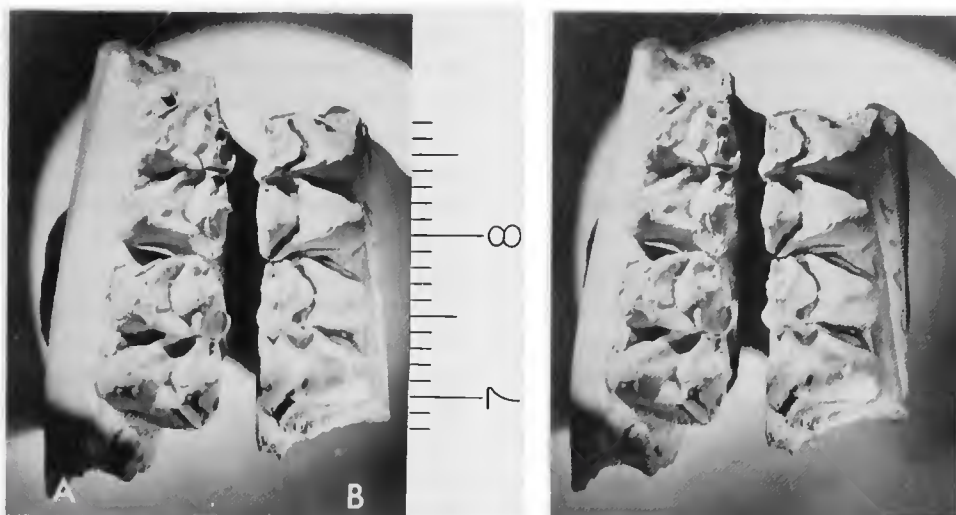


FIGURE 6.—*Protoreodon pumilus* referred: A, left M_{1-2} , USNM 181391, from upper 15 feet (4.6 meters) of volcanic conglomerate and tuff sequence, in NE $\frac{1}{4}$, sec 9, T 31 N, R 95 W, about $1\frac{1}{2}$ miles (2.4 kilometers) southwest of Wagon Bed Spring (see Van Houten, 1964: 67, pl. 2); B, right M_{1-2} , USNM 20417, from Leland Bench Draw, Uinta Basin, Utah. (Stereogram; scale in millimeters.)

Leptotragulus cf. L. clarki

A single M_3 , with the hypoconulid broken away, was discovered by Van Houten who reported it (1964:67) as "Hypertragulid or leptomerycid (USGS specimen)" from the "SE $\frac{1}{4}$ sec 24, T 31 N, R 96 W, measured section 14; 15 feet below top of Beaver Divide Conglomerate Member (volcanic facies)."

The specimen is now cataloged as USNM 181390. Comparisons are limited by the fragmentary nature of the specimen. It is, however, almost certainly a leptotragulid, somewhat smaller than *Leptotragulus medius* and *Leptoreodon marshi*. It compares best, in size and crown height, with specimens from Uinta "C" referred to *Leptotragulus clarki* Gazin, 1955.

Camelodon arapahovius Granger, 1910

Illustrated by Granger (1910, fig. 4) and Scott (1945, pl. 2: fig. 2).

The type, and as yet the only known specimen, of *Camelodon arapahovius* (AMNH 14604) was collected in 1909 by Granger, who, in his description of it (1910:248), recorded the locality as "Uinta beds (Diplacodon zone) of the Beaver Divide." According to Granger it was found at the same locality and same level as a skull of *Amyno-*

don advenus, two specimens of *Protoreodon parvus*, and a titanothere jaw fragment, all of which indicate Uintan age, more specifically Uinta "B" equivalence. Peterson and Kay (1931:296) suggested that *Camelodon arapahovius* "appears too far advanced for a form from the horizon C. of the Uinta." This suggestion was apparently Scott's basis (1945:212, 214, 227) for including the species in his Duchesne River fauna, as he gave no other reason for doing so, and he explicitly excluded the *Amynodon*, which Wood had identified as a Uinta species.

Wood (1948:39) correctly listed *C. arapahovius* with the other Uintan forms from the upper part of the Wagon Bed Formation, as have later authors (Gazin, 1955, Van Houten, 1964).

Menodus heloceras

Illustrated by Osborn (1929:526, fig. 436).

This specimen (AMNH 14576) is the skull of "*Titanotherium heloceras*" collected by Granger in 1909 from what is now known as the Big Sand Draw Sandstone Lentil of the White River Formation. Granger (1910) and Sinclair and Granger (1911) correctly regarded the specimen as confirmatory evidence of the early Oligocene age of the containing rocks.

Osborne (1929:525-526) assigned the specimen

to *Menodus heloceras*, but noted that it is a "very primitive skull." Wood (1948:39) incorrectly stated that the titanotherium was found in the same "level" as the two protoreodont specimens discussed above (AMNH 22558, CM 12049), and concluded that the "level must certainly be of Duchesnean age." As additional supporting evidence for the presence of the Duchesnean at Beaver Divide, Wood (1948:39) noted that Tourtelot had found "a Duchesnean fauna on the north rim of the basin which supports the suspicion that Duchesnean beds may be present along the southern rim." This "Duchesnean fauna" from the northern part of the basin (Tourtelot and Nace, 1946) was later shown by Gazin (1956) to be Uintan. Wood also cited *Eotylopus reedi* Matthew, from the Bates Hole region about 100 miles east of the Wagon Bed Spring area, as "confirmatory evidence for the presence of a Duchesnean Level." *Eotylopus reedi* was described by Matthew (1910:36) as being from the lower Oligocene of Wyoming. The species has subsequently been found at various other localities and, so far as known, is restricted to the Chadronian ("early Oligocene").

The two Beaver Divide protoreodonts mentioned by Wood are now referred to *Protoreodon pumilus*, are from the volcanic conglomerate disconformably underlying the White River Formation, and indicate Uinta "C" temporal equivalence. The *Menodus heloceras* has been regarded as Chadronian by all authors except Wood. The Duchesnean "stage" is not represented in the Beaver Divide sequence.

Brachyhyops wyomingensis Colbert, 1938

Illustrated by Colbert (1938, figs. 2, 4) and Scott (1945, pl. VI).

The skull that is the type-specimen of *Brachyhyops wyomingensis* (CM 12048) was collected by the Carnegie Museum expedition of 1934, under the leadership of J. LeRoy Kay. In his paper describing the skull, Colbert (1938:88) recorded the "horizon" as the "uppermost portion of the Uinta formation, immediately beneath the basal Oligocene agglomerate at Beaver Divide" and the locality as "one half mile north of Wagon Bed Spring, Wyoming." Fortunately, Colbert also included a photograph (1938:88) of the locality with an X marking the position at which the skull was discovered. From this photograph it can be determined that the source of the specimen was the

upper part of the Big Sand Draw Sandstone Lentil, of Chadronian age. The "basal Oligocene agglomerate" mentioned by Colbert is not basal Oligocene, nor is it the volcanic conglomerate. It is the conglomerate of Precambrian crystalline rock (the Beaver Divide Conglomerate Member of the White River Formation) that overlies the Big Sand Draw Sandstone Lentil.

Scott (1945) included *Brachyhyops* in his "Duchesne River Oligocene" fauna, and cited it and other specimens from lower units as evidence of the Duchesne River Stage in the Beaver Divide section.

H. E. Wood (1948) favored Scott's idea of a Duchesnean stage in the Beaver Divide sequence, but followed Colbert in incorrectly assigning *Brachyhyops* to the "uppermost Uinta."

Gazin (1955:7) corrected the error when he wrote that "the top of the Uintan sequence is deeply channeled, and the fill has produced remains of Oligocene age. At least one of these, the *Brachyhyops* skull, was described as coming from the uppermost part of the Uintan sequence."

Van Houten (1964:67) correctly listed *Brachyhyops* with other taxa from the Big Sand Draw Lentil and considered it "early Oligocene (early Chadronian) age."

Wilson (1971) described additional specimens of *Brachyhyops* from the Lapoint Member of the Duchesne River Formation of Utah and from the Porvenir local fauna in the Chambers Tuff of the Vieja Group of Trans-Pecos Texas. He concluded that *Brachyhyops* furnishes a tentative correlation between these localities and indicates an Oligocene age for the upper part of the Duchesnean of Wood et al. (1941). Characteristic Chadronian and later genera are associated with *Brachyhyops* at Beaver Divide and also in the Porvenir local fauna. I have collected a specimen of *Brachyhyops* from the White River Formation in the Flagstaff Rim area of central Wyoming (Emry, 1973:33). It is from the lower part of the section, and on the basis of associated fauna is approximately equivalent to the Yoder fauna of eastern Wyoming, which is usually considered earliest Chadronian. I have also collected two additional specimens (previously unreported) of *Brachyhyops* from the White River Formation near the eastern end of Beaver Divide in the Gas Hills area. These two specimens are also associated with typical Chadronian forms.

Brachyhyops may range from the Duchesnean into the Chadronian, but there is also the possibility that the occurrence in the Duchesne River Formation is temporally equivalent to the occurrences in the White River Formation. The implication here is that the Duchesnean and Chadronian, as defined by Wood and others (1941), may not be mutually exclusive; late Duchesnean may overlap early Chadronian. At present there is not enough biostratigraphic information to resolve this issue. If these two "ages" are to be time sequential, and neither separated by a gap nor overlapping, the boundary between them must eventually be redefined on the basis of biostratigraphic rather than lithostratigraphic criteria. The eventual resolution of the Duchesnean-Chadronian boundary will still not resolve, in fact will have no bearing whatever on, the issue of whether the Duchesnean is Eocene or Oligocene.

Ages and Correlations

The Wagon Bed Formation, which crops out extensively along Beaver Divide, along the southern margin of the Wind River Basin, was divided into five units west of Conant Creek anticline by Van Houten (1964). The lower part (units 1 to 3 of Van Houten) was considered Bridgerian on the basis of rather meager, and somewhat equivocal, fossil mammal evidence (Van Houten, 1964:50) from unit 3. The upper two units were determined to be Uintan on the basis of fossil mammals from unit 5 (Van Houten, 1964:50-52). *Amyndodon advenus* and *Protoreodon parvus* from the uppermost part of the Wagon Bed Formation near Wagon Bed Spring indicate, more specifically, "Uinta B" temporal equivalence.

Van Houten (1964, table 3) correlated the Bridgerian part of the Wagon Bed Formation with the Aycross Formation in the northwest part of the Wind River Basin, and the Uintan part of the Wagon Bed with the Tepee Trail Formation, also in the northwest part of the Wind River basin, which Love (1939:78) tentatively correlated with upper Eocene strata. Van Houten (1964:34-35) did not extend the name Tepee Trail to the Beaver Divide area because he believed this could "only create confusion, because the lower part [of the Wagon Bed] includes established middle Eocene

deposits than can locally be separated from the upper Eocene."

More recent evidence suggests that the lower, rather than upper, part of the Wagon Bed correlates with the Tepee Trail. Smedes and Prostka (1972:30) concluded that the Tepee Trail is most likely "middle and late (?) Eocene age," on the basis of radiometric dates and limited paleontologic evidence. Malcolm McKenna of the American Museum of Natural History is currently studying assemblages of mammals from the type section of the Tepee Trail and from correlated strata in the Togwotee Pass area, which suggest (McKenna, 1972; pers. comm.) an early Bridgerian to possibly earliest Uintan age for at least the parts of the formation yielding these faunas. Volcanic debris in unit 2 of the Wagon Bed Formation is the most basic in composition of any in the Tertiary rocks along Beaver Divide (Van Houten, 1964:39), and the volcanic material of the Tepee Trail Formation is also more basic than that of the formations that underlie and overlie it.

It is less clear whether the upper (Uintan) part of the Wagon Bed Formation correlates with the upper part of the Tepee Trail Formation or with the Wiggins Formation. Van Houten (1964:53) mentioned that "the color and even bedding of units 4 and 5 [of the Wagon Bed] west of Conant Creek anticline are duplicated in the finer facies of the Tepee Trail Formation in its southernmost and easternmost exposures in the southern Absaroka Range." But unit 5 also has beds of volcanic pebbles and cobbles, and rare boulders up to three feet in diameter (Van Houten, 1964:43-45). This debris is, in mineralogical composition (Van Houten, 1964:80-81), similar to that of the Wiggins. Furthermore, the high energy stream transport necessary to move boulders three feet in diameter into the Beaver Divide area is abundantly evident in the Wiggins Formation and not in the Tepee Trail.

The youngest known fauna of the Tepee Trail-Wiggins sequence occurs in the type section of the Tepee Trail, at least 514 feet, and maybe as much as 700 feet, above the base, and is overlain by at least another 900 feet of Tepee Trail deposits. This fauna is no younger than earliest Uintan (McKenna, 1972). The upper part of the Tepee Trail, undated paleontologically, is therefore probably Uintan, but how far it extends into the Uintan

is not determined. There is no good paleontologic evidence for the typical Wiggins Formation, but radiometric dates (Smedes and Prostka, 1972) indicate that at least the lower half of the Wiggins is no younger than Uintan. The Uintan part of the Wagon Bed Formation could therefore be correlated with the upper (possibly Uintan) part of the Tepee Trail, or with the (probably Uintan) Wiggins. The composition and texture of volcanic debris in the Wagon Bed support the latter alternative.

The coarse volcanoclastic deposits overlying the Wagon Bed Formation in the western Beaver Divide area are, in gross lithology, very similar to the Wiggins Formation (Love, 1939:79), a sequence of light-colored, coarse, andesitic volcanoclastic strata in the southern part of the Absaroka Range. Until recently the Wiggins was thought to be early Oligocene in age, on the basis of vertebrate fossils (Love, 1939), but Smedes and Prostka (1972:32) and Love, McKenna, and Dawson (in press) have determined by re-examining field relationships that the vertebrate fossils were from a channel fill deposited on eroded Wiggins. As previously mentioned, radiometric dates indicate the Wiggins is no younger than Uintan. Fossil mammals from the coarse volcanoclastics on Beaver Divide (see preceding paleontology section) indicate lower "Uinta C" temporal equivalence. Love (1939:84) stated that the Beaver Divide rocks cannot be distinguished petrographically from those of the typical Wiggins Formation, and believed (1939:111) that the vents that furnished the material for the Wiggins Formation were also the source for the "agglomerates" in the Beaver Divide White River deposits." It is interesting to note that both the Wiggins Formation and the coarse volcanoclastic unit on Beaver Divide were originally dated as "Oligocene" on the basis of fossil mammals, but in both instances the fossils have since proven to be from deposits filling channels cut into the units they were thought to date. Of the formations along the southeast margin of the Absaroka volcanic field, only the Wiggins Formation shows evidence of the high-energy stream transport that would be required to carry the coarse volcanic material 80 to 90 miles southeastward into the Beaver Divide area. On the basis of the above evidence, the application of the name Wiggins Formation to the

coarse volcanoclastic unit on Beaver Divide appears to be a valid extension of the name.

The White River Formation of the western Beaver Divide area can be assigned confidently to the Chadronian "age" on the basis of its mammalian fauna (see Van Houten, 1964:67-71). Van Houten indicated (1964:67, table 3) that the White River of this area may extend into the "middle Oligocene" (Orellan), but this is not supported by paleontologic evidence. An early Chadronian age for the Big Sand Draw Sandstone Lentil is suggested by the presence of *Brachyhyops*, which has been found elsewhere in rocks no younger than earliest Chadronian.

The Big Sand Draw Sandstone Lentil of the White River Formation fills a channel cut into Uintan Rocks. Along the eastern part of Beaver Divide, in the Gas Hills area, the White River also lies on a very irregular surface, in two places filling channels cut completely through the Wagon Bed Formation into the early Eocene Wind River Formation (Van Houten, 1964, pl. 2). Farther east, in the Flagstaff Rim northwest of Alcova, and in the Bates Hole area, the White River lies on a surface with several hundred feet of relief (Emry, 1973). Another example is the locality previously mentioned, just south of Yellowstone Park, where vertebrates, originally thought to date the Wiggins Formation, are now known to be from a channel deposited on eroded Wiggins. It is evident that over much of Wyoming, pre-Chadronian erosion had developed considerable relief on older rocks before the beginning of White River deposition.

Summary

In the Tertiary sequence of the western Beaver Divide, a unit of coarse volcanic conglomerate that was previously called the volcanic facies of the Beaver Divide Conglomerate Member of the White River Formation is shown to underlie an erosional disconformity cut before the beginning of White River Deposition. The volcanoclastic unit has produced *Hyopsodus* cf. *H. uintensis*, *Protoreodon pumilus*, and *Leptotragulus* cf. *L. clarki*, which date the unit as Uintan, approximately temporally equivalent to Uinta "C" of the Uinta Basin. The unit is assigned to the Wiggins Formation. The Beaver Divide Conglomerate Member is restricted to the conglomerates in the lower part of the White

River Formation, composed predominantly of clasts of Precambrian rock derived locally from the Granite Mountains. The ordering of the lithostrati-

graphic units on the basis of physical stratigraphic observations agrees with the order expected on the basis of fossil mammals.

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