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WASATCH FOSSILS IN SO-CALLED FORT UNION BEDS
OF THE POWDER RIVER BASIN, WYOMING

AND THEIR BEARING ON THE STRATIGRAPHY OF THE REGION

BY

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WASATCH FOSSILS IN SO-CALLED FORT UNION BEDS OF THE POWDER RIVER BASIN, WYOMING, AND THEIR BEARING ON THE STRATIGRAPHY OF THE REGION.

By CARROLL H. WEGEMANN.

Northeastern Wyoming is occupied by a broad structural basin opening to the north and bounded on the east, south, and west by three mountain uplifts—the Black Hills, the Laramie Mountains, and the Big Horn Mountains. (See fig. 16.) Throughout much of this basin the surface rocks are of Tertiary age. They contain the principal coal beds of the region and have been classified in all the more recent Survey reports as Fort Union. The true age of these rocks and the general stratigraphy of the fresh-water beds that underlie them are the theme of this paper.

The rocks above the Fox Hills sandstone on the southwest side of the basin may be separated, on lithologic grounds, into three divisions. The Lance formation, about 3,200 feet thick, consisting of gray shale and buff fine-grained slabby or concretionary sandstone, is at the base. It contains a few thin coal beds at various horizons in the formation, particularly near the base and top, but they are so thin and the coal is so poor as to be of no commercial value. One of the most characteristic features of the Lance consists of large round concretionary masses that weather from the sandstone beds. (See Pl. XXII, A.) These masses resemble great boulders, and some of them are as much as 10 or 15 feet in diameter.

At its top the Lance grades almost imperceptibly into the beds of the overlying forma-

tion, the transition being marked by thin beds of coal and carbonaceous shale. Neither at the base nor at the top has evidence of unconformity been observed in this region.

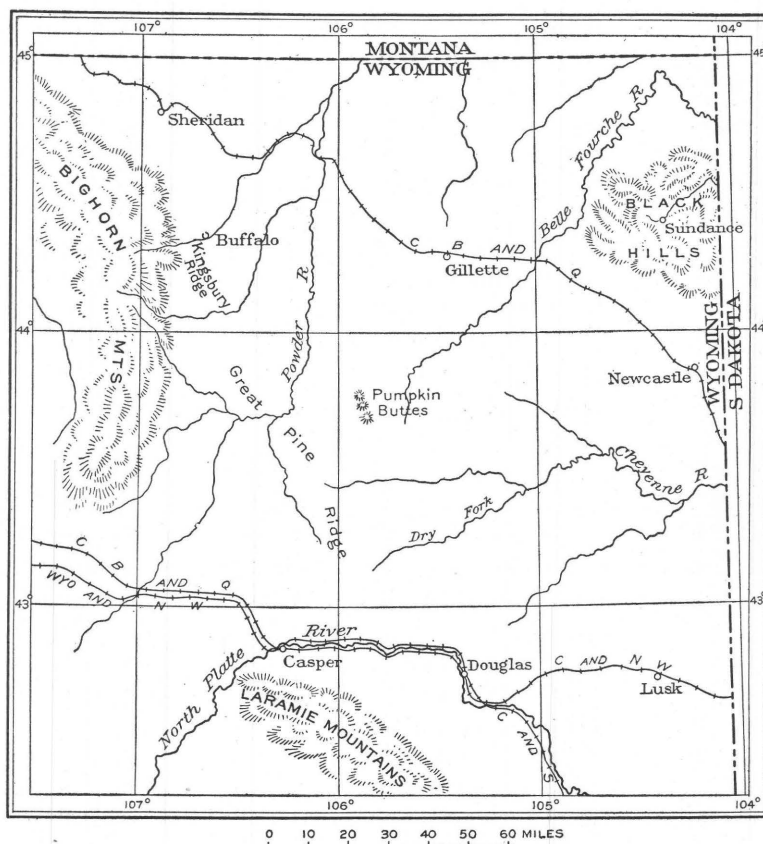


FIGURE 16.—Map of northeastern Wyoming.

The Lance formation, as a whole, is a unit that is not susceptible of division on lithologic grounds. The vertebrate remains, however (for the most part *Triceratops* and *Trachodon*), are not distributed through the whole formation, but are found only in the lower 2,000 feet. The upper 1,200 feet of beds, although identical in appearance with those below, are apparently barren of vertebrate fossils.

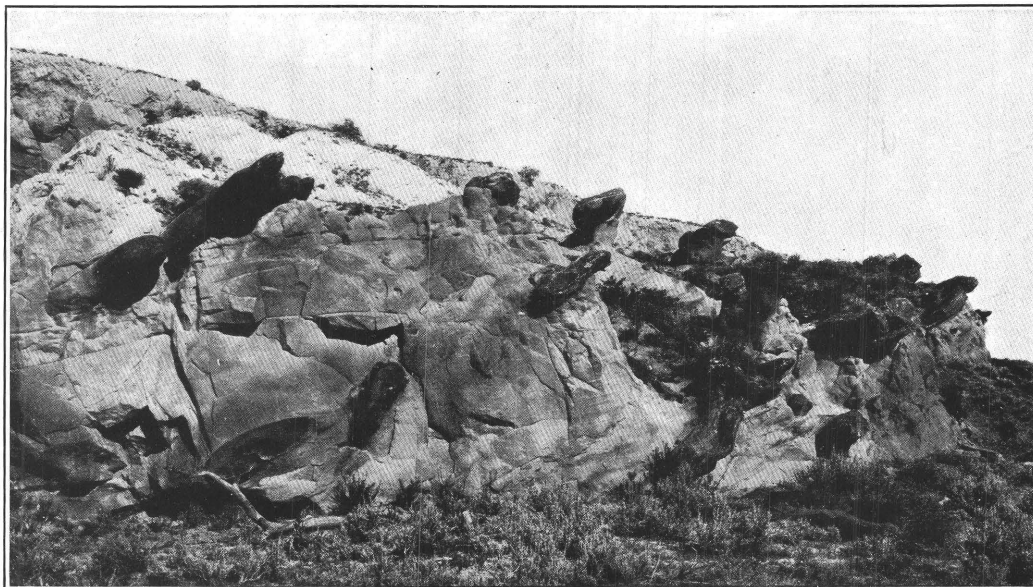
Above the Lance formation is about 2,000 feet of very fine grained bluish-white sandstone interbedded with gray shale and with a few beds of coarser sandstone, containing grains one-eighth of an inch in diameter. This formation is distinguished from the underlying Lance by its bluish-white color, the absence of large round concretionary masses, and the presence of beds of highly ferruginous sandstone only a few inches thick. The iron in many of these ferruginous beds appears to be of secondary origin, having probably been deposited from ground water. Some of it may represent swamp deposits, although this is difficult to demonstrate.

The formation as a whole is more resistant to erosion than the formations above and below it, so that its outcrop around the margin of the great basin already described forms a prominent escarpment, which is generally timber covered, and to which the writer has referred in several reports as the "Great Pine Ridge." (See Pl. XXII, B.) Fossil leaves, that are found in abundance in some of the ferruginous beds, have been determined by F. H. Knowlton as of Fort Union age, but the strata have heretofore been considered as comprising only the basal member of that formation.

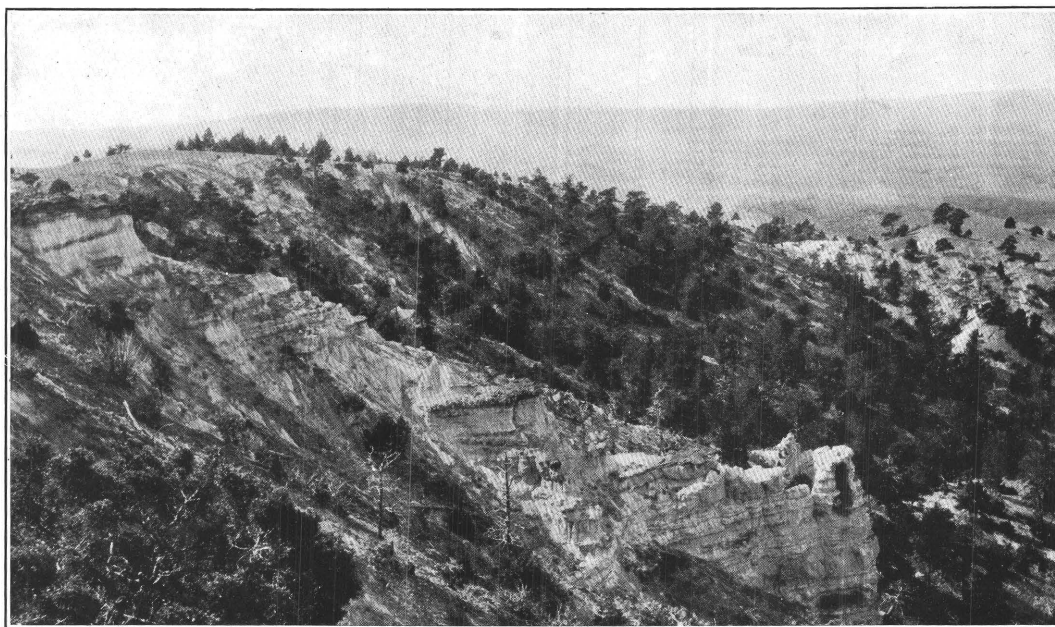
The bluish-white shale and sandstone of the Great Pine Ridge are overlain by about 2,500 feet of beds that are the principal coal-bearing rocks of the upper Powder River valley and that have in the past been considered by most workers in the region, the writer included, as of Fort Union age, constituting the upper division of that formation. (See Pl. XXIII, A.) These beds consist mainly of gray shale and fine-grained dirty-white sandstone. They include some beds of coarser sandstone, especially in the upper part of the formation, and at the bases of these are found in many places thin layers of conglomerate. At certain horizons there are layers of pink shale and pink sandstone whose color—in the sandstone at least—is variable from place to place. Ferruginous layers, so abundant in the underlying formation, are here absent. Distributed through the formation at various horizons are beds of subbituminous coal, which range in thickness from a few inches to 50 feet. Some of the beds are apparently very lenticular and can be traced for only a few miles along their outcrop. Others

are very persistent and underlie hundreds of square miles of territory.

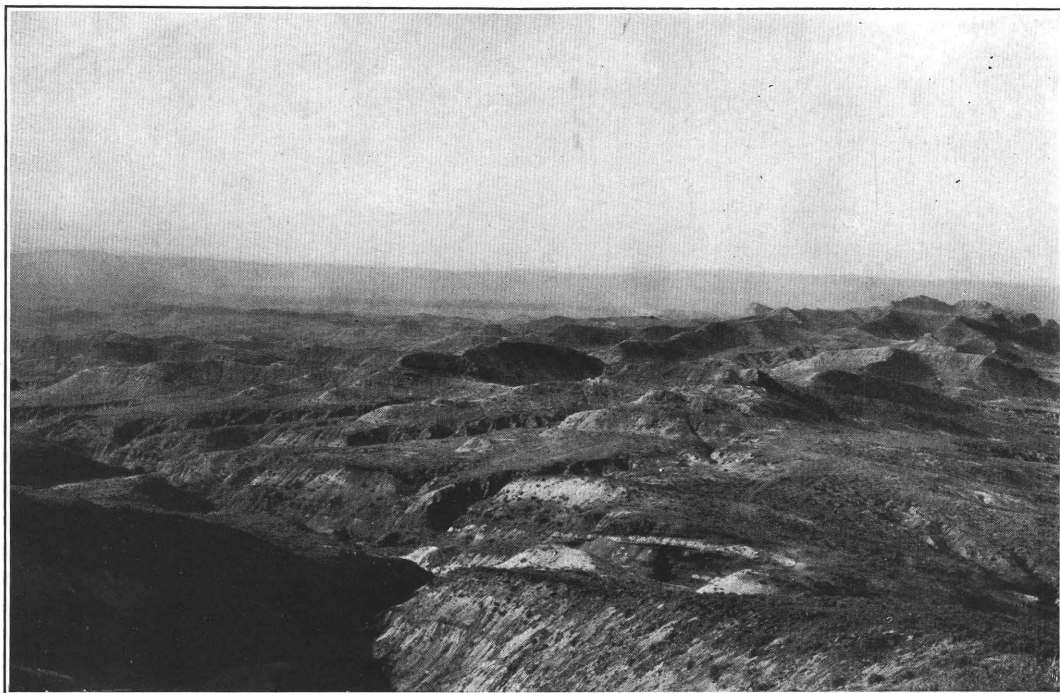
During the season of 1915 R. W. Howell and the writer examined an area of about 2,000 square miles, extending from northwest Converse County northward along the divide on which are situated the Pumpkin Buttes to the Powder River valley. In the Pumpkin Buttes are exposed the highest beds that are present in this general region. About 12 miles west of the buttes lies the Great Pine Ridge, and between this ridge and the buttes is the most advantageous locality at which to measure the thickness and study the characteristics of the overlying formation, the so-called upper division of the Fort Union. To Mr. Howell belongs the credit of finding the first tooth of *Coryphodon* discovered by the party. The specimen was found between the Middle and North buttes at about 950 feet below the top of the formation as there exposed. Mr. Howell and the writer afterward returned to the place and obtained several other teeth. All came from a blue shale underlying a thick sandstone bed, at the base of which is one of the small local unconformities characteristic of the formation. Later in the season we obtained from Mr. William Black, a rancher, other specimens of *Coryphodon* teeth, which he described as having been found at the top of Dome Butte, an outlier of North Pumpkin Butte. The sandstone that caps this butte is the same as the basal part of the thick sandstone bed that caps all the Pumpkin Buttes. Mr. Black gave the locality accurately, and Mr. Howell afterward visited it. He did not discover any more teeth but did find fragments of bone embedded in sandstone, that correspond in texture to that in which the specimens which we had received were embedded. J. W. Gidley states, with regard to this as well as the former collection, that the teeth belong to *Coryphodon molestus*, a genus known only from the Wasatch. It would seem, therefore, that these remains afford definite evidence for correlating the rocks that form the Pumpkin Buttes, or the upper 1,000 feet of the formation heretofore called Fort Union, with the Wasatch. The 1,400 feet of beds from the base of the Pumpkin Buttes down to the top of the Great Pine Ridge are lithologically similar to the rocks of the buttes themselves, and there is every reason, on lithologic grounds, to suppose that they belong to the same formation



A. SANDSTONE BED IN LANCE FORMATION, SHOWING LARGE "CONCRETIONS."



B. GREAT PINE RIDGE, WYO., FORMED BY OUTCROP OF FORT UNION FORMATION.



A. BADLANDS IN WASATCH FORMATION AT FOSSIL LOCALITY NEAR THE DAVIS RANCH, SUSSEX, WYO.

Photograph by T. W. Stanton.



B. KINGSBURY CONGLOMERATE ON KINGSBURY RIDGE, 8 MILES SOUTHWEST OF BUFFALO, WYO.

as the rocks from which *Coryphodon* has been obtained.

In 1910 T. W. Stanton, A. R. Schultz, and the writer made a collection of small mammal teeth from a horizon about 700 feet above the top of the beds forming the Great Pine Ridge, at a place 20 miles west of Pumpkin Buttes. (See Pl. XXIII, A.) Some shale beds in the vicinity are pink or red and resemble the Wasatch beds of southwestern Wyoming. The writer was directed to this locality by Mr. H. W. Davis, an old-time rancher of the region, who stated that some years before students from Amherst, Mass., had made a collection from the locality and found the jaw of a fossil horse. Concerning this statement Prof. F. B. Loomis, of Amherst, has informed the writer that a party under his direction made a collection near the Davis ranch in 1904 which included teeth regarded by him as belonging to *Eohippus* and *Coryphodon*. With regard to the 1910 collection near the Davis ranch, Mr. Gidley has very kindly prepared the following statement:

On a former preliminary examination of the material from the vicinity of the Davis ranch, Sussex, Wyo., I was led to believe that it indicated Fort Union deposits at that locality. My conclusion was based principally on the presence in the collection of a little insectivorous mammal represented by a portion of a lower jaw containing two teeth. This or a closely related species occurs also in the Fort Union beds of Sweet Grass County, Mont., and so far as I know has never been found elsewhere. Its presence, however, is by no means conclusive evidence of the Fort Union age of these beds. For, while this particular animal has not yet been found in other formations, there are several forms commonly found in the Fort Union (or the Torrejon) which are known to extend beyond the limits of this formation and occur in beds recognized as lower Wasatch.

Of the three mammal molars also included in the collection from the Davis ranch, I stated five years ago that they represented undescribed species but seemed to be generically identical with certain forms of the Torrejon. To this I can now add that one of these (catalogue No. 6734) is very close to if not identical with *Polycodus ralstoni*, recently described by Matthew¹ from beds in the Clark Fork basin, Wyo., designated by Granger² the Sand Coulee beds and regarded as transitional in age between the Fort Union (represented in northwestern New Mexico by the Puerco and Torrejon) and the Wasatch. This suggests that the other specimens may also prove to belong to this horizon, especially as it now seems very evident that many of the Fort Union forms have passed without much change into the basal Wasatch.

As the Clark Fork beds and Sand Coulee beds of Granger, which contain both Fort Union and Wasatch forms are regarded as a transitional phase, there appears to have been no great time break between the Fort Union and Wasatch formations. A series of beds near Ignacio, Colo., mapped by Gardner³ as Wasatch, also appears to contain a fauna intermediate between Fort Union and Wasatch. The fossils from this locality are not numerous, but they show the presence of *Coryphodon* (species not determinable) in the upper levels. The lower levels contain a phenacodont, intermediate between *Phenacodus* of the Wasatch and *Euprotogonia* of the Torrejon; *Hemiacodon* (probably a new species), a Bridger genus; and *Nothodectes* sp., a genus from Granger's Clark Fork beds² (species may also be identical). A few other teeth in the collection appear to be species belonging to the Clark Fork beds.

Coryphodon and *Eohippus* are not known to occur lower than the beds designated by Granger Sand Coulee beds. Therefore, as *Coryphodon* has been found in the Pumpkin Buttes locality and as Loomis has reported *Coryphodon* and *Eohippus* from the Davis ranch locality it seems reasonable that these beds should be classed with the Wasatch formation and that those at the Davis ranch should be regarded as probably equivalent to one of the lower members of this group, either the Sand Coulee or the Clark Fork of Granger.

It is evident, then, that the fresh-water beds above the Fox Hills sandstone in this part of Wyoming comprise at the base a formation 3,200 feet in thickness which bears *Triceratops* in its lower 2,000 feet and which is unquestionably Lance, at the top a formation 2,400 feet in thickness which bears *Coryphodon* and is therefore Wasatch, and intermediate between these two a formation 2,000 feet in thickness which bears Fort Union leaves in abundance and which probably represents that formation. We may therefore refer to the rocks of the Great Pine Ridge as the Fort Union of this region, and to the formation overlying it as Wasatch.

That the Wasatch rests unconformably upon the Fort Union would seem to be indicated by the following observations: At Kingsbury Ridge, 8 miles southwest of Buffalo and about 50 miles northwest of the Pumpkin Buttes, is a thick conglomerate named by Darton⁴ the Kingsbury, which appears to represent a great alluvial fan, its outcrop being some 40 miles in length from north to south and 2 to 5 miles in width from east to west. (See Pl. XXIII, B.) It was apparently deposited by streams which flowed from the highest part of the Big Horn Mountains and which had, prior to the deposi-

¹ Matthew, W. D., The Cretaceous-Tertiary problem: Geol. Soc. America Bull., vol. 25, pp. 387-402, 1914.

² Granger, Walter, On the names of lower Eocene faunal horizons of Wyoming and New Mexico: Am. Mus. Nat. Hist. Bull., vol. 33, pp. 204-205, 1914.

³ Unpublished material.

⁴ Darton, N. H., Geology of the Bighorn Mountains: U. S. Geol. Survey Prof. Paper 51, p. 61, 1906.

tion of the conglomerate, cut deep valleys in the underlying beds. The conglomerate thus rests unconformably on the rocks below it, transgressing at Kingsbury Ridge strata ranging in age from Tertiary to Carboniferous. Its greatest thickness is estimated by Darton¹ as 2,500 feet. In recent Survey reports it has been treated as a member of the Fort Union formation. It is certainly younger than the Fort Union beds on which it rests toward the south, and in that direction also the conglomerate as a member thins out within a few miles, although layers a few inches to several feet in thickness can be found at or near its horizon as far south as Powder River. To the east the Kingsbury conglomerate appears to become finer grained and to finger out into the shale and sandstone of the coal-bearing beds that are now believed to be of Wasatch age. In other words, it is the writer's opinion that the Kingsbury conglomerate is equivalent to part of the Wasatch, and that the unconformity at its base separates that formation, in the Kingsbury region at least, from all older rocks.

Along the Dry Fork of Cheyenne River 35 miles south of Pumpkin Buttes and 90 miles southeast of Kingsbury Ridge there is some evidence of an unconformity between the Wasatch and underlying Fort Union beds. The Dry Fork of the Cheyenne heads in the Great Pine Ridge, and along its valley there are exposed two beds of coal stratigraphically about 160 feet apart. The lower coal bed is only a few feet above the top of the Fort Union as exposed in the Great Pine Ridge. The upper coal bed may be traced eastward along the Cheyenne

Valley for about 10 miles from the ridge to a point where both the lower and upper beds are exposed, together with about 50 feet of strata underlying the lower bed. There is no indication at this locality of the highly ferruginous layers characteristic of the Fort Union. Still farther east along the Cheyenne lower rocks are exposed, including a third coal bed that lies about 220 feet below the lower coal bed above described. The rocks associated with this third bed are in appearance Wasatch rather than Fort Union. A coal bed, therefore, which at the head of the Dry Fork of the Cheyenne rests almost directly on the Fort Union beds has below it in an area 15 miles farther east at least 275 feet of strata that appear to be Wasatch, and it seems probable that an unconformity is here present between the two formations. Inasmuch, however, as the coal beds in the lower part of the Wasatch do not extend for any great distance north and south in the region of the Fort Union outcrop, and as there are, besides the coal beds, no other key rocks that are easily recognizable in the lower part of the Wasatch, it is impossible to prove conclusively the amount of the unconformity.

In summary, we find in the region southeast of the Big Horn Mountains three fresh-water formations above the marine sandstone of the Fox Hills; the lowest of these is Lance, the highest Wasatch, and the intermediate formation may reasonably be considered to be Fort Union. A local unconformity is known to exist in the vicinity of Buffalo between the Wasatch and Fort Union, and there is evidence to indicate that this unconformity is present, although less evident in other parts of the Powder River basin.

¹ Darton, N. H., *Geology of the Bighorn Mountains*: U. S. Geol. Survey Prof. Paper 51, p. 61, 1906.