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GEOLOGY OF SOUTHERN PART OF LA BARGE REGION, LINCOLN COUNTY, WYOMING

BY

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Contribution from the Geological Survey of Wyoming
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GEOLOGY OF SOUTHERN PART OF LA BARGE REGION, LINCOLN COUNTY, WYOMING[1]

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ABSTRACT

In general, the area consists of a northward-trending ridge, bounded on the west by a valley and on the east by a gently rolling basin. The dominant structural feature is the northward-trending ridge. The Darby thrust cuts the eastern flank of the ridge; the extreme northern end of the ridge is cut by a west-striking tear and two minor high-angle westward-dipping thrusts or reverse faults. In the eastern part of the area there is a secondary thrust which was detected by well data.

INTRODUCTION

The area described in this report consists of approximately 42 square miles in Lincoln County, Wyoming, about 50 miles north of Kemmerer and 4 miles west of La Barge, in T. 26 N., Rs. 113 and 114 W. (Fig. 1). The southern part of the area is traversed by the graded La Barge road, which parallels La Barge Creek, and many secondary roads. The eastern part can be reached by the graded road from La Barge to Calpet, the foothills of the central part by wagon roads, and the western part by wagon trails. The whole of La Barge Ridge, which is in the northwestern part of the area, is without roads and trails and is too rough for travel except on foot.

The geological work was undertaken for the purposes of (1) obtaining an accurate geologic map of the area and (2) description and interpretation of the stratigraphy and structural geology.

The field work was begun on July 1, 1939, and was completed on September 15, 1939. Stratigraphic sections were measured normal to strike and downdip, with the aid of the Brunton compass and a steel tape. A geologic map on the scale of 1 inch = 1,000 feet was made by the use of the plane table and telescopic alidade. The triangulation method of geologic mapping was used.

No previous detailed geological investigations of the area have been published. Schultz[3] mapped a much larger area including the one mapped by the writer, but made no attempt to differentiate the Paleozoic rocks in La Barge Ridge.

The writer wishes to express his thanks to S. H. Knight, chairman

[1] Thesis submitted to the department of geology and the committee on graduate study at the University of Wyoming, in partial fulfillment of the requirements for the degree of Master of Arts, Laramie, Wyoming, 1940. Manuscript received, March 14, 1941.

[2] Home address, 1028 Sixth Street, Rock Springs, Wyoming.

[3] A. R. Schultz, "Geology and Geography of a Portion of Lincoln County, Wyoming," *U. S. Geol. Survey Bull. 543* (1914). 136 pp.

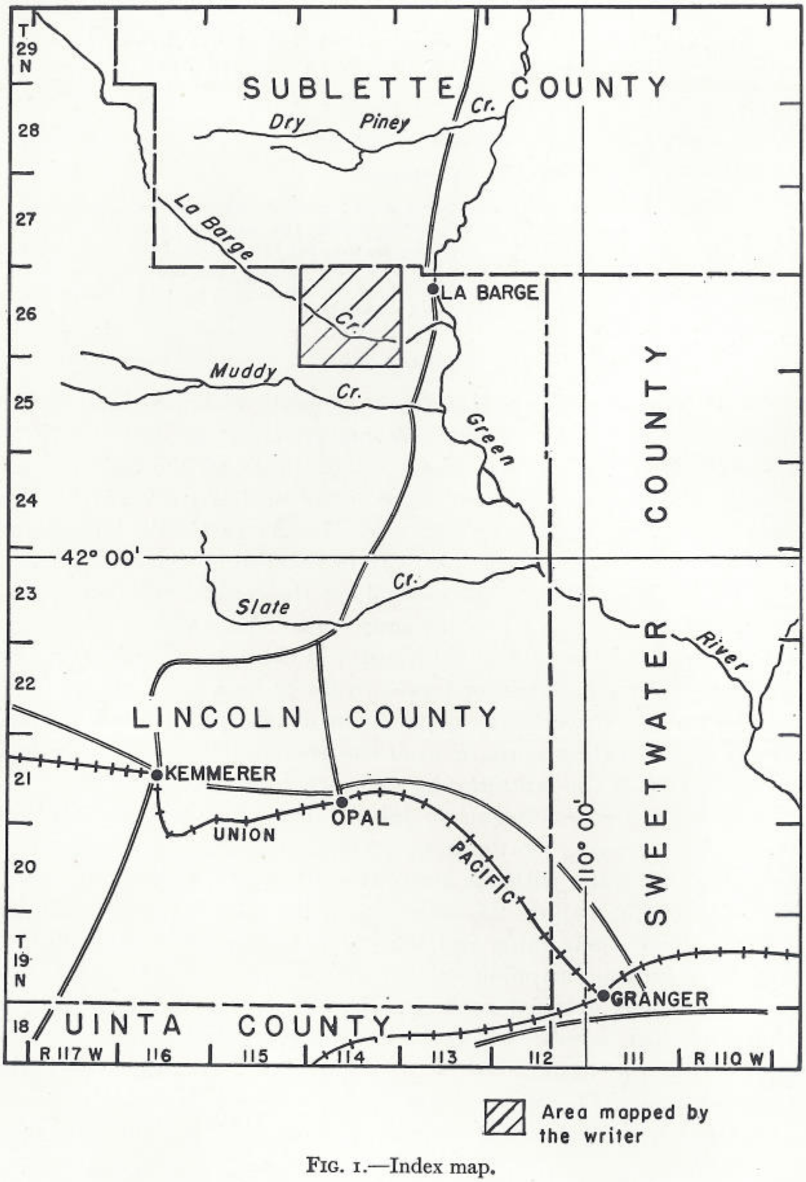


FIG. 1.—Index map.

of the geology department, who made possible the completion of this report through the facilities of the geology department of the University of Wyoming. The assistance of R. H. Beckwith, associate professor, in both the preparation of the manuscript and drafting pro-

cedure is greatly appreciated. The writer is also indebted to George R. Veronda for his valuable assistance in the field. Thanks are due also to the ranchers and oil operators in the area, whose hospitality and information greatly facilitated the completion of the field work. Stratigraphic studies were made, in the general area, in conjunction with Robert J. Minton.

TOPOGRAPHY AND DRAINAGE

La Barge Ridge is a northward-trending ridge occupying the northwestern part of the area. The western flank of the ridge drops off steeply into a valley filled with Tertiary sediments. The eastern flank of the ridge is much steeper, and in some places nearly vertical. At the north end of the area the crest of the ridge attains an elevation of 8,200 feet and gradually decreases in elevation toward the south to 7,200 feet. At the extreme southern part, La Barge Ridge disappears under the Tertiary sediments, which rise to an elevation of 7,400 feet. On the east is a gently rolling basin whose average elevation is 6,800 feet. Within the eastern half of the area, there are long, narrow ridges which rise 200 feet above the floor of the basin and slope gently east.

The major part of the area is drained by La Barge Creek, a tributary of the Green River. The northwestern slope of La Barge Ridge drains southwest into La Barge Creek, which flows southeast through a V-shaped cut in the Paleozoic rocks of La Barge Ridge. The southwestern part of the area is drained by ephemeral tributaries of La Barge Creek. The northeastern part drains into a steep-walled water course flowing directly to Green River.

STRATIGRAPHY

The thicknesses and lithologies given in the following table and discussion were obtained by measurements of stratigraphic sections in the La Barge Ridge area. The work was done by the writer and Robert J. Minton, who was at the time preparing to map the northern part of La Barge Ridge. As the same stratigraphic units are present in all parts of the ridge, the study of the stratigraphy was carried out in coöperation. Stratigraphic sections were measured with the aid of the Brunton compass and steel tape in traverses normal to strike.

CAMBRIAN ROCKS

Death Canyon limestone.—The Death Canyon is commonly included in the Gros Ventre formation as a member. Because of its distinct lithologic character and easy separation, the limestone was mapped as a separate unit. It overlies Cretaceous sediments with fault contact, is conformably overlain in some places by the Gros Ventre, and in others is unconformably overlain by the Almy formation of Tertiary age. The Death Canyon is blue to dark gray finely crystalline

TABLE I

GEOLOGIC FORMATIONS IN LA BARGE RIDGE AREA

Age	*Unit Mapped*	*Thickness (Feet)*	*Characteristics*
Quaternary		0–75(?)	Floodplain gravels and sand
Tertiary	Green River	700	Light gray and tan thin-bedded sandstones, black fossiliferous paper shales, and medium-brown blocky sandstones
	Knight formation	300	Red and yellow sandy clays and variegated shales with some brown sandstones
	~*Unconformity*~	~~~~~	~~~~~~~~~~~~~~~~~~~
	Almy formation	600	Red and white conglomerates, red shales and sandy clays, and red and white sandstones
	~*Unconformity*~	~~~~~	~~~~~~~~~~~~~~~~~~~
Cretaceous	Adaville formation	1,000	White and buff sandstone, brown blocky cross-bedded sandstones, thin gray shales and sandy shales, and coal seams
	Hilliard formation	4,200	Light to dark gray sandy shales with some clays and thin-bedded sandstones. It underlies areas of low relief
	— *Fault* —		
Mississippian	Madison limestone	715	Gray to gray-blue thin-bedded to thick-bedded fossiliferous pure to sandy limestone, which weathers to pitted surface
Devonian	Jefferson limestone	498	Brown to black slabby to blocky sandy magnesian limestone with white to gray to buff sandstone, which changes along strike to quartzite. Two specimens of *Atrypa reticularis* found
Ordovician	Bighorn limestone	890	Light gray brittle seamed dolomitic limestone and sandy limestone which weathers to pitted surface
~~	~*Unconformity*~	~~~~~	~~~~~~~~~~~~~~~~~~~
Cambrian	Gallatin limestone	180	Blue dense fossiliferous limestone with thin layers of edgewise conglomerate
	Gros Ventre shale	450–800	Dark green fissile shales with thin gray fossiliferous limestones
	Death Canyon limestone	180+	Dark gray massive seamed limestone with thin shale lenses

thin-bedded calcite-veined limestone with a few dark shale layers. No fossils were found. The top of the unit was drawn at the bottom of the overlying green shales. The thickness of the formation is variable, as parts are faulted out; the maximum thickness is 180 feet.

Gros Ventre shale.—The Gros Ventre is green fine-grained fissile soapy micaceous glauconitic shale with brown mottling on weathered surfaces. Within the shale are thin limestones 10–20 feet thick. They are mottled gray and tan and are finely crystalline thin-bedded fossiliferous and glauconitic. Numerous trilobite cephala and pygidia were found along with worm borings. The fossils were found only in the limestones. The thickness ranges from 450 to 800 feet. The area in which the thickness is apparently 800 feet is one of abnormally high dips, up to 80°. The formation may be abnormally thick or partly repeated by folding or faulting, although there is no visible evidence of this. In the exposures in which the dip is 38°–40° the thickness is 450 feet.

Gallatin limestone.—The Gallatin conformably overlies the Gros Ventre. It is dark blue thin-bedded dense fossiliferous limestone with some calcite veining. At the base there is a 5–8-foot bed of edgewise pebble conglomerate, which has pebbles covered with glauconite. Shells of brachiopods and trilobites are all oriented in a plane parallel with bedding; it is difficult to obtain good specimens, however, because the limestone will not break readily in a plane parallel with bedding. Sandy shale layers a fraction of an inch thick occur within the limestone and create the thin-bedded appearance characteristic of the limestone. Abrupt nearly vertical slopes are characteristic of its outcrops. The formation is 180 feet thick.

ORDOVICIAN ROCKS

Bighorn limestone.—The Bighorn overlies the Cambrian succession with an angular discordance of 3°–6°. It is light gray dense massive fractured fossiliferous dolomitic limestone and sandy limestone with extensive calcite veining. Its exposures weather to form a rough pitted surface on westward-dipping slopes. Among the fossils found are *Endoceras* sp., corals, brachiopods, and crinoid stems. The structure of smaller fossils has been largely destroyed by replacement. The Bighorn is more easily eroded than the adjacent limestones and commonly forms a strike valley. The Bighorn is 890 feet thick.

DEVONIAN ROCKS

Jefferson formation.—The Jefferson disconformably overlies the Bighorn without noticeable angular discordance. It is a dark brown medium-grained slabby to blocky sandy magnesian limestone with calcite-filled cavities. Lying 216 feet above the base is a 16–25-foot gray to buff thin-bedded to blocky sugary friable sandstone, which changes along strike to quartzite. A few specimens of *Atrypa reticularis* were found in the magnesian limestone. The Jefferson is 498 feet thick. The formation is divisible into an upper 257-foot magnesian limestone, a 16–25-foot sandstone member and a lower 216-foot magnesian limestone.

MISSISSIPPIAN ROCKS

Madison formation.—The Madison overlies the Jefferson with apparent angular conformity. It is a deep blue dense thin-bedded to thick-bedded fractured fossiliferous calcite-seamed limestone that weathers to a light gray color and has a pitted surface on westward dipping slopes. The surfaces formed by weathering on eastward-facing slopes or cliffs are covered by a yellow-orange coating and chips are easily broken out. At the base is a 75-foot gray thin-bedded to platy sandy limestone that weathers tan and contains *Spirifer centronatus* and thin layers of gray ribbon limestone. Fossils found are *Spirifer centronatus*, *Leptaena* sp., *Schuchertella* sp., *Straparollus* sp., and replaced corals. The maximum exposed thickness of the formation is 715 feet.

CRETACEOUS ROCKS

Hilliard formation.—The Hilliard is overlain by Paleozoic rocks with fault contact and is also overlain unconformably by Tertiary sediments. The Hilliard is a sequence of light gray soft shales and thin gray sandstones. The shale is gray fine-grained thinly laminated shale that weathers to clay. The sandstones are gray medium-grained thin-bedded friable soft salt and pepper sandstones. Weathering of the formation forms basin-like depressions filled with clay. Fossils found are fragments of *Inoceramus* sp., and *Scaphites* sp. The exposed thickness is 4,200 feet.

Adaville formation.—The Adaville conformably overlies the Hilliard and is in fault contact with the overlying Paleozoic rocks. Only the basal part of the formation is exposed. It consists of white and buff medium-grained blocky to massive soft friable porous cross-bedded sandstones. There are interbedded light gray soft shales, lignitic shale, and coal. No fossils were found. The maximum thickness of Adaville exposed is 1,000 feet. The upper part of the formation is covered by the over-riding block of Paleozoic rocks.

TERTIARY ROCKS

Almy formation.—The Almy unconformably overlies the Paleozoic and Mesozoic sediments. It consists, for the most part, of conglomerates containing boulders up to 8 inches in diameter. Some of the quartzite pebbles are angular; the greater part are well rounded and uniform. The conglomerate on the west side of La Barge Ridge is composed of boulders. The conglomerates are gray or red, and are interstratified with red clays and shales, and thin sandstones. Light colored sandy clay-shales with beds appearing to have an ash content were mapped in the Almy. These light-colored beds may be the equivalent of the Fowkes formation of southwestern Wyoming. Jurassic derived fossils were found. There are 600 feet of these sediments present in the area.

Knight formation.—The Knight rests on the Almy in apparent angular accordance. There is probably an erosion surface between them. The Knight consists of red soft clay-shales, variegated green and purple clay-shales, and intercalated red and yellow medium-grained massive sandstones. Light gray soft clays occur at various places within the red clay series. The surface cap rock found throughout the most of the basin to the east of La Barge Ridge is a brown slightly conglomeratic sandstone. The conglomeratic sandstone is in the lower part of the formation. Several fresh-water limestones up to a foot thick are exposed in Sec. 21, T. 26 N., R. 113 W. The fossils found were derived and were probably reworked by water. The maximum thickness of the Knight is 300 feet.

Green River formation.—The Green River conformably overlies the Knight. It consists of light gray medium-grained massive friable argillaceous sandstone, black soft fossiliferous paper shales, light tan slabby friable soft sandstone which has carbonaceous films along bedding planes. The whole of the formation is easily eroded and it forms mesas, pinnacles, and badlands. Many imprints of plants were found in the paper shales. The maximum thickness of the Green River in the area is 700 feet.

QUARTERNARY ROCKS

Quaternary alluvium.—The only extensive area of alluvium is the floodplain of La Barge Creek. It consists of coarse sands and gravels covered by a sandy loam suitable for raising hay. The thickness of the alluvium ranges from 0 to 75 (?) feet.

POST-MADISON AND PRE-HILLIARD SUCCESSION

The stratigraphic succession from Madison to Hilliard is not represented in the area mapped by the writer, but is well known in an area beginning 10 miles west. The missing succession is either faulted out, or covered by Tertiary sediments. The thickness is approximately

20,000 feet, a figure obtained from Mansfield,[4] Schultz,[5] and the writer's knowledge of the succession.

STRUCTURE

PRE-TERTIARY

The Paleozoic rocks on the west side of La Barge Ridge dip 33°–78° W.; the dips generally steepen southward and are steepest on the flanks of the cut formed by La Barge Creek, in Sec. 19, T. 26 N., R. 113 W.

Three isolated masses of Jefferson limestone in Secs. 6 and 7, T. 26 N., R. 113 W., rest on middle Bighorn, which dips 34° W. The northern remnant is composed of Jefferson chips. The northern part of the middle remnant consists of chips and the southern part of blocks up to 12 feet across in which stratification dips 10° W. The base of the southern remnant is a block of Jefferson dipping 12° W.; it is covered by limestone chips. The remnants could have been formed as follows.

1. The Jefferson masses were brought into their present position by a thrust fault, which was nearly parallel with the bedding in the Jefferson and became a horizontal thrust fault at the upper limits of the formation. Thus the limestones of the present remnants moved up the gently dipping thrust, east on the horizontal thrust, and came to rest on the middle Bighorn. The principal objection to this hypothesis is that there is no evidence of the thrust to the west of the remnants.

2. The masses are land-slip or talus breccia formed at a time when the main outcrop of the Jefferson to the west stood out as a ridge much higher than the present one, the crest of which is only 50 feet above the intervening valley. This hypothesis would account for the breccia in the isolated masses, but would not explain the consistency of strike and dip of stratification in the larger blocks.

3. The remnants are parts of fallen cavern roofs. At one time the water table was at a higher elevation than at present. Caverns were formed in the Bighorn limestone, which is more soluble than the underlying and overlying limestone, as the Jefferson and Gallatin now stand out as ridges above the strike valley on the Bighorn. As the caverns grew in size, their roofs began to fall in; this resulted in chips and blocks of Jefferson collecting on the cavern floors. This hypothesis accounts for the breccias, the distance of the isolated masses from the formation outcrop, the consistency of strike and dip of stratification

[4] G. R. Mansfield, "Geology, Geography, and Mineral Resources of Part of Southeastern Idaho," *U. S. Geol. Survey Prof. Paper 152* (1927), pp. 48–118.

[5] A. R. Schultz, *op. cit.*, pp. 27–76.

in the larger blocks, and the fact that the westward dips in the Jefferson blocks are less than those of the underlying middle Bighorn.

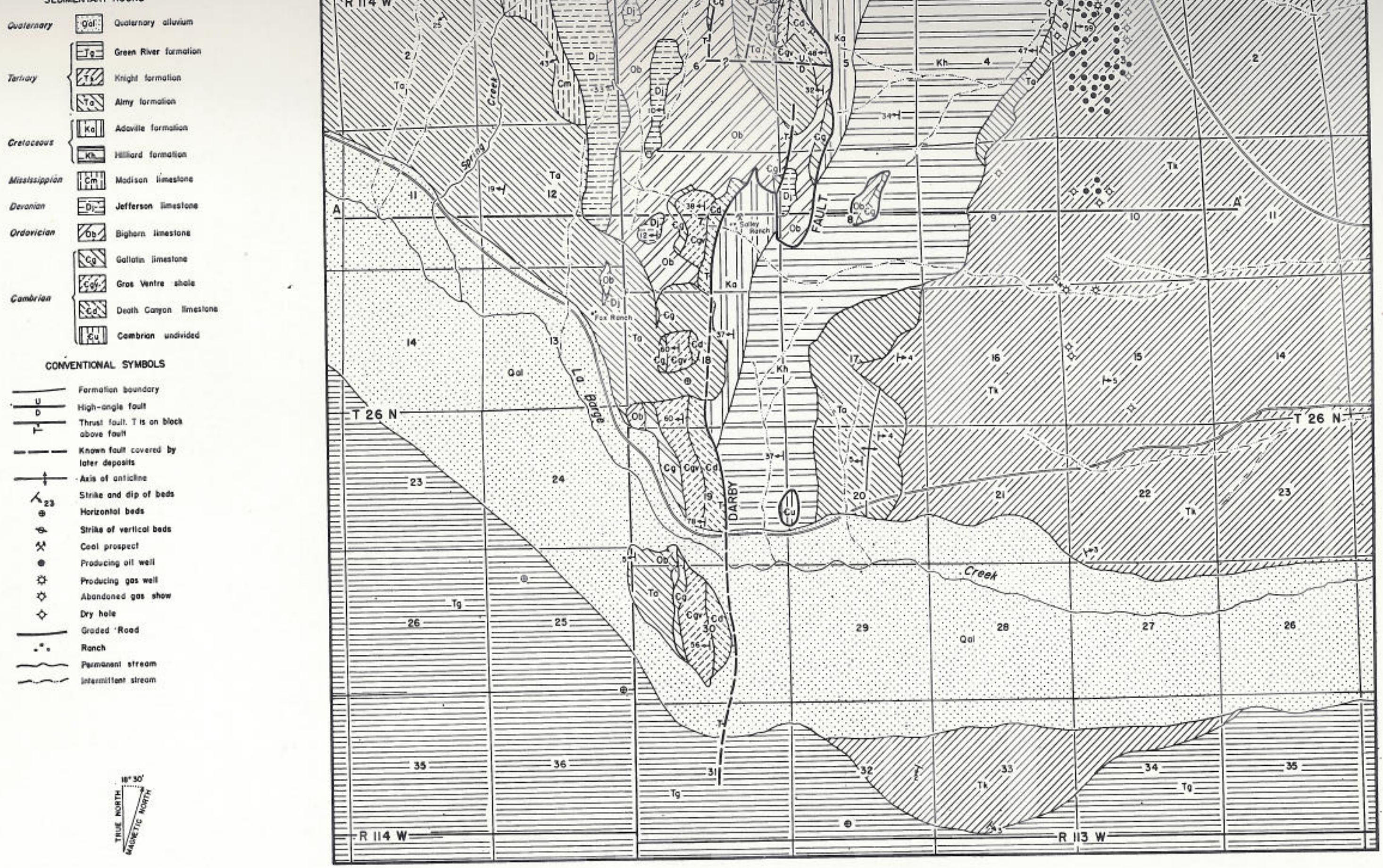
The Adaville and Hilliard on the east side of La Barge Ridge dip 34°–37° W. Cross-laminated Adaville sandstones in Secs. 5 and 7, T. 26 N., R. 113 W., show that the formation is not overturned. The upper part of the Adaville is covered by the block above the fault. The Darby fault on the east side of La Barge Ridge is covered by younger rocks in the southern part of the area and extends to the

FIG. 2.—Semi-fenster at Salley's Ranch, looking north.

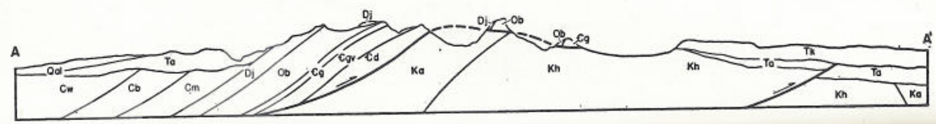
north for approximately 120 miles.[6] The fault has a general westward dip, but nowhere in the writer's area is it possible to obtain a dip on the thrust plane. At places where the Death Canyon lies on Hilliard, as in Sec. 19, T. 26 N., R. 113 W., 30,000 feet of beds found a few miles west are faulted out. The net slip is therefore at least $5\frac{1}{2}$ miles and probably several times as much dependent on the respective strikes and dips of beds and thrust west of the surface trace of the thrust.

At Salley's Ranch in Sec. 7, T. 26 N., R. 113 W., a semi-fenster (Fig. 2) is shown by the curved trace of the fault (Fig. 3). The fault plane is at approximately the same elevation on both sides of the semi-fenster, which indicates that the thrust is here nearly horizontal. In Sec. 8, T. 26 N., R. 113 W., an isolated mass of Gallatin and Bighorn rests on the Hilliard. Another mass in Sections 19 and 20 of the same township is composed of Gallatin, Gros Ventre, and Death Canyon

[6] G. R. Mansfield, *op. cit.*, p. 381.



SCALE



Geologic map and structure section of southern part of La Barge Ridge, Lincoln County, Wyoming. Department of geology, University of Wylimestones and shales and shows the same relation to the Hilliard. Both are 150–300 feet below the surface trace of the fault at the west. It is possible that the Paleozoic remnants attained their present position by movement down eastward-dipping landslide faults long after the movement on the thrust. It is the writer's belief, however, that they are klippen which were at one time part of the block above the thrust fault, which here dipped eastward at a low angle.

The Gallatin in the NE. $\frac{1}{4}$ of Sec. 7, T. 26 N., R. 113 W., dips 55° NW. It is in normal stratigraphic position under the Bighorn at the west, and in fault contact with the Jefferson on the east. The Gallatin was probably brought into its present position by a high-angle thrust or reverse fault branching upward from the main thrust. The minor fault must necessarily dip west at an angle greater than the dip of the beds in order to produce repetition. In the NW. $\frac{1}{4}$ of Sec. 8, lower Bighorn is in contact with lower Jefferson and in the SW. $\frac{1}{4}$ of Sec. 5, part of the Bighorn is repeated. The fault therefore decreases in displacement northward and probably dies out beneath the Almy.

Several faults occur in the NE. $\frac{1}{4}$ of Sec. 6, and the NW. $\frac{1}{4}$ of Sec. 5, T. 26 N., R. 113 W. West of the center of Section 5, the Death Canyon on the north side of a west-striking fault is in contact with Bighorn on the south side. The north block is relatively upthrown, and beds 600–650 feet thick are faulted out. In the E. $\frac{1}{2}$ of Sec. 6, and the W. $\frac{1}{2}$ of Sec. 5, the bottom of the Bighorn is offset left approximately 3,000 feet, a figure obtained by projecting the bottom of the Bighorn along strike to the fault. North of the fault the Gallatin and Bighorn are repeated by two faults striking north. The dips of beds near these are toward the west, steeper than those of the beds farther west in unfaulted territory, and steeper than those of beds south of the west-striking fault. The western exposure of Gallatin lies in normal stratigraphic position under the Bighorn on the west, and is in fault contact with the Bighorn on the east. The second exposure of Gallatin on the east is in sedimentary contact with the Almy on the west, and in fault contact with Bighorn, which is covered in part by Almy, on the east. The third exposure of Gallatin is in normal stratigraphic position with respect to the overlying and underlying sediments.

The writer believes that the west-striking fault is a tear that probably terminates downward on the main low-angle thrust, and that the two faults north of the tear are high-angle westward-dipping thrusts or reverse faults branching upward from the main thrust and terminating laterally at the south against the tear. In order to produce repetition, they must have dips greater than that of the beds. The two blocks north of the tear moved relatively eastward and upward along the main low-angle thrust, and were at the same time rotated on horizontal axes striking north so that, when viewed looking northward along the axes, the rotation would be counter-clockwise. This explanation accounts for the Death Canyon in contact with the Bighorn at the east end of the tear, the offset of beds at the left, and the greater dips of beds in the block north of the tear.

The faults described so far are younger than Adaville and older than Almy, as the Almy lies across the main thrust in Sec. 18, T. 26 N., R. 113 W., and shows no evidence of subsequent disturbance.

TERTIARY

The Tertiary sediments surround La Barge Ridge, and in some places the crest of the ridge is lower than the erosion surface truncating them.

The Almy was probably deposited over the whole of the area now occupied by the ridge and filled in depressions in the Paleozoic succession. In Sec. 18, T. 26 N., R. 113 W., the Almy now extends across the crest of the ridge; at this place the beds are horizontal (Fig. 4).

FIG. 4.—Horizontal Almy sediments on crest of La Barge Ridge, Sec. 18, T. 26 N., R. 113 W.

Dips up to 25° on the west side indicate folding or arching in post-Almy time. Minor folds and thrusts formed by a second period of movement occur in the eastern part beneath the Knight. A secondary fault, now known as the La Barge fault, parallels the Darby fault; the secondary fault is recognized in the area studied by the writer from subsurface data, and from surface evidence in the area on the north.

No folding or faulting is shown in the overlying Knight, thus dating the secondary folding and faulting as younger than Almy and older than Knight.

The Knight does not cross the crest of the ridge at present and does not lie directly on Paleozoic rocks. In the area studied by the writer it is confined to the east side of the ridge, and here the eastward dips of 4°–5° are low enough to be explained as depositional dips. It is therefore probable that the ridge was in existence during Knight time,

The erosion surface truncating the Green River formation in Sec. 31, T. 26 N., R. 113 W., is higher than the surface of the Paleozoic inlier in Section 30, and of about the same elevation as the surface of the Paleozoic rocks in the northern part of Section 19. In Section 31 the Green River is arched into a very gentle anticline plunging southward. The dips are so low that they can not be measured with a Brunton; the anticline is, however, readily visible from the crest of the ridge in Sections 18 and 19. The anticline may have been formed by very gentle horizontal compression in post-Green River time. It is more probable, however, that La Barge Ridge existed in Green River time, the sediments lapped onto its flanks, and the gentle anticline is a fold resulting from differential subsidence during compaction of a succession of sediments thickening away from the buried ridge.

LA BARGE OIL FIELD

The southern end of the La Barge field is in the northeastern part of the area. The surface formation here is the Knight, which covers all underlying structure. H. F. Davies[7] says,

> Parallel with the Darby thrust is a smaller fault, now called the La Barge fault, which has thrust Adaville and Hilliard beds of Upper Cretaceous age over the Almy formation of the Eocene. A small anticline was formed in the Eocene beds in front of the La Barge fault and oil that originated in the underlying unconformable Upper Cretaceous beds has accumulated in the basal sandstones of the Eocene.

This conclusion is substantiated by information received by the writer from operators in the southern part of the field. They report drilling through the Knight and Almy, into Hilliard, and into Almy again, in which production was obtained. The repetition of the Almy can result only from a thrust fault whose west block is upthrown.

HISTORY

The sequence of events in the history of the area is as follows.

[7] H. F. Davies, "Structural History and Its Relation to the Accumulation of Oil and Gas in the Rocky Mountain District," *Problems of Petroleum Geology* (Amer. Assoc. Petrol. Geol., 1934), pp. 692–93.

1. Deposition of sediments from Cambrian to Cretaceous in age
2. Strong folding and thrust faulting. Cambrian sediments were brought into contact with Cretaceous sediments
3. Erosion of rocks to depths as great as 30,000 feet
4. Deposition of Almy sediments over entire area
5. Secondary folding and thrust faulting. Almy sediments were folded and Hilliard was thrust onto Almy in eastern part of area. In western part, Almy was tilted possibly as much as 25°
6. Erosion of Almy. Almy sediments were eroded from part of area, but survived on both sides of ridge and in at least one place on crest
7. Deposition of Knight, probably in overlapping relation on east side of ridge. If it was deposited on west side, it has not survived
8. Deposition of Green River formation
9. Gentle arching of Green River, possibly by differential compaction
10. Erosion to present land surface

The main thrust near the crest of the ridge is younger than Adaville and older than Almy; the secondary thrust encountered in wells is younger than Almy and older than Knight.

ECONOMIC RESOURCES

There is no evidence of igneous activity in this area; therefore, it is improbable that there are any metallic mineral deposits. Crystalline gypsum is found on several of the Almy and Hilliard slopes in the east-central part of the area, but not in large enough quantities to be of economic importance.

Coal seams in the Adaville have been exploited to a limited extent, but at present are worked only for ranch use. The larger users truck in coal of better quality from the Kemmerer coal field. A prospect or surface pit is located in Sec. 5, T. 26 N., R. 113 W., and a mine, which is worked during the winter to supply local ranches, is adjacent to Salley's Ranch in Sec. 7, T. 26 N., R. 113 W. The Twitchell mine about 2 miles north of the prospect in Section 5 has been worked in the past.

The discovery of oil in the La Barge field in 1907 caused considerable excitement and development.[8] Oil and gas are now produced in Secs. 3 and 10, T. 26 N., R. 113 W. The fact that operators drill through the Almy, then Hilliard, and into Almy, in which they obtain production gives evidence for the fault trap shown in cross section *AA′* (Fig. 3). The oil escapes from the oil-generating Cretaceous rocks beneath the secondary fault, and migrates upward into the basal Almy sands of the east block. Marginal drilling may prove a greater area of production in the Tertiary sediments. Deep tests may prove an anticline in the underlying Cretaceous beds, of which Schultz[9] says,

[8] A. R. Schultz, *op. cit.*, p. 116.

[9] *Ibid.*, p. 79.

The crest of the La Barge Anticline is exposed along the east side of La Barge Ridge in only two localities, at both of which numerous minor folds are visible. Throughout the remainder of the region the anticline is covered by Tertiary deposits, which commonly dip regularly eastward across it and give no hint of its position.

The gas is used for repressuring, power production, and local domestic fuel. The oil is piped to Opal on the Union Pacific Railroad about 45 miles southeast.

UNDERGROUND WATER

Because the water supply of the ranchers has been obtained from La Barge Creek and springs in the area, no wells except those in the La Barge field have been drilled.

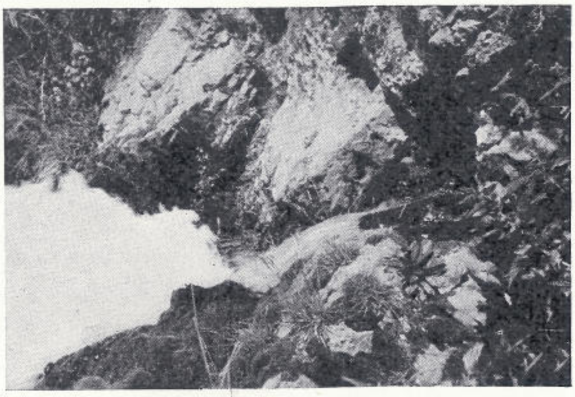


FIG. 5.—Spring on west side of La Barge Ridge, Sec. 1, T. 26 N., R. 114 W.

A spring in the NW. $\frac{1}{4}$, NW. $\frac{1}{4}$ of Sec. 1, T. 26 N., R. 114 W., discharges water under pressure from open fractures in the Madison limestone in a circular area approximately 7 feet in diameter. The water forms a stream, Spring Creek, 8 feet wide of average depth of 6 inches flowing at least 2 miles an hour. The flow, based on these figures, is at least 10 second feet. In the area on the north, the outcrop of the Madison provides a large catchment area. In Section 1 the Madison is deeply dissected; this furnishes an outlet for the water in the Madison at a low elevation. Solution caverns in the Madison act as reservoirs.

A spring in the NW. $\frac{1}{4}$, SE. $\frac{1}{4}$ of Sec. 7, T. 26 N., R. 113 W., comes out of a sandy lens in the Gros Ventre. The water flows to the surface, and forms a stream of approximately 2 second feet. The Bighorn is probably the reservoir rock from which most of the water coming to the surface is derived. Water, accumulated in the Bighorn, seeps downward to the fault plane, and flows up the fault plane to a place of easy escape.

Water for irrigation purposes could be obtained by drilling wells in the Quaternary alluvium; however, this has not yet been done, as water from creeks and springs is sufficient to supply present demands for irrigation and domestic purposes.