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DEPARTMENT OF THE INTERIOR

Roy O. West, Secretary

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U. S. GEOLOGICAL SURVEY

George Otis Smith, Director

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Bulletin 806—D

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GEOLOGY OF THE  
ROCK CREEK OIL FIELD AND ADJACENT AREAS  
CARBON AND ALBANY COUNTIES, WYO.

BY

C. E. DOBBIN, H. W. HOOTS, C. H. DANE  
AND E. T. HANCOCK

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Contributions to economic geology, 1928, Part I

(Pages 131-153)

Published February 16, 1929



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# GEOLOGY OF THE ROCK CREEK OIL FIELD AND ADJACENT AREAS, CARBON AND ALBANY COUNTIES, WYO.

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By C. E. DOBBIN, H. W. HOOTS, C. H. DANE, and E. T. HANCOCK

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## INTRODUCTION

*Location and accessibility.*—This report describes the geology of the Rock Creek oil field and the geology and oil and gas prospects of an additional area of about 260 square miles lying in the west central part of the Laramie Basin in Albany and Carbon Counties, Wyo., along the eastern foothills of the Medicine Bow Mountains. (See fig. 11.) Rock River, on the Union Pacific Railroad 40 miles north of Laramie, is the principal town of the area described, and the town of McFadden, built by the Ohio Oil Co., is the center for the active operation of the Rock Creek oil field. Arlington and Morgan, which consist of a few houses, serve as post offices for ranchers, forest rangers, and prospectors.

Roads and trails abound in the area, which is rendered readily accessible by the extensive development of gravel terraces and the low relief within the field. All parts of the area mapped may be reached by automobile without serious difficulty.

*Field work and acknowledgments.*—The field investigations that furnish the basis for this report were begun in the summer of 1919 by E. T. Hancock, assisted by C. E. Dobbin. The area examined at that time amounted to 90 square miles, centered around the Rock Creek oil field, which then had some 10 producing oil wells. The subsequent resignation of Mr. Hancock from the Geological Survey delayed the final preparation of the report until the summer of 1925, when C. E. Dobbin, H. W. Hoots, and C. H. Dane reexamined the Rock Creek field and also studied the Medicine Bow, Dutton Creek, and Cooper Cove districts.

The writers were greatly aided in their work by M. D. Woolery and L. M. Kiplinger, officials of the Ohio Oil Co. at Laramie, who kindly furnished logs of all wells and other pertinent data about the Rock Creek oil field; by C. L. Westcott, of the Southwestern Petroleum Co. and Cliff Petroleum Co., who contributed much information regarding developments on the Medicine Bow anticline; by

the officials of the Producers & Refiners Corporation, the Utah Oil Refining Co., the Midwest Refining Co., and the Continental Oil Co. for logs of their wells; and by Paul D. Torrey, who rendered able assistance in the investigation.

*Land surveys.*—The township, section, and quarter-section corners originally established have either been found or reestablished from known locations by local surveys, and at present most of the section corners are marked by set stones or square painted posts.

## GEOGRAPHY

*Land surveys.*—The township, section, and quarter-section corners variety of topographic forms, its most conspicuous features are its broad, shallow terraced valleys separated by nearly flat gravel-covered ridges. A considerable part of the area is included in

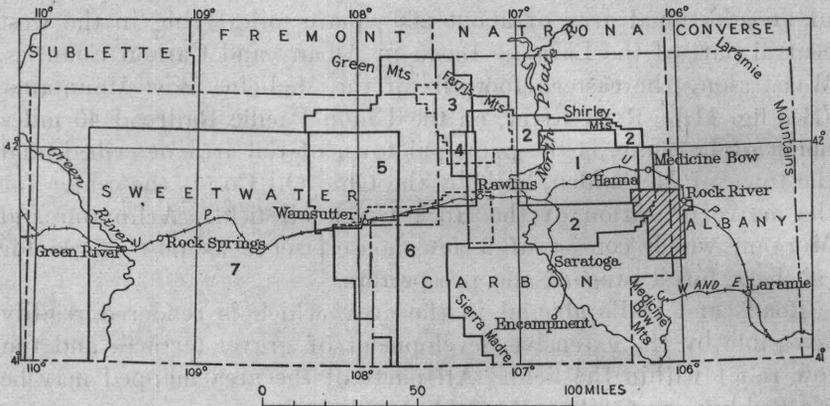


FIGURE 11.—Map of southern Wyoming showing relations of the Rock Creek oil field and adjacent areas (indicated by shading) to other coal and oil and gas fields. 1, Hanna and Carbon Basins (U. S. Geol. Survey Bull. 804); 2, east-central Carbon County (Bull. 316); 3, Lost Soldier-Ferris district (Bull. 756); 4, Bell Springs gas field (Bull. 796); 5, Great Divide Basin coal field (Bull. 341); 6, Little Snake River coal field (Bulls. 341 and 381); 7, Rock Springs district (Bulls. 341, 381, 702, 751, and 781)

the broad valley of Rock Creek and in the extensive system of gravel terraces adjacent to that stream.

The oldest and most prominent gravel terrace in the area is on the divide between Rock and Foote Creeks. This terrace stands about 500 feet above the valley of Rock Creek and extends from the vicinity of Arlington nearly to the town of Rock River. For convenience of description it is referred to in this report as the Arlington terrace and the gravel deposited on it is indicated by a separate color pattern on the geologic map. Terraces intermediate between the Arlington terrace and those bordering the present streams occur throughout the area, and the margins of most of them are shown on Plate 43.

The lower as well as the higher divides are commonly gravel-covered plains which rise gently in a broad expanse toward the Medicine Bow Mountains. (See pl. 36, *C*.) These plains are devoid of sagebrush and are covered with a mantle of boulders, which have a maximum diameter of 3 feet and an average diameter of 6 inches. Here and there, however, the plain is interrupted by hogback ridges of sandstone that project to varying heights above the terrace level (see pl. 40, *A*), and many shallow depressions which have no outlets occur throughout the area. Trees are abundant on the flood plains of Cooper and Rock Creeks and Medicine Bow River.

Cooper Cove is a small basin in the southwest corner of T. 18 N., R. 77 W., and is surrounded by low hills on the north, east, and south and by the foothills of the Medicine Bow Mountains on the west. (See pl. 36, *C*.) North and northwest of Cooper Cove as far as the Arlington terrace the country is featured by broad gravel-covered benches of varying altitude, interrupted locally by shallow stream valleys. Northwest of the Arlington terrace the land slopes rapidly into a broad, gravel-floored basin which is bordered on the north by a prominent hogback of sandstone and on the west by a conspicuous bluff that rises above the lowlands adjoining Medicine Bow River.

Around the Medicine Bow anticline the surface is much more dissected than near Rock Creek, and rock exposures are numerous. The exposures are particularly conspicuous above the steep sandstone hogback that outlines the anticline. (See pl. 36, *A*.) The area within this hogback is rough along Medicine Bow River, but only moderately dissected elsewhere, and the remnant of an old plain of erosion occupies the north-central part of the anticline.

*Drainage.*—Medicine Bow River and its tributary, Rock Creek, are the largest streams in the area and are perennial. Rock Creek is a beautiful mountain stream fed by snow fields along the summit of the Medicine Bow Mountains. It flows through a deep canyon in the crystalline rocks and at Arlington enters the broad terraced valley which extends to and beyond the town of Rock River. Threemile Creek is a perennial branch of Rock Creek which joins the main stream about 2 miles southwest of Rock Creek. Dutton and Cooper Creeks are also perennial streams but have smaller flow than Rock Creek. These two streams empty into Cooper Lake about 8 miles east of the area described. Fourmile Creek, a tributary of Laramie River, crosses the southeast corner of the area and has a small but steady flow. The remainder of the area is but little dissected and is drained by intermittent streams; the largest is Foote Creek, which traverses the broad, shallow valley northwest of the Arlington terrace.

## GEOLOGY

## STRATIGRAPHY

## GENERAL SECTION

Parts of the Laramie Basin, within which the area described is included, are underlain by 12,000 feet of Paleozoic and Mesozoic sedimentary rocks, ranging from Carboniferous to Quaternary in age. The oldest rocks exposed east of the Arlington fault in the area covered by Plate 43 belong to the upper part of the Steele shale, of late Upper Cretaceous age, which crops out in the crest of the Medicine Bow anticline and in the bluffs of Rock Creek south of Rock River and northwest of McFadden. The older formations underlying the area were studied by the writers where they crop out around the Flat Top and Como Ridge anticlines near Medicine Bow, and they have been previously described by Darton and Siebenthal.<sup>1</sup>

*General section of formations in the Rock Creek and Medicine Bow districts, Wyoming*

Age	Group	Formation	Thickness (feet)	General characteristics
Recent.		Alluvium.	Variable.	Fine silt, clay, and loam.
Pliocene and later.		Terrace gravel.	Variable.	Fine to coarse gravel and moderate-sized boulders in places firmly cemented.
Eocene.		Hanna formation. Unconformity	(?)	Yellowish-green sandy shale, massive yellowish-brown sandstone, carbonaceous shale, coarse conglomerate, and coal.
Upper Cretaceous.	Montana.	Lewis shale.	2,500±	Dark marine shale containing several yellowish-brown sandstones, which as a rule are very fossiliferous.
		Mesaverde formation.	1,250	Chiefly massive to slabby and concretionary brown sandstone and zones of sandy material containing carbonaceous shale and thin beds of coal alternating with sandy shale. Top marked by grayish-white Pine Ridge sandstone member, which contains several beds of coal. Alternating marine and continental beds occur throughout the formation. Base marked in the Medicine Bow anticline by a brownish-white sandstone 75 feet thick.
		Steele shale.	3,300±	Dark-gray to black shale containing several soft brown sandstones in its upper part.
	Colorado.	Niobrara shale.	700	Dark-gray calcareous shale containing thin beds of sand and layers of impure chalk.
		Carlisle shale.	460	Soft dark shale containing many ironstone concretions.
		Frontier formation.	665	Dark shale about 625 feet thick, overlain by a brownish sandstone about 40 feet thick herein called the Wall Creek (?) sandstone member.
		Mowry shale.	120	Hard fissile dark-gray shale, weathering light gray, which contains numerous fossil fish scales.
		Thermopolis shale.	130	Soft dark shale containing near its middle a sandstone locally called the First Muddy sand.

<sup>1</sup>Darton, N. H., and Siebenthal, C. E., *Geology and mineral resources of the Laramie Basin, Wyo.*: U. S. Geol. Survey Bull. 364, 1909.

*General section of formations in the Rock Creek and Medicine Bow districts, Wyoming—Continued*

Age	Group	Formation	Thickness (feet)	General characteristics
Lower Cretaceous.		Cloverly formation.	125±	An upper sandstone 30 to 85 feet thick and a lower one about 60 feet thick, separated by about 30 feet of shale. Principal oil-producing formation of the Rock Creek field.
Cretaceous (?).		Morrison formation.	225	Maroon, pink, and olive-green shale and a few thin sandstones. Yields a characteristic dinosaurian fauna.
Upper Jurassic.		Sundance formation.	350	Green and gray fossiliferous shale in upper part and massive to cross-bedded gray sandstone and gray shale in lower part.
Triassic.		Chugwater formation.	1,350	Red shale, sandy shale, and gypsum, with beds of gray sandstone in upper part and thin beds of limestone.
Permian.		Forelle limestone.	3	Lavender-colored limestone.
		S a t a n k a shale.	140±	Red and green shale, gray limestone, gray sandstone, and gypsum.
Pennsylvanian and Mississippian.		Casper formation.	1,000	About 300 feet of massive to cross-bedded sandstone probably corresponding to the Tensleep sandstone, merging downward into light-colored limestones, dolomite, and gray and brown sandstones.
Pre-Cambrian.		Crystalline rocks.		

MISSISSIPPIAN AND PENNSYLVANIAN ROCKS

*Casper formation.*—The Casper formation in the Laramie Basin is chiefly of Pennsylvanian age, according to Darton and Siebenthal,<sup>2</sup> and usually exhibits a cross-bedded buff to light gray sandstone of variable thickness at its top, merging downward into light-colored limestone, dolomite, and gray and brown sandstones which lie upon pre-Cambrian crystalline rocks. The uppermost sandstone is probably equivalent to the Tensleep sandstone, and the lower beds to the Amsden formation of the Big Horn region. The following section measured by Darton and Siebenthal<sup>3</sup> shows the principal features of the Casper formation where it attains its maximum thickness in the Laramie Basin:

*Section of Casper formation in Gilmore Canyon near Laramie, Wyo.*

	Feet
Sandstone .....	2
Red shale with a few thin beds of white and red sandstone .....	120
Red to buff sandstone .....	65
Limestone, fossiliferous .....	8
Upper monumental sandstone .....	45

<sup>2</sup> Darton, N. H., and Siebenthal, C. E., Geology and mineral resources of the Laramie Basin, Wyo.: U. S. Geol. Survey Bull. 364, pp. 13-20, 1909.

<sup>3</sup> Idem, p. 14.

	Feet
Hard buff limestone.....	21½
Lower monumental sandstone, red.....	78
Massive lumpy limestone (in middle of hill 1 mile north- west of Colores).....	20
Reddish soil (rocks concealed).....	33
Red sandstone.....	92
Heavy-bedded limestone, carrying <i>Spirifer cameratus</i> .....	24
Salmon-red sand and fine-grained sandstone.....	120
Purple limestone.....	4
Concealed (shale?).....	110
Limestone, with crinoid stems.....	5
Concealed (shale?).....	45
Purplish sandy limestone.....	15
Shale(?).....	50
Purple thin slabby sandy limestone.....	3
Shale(?).....	15
Purplish slabby sandy limestone.....	15
Massive shelly cross-bedded purple sandy limestone.....	25
Concealed; probably red shale and sandstone.....	90
Purple sandy oolitic limestone.....	1
Massive red arkose and conglomerate, with ¼-inch pebbles.....	20
Granite.....	
	1, 007½

The sandstone at the top of the Casper formation is well developed in the northern part of the Laramie Basin and is of particular interest to oil operators in the Rock Creek and Medicine Bow districts, as experience indicates that it is probably the lowest zone which may yield oil within these districts. In the Flat Top anticline, north of Medicine Bow, at least 250 feet of it is exposed; its lower portion is massive to thick-bedded and its upper portion very much cross-bedded. (See pl. 37.) More than 300 feet of it was penetrated in a well drilled by the Prairie Oil & Gas Co. in sec. 25, T. 22 N., R. 78 W., 5 miles southeast of Medicine Bow. (See pl. 42.)

#### PERMIAN AND TRIASSIC ROCKS

*Satanka shale and Forelle limestone.*—The Satanka shale and Forelle limestone are about 140 and 3 feet thick, respectively, in the northern part of the Laramie Basin and correspond in position to the Embar of north-central Wyoming. The Satanka consists of red and green shale, thin beds of limestone, and a few thin beds of sandstone, all resembling closely the overlying Chugwater formation. The Forelle is a lavender and pink limestone which crops out in a persistent low ridge rising above the area underlain by the red shale.

The following section measured on the south limb of the Flat Top anticline illustrates the character of the Satanka and Forelle at their nearest outcrop to the area here described:

*Section of Forelle limestone and Satanka shale in sec. 13, T. 23 N., R. 79 W., Wyoming*

Base of Chugwater formation.	Feet
Forelle limestone: Limestone, lavender-colored-----	3
Satanka shale:	
Shale, red-----	85
Limestone, gray, slabby-----	10
Shale, green and brown-----	30
Gypsum-----	6
Shale, grayish brown-----	6
Sandstone, gray, calcareous; contains thin laminae of asphalt and gives a strong odor of petroleum-----	2
Shale, gray-----	4
Top of Casper formation.	-----
	146

*Chugwater formation.*—The Chugwater formation is 1,350 feet thick in the Medicine Bow district and consists mostly of red shale and red sandstone, with a subordinate amount of gray sandstone, gypsum, and thin beds of limestone. Red beds that are poorly exposed in the foothills of the Medicine Bow Mountains 3 miles south of Arlington may belong to either the Casper or the Chugwater formation.

Details regarding the character of the formation are given by Darton and Siebenthal<sup>4</sup> and in the log of the well drilled by the Prairie Oil & Gas Co. in sec. 25, T. 22 N., R. 78 W., shown graphically in Plate 42.

#### JURASSIC ROCKS

*Sundance formation.*—Excellent exposures of the marine Sundance formation occur in the western face of Como Ridge (see pl. 38, B) and exhibit the features that are characteristic of it over the greater part of Wyoming. Its top was drawn at the base of the variegated dinosaur-bearing shale that makes up the Morrison formation and its base was drawn at the base of the lowest prominent gray sandstone that rests on typical Chugwater red beds. The following section shows the details of the Sundance formation in this area:

*Section of Sundance formation in Como Ridge, Wyo.*

Base of Morrison formation.	
Sundance formation:	Feet
Sandstone, gray, cross-bedded-----	2
Sandstone, green, shaly-----	5
Sandstone, light gray, cross-bedded-----	5

<sup>4</sup> Op. cit., pp. 22-25.

Sundance formation—Continued.		Feet
Shale, green, sandy, and thin limestones.....		34
Sandstone, buff, thin-bedded.....		5
Shale, green, containing <i>Belemnites</i> .....		68
Sandstone, grayish brown, thin-bedded.....		12
Shale, gray, sandy.....		29
Sandstone, light gray, cross-bedded.....		7
Sandstone, gray, massive to thin-bedded and cross-bedded.....		70
Shale, green.....		15
Shale, red, and thin-bedded red sandstone.....		36
Sandstone, gray, massive, friable.....		15
Shale, green, and shaly sandstone.....		12
Sandstone, light gray, massive, with brown sandstone concretions, cross-bedded in upper part.....		35
Top of Chugwater formation.		<hr/>
		350

## CRETACEOUS (?) ROCKS

*Morrison formation.*—The Morrison formation is 222 feet thick at Como Ridge (see pl. 38, *B*) and consists largely of maroon, pink, and olive-green shale containing several thin layers of brown sandstone.

*Section of Morrison formation at Como Ridge*

Base of Cloverly formation.		Feet
Morrison formation:		
Shale, maroon, pink, and green near base; upper part olive-green.....		175
Sandstone, brown, cross-bedded.....		7
Shale, variegated, with several brown sandstones less than 1 foot thick.....		40
Top of Sundance formation.		<hr/>
		222

## CRETACEOUS ROCKS

*Cloverly formation.*—The Cloverly formation is the principal oil-producing zone in the Rock Creek oil field and where penetrated by the drill consists of an upper sandstone 30 to 85 feet thick and a lower one as much as 60 feet thick, separated by about 30 feet of shale. (See pl. 42.) At its nearest exposures in Como Ridge and in the Flat Top anticline north of Medicine Bow the sandstones, especially the lower one, are conglomeratic, with pebbles of jasper and chert. The following section (see pl. 38, *A*) and the graphic well logs shown in Plate 42 illustrate the character of the formation in this region:

Section of Cloverly formation on Little Medicine Bow River in the SW.  $\frac{1}{4}$   
sec. 14, T. 23 N., R. 79 W., Wyoming

Base of Thermopolis shale.	
Cloverly formation:	Feet
Sandstone, light gray, hard, sugary, fine-grained, locally massive and cross-bedded; conglomeratic; makes the prominent hogback shown in Plate 38, A.....	85
Largely concealed by débris but shows scattered exposures of green shale.....	25
Sandstone, conglomeratic and very hard.....	2
Green shale and greenish-gray sandstone; both soft.....	6
Sandstone, light gray, cross-bedded; conglomeratic, the pebbles consisting of chert and jasper.....	10
Top of Morrison formation.	—
	128

*Thermopolis shale.*—The Thermopolis shale is about 180 feet thick in the Rock Creek field and consists chiefly of dark-gray to black shale. A sandstone, locally called the First Muddy sand, occurs about 80 feet above the base of the formation and produces oil in commercial quantities in parts of the Rock Creek field.

*Mowry shale.*—The Mowry shale is 120 feet thick in Como Ridge. It is a hard, compact fissile deep brown to blackish shale that weathers to a silver-gray color. It contains an abundance of fish remains, chiefly scales and vertebrae, and also much macerated vegetal matter.

*Frontier formation.*—In this region the Frontier formation consists of about 625 feet of dark-gray to black shale overlain by a brownish sandstone member about 40 feet thick. The sandstone member is locally known as the Wall Creek sandstone, though it may not be the precise stratigraphic equivalent of any of the "Wall Creek sands" which yield oil in the Salt Creek and other fields in central Wyoming. It is therefore here designated the Wall Creek (?) sandstone member.

*Carlile shale.*—The Carlile shale consists of very dark shale containing large ironstone concretions. It is about 460 feet thick in this area, and its outcrop usually forms a shallow valley above the Wall Creek (?) sandstone member of the Frontier formation.

*Niobrara shale.*—The Niobrara shale consists chiefly of dark calcareous shale but contains thin beds of sand and layers of chalky material that crop out in conspicuous light-colored ridges south of Como Ridge (see pl. 39, A) but as a rule are concealed by gravel and alluvial deposits. Large numbers of the fossil oyster *Ostrea congesta* occur in the chalky parts of the formation. The total thickness is about 700 feet.

*Steele shale.*—As mapped in the Medicine Bow anticline the top of the Steele shale corresponds to the base of a brownish-white sandstone about 75 feet thick conspicuously exposed in the northern part of the anticline. The formation as thus delimited is about 3,300 feet thick, and consists largely of gray shale, which becomes increasingly sandy toward the top of the formation.

Over the remainder of the area the Steele and Mesaverde formations can not be satisfactorily separated because of the gradation between the types of strata that make up the two formations and because of the lack of diagnostic fossils. Near Rock River and McFadden the transition zone is occupied by brown sandy shale containing several brownish sandstones of variable thickness. The Steele shale beneath the transition zone consists mostly of dark-gray to black shale with a few beds of sandstone and some sandy shale.

*Mesaverde formation.*—The Mesaverde formation is the best exposed of the consolidated formations in this area, and as the determination of the structure of the area must be based chiefly upon a study of this formation it will be described more fully than the others. Normally it is divisible into an upper and a lower sandstone member, separated by shale and sandy shale.

In the Medicine Bow anticline the Mesaverde has a thickness of about 1,250 feet. The lower member is about 500 feet thick and consists of brown and gray sandstones of variable thickness interbedded evenly throughout with dark-gray shale, carbonaceous shale, and sandy shale in beds as much as 60 feet thick. The sandstones are commonly cross-bedded and ripple marked. The middle member is about 300 feet thick and consists of brown and gray shale interbedded with sandstone and carbonaceous shale, which are in few places well exposed. The upper member, here named the Pine Ridge sandstone member, is made up of 450 feet of light-gray slabby to massive sandstone interbedded with gray sandy shale, carbonaceous shale, and four coal beds, one of which, near the top, is locally as much as 8 feet thick. Because of its greater hardness the Pine Ridge sandstone encircles the anticline in a prominent hogback ridge. (See pl. 36, A.) It was named for its exposure in Pine Ridge, about 2 miles southeast of the town of Rock River.

The Pine Ridge sandstone in its local development resembles the Teapot sandstone member of the Mesaverde formation of central Wyoming, to which it is probably equivalent. Two miles southeast of Rock River the Pine Ridge sandstone is about 80 feet thick (see pls. 39, B, and 40), as compared with a thickness of 450 feet around the Medicine Bow dome, and consists of light-gray sandstone with interbedded shale, sandy shale, carbonaceous shale, and coal beds. The uppermost coal bed of the member lies near the top of the sandstone and is 6 to 8 feet thick in the N.  $\frac{1}{2}$  sec. 16, T. 20 N., R. 76 W. Its

three lower coal beds range in thickness from 3 to 4 feet. These coal beds have been mined in sec. 16, T. 20 N., R. 76 W., by the Rock River Coal & Fire Clay Co. and in sec. 18 of the same township by the Rock Creek Coal Co. The heavier portions of the Pine Ridge sandstone are medium to fine grained and contain scattered limonitic concretions. Toward the top the sandstone becomes browner and its surface is rather uneven, although not ripple marked. Macerated plant remains and impressions of what appear to be large plant stems are common within it.

Rocks equivalent to part of the Mesaverde formation of the Medicine Bow anticline crop out in a number of low but conspicuous sandstone ridges below the Pine Ridge sandstone at this locality. The intervening beds are concealed by gravel but presumably consist of shale, sandy shale, and carbonaceous shale. Good exposures of the Pine Ridge sandstone and of some 1,300 feet of the beds below it occur in sec. 33, T. 20 N., R. 78 W. In the lower 225 feet these beds contain many thin layers of lignitic shale and some thin beds of lignite, gray shale, and brown sandstone, all of which alternate with beds containing marine fossils. The remainder of the section consists of brown and white concretionary sandstone, and gray sandy shale, surmounted by the typical Pine Ridge sandstone hogback.

In the banks of Rock Creek between the southeast corner of section 33 and the northeast corner of sec. 34, T. 20 N., R. 78 W., several sandstones crop out below those described in the preceding paragraph and undoubtedly belong to the Steele shale. The most prominent of these sandstones appears in the creek bank in the NE.  $\frac{1}{4}$  sec. 34. This sandstone is gray-brown, well bedded, and fine grained. Exposures of the Pine Ridge sandstone are fairly numerous in the mantle of gravel that covers the Rock Creek district and give an index to local variations in the geologic structure. The accompanying geologic map shows the known position of its outcrop.

The fossils collected in the 1,250 feet of beds below the Pine Ridge sandstones are such as occur in both the Mesaverde formation and the Steele shale, according to T. W. Stanton.

*Lewis shale.*—The Lewis shale is a dark marine shale, approximately 2,500 feet thick in this area, and contains several yellowish-brown fossiliferous sandstones which crop out as rather prominent hogback ridges. Because of its softness the shale is rarely exposed, and its upper limits could not be determined with precision. Fairly good exposures of the Lewis shale occur in secs. 20 and 21, T. 20 N., R. 78 W., revealing two prominent sandstone beds about 700 and 950 feet above the base of the formation.

The Lewis is well exposed in parts of the dissected areas adjoining the Medicine Bow anticline, but in many places is overlapped either by terrace gravel or by the Hanna formation, and terrace gravel

obscures also its lower part in the topographic and structural depression lying north and west of the Arlington terrace in the southern part of T. 21 N., R. 78 W., and vicinity.

Younger rocks corresponding to the Medicine Bow and Ferris formations of the Hanna and Carbon Basins may be present above the Lewis and beneath the overlapping gravel and Hanna formation in parts of the area described, but if so they are wholly concealed.

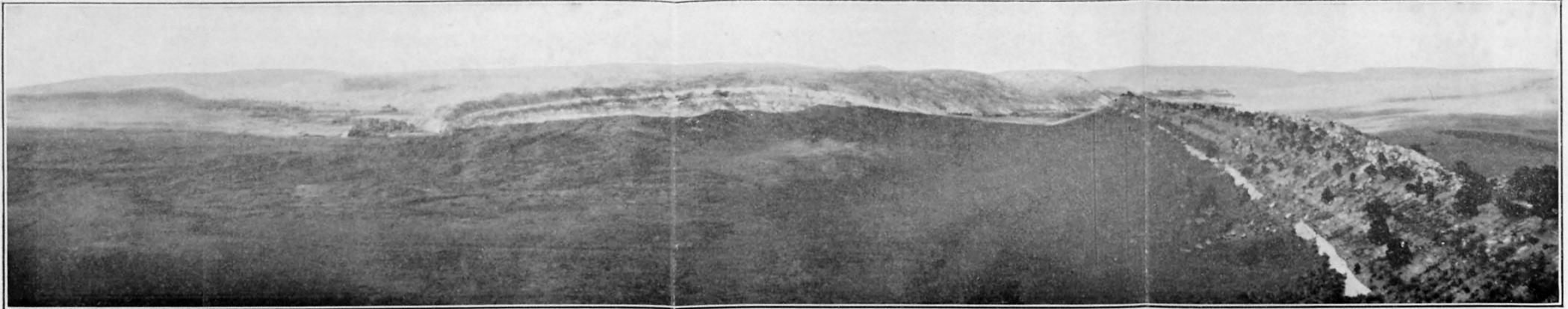
The fossils collected from the Lewis shale are such as occur also in the Mesaverde formation, according to J. B. Reeside, jr.

#### TERTIARY ROCKS

*Hanna formation.*—The Hanna formation consists of yellowish-brown sandstone, yellowish-green sandy shale, carbonaceous shale, coarse conglomerate, and coal beds and rests unconformably on the older formations. It is fairly well exposed in the high bluffs just west of the Arlington-Rock River road in the northwest corner of T. 19 N., R. 78 W., where the uppermost bed visible is a rather prominent sandstone that lies immediately below the terrace and appears to dip westward at a low angle. Carbonaceous shale and locally thin beds of coal lie about 100 feet below the terrace, and according to reports these coal beds have been mined on a very small scale. Throughout most of its extent the Hanna formation seems to be nearly horizontal, but it rises very abruptly in approaching the fault near Arlington. The basal beds of the formation are exposed near the fault not far from the southwest corner of sec. 19, T. 19 N., R. 78 W., and consist largely of yellowish-green sandy shale. Beds of similar composition were observed southeast of Arlington at short intervals along the north slope leading up to the Medicine Bow Mountains and are commonly associated with coarse conglomerate, excellent exposures of which occur west of the Arlington terrace in secs. 8, 18, 29, and 31, T. 20 N., R. 78 W. This conglomerate is composed of a dark-brown sandy matrix with markedly angular boulders, as large as 6 inches in diameter, which consist largely of fine-grained granite, diabase, an abundance of mica schist, and some vein quartz.

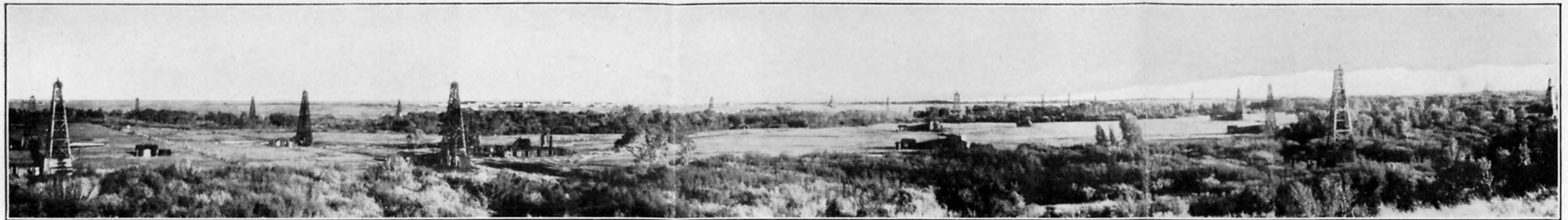
Sandstones resembling those in the bluff west of the Arlington-Rock River road are exposed in the ridge near the northeast corner of sec. 33, T. 19 N., R. 78 W., and also in the NE.  $\frac{1}{4}$  sec. 18, T. 19 N., R. 77 W., where considerable coal has been mined. At the latter locality the Hanna formation is fairly well exposed along the two coal outcrops shown in Plate 43 but is less well exposed west of the coal outcrops and is concealed by terrace gravel south and east of them.

Excellent exposures of variegated shale occur in the bluff of Cooper Creek in sec. 8, T. 18 N., R. 76 W., and vicinity. These beds



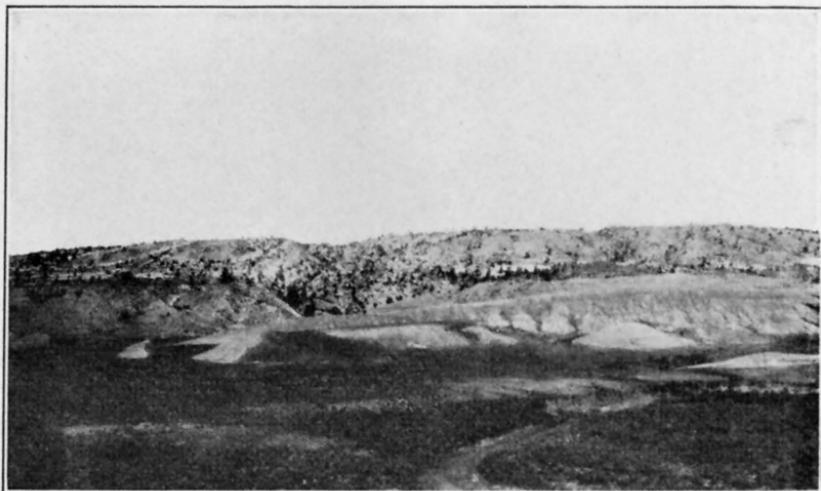
A. MEDICINE BOW ANTICLINE, FROM A POINT IN SEC. 14, T. 20 N., R. 79 W., WYOMING

View north along the axis. Shows hogback of Pine Ridge sandstone at right; flat gravel terrace in middle distance; and sandstone and shale of the lower part of the Mesaverde formation exposed in the bank of Medicine Bow River



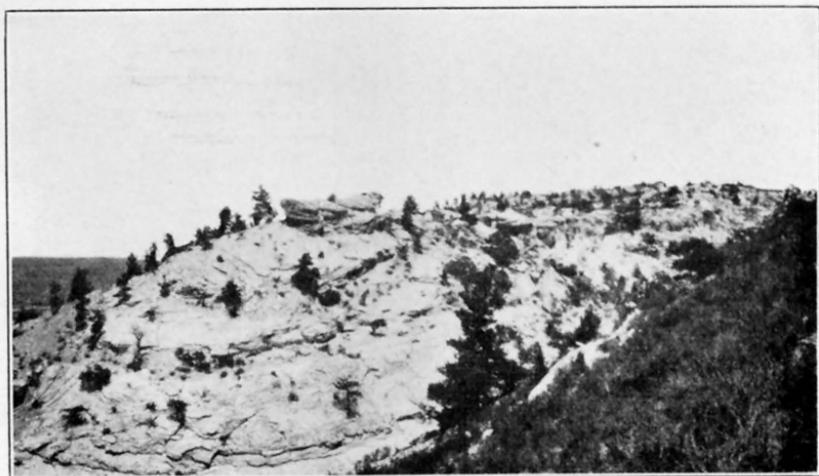
B. ROCK CREEK OIL FIELD, WYOMING

View south from a point in the NE.  $\frac{1}{4}$  sec. 34, T. 20 N., R. 78 W. Shows Rock Creek Valley in foreground; McFadden on gravel terrace in background; and Medicine Bow Mountains at extreme right



A. SOUTH SIDE OF THE ANTICLINE FROM A POINT IN THE SW.  $\frac{1}{4}$  SEC. 13,  
T. 23 N., R. 78 W.

Shows pine-clad Tensleep sandstone dipping beneath red beds



B. NEARER VIEW IN THE SE.  $\frac{1}{4}$  SEC. 12, T. 23 N., R. 79 W.

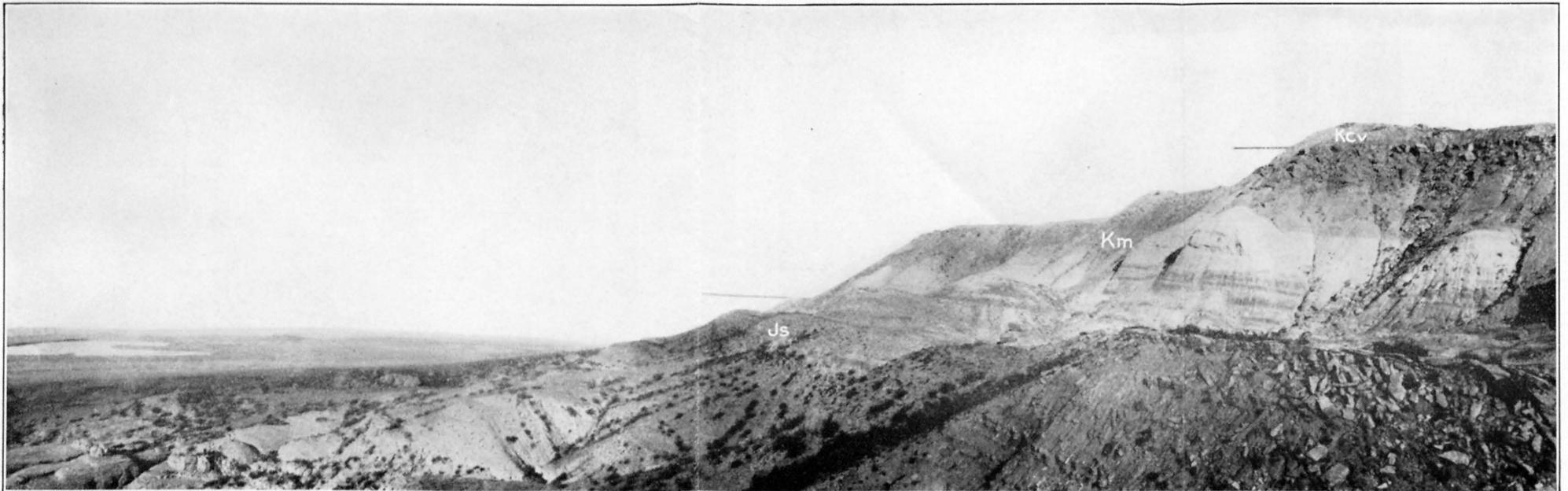
Shows cross-bedding characteristic of the upper part

TENSLEEP SANDSTONE IN THE FLAT TOP ANTICLINE NORTH OF MEDICINE  
BOW, WYOMING



A. MORRISON, CLOVERLY, AND OVERLYING FORMATIONS ON LITTLE MEDICINE BOW RIVER IN THE SW.  $\frac{1}{4}$  SEC. 14, T. 23 N., R. 79 W., WYOMING

Looking west from the Cloverly hogback on Little Medicine Bow River. Km, Morrison formation; Kcv, Cloverly formation; Kt, Thermopolis shale; Kms, Mowry shale; Kf, Frontier formation with the Wall Creek (?) sandstone member at the top



B. SUNDANCE, MORRISON, AND CLOVERLY FORMATIONS IN THE WEST FACE OF COMO RIDGE 5 MILES EAST OF MEDICINE BOW, WYOMING

Js, Sundance; Km, Morrison; Kcv, Cloverly



A. RIDGE OF CHALKY BEDS IN THE NIOBRARA FORMATION NEAR RIDGE, WYOMING

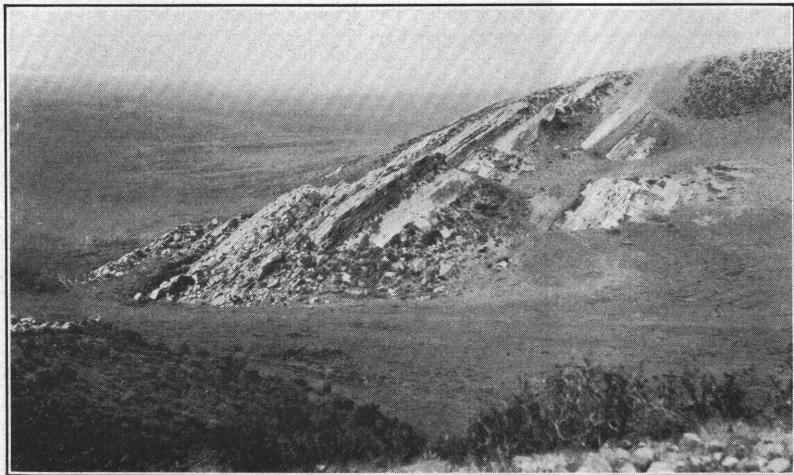


B. PINE RIDGE SANDSTONE MEMBER OF MESAVERDE FORMATION IN SEC. 4, T. 19 N., R. 78 W., WYOMING

Shows the sandstone jutting into Rock Creek flats



A. LOOKING WEST FROM THE SOUTHEAST CORNER OF SEC. 17, T. 20 N., R. 76 W.  
Elk Mountain in the distance



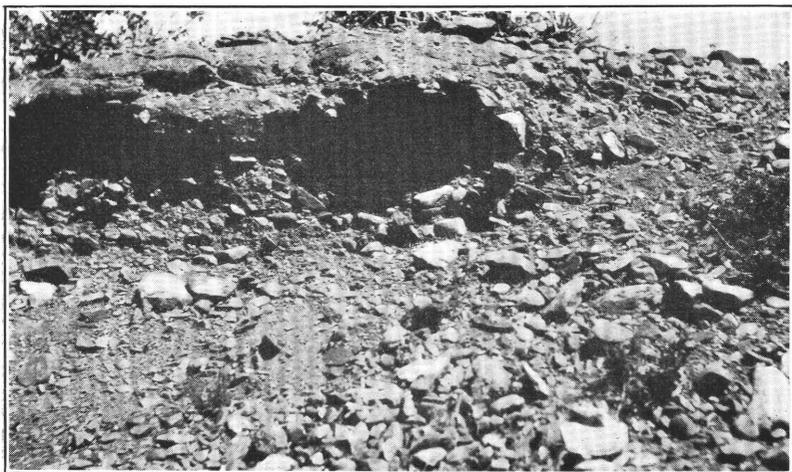
B. FROM A POINT IN SEC. 12, T. 20 N., R. 78 W.

The lowlands at the left are part of the topographic and structural depression that lies between the Rock Creek and Medicine Bow anticlines

PINE RIDGE SANDSTONE DIPPING BENEATH GRAVEL-COVERED LEWIS SHALE, FROM T. 20 N., RS. 76 AND 78 W., WYOMING



A. ARLINGTON TERRACE AND ROCK CREEK VALLEY, LOOKING NORTHWEST  
FROM A POINT 1 MILE EAST OF ARLINGTON, WYOMING



B. CONGLOMERATE AT THE BASE OF THE HANNA FORMATION IN THE SW.  $\frac{1}{4}$   
SEC. 29, T. 19 N., R. 78 W., WYOMING

resemble the variegated beds which elsewhere in Wyoming have been mapped as Wasatch, and probably they lie higher in the section than the coal beds mentioned in the preceding paragraph. The entire Hanna formation is regarded in the light of present evidence as of Wasatch (Eocene) age. A further description of the Hanna formation in its type area a few miles northwest of the Rock Creek field is given by Bowen.<sup>5</sup>

#### PLIOCENE (?) TO RECENT DEPOSITS

*Terrace gravel and alluvium.*—Deposits of Pliocene and Quaternary age, such as terrace gravel and alluvium, occur in abundance in the area and have been formed at various stages in its topographic development. Alluvium occurs along Medicine Bow River and to some extent in the Rock Creek district, though in the latter area the stream valleys are normally covered by a fairly level sheet of coarse gravel and boulders, which increase greatly in size as the mountains are approached. Such deposits characterize the valleys of Rock and Threemile Creeks where they debouch onto a broad plain after leaving the mountains.

The Arlington terrace, which, as already stated, is the highest and oldest gravel-covered terrace in the area, is probably of Pliocene or Pleistocene age, according to W. C. Alden.<sup>6</sup>

Gravel-covered terraces lower and younger than the Arlington terrace occur abundantly throughout the area, and their margins are for the most part shown on the geologic map. Nearly all interstream areas are covered by gravel, which furnishes a smooth, rolling plain.

In contrast with the boulders of the Hanna conglomerates the boulders found on all the terraces are well rounded and are composed of the most resistant rocks, such as quartzite, quartzose schist, and vein quartz. They average about 6 inches in diameter but toward the mountains are much larger.

### STRUCTURE

#### REGIONAL FEATURES

The folds of the Rock Creek area are superimposed upon the broad structural uplift that separates the Laramie Basin from the great downwarp of the Carbon and Hanna Basins to the northwest. These folds are divisible into two general systems, one trending northeastward and the other northwestward. The northeast-

<sup>5</sup> Bowen, C. F., *Stratigraphy of the Hanna Basin, Wyo.*: U. S. Geol. Survey Prof. Paper 108, p. 231, 1918.

<sup>6</sup> Personal communication.

ward-trending folds are principally developed northeast of the Rock Creek oil field. The northwestward-trending folds have their strongest expression in the Rock Creek and Medicine Bow folds and lie roughly parallel to the Medicine Bow and Laramie Ranges, to which, presumably, they are related in origin, whereas the uplifts belonging to the Flat Top and Como Ridge system are, perhaps, due to the unequal elevation of crustal blocks separated by old lines of weakness in the pre-Cambrian basement rocks.

The great Arlington fault brings the pre-Cambrian rocks of the Medicine Bow Range into contact with the westward-dipping Tertiary and Cretaceous rocks that form the west limb of the Rock Creek anticline, as was pointed out by Darton and Siebenthal.<sup>7</sup> This fault is believed to be a high-angle overthrust, though conclusive evidence as to its type was not obtained by the writers.

#### METHOD USED IN DETERMINING STRUCTURE

The geologic structure in this area is shown by means of structure contours, drawn on the top of the Cloverly formation. Well records furnished the data used to determine the attitude of this surface in the Rock Creek oil field and to some extent in the Medicine Bow anticline. Elsewhere the attitude of the contoured surface was calculated from the determined altitudes of exposed key beds, the most useful of which was the Pine Ridge sandstone member of the Mesaverde formation.

About 85 per cent of the beds lying between the Pine Ridge sandstone and the Cloverly formation consist of soft shale, which when sharply folded may become appreciably thinner in parts of the folds that have undergone stretching or great compression. In the absence of trustworthy evidence to the contrary it has been assumed that the folds developed in the Cloverly within this area are similar to those visible at the surface and that their axial planes are vertical.

In the Medicine Bow anticline the interval from the base of the Mesaverde formation to the top of the Cloverly formation is about 5,300 feet. Near the Rock Creek oil field the top of the Mesaverde formation (Pine Ridge sandstone member) is the one prominent surface marker, and the interval between this horizon and the top of the Cloverly formation is about 6,500 feet where dips are less than 30°. The Mesaverde formation, consisting largely of sandstone, probably does not thin appreciably even when strongly compressed.

An attempt was made to determine from a study of well logs in the Rock Creek oil field whether appreciable thinning of beds occurs in the folds of this area. It was thought that a comparison of the intervals between the tops of the Frontier and Cloverly formations,

<sup>7</sup> Darton, N. H., and Siebenthal, C. E., *op. cit.*, p. 50.

as recorded in the logs, would solve this problem, but it was found that rarely have different drillers recognized the same horizon as the top of the Frontier formation. As a result, the apparent interval between the tops of the Frontier and Cloverly formations varies from 800 to 1,050 feet in wells which normally should show about the same thickness for this interval.

## OIL AND GAS

### ROCK CREEK ANTICLINE

#### GENERAL GEOLOGIC FEATURES

The Rock Creek anticline was mapped for about 18 miles and extends from sec. 8, T. 20 N., R. 78 W., southeastward to sec. 32, T. 18 N., R. 77 W. As shown on Plate 43, its axis is believed to be a somewhat sinuous line, though it is possible that the Cooper Cove fold may be slightly offset with respect to the major anticlinal axis farther north.

Structure section C—D, Plate 43, shows the cross section of the fold in the Rock Creek oil field and is probably characteristic of it throughout its course. It is asymmetrical, with the steeper limb on the east, where the Steele shale and Mesaverde formation dip  $45^{\circ}$  to  $50^{\circ}$  and in a few localities  $60^{\circ}$  to  $70^{\circ}$ . In the northern part of the fold, where the best exposures occur, the dips average about  $25^{\circ}$  on the western limb. A short distance both north and south of Cooper Cove dips on the western limb are as high as  $50^{\circ}$ , and it seems that here the west limb is as steep as the east limb for some distance from the axis.

#### POSSIBLE FAULTING OF THE ANTICLINE

Faults may have played an important part in the accumulation or escape of oil and gas along the Rock Creek anticline and may be hidden beneath the gravel beds that conceal the bedrock along the greater part of the fold. The only fact known to the writers which suggests the possible presence of a fault in the northern part of the area is that the producing area of the Rock Creek oil field lies on the crest and northwest flank of the anticline and does not extend far down the east limb in conformity with the apparent structure.

In Cooper Cove there is some evidence that the anticline may be faulted. Near the southwest corner of T. 18 N., R. 77 W., a sharp kink occurs in one of the gravel-covered ridges that border Cooper Cove on the west, and at the north end of Cooper Cove there are two outcrops of white sandstone, one on each flank of the anticline, which from their general appearance, texture, petrographic character, and stratigraphic position with relation to other sandstones

of distinctive character, may both represent the Pine Ridge sandstone. Lack of continuous exposures has not permitted definite proof of this correlation. The eastern exposure, at the southeast corner of sec. 17, T. 18 N., R. 77 W., is shown on the geologic map as the Pine Ridge sandstone. If the western exposure, in the SW.  $\frac{1}{4}$  NE.  $\frac{1}{4}$  sec. 19, represents the same horizon, a fault necessarily intervenes which has permitted relative uplift of the east flank of the fold and has resulted in a stratigraphic displacement of 400 to 500 feet. It is considered possible, therefore, that a fault, perhaps with north-south trend, splits the Cooper Cove anticline and may be the cause of the apparent lack of commercial oil deposits in the fold.

#### ROCK CREEK OIL FIELD

*Surface geology and structure.*—The Rock Creek oil field lies in the gravel-covered flats of Rock and Threemile Creeks in the southeastern part of T. 20 N., R. 78 W., and the northeastern part of T. 19 N., R. 78 W. (See pls. 36, B, and 43.) The presence of a dome at this locality, suggested by surface dips in sec. 34, T. 20 N., R. 78 W., and in sec. 12, T. 19 N., R. 78 W., has been confirmed by deep drilling, and its shape, dimensions, and productive area are now fairly definitely known. As shown by Plate 43, the dome has a structural closure of about 2,000 feet, and its major apex lies in the SE.  $\frac{1}{4}$  sec. 35, T. 20 N., R. 78 W. A subsidiary dome centers in the northern part of sec. 11, T. 19 N., R. 78 W. The dip of the beds on the eastern flank of the dome averages about  $40^\circ$ , compared with about  $20^\circ$  on its western flank, and the axis of the dome pitches less steeply toward the southeast than toward the northwest. Erosion has exposed the lower part of the Steele shale along the crest of the dome, and near the top the depth to the Cloverly, the main oil-producing formation, is about 2,650 feet.

*Development.*—Oil was discovered in the Rock Creek field by the Harrison & Cooper No. 1 well of the Ohio Oil Co., a few hundred feet northwest of the south quarter corner of sec. 35, T. 20 N., R. 78 W., and completed in May, 1918. This well had an initial daily production of 50 barrels of oil from the so-called Muddy sand at a depth of 2,581 feet, but on being deepened to the upper sand of the Cloverly formation produced about 1,000 barrels of oil a day. The Harrison & Cooper well No. 1, in the NW.  $\frac{1}{4}$  NE.  $\frac{1}{4}$  sec. 11, T. 19 N., R. 78 W., had an initial production of 1,000 barrels of oil a day from the Muddy sand and has never been deepened.

On December 31, 1926, there were in the Rock Creek field about 60 producing oil wells within an area about 3 miles long and less than 1 mile wide situated along the crest and northwest flank of the dome. The basal sand of the Cloverly yields the greatest amount

of oil, although good yields are obtained from the Muddy sand and the upper sand of the Cloverly, and small yields have been obtained from the Wall Creek (?) sand. In 1920 the average daily production per well from the Muddy sand was 260 barrels; from the upper Cloverly sand, 220 barrels; and from the basal Cloverly sand, 1,430 barrels.<sup>8</sup> More than 25 barrels a day has never been obtained from the Wall Creek (?) sand. As production declines in one sand the wells are deepened to the next lower one. The total production of the field in 1925 was 1,076,110 barrels and the average daily production slightly in excess of 2,900 barrels. The oil produced is transported by 6-inch pipe line to the railroad near Rock River or to a refinery at Laramie.

The producing area of the field has been defined by a number of dry holes, all of which are shown on Plate 43.

The greatest annual production from the field was obtained in 1922, when 1,758,617 barrels of oil was produced. Between the time of its discovery and December 31, 1925, the field has produced between 9,000,000 and 10,000,000 barrels of oil, and it has been estimated that the dome will afford an ultimate yield from known sands of at least 20,000,000 barrels.<sup>9</sup>

*Quality of the oil.*—The oil from the Rock Creek field has a specific gravity of about 0.85 (about 35° Baumé), averages about 0.25 per cent sulphur, and contains from 28 to 33.2 per cent of gasoline on the basis of present specifications. Analyses made by the Bureau of Mines of samples of oil taken from four wells are given in the table below.

*Analyses of oils from wells of the Ohio Oil Co., Rock Creek oil field, Wyoming*

[Made in the laboratory of the Bureau of Mines. Distillation in Bureau of Mines Hempel flask. Amount distilled, 300 centimeters]

Well	Gravity at 15° C.		Air distillation, with fractionating column			
	Specific	Baumé	Barometer reading	Distillation begins	To 150° C.	
					Total percentage distilled, by volume	Specific gravity at 125°-150° C.
Harrison & Cooper No. 1, SW. ¼ sec. 35, T. 20 N., R. 78 W	0.852	34.3	Milli-meters 747	°C. 24	21.9	0.768
Harrison & Cooper No. 1, NE. ¼ sec. 11, T. 19 N., R. 78 W			750	22		
State land No. 1, NE. ¼ sec. 34, T. 20 N., R. 78 W	.845	35.7	742	25	20.7	.770
University land No. 1, NE. ¼ sec. 14, T. 19 N., R. 78 W	.846	35.5	738	26	19.6	.772

<sup>8</sup> Wyoming Geol. Survey Press Bull. 7, 1920.

<sup>9</sup> Wyoming Geol. Survey Press Bull. 12, 1922.

*Analyses of oils from wells of the Ohio Oil Co., etc.—Continued*

Well	Air distillation, with fractionat- ing column		Vacuum distillation, without fractionating column			
	150° to 300° C.		Pres- sure	175° to 300° C.		
	Total percent- age dis- tilled, by vol- ume	Specific gravity at 275°- 300° C.		Total percent- age dis- tilled, by vol- ume	Re- siduum	Sul- phur
Harrison & Cooper No. 1, SW. ¼ sec. 35, T. 20 N., R. 78 W.-----	25.2	0.842	<i>Milli- meters</i> 40	17.9	<i>Per cent</i> 35	<i>Per cent</i> 0.192
Harrison & Cooper No. 1, NE. ¼ sec. 11, T. 19 N., R. 78 W.-----	29.1	.845	40	19.4	31	.25
State land No. 1, NE. ¼ sec. 34, T. 20 N., R. 78 W. University land No. 1, NE. ¼ sec. 14, T. 19 N., R. 78 W.-----	30.4	.849	40	17.7	31.2	.27
	30.5	.850	40	14.4	35.5	.20

° Distillation ended at 275° C. Specific gravity taken on 250°-275° fraction.

*Possibilities for oil production from deeper sands.*—Information regarding deeper sands that underlie the Rock Creek dome and may be found to be oil-bearing is afforded by the well drilled by the Prairie Oil & Gas Co. on the Foote Creek anticline, in sec. 25, T. 22 N., R. 78 W. This well was started in the Cloverly formation and penetrated to a depth of more than 300 feet below the top of the heavy sandstone (probably Tensleep) at the top of the Casper formation. (See pl. 42.) As this well is only 12 miles north of the Rock Creek oil field, it is logical to assume that the sands encountered in it may underlie the Rock Creek dome. The logs of this well and others in the Rock Creek field shown graphically in Plate 42 illustrate the character and sequence of the rocks between the Cloverly formation and the upper part of the Casper formation in the central part of the Laramie Basin and indicate the relative position and thickness of the deeper sands that may yield oil or gas.

The massive sandstone encountered near the middle of the Sundance formation in the Prairie well is 70 feet thick in the western face of Como Ridge, 3 miles to the northeast, and appears to be suitable in all respects to serve as a reservoir for oil. In the Prairie well, however, it yielded water. A similar sand 35 feet thick lies at the base of the Sundance in Como Ridge.

The Forelle limestone and Satanka shale were recorded in the log of the Prairie well as lime, shale, and sand shale, closely resembling the measured surface section of these formations given on page 137. This part of the section is probably equivalent to the Embar formation, which yields heavy black oil elsewhere in Wyoming, but because of its local composition it is unlikely to yield oil within the Rock Creek field.

The most promising bed for oil beneath the Cloverly sands in this region, in the opinion of the writers, is the massive sandstone at the top of the Casper formation. In the Prairie well this sand lies 2,090 feet below the base of the Cloverly formation and is over 300 feet thick. Wells located on the apex of the Rock Creek dome should reach this sand at a depth of about 4,900 feet.

#### DUTTON CREEK DOME

*Surface geology and structure.*—The Dutton Creek dome lies in secs. 1 and 12, T. 18 N., R. 78 W., and is a small bulge on the Rock Creek anticline. (See pl. 43.) The field evidence for delimiting the dome is exceedingly meager, owing to the absence of outcrops in the widespread mantle of gravel. The presence of the dome is suggested by the reverse dips in and near sec. 36, T. 20 N., R. 78 W., but not until extensive core drilling was done was its precise location determined. According to Prof. S. H. Knight,<sup>10</sup> of the University of Wyoming, the closure of the dome, as determined by core drilling, is 900 feet.

*Development.*—A well drilled on the Dutton Creek dome near the center of sec. 1, T. 18 N., R. 78 W., by the Midwest Refining Co. and Argo Oil Co. was reported to have produced 60 barrels of 33° Baumé oil from the Muddy sand between depths of 4,876 and 4,905 feet. The sands in the Cloverly formation, however, yielded water in this well between depths of 4,994 and 5,055 feet.

#### COOPER COVE DOME

*Surface geology and structure.*—The Cooper Cove dome lies in Cooper Cove, a small natural basin in the foothills of the Medicine Bow Mountains, in secs. 20 and 29, T. 18 N., R. 77 W. (See pl. 36, C.) The floor of the basin is nearly level and is covered with a mantle of gravel. Numerous exposures of the Mesaverde formation occur in the hills at the north and south ends of the dome, but elsewhere the bedrock is concealed by gravel.

All available field evidence indicates that the Cooper Cove dome is of about the same magnitude as the Dutton Creek dome and is along the same line of folding—that is, the Rock Creek anticline. It is possible, however, that the Cooper Cove dome is en échelon with the Dutton and Rock Creek domes and that it may be broken by a fault which has permitted the relative uplift of the east half of the dome.

*Development.*—The Utah Oil & Refining Co. has made five attempts to put down a well in Cooper Basin, but all were abandoned

<sup>10</sup> Personal communication.

before reaching the Muddy sand. The deepest well, in the SW.  $\frac{1}{4}$  sec. 20, T. 18 N., R. 78 W., was drilled to a depth of 4,573 feet in 1921. The bottom of the hole was in black shale. Only slight shows of oil and gas were encountered in the well. Other holes started by the Utah Oil & Refining Co. in Cooper Cove were much shallower and are shown as dry holes on Plate 43.

The next and last attempt to test this dome was made by the Ohio Oil Co. in a well in the SE.  $\frac{1}{4}$  sec. 19, T. 18 N., R. 77 W., half a mile west of the Utah well. This well was abandoned in November, 1925, after drilling to a depth of about 5,400 feet without encountering any important shows of oil and gas. It appears that the sand encountered at a depth of 4,530 feet in the Ohio well is the Wall Creek (?) sand. If so, the well was probably within less than 100 feet of the Muddy sand when it was abandoned.

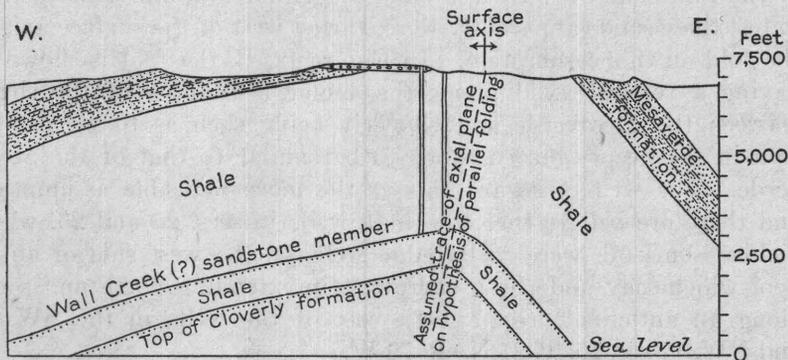
Although the Muddy and Cloverly sands may contain oil in this dome, it is of comparatively small size and its more promising oil sands lie at depths of more than a mile.

#### MEDICINE BOW ANTICLINE

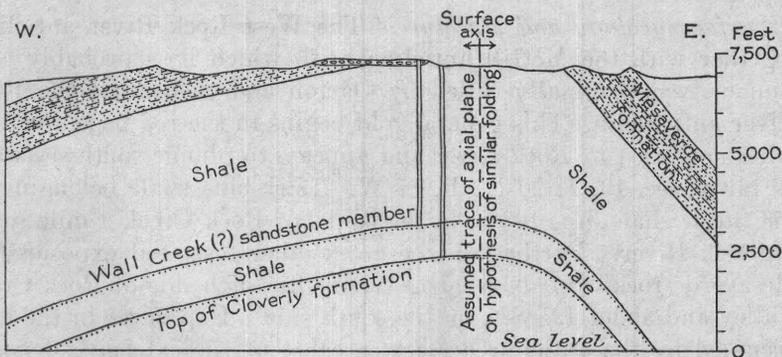
*General geologic features.*—The Medicine Bow anticline or dome is a pronounced asymmetrical fold which exposes the Steele shale and is encircled by a prominent hogback of Pine Ridge sandstone (see pl. 36, A) extending from the southeastern part of T. 21 N., R. 79 W., southward into sec. 23, T. 20 N., R. 79 W. The length of the fold inside the Pine Ridge hogback is 7 miles and its maximum width slightly less than 3 miles. Dips on the western limb of the anticline range from  $10^{\circ}$  to  $20^{\circ}$ ; those on the eastern limb average about  $50^{\circ}$ . The northward plunge of the fold ranges from  $10^{\circ}$  to  $35^{\circ}$ , and the southward plunge is between  $1^{\circ}$  and  $5^{\circ}$  over much of the central part of the fold, but becomes much steeper toward the south end.

*Development.*—The first well to give promising shows of oil in the Medicine Bow anticline was drilled by the Southwestern Petroleum Co. and Cliff Petroleum Co. in the SW.  $\frac{1}{4}$  sec. 25, T. 21 N., R. 79 W. Oil was struck in the Wall Creek (?) sandstone at a depth of 4,033 to 4,035 feet in July, 1923. For several days the well flowed about 200 barrels of oil a day and then declined rapidly. Below a depth of 4,035 feet the sand carried water, which filled up the hole when a depth of 4,039 feet was reached. The bottom of the sand was reached at 4,080 feet. Drilling was then continued to a depth of 4,860 feet, when water was struck in a sand 27 feet thick, which is probably one of the persistent sands in the Thermopolis shale. Between 4,887 and 4,966 feet two thin dry sands were encountered. At 4,966 feet what is probably the upper sand of the Cloverly formation was struck and yielded water. After plugging back to 4,033 feet and failing

to get paying quantities of oil the operators abandoned the well in 1926. Another well drilled in the NW.  $\frac{1}{4}$  sec. 25 of the same township by the Producers & Refiners Corporation in 1927 produced five barrels of oil a day from the Wall Creek (?) sand at a depth of 4,040 feet but was later abandoned. The well drilled by the Southwestern Petroleum Co. and Cliff Petroleum Co. in the SE.  $\frac{1}{4}$  sec. 26, T. 21 N., R. 79 W., encountered oil and water in the Wall Creek (?)



A



B

FIGURE 12.—Cross sections of Medicine Bow anticline, Tps. 20 and 21 N., R. 79 W., Wyoming, showing position of traces of axial plane, based on assumption (A) of parallel folding with consequent westward shift of the anticlinal axis with depth or (B) of similar folding of Mesaverde and Cloverly formations

sand at a depth of 4,098 feet, but the amount of oil was much less than in the well described above. A well drilled in 1917 by the Ohio Oil Co. in the NW.  $\frac{1}{4}$  sec. 36 of the same township, one drilled by the Jorth Oil Co. in the SE.  $\frac{1}{4}$  sec. 26, and two drilled by the Southwestern Petroleum Co. and Cliff Petroleum Co. in the SE.  $\frac{1}{4}$  sec. 23 and the NW.  $\frac{1}{4}$  sec. 36 failed to reach the Wall Creek (?) sand and gave no shows of oil and gas.

*Oil and gas possibilities.*—Figure 12 has been prepared to illustrate the two more plausible interpretations of underground conditions beneath the Medicine Bow dome, and indicates that the possibilities of the fold have not been completely tested. In Figure 12, A, a cross section of the Wall Creek (?) and Cloverly sands has been drawn on the assumption commonly made in the past that in an asymmetric fold, such as the Medicine Bow anticline, the axial plane of the fold slopes toward the flank of gentler dip, and wells drilled to test these sands apparently were started west of the surface axis of the fold on this assumption. In Figure 12, B, the fold is shown as having a vertical axial plane, the assumed thinning of the shales between the Mesaverde and Cloverly being such as to permit the fold in the deeply buried sands to be similar to that of the Mesaverde. The writers regard this as the more plausible assumption, and therefore believe that the three wells in secs. 25 and 26, which yielded some oil, were really edge wells on the west side of an oil pool which may underlie a narrow strip extending north and south along an anticlinal crest a little east of the wells in the SW.  $\frac{1}{4}$  and NW.  $\frac{1}{4}$  sec. 25, T. 21 N., R. 79 W.

#### WEST ROCK RIVER ANTICLINE

*Surface geology and structure.*—The West Rock River anticline, together with the McGill anticline, with which it is probably continuous, was originally called by Darton and Siebenthal the Rock River anticline.<sup>11</sup> This general fold begins in the red beds about 18 miles northeast of Rock River and appears to plunge southwestward as far as sec. 19, T. 20 N., R. 77 W. Dark-blue shale belonging to the Steele shale dips 10° S. in the banks of Rock Creek a mile south of Rock River. Farther up the creek other scattered exposures of Mesaverde rocks dip about 20° NW. on the north side of Rock Creek Valley and about 12° SE. on the south side. Exposures in the area occupied by the anticline are few because of the extensive deposits of terrace gravel and alluvium. The character of the anticline is shown by structure section E-F, Plate 43.

*Development.*—The Associated Oil Co. of Wyoming has drilled three wells on the West Rock River anticline in this area without obtaining oil. The well in the western part of sec. 6, T. 20 N., R. 76 W., was drilled to a depth of 3,023 feet and penetrated the variegated shales of the Morrison formation. The well in the north-west corner of section 12 of the same township got a show of gas in the Wall Creek (?) sand at a depth of 2,419 feet. Both the Cloverly and Muddy sands were of considerable thickness in this well but contained no oil or gas. The third well, drilled in the southern part of

<sup>11</sup> Darton, N. H., and Siebenthal, C. E., op. cit., p. 51.

section 2, was abandoned at a depth of 1,500 feet without reaching the Cloverly sands.

#### **SOUTH FOOTE CREEK ANTICLINE**

The South Foote Creek anticline is a prominent and rather narrow fold which follows a northward and then eastward course from the center of sec. 36, T. 20 N., R. 78 W., at least as far as sec. 27, T. 21 N., R. 77 W. From such observations as could be made in the gravel-covered areas occupied by this anticline it appears that it is asymmetric, with steeper dips on the western limb, as shown in Plate 43. The only rock exposures observed along this fold were those of the lower sandstones of the Mesaverde formation, bordered on the south by the younger Pine Ridge sandstone, which crops out in secs. 8 and 9, T. 20 N., R. 77 W., occupying the center of the conspicuous syncline that extends from section 18 to section 1. The Inland Oil Co. drilled two wells on this anticline in sec. 24, T. 20 N., R. 78 W., but both were abandoned before reaching the Muddy sand.

#### **LITTLE MEDICINE BOW DOME**

The Little Medicine Bow dome is a small uplift having its apex in sec. 23, T. 21 N., R. 78 W., and its position is marked by the outcrop of the Pine Ridge sandstone, which is encircled by the Lewis shale. This dome has not yet been tested for oil and gas, and its small size and the great depth to the productive sands of the Rock Creek field render such a test doubtful, though not necessarily a hopeless venture.

#### **OTHER ANTICLINES**

A minor anticline passes through the NW.  $\frac{1}{4}$  sec. 2, T. 18 N., R. 78 W., and the southeast corner of sec. 34, T. 19 N., R. 78 W., but it is small and narrow and may be merely an adjustment fold in surface beds and may not represent the structure of the underlying sands.

Dips in the valley of Threemile Creek, in sec. 28, T. 19 N., R. 78 W., suggest that this anticline may extend northwestward parallel to the Arlington fault and may perhaps be enlarged in a dome east or northeast of Arlington. That such is the case can be established only by core drilling, however, because of the absence of exposures at critical points.

