GEOLOGY OF THE BAXTER BASIN GAS FIELD, SWEETWATER COUNTY, WYOMING

By Julian D. Sears

INTRODUCTION

PURPOSE OF THE REPORT

The Baxter Basin gas field is in Tps. 16 to 18 N., Rs. 103 and 104 W., Wyo. Structurally it occupies the highest part of the long Rock Springs anticline, of which it is and probably will continue to be the only productive portion. The gas content of the field was proved in the fall of 1922 by the completion of two wells of large yield. Previous drilling on the anticline had given only small showings of oil and gas; the later drilling and the choice of the new locations were largely influenced by a report and generalized structural map by Schultz.[1]

The discovery of gas in commercial quantity brought a demand for further information concerning the structure and extent of the field, the relations of the gas to the structure, and the possibility of the occurrence of oil. To obtain this information, the writer was assigned to a detailed study of the field in the season of 1923; the results of this study are given in the present report.

FIELD WORK

During this investigation the writer was ably assisted by P. C. Benedict and Q. D. Singewald. The work was confined to the southern half of the area of Baxter shale outcrops as shown by Schultz.[2] Mapping was done by means of telescopic alidades and 15 by 15 inch plane tables, points being located either by triangulation or by use of the stadia rod. The survey was tied to the land lines by locating the easily found stones and pipes marking section and township corners. Altitudes were calculated by vertical angles and were checked with several bench marks. Structure was determined by dip and strike readings on outcrops and in many shallow pits and by altitude readings at many points on all the beds that could be identified and traced. In parts of the field the older rocks

[1] Schultz, A. R., Oil possibilities in and around Baxter Basin, in the Rock Springs uplift, Sweetwater County, Wyo.: U. S. Geol. Survey Bull. 702, 1920.

[2] Idem, pl. 1.

are covered with unconformable Tertiary beds, or else the outcrops are poor and the thin layers of sandstone or concretions can not be recognized with certainty or traced for any considerable distance; in these areas the details of structure could not be definitely determined and had to be somewhat generalized.

The geology of the field is shown on the accompanying map (Pl. II, in pocket).

ACKNOWLEDGMENTS

The writer desires to express his obligation to geologists and officials of the Midwest Refining Co., the Ohio Oil Co., the Associated Oil Co., the Producers & Refiners Corporation, and the Montacal Oil Co., for cordial assistance and information concerning the field and for permission to publish the logs of their wells.

GEOGRAPHY

SURFACE FEATURES AND DRAINAGE

The most conspicuous topographic feature of this field is Aspen Mountain, a narrow rounded ridge extending northeastward for nearly 5 miles in the middle of the field; its average altitude is about 8,600 feet. The ridge is partly flanked by extensive gravel terraces, which range in altitude from 7,500 to 8,200 feet. Below these terraces are basins eroded in the soft Baxter shale, which are partly rimmed by low escarpments of the basal sandstone of the Blair formation. The basin south of Aspen Mountain is known as The Circle; that on the north is called Baxter Basin and supplies the name for the whole gas field. The altitude of Baxter Basin ranges from about 6,500 feet in the lower valleys to approximately 7,000 feet on the interstream divides; The Circle is considerably higher. The total relief of the field is about 2,100 feet.

Salt Wells Creek, which flows northward across the northeast corner of the field, and its branches, Sweeney and Circle creeks, are the largest streams of the area. All the streams are tributary to Bitter Creek, which flows westward into Green River; all of them are intermittent except for a small flow from springs in some of the upper courses.

TRAVEL ROUTES

The northwest corner of the field is only 6 miles from Rock Springs, a busy town of nearly 7,000 population on the Union Pacific Railroad. Two branches of the road from Rock Springs to Browns Park, Colo., cross the field, one on its west side, the other across the northeast corner; these are in good condition except after heavy rains. Many side roads make all parts of the field readily accessible.

WATER AND FUEL SUPPLY

Water for drilling and camp use is obtained almost wholly by piping from some of the many springs that issue along fault lines and along the contact of the Bishop conglomerate with older formations. An abundant supply of coal from the Rock Springs field is available, but lately gas from the first productive wells has been piped to the newer drill sites.

GEOLOGY

STRATIGRAPHY

GENERAL SECTION

Within the area shown on the map (Pl. II) the only rocks exposed are the Baxter shale and the Blair and Rock Springs formations, all of Upper Cretaceous age, and the unconformably overlying Bishop conglomerate, of Miocene (?) age. The uplift is underlain by older rocks whose thickness and character are either shown by well records or deduced from the outcrops of the beds on Vermilion Creek, northwestern Colorado, as measured by the writer.[3] Younger Cretaceous and Tertiary rocks are exposed on the flanks of the uplift outside of the area here mapped; these have been described by Schultz,[4] and two of the formations have been more recently discussed by the writer.[5]

The succession and character of the formations involved in the Rock Springs uplift are summarized in the following general section; in the succeeding text only those formations that are of special stratigraphic interest or of importance in the search for oil and gas are described.

[3] Sears, J. D., Geology and oil and gas prospects of a part of Moffat County, Colo., and southern Sweetwater County, Wyo.: U. S. Geol. Survey Bull. 751, pp. 278–281, 1924.

[4] Schultz, A. R., Oil possibilities in and around Baxter Basin, in the Rock Springs uplift, Sweetwater County, Wyo.: U. S. Geol. Survey Bull. 702, 1920.

[5] Sears, J. D., and Bradley, W. H., Relations of the Wasatch and Green River formations in northwestern Colorado and southern Wyoming: U. S. Geol. Survey Prof. Paper 132, pp. 93–107, 1924.

General section of geologic formations in the Rock Springs uplift, Sweetwater County, Wyo.

System	Series		Formation	Thickness (feet)	Character
Quaternary.			Alluvium; terrace gravel.		Sandy clay along streams and in valley bottoms; terrace gravel on benches.
			Unconformity		
Tertiary.	Miocene (?).		Bishop conglomerate.	[a] 0-200	Waterworn and subangular pebbles and boulders embedded in finer gravel and sand matrix. In writer's opinion this conglomerate is equivalent to the basal member of the Browns Park formation of northwestern Colorado.
			Unconformity		
	Eocene.		Bridger formation.	[a] 0-2,000	Ash-gray and greenish clay shale; gray, buff, and blue-green sandstone; light-gray and white marl, limestone, and chert; conglomerate.
			Unconformity locally		
			Green River formation (including Tower sandstone lentil, Laney shale member, and Tipton tongue).	1,350-1,500	Gray fissile shale and oil shale; gray clay shale; gray and buff sandstone and limestone; oolitic layers and alga reefs.
			Wasatch formation (including Cathedral Bluffs tongue).	2,000+	Variegated clay shale; gray, buff, and pink sandstone, grit, and conglomerate; coal beds.
			Unconformity		
Cretaceous.	Upper Cretaceous.		"Laramie" formation.	[a] 1,500	White, yellow, and gray sandstone and shale; coal beds.
			Lewis shale.	[a] 750	Gray and drab marine shale; some soft shaly sandstone; concretions.
		Mesaverde group.	Almond formation.	[a] 700-950	White, yellow, and brown sandstone; gray and drab shale; coal beds.
			Ericson sandstone.	800-1,100	Thick-bedded and massive white and yellow sandstone; very little shale.
			Rock Springs formation.	[a] 600-1,400	White, gray, and yellow sandstone; gray and drab shale; valuable coal beds in northern part of uplift.
			Blair formation.	1,000-1,800	Gray and drab sandy shale and soft shaly sandstone; massive and thin-bedded sandstone prominent in northern part of uplift, inconspicuous in southern part.
			Baxter shale.	3,350-3,600	Gray and drab marine shale; thin-bedded sandstone; concretions.
			Frontier formation.	70-160	Gray and white sandstone and sandy shale.
			Aspen shale.	320-480	Dark-gray to black fissile and platy shale.

[a] Measurements by A. R. Schultz, U. S. Geol. Survey Bull. 702, pp. 22, 23.

General section of geologic formations in the Rock Springs uplift, Sweetwater County, Wyo.—Continued.

System	Series	Formation	Thickness (feet)	Character
Cretaceous.	Upper Cretaceous.	Dakota sandstone.	110-150	Gray sandstone, in part conglomeratic; gray clay shale.
		Unconformity		
Cretaceous(?).	Lower Cretaceous (?).	Morrison formation.	[b] 500	Variegated clay shale; thin lenses of sandstone; conglomerate.
Jurassic.		Twin Creek limestone.	[b] 125	Gray thin-bedded limestone above; gray shale below.
		Nugget sandstone.	[b] 950	White and gray cross-bedded sandstone; some red sandy shale in upper part.
Triassic (?).		Ankareh (?) shale.	[b] 200	Red and gray sandy shale; sandstone and grit.
		Unconformity		
Triassic.		Thaynes (?) formation and Woodside shale.	[b] 760	Gray or red shale; thin beds of limestone and sandstone.
Carboniferous	Permian and Pennsylvanian.	Park City formation.	[b] 115	White and gray limestone; chert; sandstone and shale; phosphate beds.

[b] Measurements on Vermilion Creek, Colo., by J. D. Sears, U. S. Geol. Survey Bull. 751, pp. 280, 281.

PARK CITY FORMATION (PENNSYLVANIAN AND PERMIAN)

Although the Park City formation is at least 5,100 feet beneath the surface in Baxter Basin, it is of interest as a possible source of oil or gas that might migrate upward into younger beds more easily reached by the drill. Where the formation is exposed on Vermilion Creek, Colo.,[6] it includes about 115 feet of fossiliferous limestone, chert, sandstone, shale, and phosphate beds; at places oil seems to have migrated from the formation and saturated adjacent beds, and samples of the phosphate rock give an appreciable amount of oil by dry distillation.

FORMATIONS OF TRIASSIC AND JURASSIC AGE

Above the Park City formation is a body of shale about 760 feet thick, which on Vermilion Creek is gray and drab but farther west is red. This shale body has been identified by Schultz[7] as the Woodside shale and the Thaynes (?) formation. Overlying these beds is the Ankareh (?) shale, about 200 feet thick, including red and gray sandy shale, sandstone, and grit; this is succeeded by about 950 feet of white and buff cross-bedded sandstone and some red and gray sandy shale mapped as the Nugget sandstone. Oil or gas

[6] Sears, J. D., op. cit. (Bull. 751), p. 281, 1924.
[7] Op. cit., pl. 1.

migrating upward along fault planes from the Park City formation might be held in the sandy portions of the Ankareh (?) shale or in the Nugget sandstone.

Overlying the Nugget is the Twin Creek limestone, about 125 feet thick, composed of a gray marine shale member below and a light-gray thin-bedded fossiliferous limestone above. This formation may be a source rock of oil or gas but is not believed to be porous enough to serve as an efficient reservoir.

MORRISON FORMATION (CRETACEOUS?)

Where the Morrison formation is exposed on Vermilion Creek it consists of about 500 feet of variegated clay shale in which there are a few lenses of coarse conglomeratic sandstone. In the upper half the shale is largely gray and mauve; in the lower half chiefly red and white. The records of two wells indicate that the Morrison has a similar character under Baxter Basin; the sandstones shown by the logs are probably sufficiently porous to serve as reservoirs, but it is not known whether in this area they are lenses or continuous beds.

DAKOTA SANDSTONE (UPPER CRETACEOUS)

Overlying the Morrison formation with probable unconformity is the Dakota sandstone, the "second" or "lower gas sand" of the Baxter Basin field. This formation and the Morrison together constitute the Beckwith formation as mapped by Schultz [8] on Vermilion Creek, northwestern Colorado. In that area the Dakota is 155 to 250 feet thick and includes an upper sandstone member, a middle zone of clay shale and sandstone, and a basal conglomeratic sandstone. It is shown by two wells to have essentially the same character under Baxter Basin but to be somewhat thinner.

ASPEN SHALE AND FRONTIER FORMATION (UPPER CRETACEOUS)

On Vermilion Creek the Dakota is overlain by 155 feet of hard gray to black fissile and platy shale, containing abundant fish scales and weathering to a characteristic bluish white; this shale, which strongly resembles the Mowry of Wyoming, was mapped by Schultz [9] as the Aspen shale. It is followed by 140 feet of beds which Schultz called the Frontier formation; they consist of sandy shale, thin sandstones, and a single massive sandstone at the top. Both the Aspen shale and the Frontier formation at this locality were included by the writer [10] in the Mancos shale.

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[8] Op. cit., pp. 75–77.

[9] Idem, pl. 1, pp. 74–75.

[10] Sears, J. D., op. cit. (Bull. 751), pl. 35.

Under Baxter Basin the interval from the top of the Frontier to the top of the Dakota ranges from 425 to 560 feet; probably 70 to 160 feet of these beds represent the Frontier. The Aspen shale is thus much thicker under Baxter Basin than at Vermilion Creek and may include the equivalent of part of the Thermopolis shale. The Frontier formation is the "first gas sand" or "upper gas sand" of Baxter Basin. Owing probably to an incomplete record of the Empire well in sec. 20, T. 18 N., R. 103 W., Schultz[11] included the "lower gas sand" (Dakota) in his Frontier, making that formation about 500 feet thick. The names and correlation by Schultz for Baxter Basin and Vermilion Creek as compared with those used by the writer are shown in Figure 1.

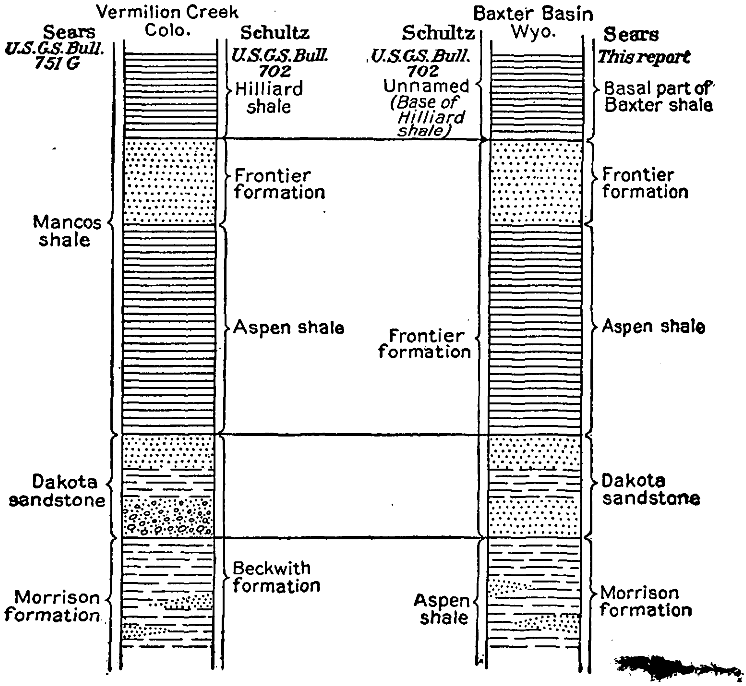


FIGURE 1.—Diagrammatic sections on Vermilion Creek, Colo., and in Baxter Basin, Wyo., showing stratigraphic divisions used by A. R. Schultz and J. D. Sears

BAXTER SHALE (UPPER CRETACEOUS)

Between the Frontier and Blair formations is 3,350 to 3,600 feet of homogeneous gray and drab shale, in part of Colorado age and in part of Montana age. Only the upper portion of this shale is exposed. Schultz gave the name Baxter shale to this portion, but in the present report the name is extended to include the whole body. It includes numerous zones of calcareous concretions and soft thin-bedded sand-

[11] Op. cit., pl. 17.

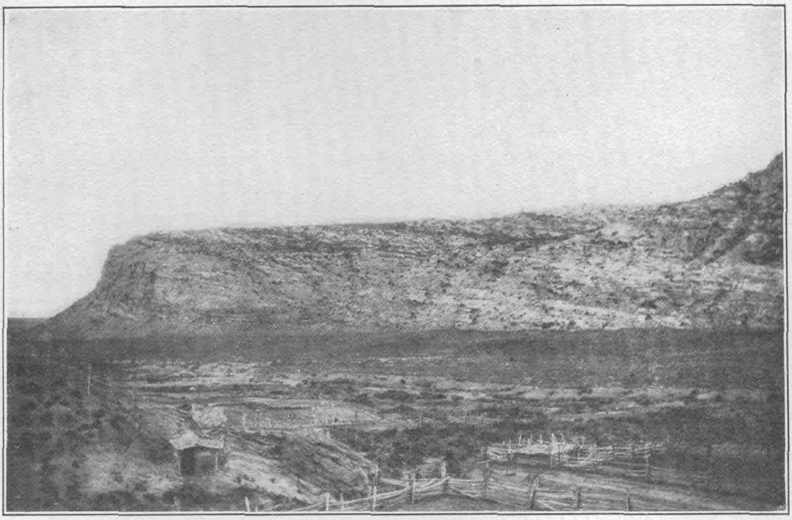
stone, which in parts of the field are excellent horizon markers. Several of these sandstones are about 6 inches to 1 foot thick, are somewhat calcareous, break with a blocky fracture, and are notably banded in yellow and brown, so that they have been frequently termed "ribbon rock"; one such layer, called in the field the "marker bed," is readily recognizable and was used as the key bed for structure contours. The "marker bed" is about 850 feet below the base of the Blair formation; it seems to be about 2,750 feet above the Frontier in Baxter Basin and about 2,490 feet in The Circle. In the "marker bed" were found several specimens of *Scaphites bassleri* Reeside (MS.), which is characteristic of the Telegraph Creek formation of southeastern Montana. It seems probable, therefore, that the "marker bed" is of very early Montana age and that at least part of the several hundred feet of shale exposed below it in Baxter Basin is of Colorado age. The stratigraphic relations of the Baxter shale are discussed further in the following section.

BLAIR AND OVERLYING FORMATIONS (UPPER CRETACEOUS)

Schultz [12] considered that the Blair formation is equivalent to the top of the Hilliard shale, and that the overlying Rock Springs and Almond coal groups, with an unnamed intermediate body of white sandstone, together represent the Mesaverde formation. The writer does not concur in this opinion. In Colorado the boundary between Mancos and Mesaverde has been placed at the horizon where there is a marked change in sediments—namely, at the transition between the underlying shale and the overlying sandstone, shale, and coal. This rule, if strictly applied in the Rock Springs uplift, would, for reasons given below, place the Mancos-Mesaverde boundary at the base of the Blair in the northern part of the field and at the top of the Rock Springs in the southern part. However, the basal sandstone of the Blair formation is persistent around the inner part of the arch, and, for the sake of uniformity, the Mancos-Mesaverde boundary is therefore mapped throughout at the base of this sandstone—that is, at the Blair-Baxter contact. In this report the Rock Springs and Almond coal groups are given the rank of formations, and the intermediate body of white sandstone, 800 to 1,100 feet thick, is named the Ericson sandstone, from its excellent exposure near the old Ericson ranch, on Salt Wells Creek, in sec. 31, T. 16 N., R. 102 W. (See Pl. III, *A*.) The Blair, Rock Springs, Ericson, and Almond formations are regarded as making up the Mesaverde group in Baxter Basin.

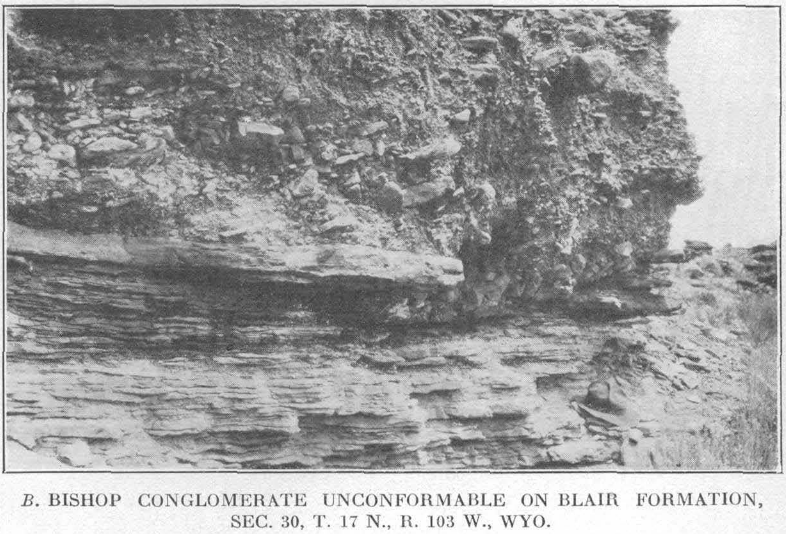
The stratigraphic evidence upon which the writer's opinion is based is not only of scientific interest but also of importance because

[12] Op. cit., p. 32.



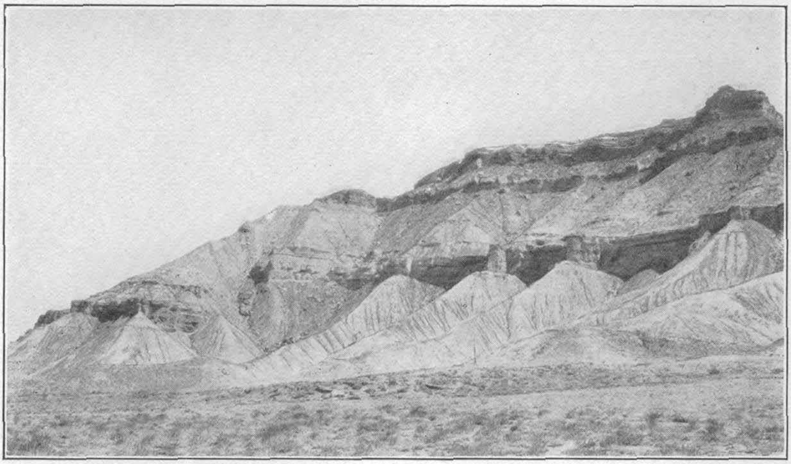
A. ERICSON SANDSTONE ON SALT WELLS CREEK, SEC. 31, T. 16 N., R. 102 W., WYO.

Buildings of the abandoned Ericson ranch in the foreground. Photograph by A. R. Schultz

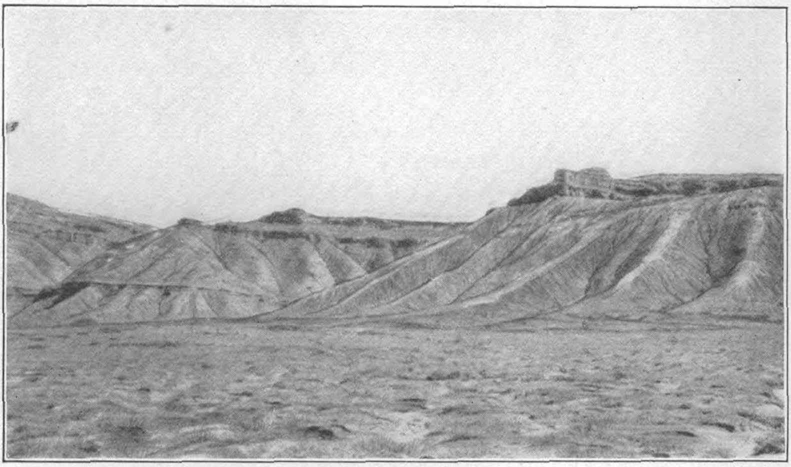


B. BISHOP CONGLOMERATE UNCONFORMABLE ON BLAIR FORMATION, SEC. 30, T. 17 N., R. 103 W., WYO.

Note angularity of fragments in the conglomerate

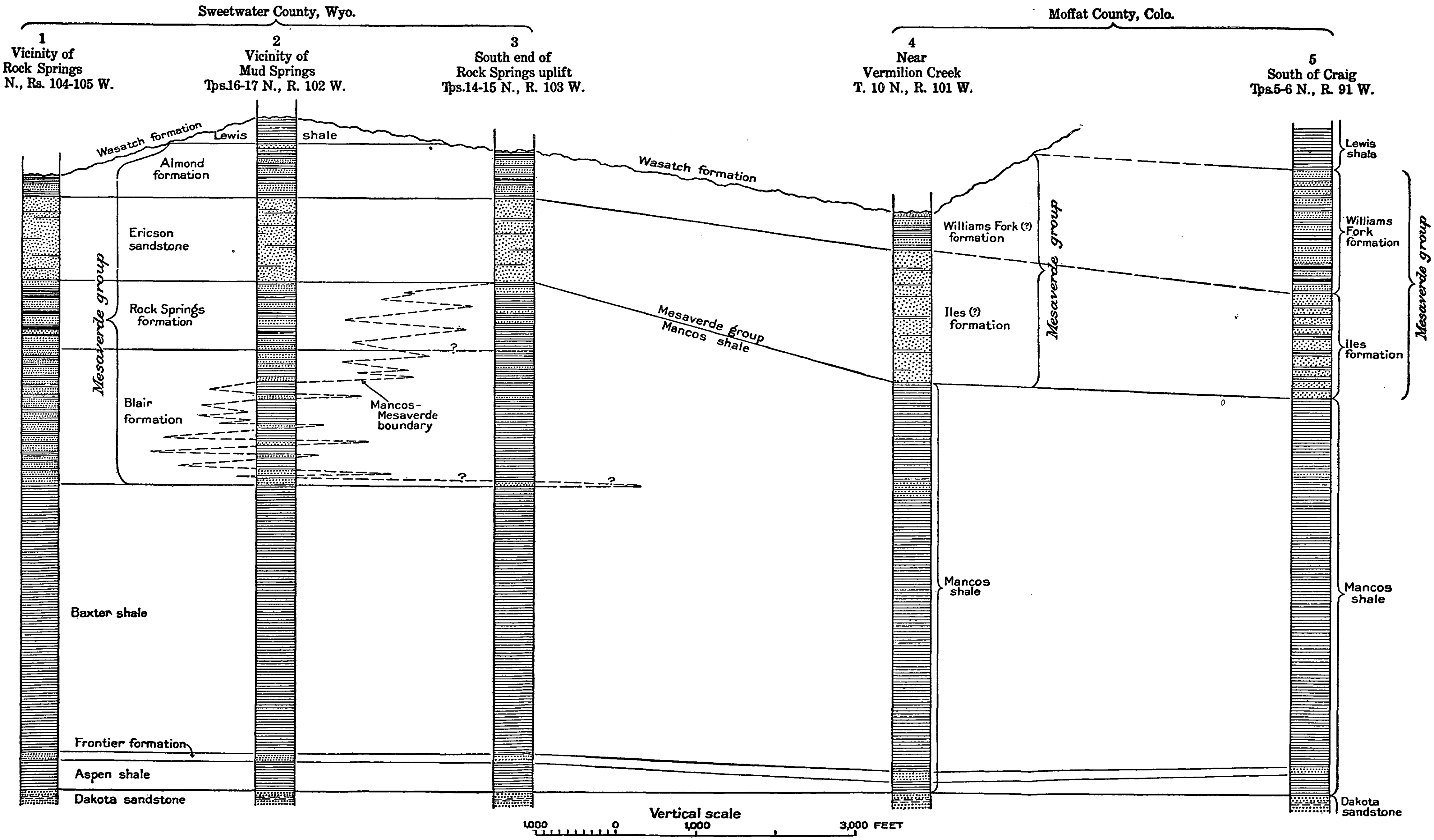


A. THREE SANDSTONES IN UPPER PART OF BLAIR FORMATION, SEC. 17, T. 17 N., R. 102 W., WYO.



B. SAME SANDSTONES HALF A MILE FARTHER SOUTH

The lowest sandstone is pinching out in the shale



SECTIONS IN SWEETWATER COUNTY, WYO., AND MOFFAT COUNTY, COLO., SHOWING CORRELATION OF THE FORMATIONS AND TRANSGRESSION OF THE MANCOS-MESAVERDE BOUNDARY it involves correlation with the section on Vermilion Creek, Colo., which many petroleum geologists have studied for light on the rocks concealed under Baxter Basin. Stated briefly, it seems clear that from north to south in Baxter Basin there is a lateral gradation in the sediments whereby the massive sandstones of the Blair and the Rock Springs formations become softer and more shaly (see Pl. IV), the thicker coal beds die out, and both formations become almost wholly gray shale, which in the south end of the uplift can scarcely be distinguished from the Baxter. Farther south under cover the change becomes complete, and on Vermilion Creek the continuous body of shale above the Frontier is overlain by a great mass of white sandstone that is unmistakably the representative of the Ericson sandstone of Baxter Basin; this is followed by drab shale, white and buff sandstone, and coal beds typical of the Almond formation. At this locality the Mancos-Mesaverde boundary has been mapped [13] at the contact between the shale and the overlying white sandstone of the Iles (?) formation (=Ericson sandstone). The relations of the strata in Baxter Basin and at Vermilion Creek are shown graphically in Plate V; the broken line shows diagrammatically the downward transgression of the lithologic Mancos-Mesaverde boundary northwestward in Baxter Basin.

BISHOP CONGLOMERATE (MIOCENE ?)

Southwest and south of Aspen Mountain is a partly eroded terrace that slopes southward for several miles and thence rises gradually toward the Uinta Mountains, many miles distant. This terrace is developed upon the resistant Bishop conglomerate, which rests unconformably upon the older beds. Near Aspen Mountain the conglomerate (see Pl. III, *B*) consists chiefly of angular and subangular fragments of sandstone from the Blair formation, but farther south, beyond the limits of this field, the conglomerate over wide areas is made up almost entirely of boulders of the red quartzite that forms the core of the Uinta Mountains. At the lowest part of the terrace in the south end of this field, where the two slopes converge, there is a noteworthy interfingering of angular sandstone fragments from the Blair formation and very small rounded pebbles and grains of the red quartzite; the dips of the layers still show the southward and northward inclination of the old surfaces on which the material was moved.

Several lenses of white fresh-water limestone, found in the conglomerate near Aspen Mountain, were probably formed in temporary ponds on the old peneplain upon which the conglomerate was deposited. One of these lenses, near Willow Spring, in sec. 34, T. 17 N., R. 104 W., reaches a thickness of 75 feet.

[13] Sears, J. D., op. cit. (Bull. 751), pl. 35.

For reasons given in another paper [14] the writer believes that the Bishop conglomerate is equivalent to the basal member of the Browns Park formation of the Uinta Mountain region.

STRUCTURE

DEFINITION AND REPRESENTATION

The term structure as applied to rock beds means their present attitude. Most sedimentary rocks were deposited in approximately horizontal beds, but many such beds have been later warped into other positions by the great forces that slowly modify the earth's crust. Some beds have been uplifted thousands of feet without being tilted; others have been inclined or bent into more or less complicated folds. Upward folds are called anticlines or, if nearly equal in length and width, domes; downward folds are called synclines. In the process of deformation many beds have been broken, and the portions on one side of the break, or fault, have been raised or lowered with reference to those on the other side.

The structure must not be confused with the shape of the present land surface. At many places the topography bears a definite relation to the structure, but at others synclines underlie the hills and anticlines are eroded to form valleys.

Knowledge of the structure is important to the seeker of petroleum and natural gas, as these substances if present are likely to accumulate in folds of certain types. It is generally believed that oil and gas are formed by the decomposition of buried organic material and are forced through porous beds or fissures by capillary action or by water and gas pressure. Where the rocks are more or less saturated with water the oil and gas tend to collect in the crests or high on the flanks of anticlines or domes, so that in general the upfolds are looked upon as the most favorable places for drilling.

Consideration should be given also to the nature of any faults that may exist in the field. Formerly unbroken anticlines were regarded with greater favor, as faults were supposed to have permitted the escape of oil and gas. To-day there is a growing tendency among petroleum geologists to look upon faulting as advantageous, on the theory that freer circulation through fissures allows more oil and gas to migrate to the higher parts of the upfolds. Moreover, by the movement of an impervious bed against a porous layer in which oil or gas may be migrating, a barrier may be formed that will trap these substances and cause accumulation behind the fault.

One method of representing structure consists of the dip and strike symbol, which consists of a bar showing the strike or direction of a

[14] Sears, J. D., Relations of the Browns Park formation and the Bishop conglomerate, and their rôle in the origin of Green and Yampa rivers: Geol. Soc. America Bull., vol. 35, pp. 279–304, 1924.

level line on the bed, and an arrow and figure showing the direction and amount of the dip (or variation from a horizontal position). A second method may be employed where the thicknesses of the formations are fairly constant and the boundary planes between them are nearly parallel. This method is the use of structure contours drawn on a key horizon. These contours are lines connecting points of equal altitude on the horizon; they are far apart where the dip is gentle and are closer where the dip is steep. The altitudes on the key horizon are determined by direct readings in the field or calculated from readings taken on other beds at known intervals above or below the key bed. On the map accompanying this report (Pl. II) the key horizon is the top of the "marker bed"; its depth above or below the surface at any point may be determined from the contours and the surface altitude; and by adding or subtracting the proper interval the altitude of any bed at that point may be calculated.

In most fields the structure of the rocks can not be seen as a whole but must be deduced by carefully piecing together all the available data, such as the attitude and varying altitude of outcropping beds, the distribution of recognizable layers and the interval between them, and the records of wells. Structure as depicted on the map, therefore, is only the student's best interpretation of the facts noted, and the accuracy of the result is in direct proportion to the amount of evidence at hand. In those parts of the field where evidence is abundant the interpretation seems definite, and the contours are drawn as solid lines; in other parts where outcrops are poor the determination is more doubtful, and the contours are broken to indicate the uncertainty.

FOLDS

As already mentioned, the Baxter Basin gas field is on the highest part of the Rock Springs uplift, which is not a simple anticline but is somewhat complicated by minor folding and much faulting. On the crest are two well-developed minor domes; the north dome has its apex in the southern part of sec. 2, T. 17 N., R. 104 W., and the south dome has its crest in the SW. ¼ sec. 10, T. 16 N., R. 104 W. A half dome, which has its apex in the SE. ¼ sec. 23 and the SW. ¼ sec. 24, T. 17 N., R. 104 W., is possibly a faulted portion of the north dome, the shape being modified somewhat by drag on the fault that bounds it on the north. For convenience, this fold will be referred to as the middle dome. It seems probable that an anticline plunges southward from the middle dome under the cover of Bishop conglomerate, passes west of the Producers & Refiners Corporation well (No. 18 on map, Pl. II), in the NW. ¼ sec. 36, T. 17 N., R. 104 W., thence continues southwestward through the isolated outcrop of the Blair formation in the NW. ¼ sec. 9, T. 16 N., R. 104 W., and passes west of the

Montacal Oil Co. well (No. 19) in the SE. ¼ sec. 8, as indicated by dips in the Blair formation at the heads of Circle and Cedar creeks.

FAULTS

All the faults observed in the field have a northeasterly direction and thus cut the Rock Springs uplift obliquely; most of them, therefore, could not have been effective as barriers against oil or gas migrating toward the highest parts of the fold. A notable exception is the supposed fault (mentioned above) that extends across the NW. ¼ sec. 24, T. 17 N., R. 104 W., and serves to close the north end of the middle dome. This closure is apparently responsible for the accumulation of gas found in the Associated Oil Co. well (No. 14) in the SE. ¼ sec. 23 and the Producers & Refiners Corporation wells (Nos. 13 and 18) in the SE. ¼ sec. 13 and the NW. ¼ sec. 36. The position of the fault as mapped by the writer is based on the direction of the fault where seen farther northeast in sec. 5 and also on the location of springs in secs. 13 and 23 near the wells.

Two other faults have possibly served to trap migrating oil or gas; these cut across curving strata and help to form semielliptical anticlines, the crests of which are in the E. ½ sec. 19 and the NW. ¼ sec. 21, T. 17 N., R. 103 W. It should be pointed out, however, that exposures at these places are poor, and that the interpretation of the structure may be incorrect as to detail.

GAS AND OIL RESOURCES

WELLS ALREADY DRILLED

Twenty-three wells have been drilled within the area mapped. (See Pl. II.) The records of the deeper holes are shown graphically in Plate VI, and a brief description of all the wells is given in the following table:

Wells in the Baxter Basin gas field, Sweetwater County, Wyo.

No. on map	Location	Company	Date of drilling	Total depth (feet)	Formation in which well stops	Remarks
	T. 18 N., R. 103 W.					
1	SW. ¼ sec. 16	Dry Lake Oil & Gas	1915-16	2,654	Dakota	Showings of oil and gas; some water; flowing water in Dakota; abandoned.
2	NW. ¼ sec. 20	Dry Lake Oil & Gas and Empire Gas & Fuel.	1915-1918	3,490	Nugget	Some gas, oil, and water; abandoned.
3	NW. ¼ sec. 30	Midwest Refining	1922-23	513	Baxter	Abandoned.
4	SW. ¼ sec. 30	Midwest Oil	1915-16	1,000	do	Rig too small; abandoned.
	T. 18 N., R. 104 W.					
5	SE. ¼ sec. 25	Midwest Refining	1923	2,478	Dakota	Water in Frontier and Dakota; abandoned.
6	NE. ¼ sec. 36	do	1922-23	2,468	do	Water in Frontier and Dakota; shut down.
7	SW. ¼ sec. 36	do	1924	1,858	Frontier	Gas, 4,000,000 cubic feet a day, in Frontier.

Wells in the Baxter Basin gas field, Sweetwater County, Wyo.—Continued

No. on map	Location	Company	Date of drilling	Total depth (feet)	Formation in which well stops	Remarks
	T. 17 N., R. 104 W.					
8	NE. ¼ sec. 2	Midwest Refining	1922-23	1,848	Frontier	Gas, 8,000,000 cubic feet a day, in Frontier; some water. Rig burned.
9	NE. ¼ sec. 11	do	1921-1924	3,502	Nugget	Gas, 2,000,000 cubic feet a day, in Frontier, 27,000,000 in Dakota; water at several horizons in Morrison and Nugget. Trying to plug back to gas in Dakota.
10	N. ½ sec. 14	Ohio Oil	1923	1,150	Baxter	Hole lost.
11	do	do	1923	20	do	Abandoned.
12	SW. ¼ sec. 13	Producers & Refiners.	1922-23	1,635	do	Hole lost.
13	SE. ¼ sec. 13	do	1924-25	3,346	Dakota	Water in Frontier; gas, 21,000,000 cubic feet a day, in Dakota.
14	SE. ¼ sec. 23	Associated Oil	1922-1924	3,283	do	Gas in Frontier and 24,000,000 cubic feet a day in Dakota.
15	SW. ¼ sec. 24	Montacal Oil	1922		Baxter	Shallow hole; shut down.
16	SE. ¼ sec. 26	Associated Oil	1922-23	950	do	Shut down.
17	SE. ¼ sec. 27	Montacal Oil	1922-23		do	Spudded in and shut down.
18	NW. ¼ sec. 36	Producers & Refiners.	1922-1924	3,440	Dakota	Gas, 20,000,000 cubic feet a day, in Dakota
	T. 16 N., R. 104 W.					
19	SE. ¼ sec. 8	Montacal Oil	1922-23	509	Baxter	Shut down.
20	SW. ¼ sec. 10	Midwest Refining	1923	2,607	Frontier	Gas, 1,000,000 cubic feet a day, in Frontier; shut down.
21	SE. ¼ sec. 16	Ohio Oil	1922	2,515	Dakota	Gas, 1,000,000 cubic feet a day, in Frontier, 17,000,000 to 35,000,000 in Dakota; rig burned.
22	NE. ¼ sec. 21	do	1922-23	2,950	do	Gas, 2,000,000 cubic feet a day, in Frontier, 70,000,000 in Dakota.
23	NE. ¼ sec. 22	do	1923-24	2,850	do	Gas, 2,000,000 to 5,000,000 cubic feet a day, in Frontier; water in Dakota; abandoned.

The two deep tests (Nos. 2 and 9) undoubtedly penetrated the Nugget sandstone; their records show conclusively that the "lower gas sand" is the Dakota and not part of the Frontier formation. For comparison the detailed logs of the lower parts of these wells and the corresponding section measured by the writer on Vermilion Creek, Colo., are plotted in Plate VI.

PROBABLE EXTENT OF THE GAS POOLS

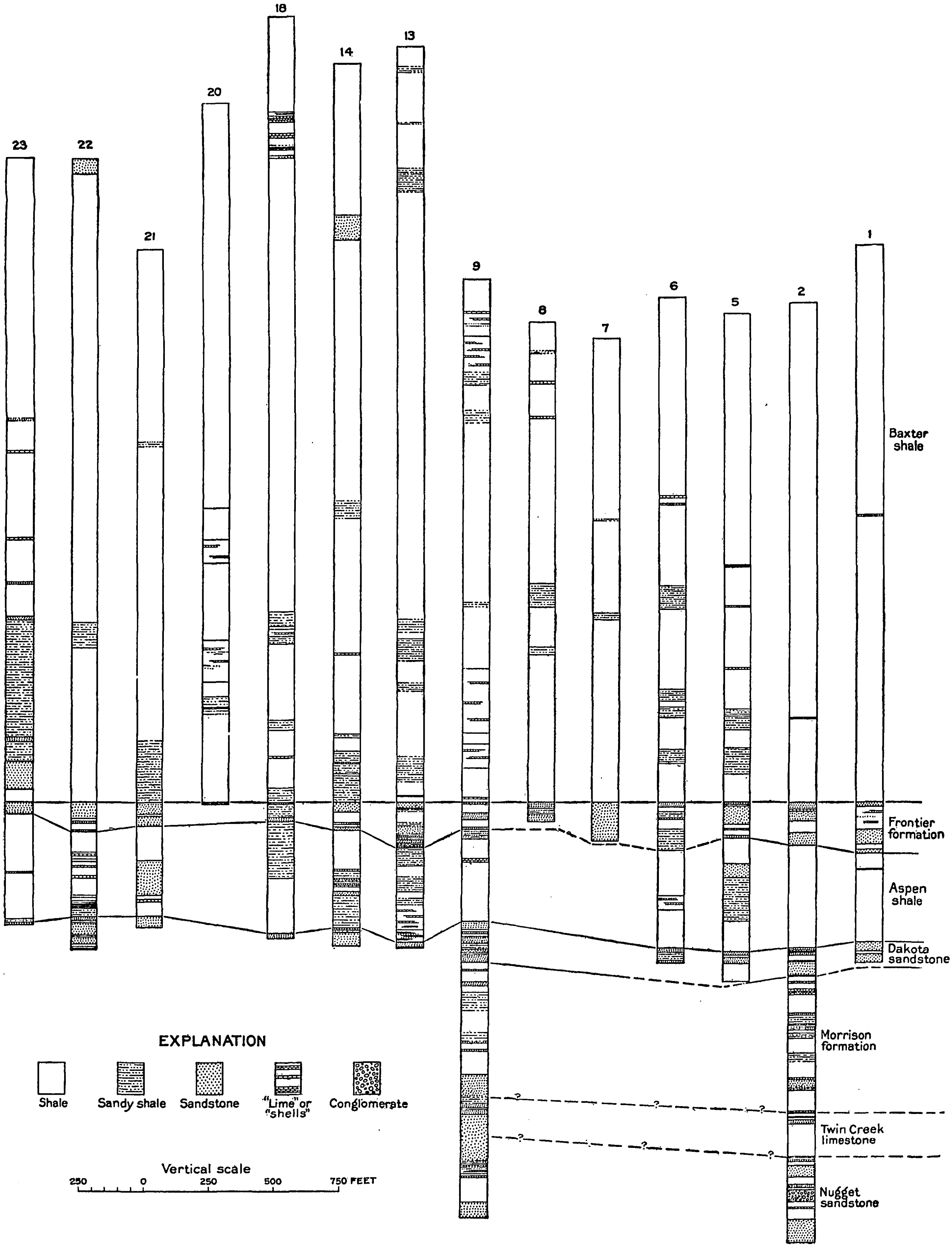
Although the productive sands reach approximately the same altitudes (Frontier, 5,100 to 5,275 feet; Dakota, 4,660 to 4,800 feet) in the north, middle, and south domes, and although gas is found in commercial quantity in each dome, the gas can scarcely occur in a single continuous pool, as the domes are separated by structural depressions and by faults that offset the reservoir beds. Each dome may therefore be considered to have its own pool, the extent of which may be estimated by the results of drilling already done.

At or near the crest of the north dome the well in the NE. ¼ sec. 11, T. 17 N., R. 104 W. (No. 9), found gas in both the Frontier and the Dakota. The well in the SW. ¼ sec. 36, T. 18 N., R. 104 W. (No. 7), about 100 feet lower structurally, found gas in the Frontier; it has not been drilled to the Dakota. The wells in the NE. ¼ sec. 36 (No. 6) and SE. ¼ sec. 25 (No. 5) found water in both the Frontier and the Dakota; these wells are about 300 feet structurally below the crest of the dome. Wells to the northeast, still lower on the dome, also found water and only showings of oil and gas. It seems probable, therefore, that commercial production will be confined to the highest part of the dome, within the 7,600-foot contour as mapped (Pl. II).

As a result of faulting the beds are at a somewhat higher altitude in part of the east flank of the south dome than on its structural crest in the SW. ¼ sec. 10, T. 16 N., R. 104 W. On the east flank the wells in the SE. ¼ sec. 16 (No. 21) and the NE. ¼ sec. 21 (No. 22) found gas in both the Frontier and the Dakota; the well in the NE. ¼ sec. 22 (No. 23), about 425 feet structurally below the highest part of the flank southeast of the fault, found gas in the Frontier, but water in the Dakota. As the Dakota is the valuable producing formation in the field, the last-named well seems to indicate the edge of the productive area; for this reason further drilling outside of the 7,300-foot contour on the east flank would appear inadvisable. The extent of the pool on the crest of the dome is less certain, as the only well on it, in the SW. ¼ sec. 10 (No. 20), found gas in the Frontier but did not test the Dakota. The Frontier is at an altitude more than 400 feet lower at this point than in the well in sec. 16. The well in sec. 10 is believed to be on the northwest or downthrown side of a fault that cuts the crest of the dome; on this side of the fault the gas pool may not extend beyond the 6,900-foot contour, and on the southeast side of the fault it may not extend beyond the 7,200-foot contour.

On the middle dome gas has been found in the Frontier and the Dakota by the three wells thus far completed. The lower two wells—No. 18, in the NW. ¼ sec. 36, and No. 13, in the SE. ¼ sec. 13, T. 17 N., R. 104 W.—are about 160 feet below the crest of the fold; they are probably not near the edge of the gas pool, which, by comparison with those on the other domes, may be expected to extend at least 300 feet structurally down the flanks. If this assumption is correct, the 7,500-foot contour would form the approximate boundary of the productive area.

Some gas may have been trapped on the southeast or upthrown sides of the faults in the semielliptical anticlines described on page 24, and these folds therefore offer some encouragement for test wells.



GRAPHIC LOGS OF THE DEEPER WELLS IN THE BAXTER BASIN GAS FIELD, SWEETWATER COUNTY, WYO.

Numbers correspond to those on map and in text

POSSIBILITY OF OIL PRODUCTION

After gas in large amounts had been discovered by the first wells on the north and south domes, it was hoped that oil would be found either by deepening these wells or by drilling others. This hope was based on three lines of reasoning. First, it was supposed that both gas sands belonged to the Frontier formation and that the possibly oil-bearing Dakota had not been reached. Second, it seemed likely that the two sands in which gas was found near the crests would contain oil farther down the flanks. Third, regional metamorphism of the rocks has not progressed so far that all the hydrocarbons must necessarily have been changed to gas; this is shown by the coal of the Rock Springs and Almond formations, and also by coal from the Frontier formation in the well in sec. 2, T. 17 N., R. 104 W. (No. 8) (obtained by the Midwest Refining Co. and analyzed by the Bureau of Mines), which contains only 52.3 per cent of fixed carbon in the moisture and ash free state.

Results of later drilling have almost dispelled the hope for oil. It is now known with certainty that the "lower gas sand" is the Dakota. Furthermore, the occurrence of water so high on the flanks of the north and south domes leaves little room for oil between the water and the gas. It still seems possible but is not probable that oil will be found on the flanks of the middle dome or in narrow zones around the north and south domes.

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