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PETROLEUM POSSIBILITIES OF CERTAIN ANTICLINES IN SOUTHEASTERN IDAHO

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FOREWORD

The State Bureau of Mines and Geology in fulfillment of its duty to the public, and as an aid to the development of the state's mineral resources, has undertaken during the past three years to study certain areas in the state which either by reason of popular excitement or of geologic configuration appear to justify investigation as to oil possibilities.

The phenomenon of popular excitement precipitated by the pronouncements of wandering self-styled "geologists", "oilologists", and the like is a familiar one, against which the voice both of prudence and of sound geologic opinion speaks for a time in vain. Some of the areas investigated are those, the residents of which have been victimized by this sort of thing. To other areas attention has been called by thoughtful and careful citizens prompted by a proper and beneficient self-interest to share in the development of the state's natural resources; to such persons the State Bureau has endeavored to extend all assistance within its power. It is to be regretted that to many earnest inquirers our replies have had to be of a discouraging nature, but it is obvious that we would indeed be derelict in our public duty if we failed to point out clearly the extent to which any area in question apparently fulfills or fails to fulfill the now well recognized and well understood requisites for a possible oil-bearing field.

The three areas, all situated near the Idaho-Wyoming line, which are described in this bulletin, appear to be, so far as can be ascertained, the least unlikely areas in the state for legitimate oil prospecting.

There have been a number of oil promotions and incipient "oil-booms" in other parts of the state, some meritorious in the sense of being honostly undertaken; some meretricious in the sense of being based upon petroleum-filled stone-jugs, or other containers, lowered into wells in basalt, or upon the assumption that ash beds in Miocene basalt are Cretaceous sandstone, and various other geological monstrosities. However, with the exception of the areas described herein and other areas adjacent to them, there are no parts of the state at present recognized as geologically favorable to oil formation and accumulation.

FRANCIS A. THOMSON

PETROLEUM POSSIBILITIES OF CERTAIN ANTICLINES IN SOUTHEASTERN IDAHO

Virgil R. D. Kirkham

Introduction.

As a result of visiting and examining various areas throughout the state, the writer has compiled this brief report and series of reconnaissance maps, dealing with those localities thought to be most favorable for petroleum prospecting.

In the preparation of the report the fullest possible use has been made of the work and publications of the United States Geological Survey. In fact, this report represents quite as much a compilation of existing data as it does the results of original field work. The writer, however, assumes full responsibility for all the deductions drawn.

A careful perusal of the following pages will advise the reader that only advantages and disadvantages are pointed out in the least unlikely areas, and that these are not held up to attention as definitely oil bearing. The purpose of this brief report is to indicate to the legitimate operator and leader of development the places where the percentage for success is higher for the same money expended than in other localities in the state.

The area discussed in this report lies in southeastern Idaho on and near the Wyoming border, and lies on a continuation of a geological series that is oil bearing in Wyoming. The location of the area is made clear by the key map. (Pl. 1, appendix)

The entire region under discussion can most conveniently be described under three area headings: the Border area, Phosphoria area, and Teton area.

Acknowledgments.

The writer takes pleasure in acknowledging his deep indebtedness to the following members of the United States Geological Survey: Mr. G. R. Mansfield, who has done the most recent and exhaustive work in southeastern Idaho; to Dr. David White, Chief Geologist; to Mr. K. C. Heald, who is on special petroleum assignment for the Survey, and to Miss W. B. Wilmarth, secretary of the committee on geologic names; also to Dr. Francis B. Laney, Professor of Geology, University of Idaho, for suggestions and criticisms advanced by them

after reading the manuscript of this bulletin. The writer also wishes to acknowledge his gratitude for the painstaking reading of the manuscript by Mr. Arthur M. Piper, Geologist of the State Bureau of Mines and Geology.

Bibliography.

An attempt is made here to present a list of all publications of the United States Geological Survey dealing with the geology of southeastern Idaho. The greater part of this work deals with the phosphate resources, and the geology of a considerable portion of the localities described in this bulletin has been covered in detail.

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Gale, H. S., Geology of the Copper Deposits near Montpelier, Bear Lake County, Idaho. U. S. Geol. Survey Bull 430, pp. 112-121, 1909.

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Girty, G. H., The Fauna of the Phosphate Beds of the Park City Formation in Idaho, Wyoming, and Utah. U. S. Geol. Survey Bull. 436, 82 pp. 1910.

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Hayden, F. V., Eleventh Ann. Rept. of the Territories. 720 pp. 1879.

Mansfield, G. R., Nitrate Deposits in Southern Idaho and Eastern Oregon. U. S. Geol. Survey Bull. 620, pp. 19-44, 1915.

Mansfield, G. R., Geography, Geology, and Mineral Resources of the Fort Hall Indian Reservation, Idaho. U. S. Geol. Survey Bull. 713, 152 pp, 1920.

Mansfield, G. R., Coal in Eastern Idaho. U. S. Geol. Survey Bull. 716, pp. 123-153, 1920

Mansfield, G. R. and Roundy, P. V., Revision of the Beehwith and Bear River Formations of Southeastern Idaho. U. S. Geol. Survey Prof. Paper 98, pp 75-84, 1917.

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Richards, R. W. and Bridges, J. H., Sulphur Deposits near Soda Springs, Idaho. U. S. Geol. Survey Bull. 470, pp. 499-503, 1910.

Richards, R. W. and Mansfield, G. R., Preliminary Report on a Portion of the Idaho Phosphate Reserve. U. S. Geol. Survey Bull. 470, pp. 371-439, 1910.

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Russell, I. C., Geology and Water Resources of the Snake River Plains of Idaho. U. S. Geol. Survey Bull. 199, 192 pp., 1902.

Schultz, A. R., A Geologic Reconnaissance for Phosphate and Coal in Southeastern Idaho and Western Wyoming. U. S. Geol. Survey Bull. 680, 84 pp. 1918.

Schultz, A. R. and Richards, R. W., A Geologic Reconnaissance in Southeastern Idaho. U. S. Geol. Survey Bull. 530, pp. 267-284, 1913.

Van Horn, F. B., The Phosphate Deposits of the United States. U. S. Geol. Survey Bull 394, pp. 157-171, 1909.

Weeks, F. B. and Ferrier, W. F., Phosphate Deposits in Western United States. U. S. Geol. Survey Bull. 315, pp. 449-462, 1907.

Weeks, F. B. and Heikes, V. C., Notes on the Fort Hall Mining District, Idaho. U. S. Geol. Survey Bull. 340, pp. 175-183, 1908.

Woodruff, E. G., The Horseshoe Creek District of the Teton Basin Coal Field, Fremont County, Idaho. U. S. Geol. Survey Bull. 541, pp. 379-388, 1914.

Field Work.

Two townships of the region namely, T. 8 S., R. 45 E., and T. 11 S., R. 45 E., Boise Meridian, have been mapped with detailed areal geology by geologists of the United States Geological Survey.[1] No attention was given by them to oil possibilities since the purpose of their mapping was to discover the extent of the western states phosphate series. Two more townships namely T. 5 S., R. 45 E. and T. 5 S., R. 46 E., were traversed by Survey geologists in a reconnaissance across southeastern Idaho;[2] in this case, however, no attempt at mapping the area was made.

The geology and a part of the structure of the Teton area has been worked out by Mr. G. R. Mansfield, of the federal Survey, in connection with his investigation of the coal beds of that region.[3] A part of the Border area was covered by another federal geologist, Mr. C. L. Breger, on a brief reconnaissance of the salt deposits of the region.[4] No attention was given to oil possibilities in his report. The remaining parts of the areas in discussion were mapped by the writer, and all localities were visited by him during three periods in the field: August and September, 1920, August, 1921, and a week's time in November, 1921.

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[1]Richards, R. W., and Mansfield, G. R., Geology of the Phosphate Deposits Northeast of Georgetown, Idaho. U. S. Geol. Survey Bull. 577, pp. 56-58 and 65-70, 1914.

[2]Schultz, A. R., and Richards, R. W., A Geological Reconnaissance in Southeastern Idaho. U. S. Geol. Survey Bull. 530, pp. 267-284, 1911.

[3]Mansfield, G. R., Coal in Eastern Idaho. U. S. Geol. Survey Bull. 716, pp. 123-153, 1920

[4]Breger, C. L., The Salt Resources of the Idaho-Wyoming Border, with Notes on the Geology. U. S. Geol. Survey Bull. 430, pp. 555-569, 1909.

Anticlines in Southeastern Idaho

The Border Area.

The Border area, includes townships as follows: 5 South, Range 46 East: 5 South, Range 45 East; 7 South, Range 46 East; 8 South, Range 46 East; 9 South, Range 46 East; 11 South, Range 45 East.

Location.

This group of townships lies in Caribou County adjacent to and near its eastern border, which is also the boundary line between the states of Idaho and Wyoming. Supplementary information may be gained by referring to the key map of Caribou County (Pl. 1. appendix) The townships are most accessible from Afton, Auburn, and Freedom, Wyoming; these towns in turn are accessible only from Cokeville, Wyoming, or Montpelier, Idaho, by stage routes. The distance to Afton from either of the latter towns is approximately sixty miles.

Topography.

The northern townships of the group lie in the Caribou mountains and along the eastern side of the range. The central group lies on the foothills bordering Star Valley. The southern-most township lies in the Preuss Range. The relief is rather bold and the country is generally rough and mountainous. The northern group has a range of altitude from 5750 to 8500 feet above sea level.

The centrally located area varies in altitude from 6050 to 7608 feet. The Preuss Mountains, in the southern part of the area under discussion, have peaks exceeding 10,000 feet elevation and the general area is above 8000 feet.

In parts of four townships bordering on Star Valley, dairying and stock raising is the only profitable industry. The rest of the area in question is included in the Caribou National Forest, and is fairly rough and timber covered.

Stratigraphic Geology.

The geological beds of this area are all sedimentary and are of marine origin with the exception of a few local areas of stream gravels, alluvial fans, and other continental deposits mapped as alluvium.

The beds of the Border area may be conveniently separated into two groups which are areally divided by the great Bannock thrust fault. Those lying to the west of the fault line are older than those that lie on the eastern side. The older beds are Carboniferous in age and are not considered in the discussion of possible oil bearing beds of the Border area. The beds areally exposed in the localities under investigation are the Gannet group (Cretaceous and Jurassic age), the Twin Creek (Jurassic age), and the Nugget (Jurassic age).

The beds of the Gannet group which cover a large part of the territory described in the Border area, have a series of general characteristics in this part of Idaho. The beds are generally made up of white, gray, yellow, brown, and reddish yellow shales and sandstones. Red and gray conglomerates are common and considerable amounts of quartzite and limestone are often found. The lower members of the formation are invariably reddish and chocolate brown sandstones; an occasional whitish or grayish bed appears. Heavy red conglomerates higher in the series outcrop as erosion-resisting ridges. Fossils of upper Jurassic or lower Cretaceous age are present in various localities. The Gannett varies in thickness throughout the area, but where uneroded is probably never less than 2000 feet thick or in excess of 4700 feet.

The Twin Creek of Middle Jurassic age ranks next in areal extent throughout the area. It is generally made up of black gray, and bluish gray limestone in which Jurassic fossils are numerous. The base and top of the formation are easily distinguished by the characteristic red beds of the contiguous formation. The Twin Creek thickness varies from 1500 feet in the northern townships to 3500 feet in the southern-most portion of the area.

The Nugget has a surface outcrop only in T. 11 S., R. 45 E., but since it can be penetrated by the drill in each township and appears in the geological structure sections it will receive mention here. It is generally a deeply colored reddish sandstone with thin layers of sandy shale; it has a white coarse grained sandstone for its base and where the upper part is uneroded a considerable thickness of white sandstone forms the topmost member. In some localities the formation contains massive limestone layers. The formation is generally resistant as compared to other nearby beds and with its high coloration is easily identified. The thickness of the Nugget where exposed is 1900 feet; however, it is suspected that a great

deal of the area is underlain by a thickness of scarcely more than 1000 feet of this formation.

No fossils have been found in this formation and its age has been allotted to the Jurassic, because it lies between beds of known ages and fossil horizons. A great deal of the folding of the area appears to have resulted from a post Gannett (Cretaceous) uplift. The complexity of the structure is the probable result of the major Cretaceous-Eocene uplift which followed. The tremendous faulting of the area is believed to have occurred from late Cretaceous to early Eocene.

Possible Horizons of Oil.

Of the formations just described, only the Twin Creek and Nugget seem feasible for testing in this area. By reference to the correlation table, (see appendix), it will readily be seen that the Gannett and Twin Creek beds are correlated with the Morrison and Sundance formations of the petroleum and gas producing fields of Wyoming. The Nugget formation is likewise the same as the Chugwater in the Wyoming geological column. There is a possibility that the beds which lie immediately below the Nugget are included in the Chugwater series of Wyoming.

Gas is produced in commercial quantities from the Morrison (Gannett)[1] formation in the Shoshone River field of Wyoming; seeps or small productions of oil and gas are obtained from the Morrison (Gannett)[2] beds in the Salt Creek[3] and Powder River[4] fields of central Wyoming, and in the Florence[5] field of Colorado. The Sundance (Twin Creek) formation also has seeps or small productions of oil and gas in the Poison Spider,[6] Salt Creek,[3] and Powder River,[4] fields of Wyoming.

The Chugwater (Nuggett) formation produces small amounts of oil and natural gas at several places in the Lander and Central Wyoming fields and at Hudson, Dallas, and Derby in the Bighorn Basin; it also produces commercial oil at many localities in the Lander field.

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[1]Hewett, D. F., The Shoshone River Section, Wyoming. U. S. Geol. Survey Bull. 541, pp. 89-113, 1914.

[2]Hares, C. J., Anticlines in Central Wyoming. U. S. Geol. Survey Bull. 641, pp. 233-279, 1917.

[3]Wegemann, C. H., The Salt Creek Oil Field, Natrona County, Wyoming, U. S. Geol. Survey Bull. 452, pp37-83, 1911.

[4]Wegemann, C. H., The Powder River Oil Field, Wyoming, U. S. Geol. Survey Bull. 471, pp. 56-75, 1912.

[5]Washburne, C. W., The Florence Oil Field, Colorado. U. S. Geol. Survey Bull. 381, pp. 517-544, 1910.

[6]Heald, K, C., Personal communication.

Township 5 South, Range 46 East. (Pl. 2, appendix)

This township lies in the Caribou Range adjacent to the Idaho-Wyoming state line. Its northern part is crossed by the 43rd parallel and Tincup Creek. The town of Freedom, Wyoming, lies on its eastern side; Gray's Lake and the town of Wayan lie about fifteen miles west of the western extremity. The region is one of high relief, rough topography, and some timber. The country near Freedom is about 5800 feet above sea level and the altitude of the rest of the area is well above 7000 feet. A traverse was made along Tincup Creek by A. R. Schulz and R. W. Richards[1] in the summer of 1911. The writer visited this area in November, 1921.

Structural Geology.

Two anticlines and a syncline are the prominent structural features of this township. One anticline is of the type known as isocline and consequently of less importance with respect to oil accumulation than the remaining one.

Along the central and eastern portions of this area the Gannett, Twin Creek, and Nugget beds, which appear to be conformable, lie in an anticlinal fold which is known to extend from Sec. 5 to Sec. 28. This fold averages a mile in width and is fairly symetrical. The dips of its flanks range from 30° to 50°, all being much more moderate than those of many anticlines in the Caribou Range. The outcrop of the Twin Creek formation occurs along an overturned fold that extends transversely of the southwestern portion of this township and into the area lying directly westward. The Gannett group has been entirely eroded and the crest of the Twin Creek removed. Very steep dips characterize this structure, inclinations of 80° to 85° and 90° being found along each limb. The dips when plotted on the map all point in an easterly direction due to asymmetrical character of the fold. No important closure was detected on either of these structures, and it is doubtful whether trapping of oil has occurred in the beds of this area, due to the lack of closed structure.

Geological Column of Area.

The Gannett group is the upper-most series and is partly removed by erosion; its greatest thickness in this area lies along the axis of the syncline.

The Twin Creek is partly eroded along the axis of the western-most anticline. It lies at a depth of approximately 1200 feet along the eastern transverse fold.

The Nugget underlies the surface along the axis of the eastern anticline at a depth of about 2700 feet.

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[1] Schultz, A. R., and Richards, R. W., A Geologic Reconnaissance in Southeastern Idaho. U. S. Geol. Survey Bull. 530, p. 267, 1913.

The Thaynes, which probably underlies the Nugget, is at a depth in excess of 3700 feet; this formation is as deep as a test would be likely to penetrate in this area.

Township 5 South, Range 45 East. (Pl. 3, appendix)

This township lies directly west of Township 5 South, Range 46 East, discussed above. Freedom is also the outlet for this territory. Gray's Lake lies eight miles west of the western extremity of the area. The township lies in the heart of the Caribou Range and has a topography similar to that of the township lying east of it, which has already been discussed.

Structural Geology.

This township is notable for seven almost parallel anticlines, and seven similar synclines. These folds traverse the area with a northwest southeast trend. The most eastern anticline is a continuation of the isocline of the township discussed just previously and the reader is referred back for its description. Another isoclinal asymmetric anticline parallels the South Fork of Tincup Creek.

The crest of the Twin Creek formation makes its appearance along the axis of five of the anticlines, thus eliminating the Gannett series from consideration with respect to these folds. The two western-most folds are in the Twin Creek at the surface and the underlying Nugget. Their dips range from 75° to 40° on No. 1 to about 35° on No. 2 a little farther east. Each of these two anticlines is a little over 1000 yards wide and extends beyond the extremities of the township. Only two other anticlines in the area deserve serious attention. The eastern one has Bechwith beds at the surface and extends from Sec. 4 to Sec. 24. It is no more than a half mile wide and its flanks dip steeply, often as much as 80° . The other structure mentioned extends from Sec. 8 to Sec. 27. It is also less than a half mile in width. It is asymmetric and has a steeply inclined eastern flank at 60° and a gentler dip of 30° or less on the western limb.

Geological Column of Area.

The geological map of this area (Pl. 3, (appendix) shows alternating bands of Gannett and Twin Creek formations, the Twin Creek being masked by the overlying Gannett except where exposed by erosion.

Oil in the Nugget and Thaynes is a possibility offered by those anticlines in which the Twin Creek forms the crest, a possibility which might well be tested. The Nugget lies no more than 1200 feet from the surface in these structures. In these folds, the Thaynes may be entered at a depth of 3000 feet.

The anticlinal fold in the Gannett (Sec. 4 to 24) covers the crest of the Twin Creek to a probable depth of 900 feet. This would permit penetration of the Nugget in this fold at a depth of about 2200 feet, and the Thaynes at less than 4000 feet from the surface.

Township 7 South, Range 46 East. (Pl. 4, appendix)

This township lies on the Idaho-Wyoming border, its northern extremity lying six miles south of T. 5 S., R. 46 E. Auburn, Wyoming lies within two miles of the boundary and with Afton serves as a distributing point for the area. Less than a fourth of this township lies in the Forest Reserve, consequently it is fairly well settled. Only a small amount of timber is present and that stands on the older rocks west of the Bannock fault escarpment.

The topography is fairly rough but the relief is mild when compared with that of the Caribou Range. Altitudes vary from 6050 to 6500 feet above sea level. The country is well drained by streams, and salt springs that are worked to some extent are numerous.

Differences in hardness of the various beds have developed several ridges on the flanks of the anticlines where the crest has been removed by erosion.

Structural Geology.

A portion of this township represents the older Carboniferous series, which in the legent of the map, appears unshaded. This series lies in the southwestern portion and is bordered by the line of the well known Bannock thrust fault. The altitude and relation of the formations are shown in the cross-section.

Of the Cretaceous, Jurassic, and Triassic series, the Gannett and Twin Creek are the only formations exposed. However, the Nugget as well must be considered in this area.

The township contains one very excellent structure. This consists of an undulation on the anticline that enters the area in Sec. 6 and leaves it in Sec. 34. The shape of this closure is easily traced by the lower gray band in the Stump sandstone of the Gannett group that forms erosion-resistant ridges and serves as an ideal horizon marker for that series. Its outcrop is indicated on the geological map by long dashes. Just north of Stump Creek in Sec. 21, the anticline plunges; it rises again in Secs. 27 and 28, thus producing closure for two structures on the anticline.

The Gannett beds cover the entire area, with the exception of a nearly circular exposure of the Twin Creek on the apex of the dome where the overlying Gannett has suffered the most erosion. The other parts of the area are covered by alluvium and by the Carboniferous

strata west of the fault escarpment. The structures in this area average two miles in width, and the northern one is four miles long. This affords considerable gathering ground should the underlying beds contain oil. The dips range from 15° to 40°.

A syncline parallels the axis of the anticline and traverses the eastern part of the area. The anticlinal axis has suffered the most erosion and a valley containing the creeks and the road lies along the crest.

Four salt springs lie along the axis of the anticline. Their location may be ascertained from the township geological map.

Geologic Column of Area.

The Gannett group, due to lack of erosion, overlies the Twin Creek in this area. Its thickness in the main eastern syncline is over 3500 feet, but along the dome it varies from nothing to 600 feet. The Twin Creek, lying next in the column, has been protected in this area, and its entire thickness is represented. Its thickness is thought to be about 2000 feet in this township since it is thinner in the region north and has a greater thickness to the south.

The Nugget underlies the Twin Creek and can probably be tested at a depth of 2600 feet at any place on the structure. It is not likely that any underlying formation could be reached at a depth less than 4000 feet.

Township 8 South, Range 46 East. (Pl. 5, appendix)

This township lies about six miles west of Afton, Wyoming, on the Idaho border and directly south of the Stump Creek township described above. This region is known as the Tygee country and is generally occupied by beef and dairy herds. Afton serves as the distributing center. The area is hilly and well cut up by drainage. It is sparsely timbered and more accessible than the Stump Creek township. Considerable stretches of alluvium covering lake gravels afford large areas suitable for agriculture and grazing. Two salt springs of commercial use lie along the anticline in this area.

Structural Geology.

The Bannock fault cuts the area into two distinct provinces as in the Stump Creek township. The Gannett and Twin Creek are exposed areally, although parts of them are covered with Oligocene and Miocene lake and continental gravels overlain by alluvium.

The anticline discussed in the Stump Creek area extends through the east central part of this township. This region contains another undulation on the axis of the anticline. Good closure is represented over the entire structure in this area.

The dips along the anticline range from 36° to 60° and its width is about three miles, thus affording a fair gathering ground for any oil, water, or gas that might exist in the underlying strata.

Geologic Column of Area.

In the northern part of the area, the erosion of the fold permits the Twin Creek to be exposed along its crest and the overlying Gannett occupies the flanks of the area. The Gannett, due to its almost vertical altitude, shows a thickness probably in excess of 3800 feet. At any place on the structure suitable for drilling the Gannett group would not be entered. The Twin Creek at this point has been slightly eroded along the crest of the fold; the Nugget underlies it at an estimated distance of 1800 feet. The latter in turn is underlain by the Thaynes at a depth less than 4000 feet from the surface. Testing would probably not extend below this formation. The structure lying in the northern half of the township is best suited for testing.

Township 9 South, Range 46 East. (Pl. 6, appendix)

This township lies immediately south of the last area described. It is called the Crow Creek country and is an extension of the terrain of the Tygee country. The eastern boundary of the township lies about eleven miles from Afton and about four miles from Fairview, Wyoming. Crow Creek, meandering over its wide flood plain valley, flows northeastly across the township to its junction with Salt River near Afton. The deep, steepsided valleys of the tributaries dissect the region; the resulting absence of flat fertile areas away from the main creek bed has limited the number of ranches. The country to the south of Crow Creek is mountainous and carries considerable timber. The area beyond the Bannock fault line is also rough and well wooded. The altitudes range from 6300 to 7700 feet. This area also contains salt springs. A rock salt mine with large deposits of salt has been worked commercially for a number of years. It lies across Crow Creek from Lowe's ranch.

Structural Geology.

The anticline that forms the main structural feature of the Stump Creek and Tygee townships lying to the north, enters and swings across this area in a southwestern direction. It is joined near Lowe's ranch by another small anticlinal fold which disappears under the edge of the older beds that make up the escarpment of the Bannock overthrust. A small complementary syncline runs up through Hansen's ranch and Sage Valley. Two noses are developed on the main structure south of Crow Creek. One lies in Sections 26 and 27, the other is in Sections 32 and 33. Either of these affords closure and would be considered a favorable gathering ground if petroleum were present. As in the northern townships of this group the Carboniferous beds appear west of the fault line and are not discussed here. Practically all the Gannett group lies south of Crow Creek and its altitude is very steep to the north. The main anticline has dips ranging from 35° to

55° and has a width of three and a half miles in some places. The dips on the eastern nose are low for this country, and all range from 39 to 15 degrees. The fold is asymmetric in the northern cross-section and normal near the southern extremity. The outline of the structure is shown by the lower gray band in the Stump sandstone, which is used as a horizon marker.

Geologic Column of Area.

Drilling on either of the noses would penetrate no more than 1300 feet of the overlying Gannett beds. Drilling on the main anticline should reach the Nugget after passing through less than 1000 feet of the Twin Creek. The Nugget is believed to be at least 1500 feet thick here and the uppermost beds of the Thaynes might be tested at a depth of 2500 feet. Because of the thickness no other formation could be explored.

Township 11 South, Range 45 East. (Pl. 7. appendix)

The southern boundary of this township is twelve miles by road from Montpelier, Idaho. It is included in the Caribou National Forest and is in the heart of the Preuss Range. The northern portion lies in Caribou County and the rest in Bear Lake County. Crow Creek in the north, and Preuss and Montpelier Creeks on the east and south respectively, drain the area. Meade Peak with an altitude of 9953 feet lies in the northwestern part of the area and is made up of Carboniferous limestone. All of the area is above 7000 feet elevation. The most mountainous country lies to the north and west of the Bannock fault and is made up of the older rocks. There is heavy timber in this part of the region.

Structural Geology.

As in the Stump Creek, Tygee, and Crow Creek townships, the Carboniferous rocks lying west of the Bannock overthrust are not discussed as to geological occurrence, structure, and oil possibilities. The beds receiving attention in this discussion lie in the eastern one-third and the southern one-half of the township. A belt of Pliocene grits and conglomerates, easily distinguished by their white color, overlies the Gannett. The Gannett inclines to the east along the entire area of its exposure in this township; the dips are from 20° to 63°.

The rest of the region considered here is areally covered by the Twin Creek formation except the crest of an anticline in Sections 31 and 32, where the underlying Nugget formation is exposed. Local faulting is believed to exist on the boundary of the Twin Creek and Gannett formations since discordant dips are found in Sections 2, 11, and 22. Valleys are cut along the probable fault line and clays, probably of fault origin, exist here. The fault probably

dies out in both directions since the formations are fairly conformable to the south. Two anticlines and two snyclines in the Twin Creek formation and one anticlinal dome with its crest in the Nugget formation are the structures to receive attention for oil-bearing possibilities in this area. The two Twin Creek anticlines are no more than four miles long and each one is less than one-half mile in width. They are asymmetrical and tip to the east. The dips are fairly steep and range from 80° to 35°. The Nugget structure is also unsymmetrical and is slightly overturned to the east. It is considerably over a mile wide and would afford a very good gathering ground if a suitable reservoir rock were present in the strata underlying the Nugget.

Geologic Column of Area.

The thickness of the Gannett group in this township is believed to be no more than 2000 feet due to the amount of erosion these beds have undergone. The Twin Creek, which is exposed along the axis of the two centrally located anticlines is probably 2000 feet thick in this area; it is slightly eroded on the anticlines and the Nugget should be reached at a depth less than 1800 feet.

The Nugget formation is 1900 feet thick in this area. It is slightly eroded on the domed anticline in Sections 31 and 32, consequently the Thaynes should be entered at 1500 feet, and deep drilling would explore the Woodside at 4000 feet below the surface on this structure.

Phosphoria Area. (Pl. 8, appendix)

Township 8 South, Range 45 East, comprises the Phosphoria area and contains outcroppings of Triassic, Permian, and older formations. Drilling in this region would test beds which underlie the formations in the Border area, and are there too deeply buried to be reached by the drill.

Location and Topography.

This township lies immediately west of the Tygee township of the Border area. It is a rougher, more mountainous region than the latter, since it is made up entirely of erosion-resistant formations. Many points are above 9250 feet in elevation and few altitudes are less than 7250 feet.

The region lies in the Caribou National Forest and contains a considerable amount of timber. Diamond Creek traverses the area, flowing in a northwesterly direction. It has a large number of tributaries that have cut deep canyons in the resistant formations. One road following the drainage line penetrates the area. The southern extremity of the township is about eighteen miles from Georgetown, Idaho.

Stratigraphic Geology

Beds of Lower Triassic, Permian, Pennsylvania, and Upper Mississipian ages are exposed in this area. The Thaynes limestone of Lower Triassic age, is the youngest bed in the area, excluding Quaternary alluvial deposits, and conformably overlies the Woodside shale. It contains marine fossils, generally ammonites, that establish its age as Lower Triassic. Near its base the formation contains considerable clay and has a gray color that distinguishes it from the contiguous Woodside. Because of the impurity of the limestone, due to the great amounts of mud and sand, the weathered rocks are often mistaken for sandstone. The thickness is considered to be 2000 feet.

The Woodside shale, also of Lower Triassic age, overlies the Phosphoria formation. The latter contains the phosphate deposits of the western states and is made up of sandy and thin bedded shales and sandy impure limestones. A massive limestone bed appears at the top of the formation. The colors are greenish, yellowish, and brownish. The base is easily determined by the Rex chert member which is the topmost bed in the Phosphoria formation. The Woodside is resistant to erosion and forms the walls of some of the canyons. Its thickness is thought to be more than 1200 feet in this area.

The Phosphoria formation of Permian age is correlated with the upper beds of the Park City formation of other localities; it is made up of two members, the "overlying chert" and the "Phosphate shales." The "overlying chert", known as the Rex chert, is the conspicuous member of the Phosphoria because of its extreme resistance to erosion; its ledges form marked topographic features. The shales, quite to the contrary, are the softest formation in the area and are easily removed where exposed. Because it bears the phosphate beds, this formation has received a large amount of attention from several U.S. Geological Survey geologists and its stratigraphy has been thoroughly worked out in various sections. The thickness of the two members varies from 75 to 627 feet, the actual thickness in this area being probably about 440 feet divided evenly between the two members. This report does not discuss phosphate or its occurrence; a complete discussion of the phosphate resources of the area will be found in the publications of the U.S. Geological Survey.[1]

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1. Gale, H.S., and Richards, R.W., Preliminary Report on the Phosphate Deposits in Southeastern Idaho and adjacent parts of Wyoming and Utah. U.S.G.S. Bull. 430, pp. 457-535, 1909.

Richards, R.W., and Mansfield, G.R., Preliminary Report on a Portion of the Idaho Phosphate Reserve. U.S.G.S. Bull. 470, pp. 371-439, 1910.

Schultz, A.R., and Richards, R.W., A Geologic Reconnaissance in Southeastern Idaho. U.S. Geol. Survey Bull. 530, pp. 267-284, 1913.

Richards, R.W., and Mansfield, G.R., Geology of the Phosphate Deposits Northeast of Georgetown, Idaho. U.S. G.S. Bull. 577, 76 pp., 1914.

Schultz, A.R., A Geologic Reconnaissance for Phosphate and Coal in Southeastern Idaho and Western Wyoming. U.S.G.S. Bull. 680, 84 pp., 1918.

Mansfield, G.R., Geography, Geology and Mineral Resources of the Fort Hall Indian Reservation, Idaho. U.S.G.S. Bull. 713, 152 pp., 1920.

The Wells formation which underlies the Phosphoria, is allotted to the Pennsylvania division of the Carboniferous period and is thought to rest conformably on the underlying Madison limestone of Mississippian age. This formation is correlated with the Morgan and Weber beds of other areas in this state and Utah, the Weber of Wyoming, and the Amsden of Montana.

The upper and lower beds of the formation are calcareous while the middle portion is sandy in nature. Sandy limestones, calcareous sandstones, and some quartzite make up a thickness of 2400 feet.

The upper Mississippian limestone lies under the Wells and above a fossil horizon in the Madison known as the Brazer limestone. The upper Mississippian is generally made up of massive limestones that vary from dark gray to a lighter gray in color and contain many fossil horizons. Its thickness is about 1100 feet.

Structural Geology.

Almost the entire area is covered by the Thaynes limestone. An anticlinal fold whose axis enters the township at Section 5 traverses the region in a gentle curve and leaves the area through Section 34. This fold has suffered sufficient erosion to expose the Woodside shale on its flanks, and in the central part of the area the Phosphoria makes up its crest. In the southern part the Wells makes up the crest and the Phosphoria, Woodside, and Thaynes are exposed in successive belts on either limb.

A parallel syncline lies on either side of the anticline. The maximum width of the antigline is two miles but the average is a mile only. Dips vary from 12° to 62° but the fold is fairly uniform in altitude.

Possible Horizons of Oil.

Drilling in Section 5 or 7 would pass through about 600 feet of Woodside shale and enter the Phosphoria. The Wells would be entered at little more than 1000 feet. The Brazer should underlie the surface at about 3400 and would be as far as any drilling would be practicable. Drilling in Section 33 or 34 would enter the Wells at the surface and the Brazer at less than 200 feet depth; however, no drilling should proceed in hope of testing the Madison lime as the fault plane of the great Bannock overthrust lies near this depth and the drill would enter younger rocks; probably Cretaceous in age, whose structure is unknown.

The Phosphoria contains large quantities of black carbonaceous shales from which oil has been distilled in some localities. These shales may be the source of some oil, perhaps due to the impervious chert capping restricting migration of the oil upward; in such case, the underlying sandy limestones, somewhat porous in character, might be the reservoir rock. If the Madison limestone bears oil, as it does in a few fields of the United States, a portion of it may have migrated to the overlying Brazer or Wells formation.

Teton Area. (Pl. 9, appendix)

The Teton area is comprised of the following townships: 5 North, Range 43 East; 5 North, Range 44 East; 5 North, Range 45 East; 5 North, Range 46 East; 4 North, Range 44 East; 4 North, Range 45 East; 4 North, Range 46 East.

Location and Topography.

This area lies in the Teton Basin, between the Big Hole Mountains to the west and the Grand Tetons on the east. A good sized swamp is just west of the town of Driggs. The latter town serves the area as the county seat of Teton County. A great portion of the area shown in the map is covered by lava which is in turn overlaid by gravel and alluvium. Only a comparatively small region about eight miles west of Driggs provides exposures of sedimentary beds. The region shown on the accompanying map is almost a plain, and is fairly well drained by the Teton River and its tributaries. The latter flows north and joins Henry's Fork, which in turn empties in to the Snake River near St. Anthony.

Stratigraphic Geology.

The geological formations of this area range from the Carboniferous to the Tertiary period.

The Tertiary is represented by the lava that covers a great portion of the area, and by the conglomerates that overlie it.

The Cretaceous contains the Frontier, Aspen, Bear River, Wayan, and part of the Gannett group. The Jurassic-Cretaceous has the Gannett beds as in the Border area. The Twin Creek, Nuggett, Thaynes, Woodside, Phosphoria, Wells, Brazer, and Madison are all present in the underlying rocks of the area and have been described in the geology of either the Phosphoria or Border area.

The Frontier, Aspen, Bear River and Wayan are the only formations whose stratigraphy will receive attention here. The Frontier represents nearly all the surface outcropping of those sedimentary beds that might possibly be oil bearing in this area. It is possible that the Bear River or Aspen shows in a thin band at the surface, but the writer was unable to identify either in the brief reconnaissance that was possible. The Frontier lies conformably on the underlying Aspen and is made up of sandstone, clay, shale, and shaly sandstone beds. There are several commercial seams of coal

in this series and they are being worked at several localities in the area[1]. Coal is also found in the same series in southern and western Wyoming. The sandstone is gray, white, and yellow and varies from massive to thinly bedded layers. The thickness here is thought to be 1300 feet.

The Aspen underlies the Frontier and is made up of gray sandstones and black shales with an occasional layer of gray sandy shale. Its thickness is approximately 3500 feet.

The Bear River, which overlies the Wayan, consists of gray and brown sandstones, calcareous sandstones, impure gray limestones, black shales, and occasional impure coal seams of no commercial value. The unconformity between the Bear River and the underlying formation is erosional and not due to difference in altitude. Fossil horizons establish the age as Upper Cretaceous. This series is thought to be 5000 feet thick.

As in many of the townships of the Border area, the sedimentary beds of this region are divided into two provinces by an overthrust fault. The Darby fault escarpment exposes a series of older beds on the western side and the younger Frontier formation in the eastern portion. The area covered by the Frontier formation and the overlying lava will receive all the discussion concerning oil possibilities.

Structural Geology.

It is shown in the geological cross-section of the area that the Darby overthrust fault has placed the Carboniferous strata contiguous to the normally overlying Frontier formation of the Upper Cretaceous. The Frontier area is about ten miles long and four miles wide. The fault scarp bounds it on the west and lava masks it on other sides. Along the eastern edge of the Frontier exposure is an anticlinal fold extending beyond the boundaries of the outcropping. It has dips along the flanks ranging from 32° to 45°; a small closure is afforded on its southern extremity. The gathering ground of the structure is in excess of three miles in width. A subordinate fold is believed to lie beneath the lava, and there is a broad syncline farther to the east.

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[1] Mansfield, G. R., Coal in Eastern Idaho. U. S. Geol. Survey Bull. 716, pp. 123-153, 1920.

Possible Horizons of Oil.

The Frontier formation produces large quantities of petroleum at the Spring Valley[1], Labarge[2], Grass Creek[3], Oregon Basin[3], Powder River[7], and Douglas[8] fields of Wyoming and at the Boulder[9] oil field in Colorado. The Elk Basin and Bridger fields in Montana also produce commercial oil from the Frontier formation. The famous Wall Creek sands of Wyoming occur in this formation.

The Frontier appears at the surface in this structure and has suffered considerable erosion, it being doubtful if more than 600 feet remains on the crest of the fold. A few sands which may possibly contain commercial quantities of oil are still uncut.

The Aspen which lies beneath the surface of the structure at a depth of about 600 feet, is known as the Mowry in many Wyoming and Montana fields. It produces commercial quantities of petroleum in the Spring Valley[1], Labarge[2], Greybull Basin[4], Lander[10], Salt Creek[6], Powder River[7], Douglas[8], Moorcroft[11], and Newcastle[12], fields in Wyoming, and in two fields in Montana. Its thickness permits the Bear River to be entered at a depth of 4100 feet. The Bear River formation, which has been correlated with the Cloverly and Greybull formations in other oil fields, produces oil and gas in large quantities in the Spring Valley[1], Labarge[2], Shoshone River[3], Greybull[4], Central Wyoming[5], Salt Creek[6], Powder River[7], Douglas[8], Moorcroft[9], and Newcastle[10], fields of Wyoming and in the Florence[11] field of Colorado. This bed also produces oil in commercial quantities in Montana.

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[1]Veatch, A. C. Geography and Geology of a portion of Southwestern Wyoming, U. S. Geol. Survey, Prof. Paper 56 pp. 157-158, 1907.

[2]Schultz, A. R., The Labarge Oil Field, central Uinta County, Wyoming, U.S. Geol. Survey Bull. 340, pp. 364-373, 1908.

[3]Hewett, D. F., The Shoshone River Section, Wyoming. U. S. Geol. Survey Bull. 541, pp. 89-113, 1914. (Also unpublished data.)

[4]Hintze, F. F., Wyoming State Geologist's Office Bull. 10, p. 40, 1915.

[5]Hares, C. J., Anticlines in Central Wyoming. U. S. Geol. Survey Bull. 641, pp. 233-279, 1917.

[6]Wegemann, C. H., The Salt Creek Oil Field, Natrona County, Wyoming, U. S. Geol. Survey Bull. 452, pp. 37-83, 1911.

[7]Wegemann, C. H., The Powder River Oil Field, Wyoming. U. S. Geol. Survey Bull. 471, pp 56-75, 1912.

[8]Barnett, V. H., The Douglas Oil and Gas Field, Converse County, Wyoming. U. S. Geol. Survey Bull. 541, pp. 49-88, 1914.

[9]Fenneman, N. M., Geology of the Boulder District, Colorado. U. S. Geol. Survey Bull. 265, pp. 76-98, 1905.

[10]Woodruff, E. G., The Lander Oil Field, Wyoming. U. S. Geol. Survey Bull. 452, pp 7-36, 1911.

[11]Barnett, V. H., The Moorcroft Oil Field, Crook County, Wyoming, U. S. Geol. Survey Bull. 581, pp. 83-104, 1915.

[12]Darton, N. H., Preliminary Report on the Geology and Underground Water Resources of the Central Great Plains. U. S. Geol. Survey Prof. Paper 32, pp. 379-388, 1905

The Wayan and Gannett group are at a dopth beyond that likely to be penetrated by a test well. The Gannett, while present in the other areas has been so badly truncated that there is scant possibility that any oil that may have been in the pores has not escaped by volatilization. It has been pointed out in a preceding paragraph in discussing possible horizons of oil in the Border area that the Gannett (Morrison) formation produces commercial gas in the Shoshone River field of Wyoming. It provides a small production of oil and gas in Central Wyoming[1], and in the Salt Creek[2], and Powder River[3] fields of the same state. Oil occurs in this formation in the Florence[4] fields of Colorado. The Gannett (Ellis) formation in Montana produces oil in a number of localities.

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[1]Hares, C. J., Anticlines in Central Wyoming. U. S. Geol. Survey Bull. 641, pp. 233-279, 1917.

[2]Wegemann, C. H., The Salt Creek Oil Field, Natrona County, Wyoming. U. S. Geol. Survey Bull. 452, pp. 37-83, 1911.

[3]Wegemann, C. H., The Powder River Oil Field, Wyoming. U. S. Geol. Survey Bull. 471, pp. 56-75, 1912.

[4]Washburne, C. W., The Florence Oil Field, Colorado. U. S. Geol. Survey Bull. 381, pp. 517-544, 1910.

Factors and Conditions Essential to the Accumulation of Oil and Gas.

A careful examination of the structure of sedimentary rocks and its relation to concentrations of gas and petroleum in many widely separated oil fields of the world has resulted in certain essential conditions being recognized by geologists as controlling the accumulation of oil and gas in rocks. These are:

1. A source or origin.
2. A reservoir or containing rock.
3. An impervious capping.
4. A suitable structure for trapping oil.
5. A high water-saturation.

A Source of Oil and Gas.

Petroleum and natural gas are mixtures of different compounds of the elements hydrogen and carbon and of various impurities. These hydrocarbons vary in chemical content and each series is given a generalized formula. No two petroleums are exactly alike.

Theories have been advanced accounting for the origin of oil by certain inorganic reactions or by fractional distillation of organic material. The former, or inorganic, theory is generally conceded to be untenable and this discussion will be confined in theories of organic origin.

One group of geologists believes petroleum to be derived from animal remains, another group believes it is obtained from plants, a still greater number of geologists believe that petroleum may originate from either plant or animal remains and that some oils are derived from both sources. Geologic evidence refutes the belief that oil and gas are derived from coal, although the distillation products of the two are very similar. Oil horizons are rarely the coal horizons in fields where both are present. Oil and gas are associated with marine formations, and salt water; on the contrary, coal is associated with continental, fresh water lake, estuarine, or brackish water deposits. As a result of these facts it is fairly generally believed that land plants may be eliminated as a source of oil and gas.

In many localities petroleum and natural gas have been found closely associated with vegetal remains, particularly in diatomaceous shales. In an equally large number of cases the oil is directly associated with the shells of animals such as mollusks or foraminifera. The beds providing the oil sources are often black muds hardened to shales, or beds of limestone containing many molluscan remains.

The fact that petroleum and gas accumulate in such large quantities indicates that migration has been very extensive to provide such a concentration. Because of this movement it becomes difficult to say definitely whether the oil originated where tapped by drilling, or whether it was derived from other localities and migrated to its present residence due to certain chemical, physical, and gravitational processes normal to the rocks of the earth's crust.

Reservoir of Containing Rock.

The reservoir is a rock that acts as a sponge to retain the oil. It is commonly known as an oil sand, and as a rule is porous. However, it may be a very sandy shale, a fractured rock of any kind, a limestone with interlocking crystals of calcite, or a sufficiently porous conglomerate. The amount of oil in such a rock and its accessibility depends on the size, shape, and number of the pores. Due to differences in the specific gravities of oil, gas, and water, the former migrate upward. On very steep folds where jointing is excessive the oil may migrate laterally into beds that are stratigraphically lower than the shales producing the oils.

An Impervious Capping.

The capping rock is an impervious rock layer that overlies and seals the reservoir rock, thus preventing the upward escape of oil and gas. This rock is usually a shale clay, or other impervious sedimentary or igneous layer. Fractures or faults in this layer may result in a complete drainage of the oil reservoir previous to drilling.

A Suitable Structure for Trapping Oil.

The great majority of structures that trap oil consist of folds in the rock layers that assist in the accumulation of oil and gas at some points along the crests due to the differences in specific gravities of oil, gas, and water. The oil and gas migrate to the more suitable structures from more extensive areas of adjoining beds that are less favorably situated for their retention. An anticlinal fold, structural terrace, monocline, geanticline, dome, saline dome, sealed fault, contact plane, or joint crack in either sedimentary or igneous rock may serve as a suitable trap for commercial petroleum.

High Water Saturation.

It is necessary for the reservoir rocks to be highly saturated by ground water if a good concentration of oil is to be expected.[1] The oil and gas, because of their lower specific gravities, are forced to the higher parts of the structure by the ground water descending along the flanks to the lower part.

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[1] Exceptions are found in the San Juan, Pennsylvania, and Catskill (West Virginia) fields.

A subordinate factor that limits the commercial production of oil in an area satisfying all the above conditions, is the drainage area of the reservoir. The amount of gas and oil in any field under any structure is restricted by the size of its gathering ground. The larger the drainage area the more productive and long lived is the field.

Given all the above conditions, one is likely to find petroleum and natural gas in any marine sedimentary formation regardless of the geologic age of the beds, unless they are older than periods in which no life is believed to have existed. It is necessary to keep each of these factors or conditions in mind when investigating a region believed to be oil bearing. If the area fails to satisfy one or more of these it has small chance of producing oil in commercial quantities. The reader is invited to keep the above brief discussion in mind to facilitate a clear understanding of the writer's conclusions in regard to the possibilities of oil in the region under discussion.

Summary of Conclusion.

This bulletin has been prepared to point out to leaders of legitimate development and promotion, those areas in Idaho least unlikely for the production of oil. It has been thought advisable to designate the areas giving the greatest promise in each locality.

One great factor in classifying the rating of an area is its distance from other productive oil and gas fields. A logical conclusion is that other conditions being equal, an area that is relatively close to and geographically related to other gas and oil fields gives greater promise than an area not so situated.

The Border and Phosphoria areas lie about 55 miles across country from the Labarge and Big Piney oil fields in Lincoln county, southwestern Wyoming. There is also a correspondingly large distance between all the oil producing regions of Wyoming. The Teton area is less than 100 miles from the Wind River Basin of Wyoming that has eight important producing fields. The factor that serves to nullify the handicap of too great separation is that the oil bearing beds of Wyoming lie in patches scattered promiscously over the state. Regardless of this condition they are of the same age and also of the same age as the rocks of the Border, Phosphoria, and Teton areas. It has been found that the same beds that carry oil in one field are likely to carry oil in a number of the other fields of the state where structure is favorable.

Considering the above it might be said that the Teton Phosphoria, and Border areas contain and are underlain by formations at varying depths, accessible to the drill, which contain productive oil and gas

series in areas nearby and throughout the states of Wyoming and Montana. These areas may be rated as promising prospective or "wild-cat" areas in which there are good speculative chances, but in which the business risk is relatively high compared with that involved in drilling within a mile or two of producing wells on equally favorable structures.

The anticlines described before and those recommended below should be classed as the best risks for testing, but not as "sure-fire" producers.

No oil seeps have been found in either of the three areas although hundreds have been reported and examined by federal and state geologists.

The occurrence of salt springs and sulphur springs as in the Border area is considered a favorable indication of oil in many oil regions. Salt water is associated with petroleum in practically all parts of the world, especially in every large oil producing region. The presence of salt water in these areas may suggest the possibility of petroliferous strata, but it has no certain significance, as many pools have been found where no salt springs issue, and, furthermore, salt springs commonly issue at places remote from oil fields. The presence of sulphur springs is likewise no criterion.

Some of the Paleozoic rocks in both the Teton and Phosphoria areas yield a petroliferous odor when freshly fractured. The phosphatic shales of the Phosphoria formation of Permian age yield petroleum when subjected to destructive distillation. In regard to the Teton area, G. R. Mansfield,[1] geologist of the federal Survey says, "The anticline along the west side of the basin east of the Horshoe district, as noted by Schultz[2] furnishes the most promising structure in the region for the accumulation of oil. The axial portion and eastern limb of this fold are largely concealed by lava, and to the west faults occur in parts of the district. The gathering area for oil is apparently not large. The presence of oil could be determined only by drilling, which should not be undertaken without full realization of the cost and the great change of failure."

A. R. Schultz[2] in speaking of the same area says: "If the anticline along the west side of Teton Basin has a closed structure, there may be oil in this part of the field."

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[1]Mansfield, G. R., Coal in Eastern Idaho. U. S. Geol. Survey Bull. 716, 123 pp. 1920.

[2]Schultz, A. R., A Geological Reconnaissance for Phosphate and Coal in Southeastern Idaho and Western Wyoming. U. S. Geol. Survey Bull. 680, p. 79, 1918.

In speaking of the Phosphoria beds which have been discussed as oil possibilities by the writer, Dr. Schultz says,"Another source of oil that promises to be of some value occurs at the same horizon as the phosphate deposits in Montana, Idaho, and Wyoming, that is, the Phosphoria formation. The phosphate on applying heat to the rock is not driven off by distillation but remains in the ash. Evidence of petroleum or bituminous compounds in rocks of this age has been observed over wide areas by the writer, who has worked on phosphate deposits, but few if any tests have heretofore been made to ascertain the quantity of oil."

In a further discussion he continues to say, "It may therefore be possible that commercial accumulations of oil have been formed in these older Paleozoic rocks. Thus far the Lander oil field of Wyoming seems to be the only place where oil has been obtained in commercial quantities from rocks of the same age, though indications of oil at this horizon have been noted at several other places in Wyoming and Utah."

Supplementary to the last statement of Schultz, later development has proven other oil fields to be of the same producing formations. There have been small quantities of petroleum distilled from the shales of the Frontier formation in the Teton area and from shales of the Phosphoria formation in the Phosphoria area. All of the areas contain suitable structure to trap petroleum. The gathering ground may not be large in some structures but if petroleum were present it would likely be sufficient to insure a commercial supply. Shales to act as capping rocks are scattered through all the formations with the exception of the limestones of the older Paleozoic formations. Nevertheless, truncation of folds has permitted a great area to be drained were any oil present.

The large number of deep-seated springs is persuasive evidence that sufficient ground water exists to force concentration of oil in crests and upper flanks of structures.

Recommendations.

In the Border area the following areas are thought to be most likely for the location of test wells:

1—Township 5 South, Range 46 East; Any point along the axis of the anticline extending from Section 5 to Section 28 as shown on the map.

2—Township 5 South, Range 45 East; Any place along the axis of the anticline extending from Section 18 to Section 32, as shown by the map, or in Section 21.

3—Township 7 South, Range 46 East: Along axis of anticlinal dome in Sections 8, 16, and 17.

4—Township 8 South, Range 46 East: Along axis of anticline in Sections 3, 10, and 15.

5—Township 9 South, Range 46 East: Along axis of anticline in Sections 9, 20, and 21, also on structural noses in Section 26 and Section 32.

6—Township 11 South, Range 45 East: Along the axis of the anticline in Sections 26 and 35, also in Section 32.

In the Phosphoria area, the following sections are suggested:

1—Township 8 South, Range 45 East: Along the axis of the anticline in Sections 5, 8, 33, and 34.

In the Teton area the following sections are most suitable for testing:

1—Township 5 North, Range 44 East: Sections 19, 21, 30, 31, and 32.

2—Township 4 North, Range 44 East: Sections 3, 4, 10, and 11.

It should be emphasized that in no case of recommendations, does the writer guarantee that petroleum or natural gas will be found at any of the points recommended for testing. Observation and experience make certain, however, that the chance of failure in an unproven area is greatly reduced by a selection of localities for drilling based on geologic investigation.

APPENDIX

Plate No. 1-County Index Map of Idaho, showing location of Townships discussed

Plate No. 2-Reconnaissance Geologic Map of T. 5 S.,R 46 E. Border Area

Plate No. 3-Reconnaissance Geologic Map of T. 5 S.,R 45 E. Border Area

Plate No. 4-Reconnaissance Geologic Map of T. 7 S.,R. 46 E. Border Area

Plate No. 5-Reconnaissance Geologic Map of T. 8 s.,R 46 E. Border Area

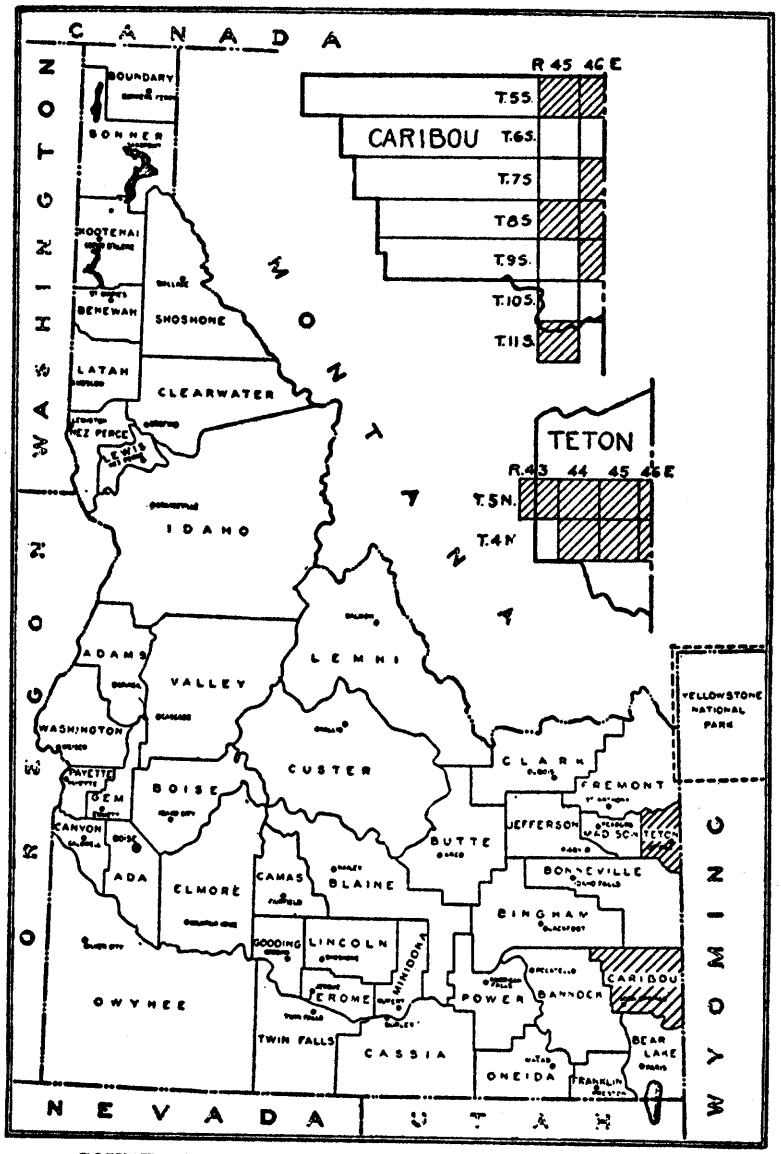
Plate No. 6-Reconnaissance Geologic Map of T. 9 s.,R 46 E. Border Area

Plate No. 7-Reconnaissance Geologic Map of T. 11 S.,R 45 E. Border Area

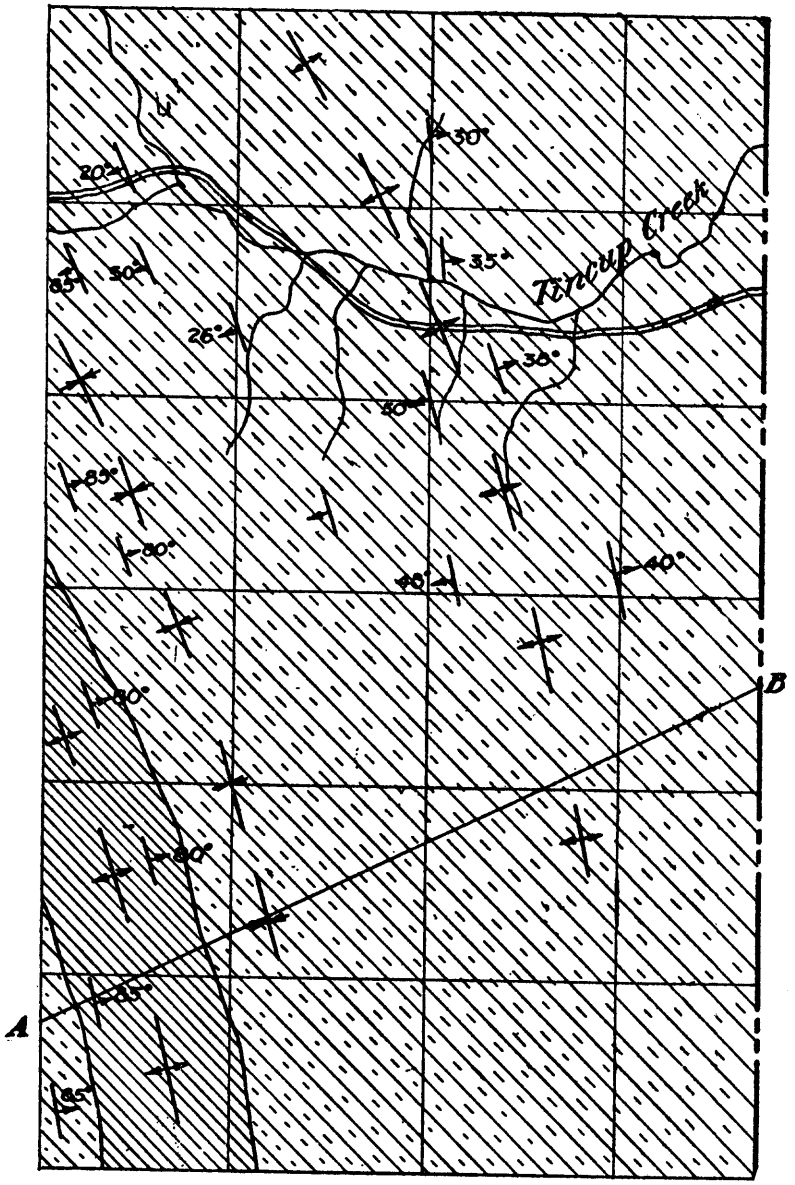
Plate No. 8-Reconnaissance Geologic Map of T. 8 S.,R. 45 E. Phosphoria Area

Plate No. 9-Reconnaissance Geologic Map of Teton Area

Correlation Table of Oil Producing Formations in Wyoming and Montana with equivalent formations in Southeastern Idaho



COUNTY INDEX MAP OF IDAHO SHOWING LOCATION OF TOWNSHIPS DISCUSSED



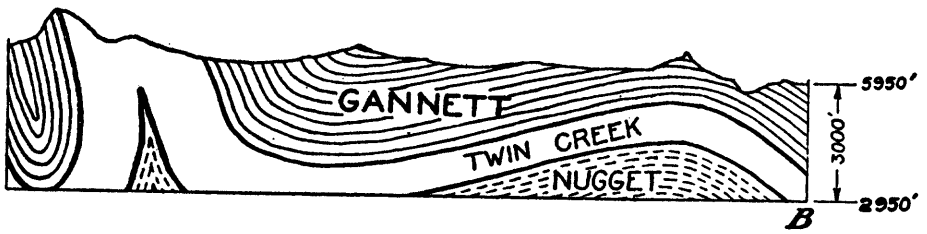
LEGEND

Gannett red sandstone & conglomerate - Jur. - Cret.

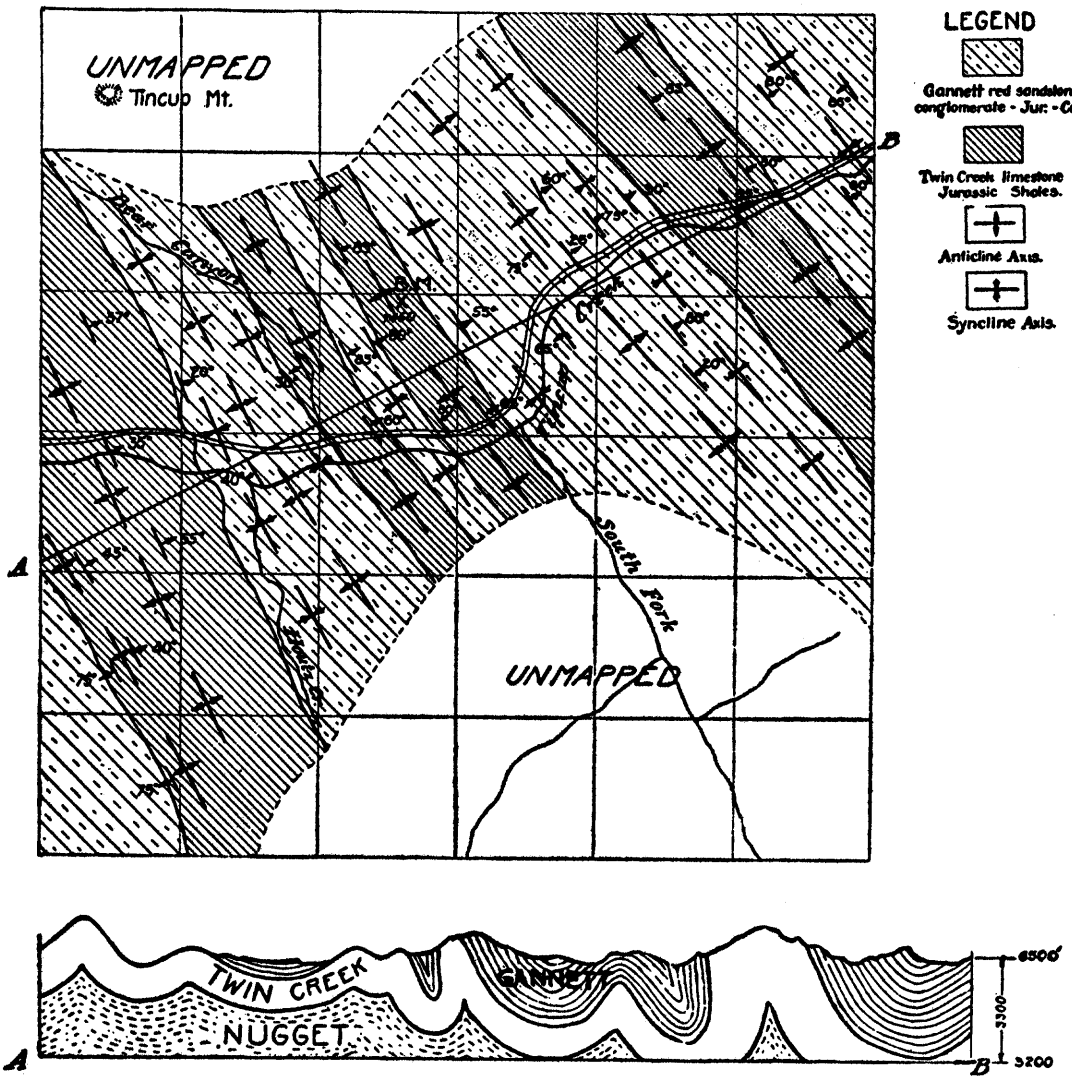
Twin Creek limestone Jurassic Shales.

Anticline Axis.

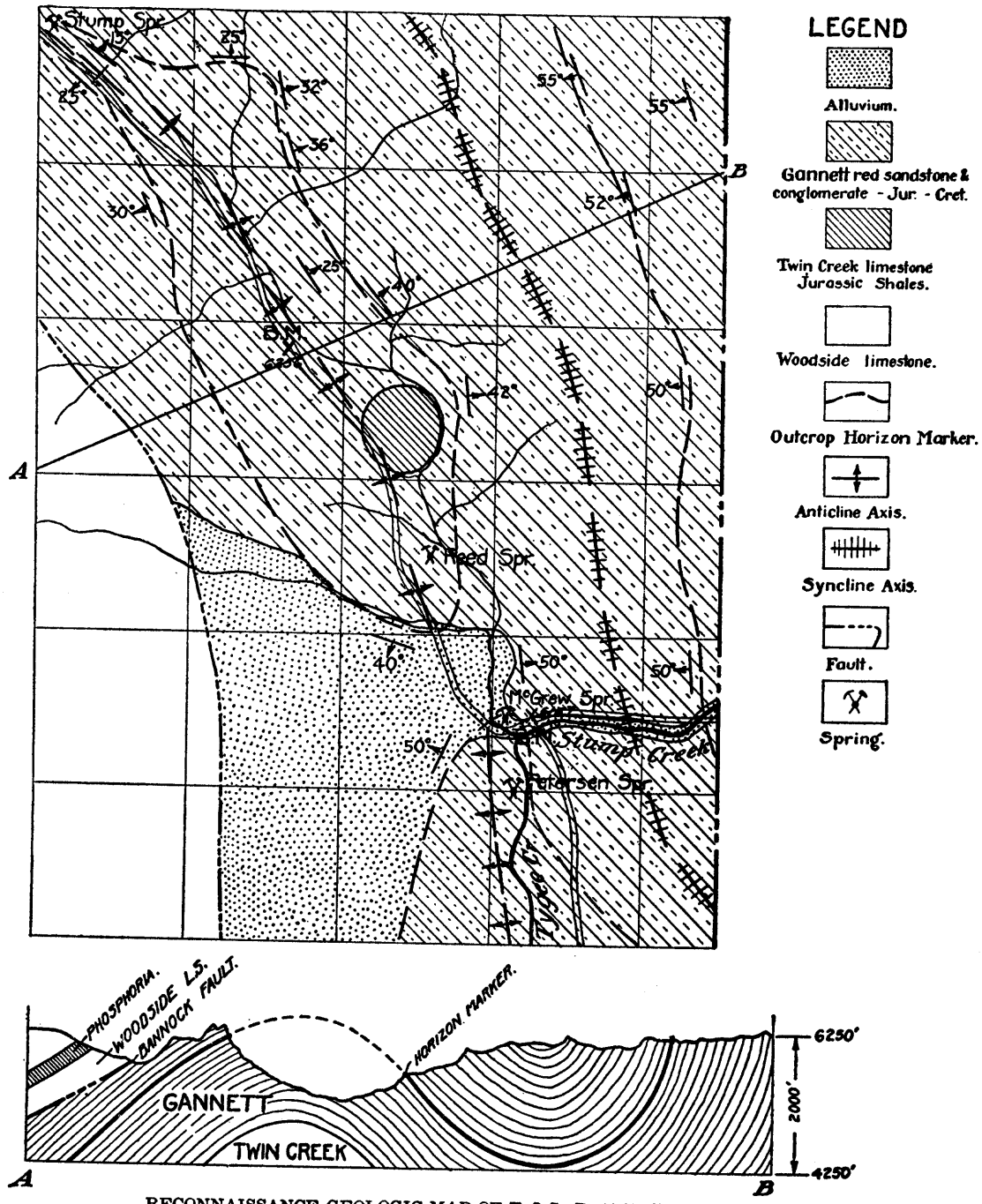
Syncline Axis.



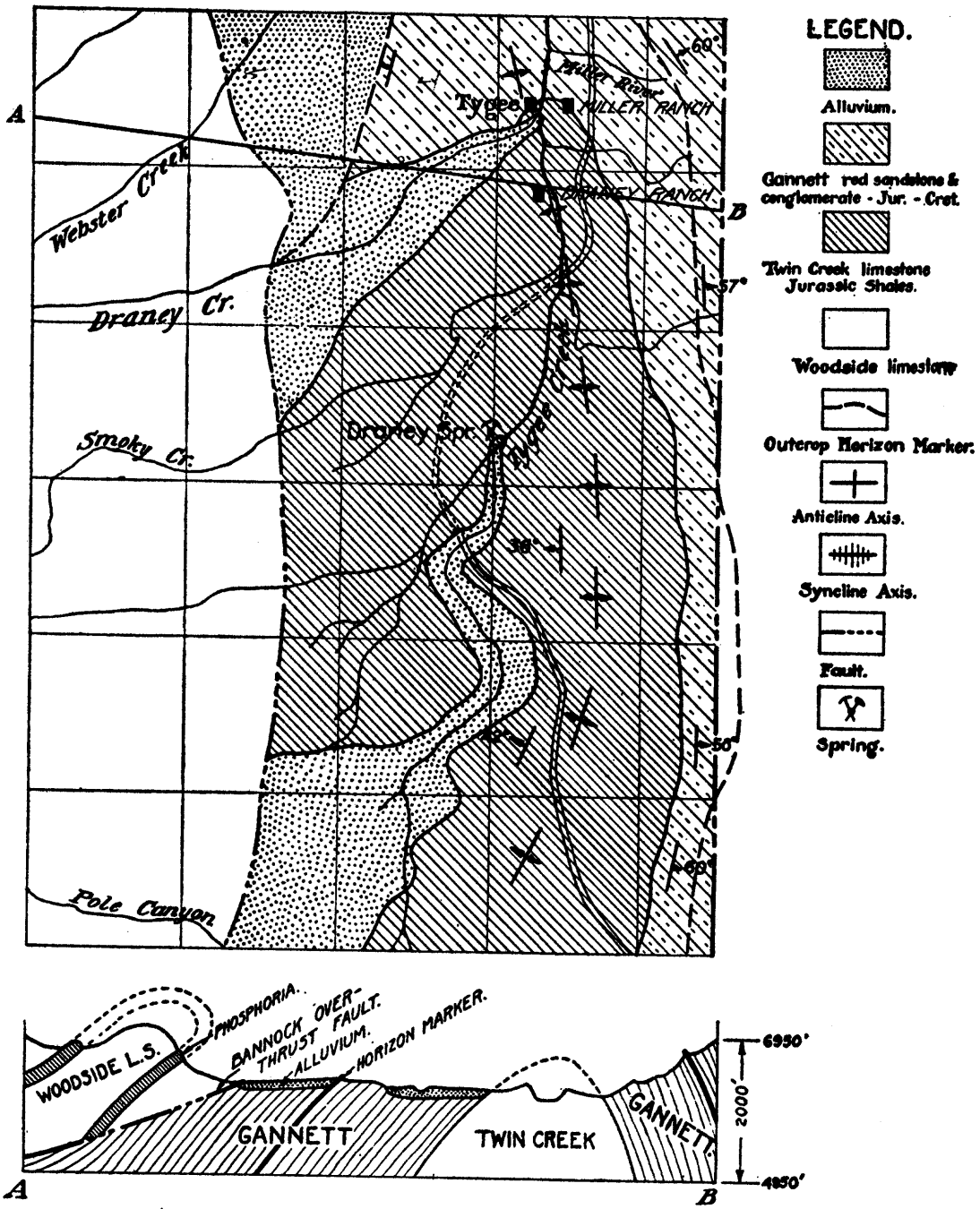
RECONNAISSANCE GEOLOGIC MAP OF T. 5 S., R. 46 E. BORDER AREA



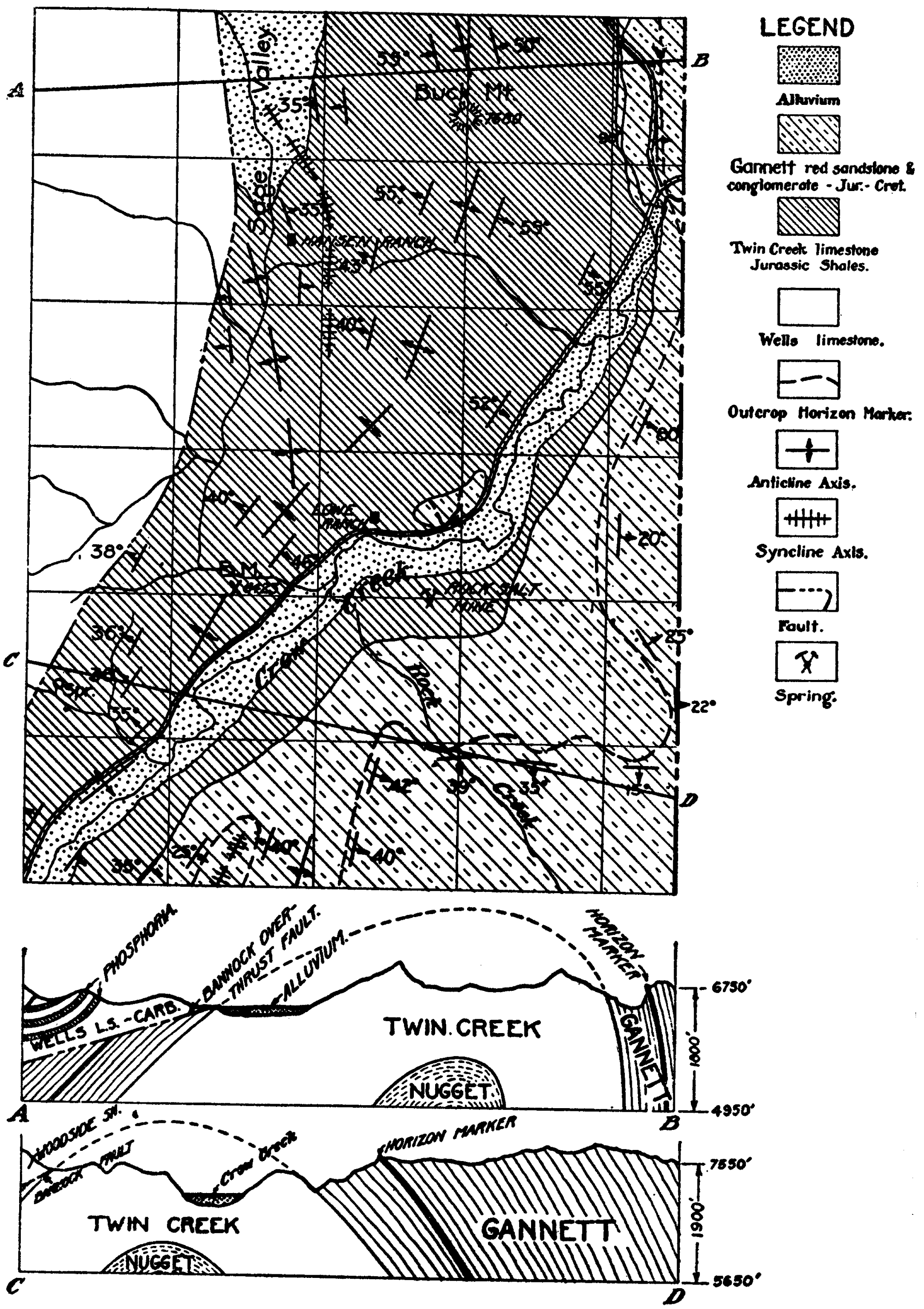
RECONNAISSANCE GEOLOGIC MAP OF T. 5 S., R. 45 E. BORDER AREA



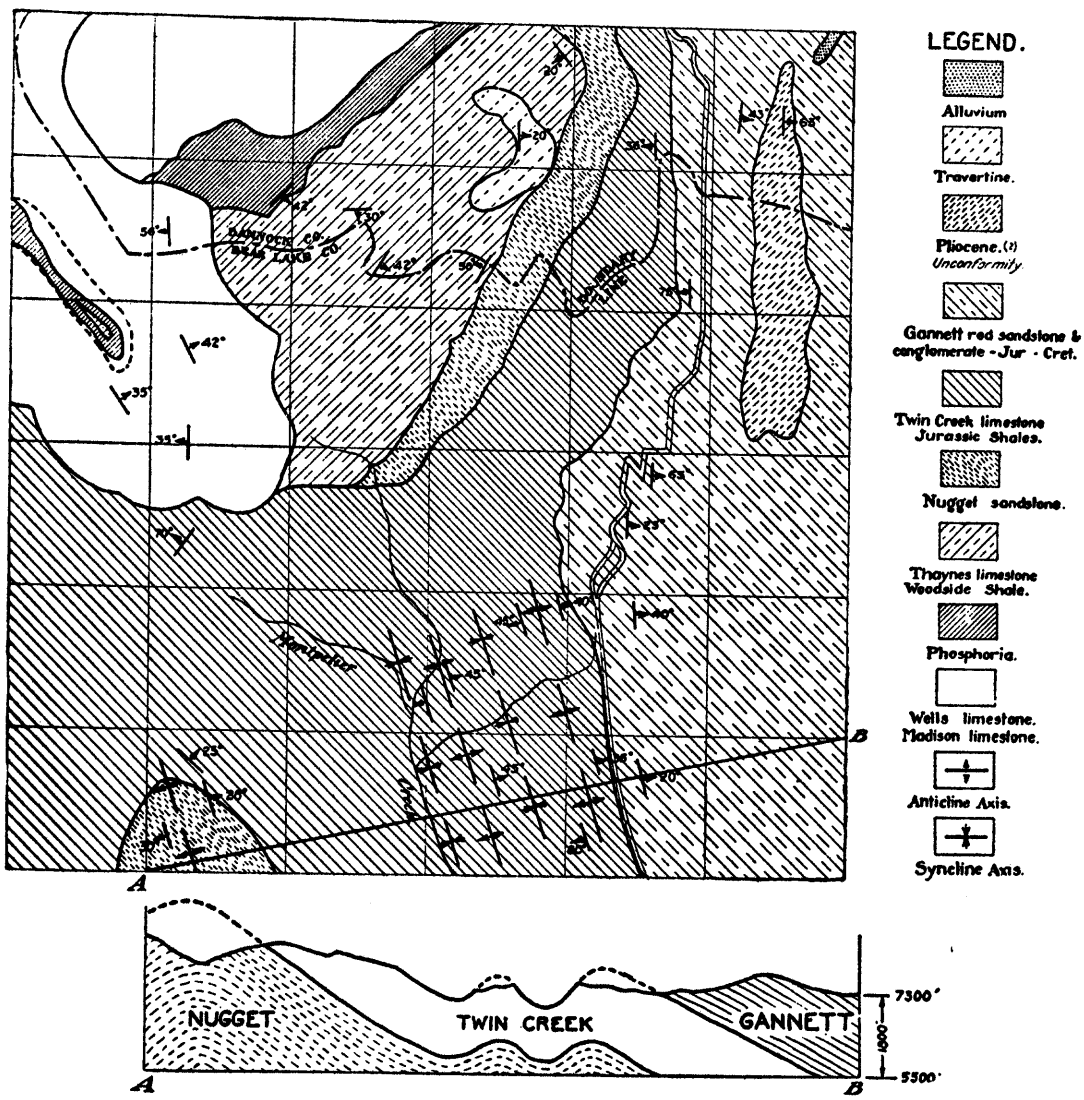
RECONNAISSANCE GEOLOGIC MAP OF T. 7 S., R. 46 E. BORDER AREA



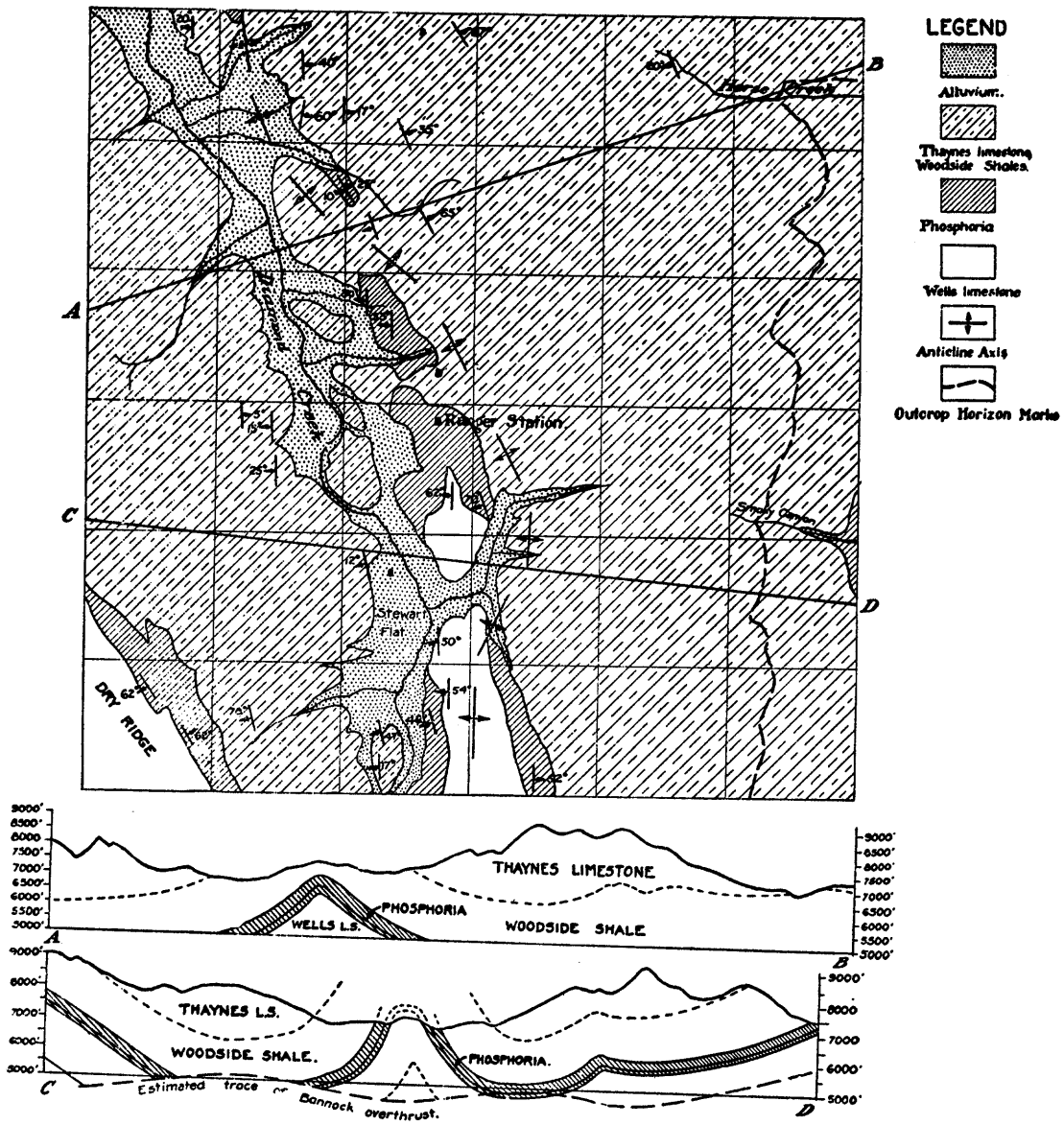
RECONNAISSANCE GEOLOGIC MAP OF T. 8 S., R. 46 E. BORDER AREA



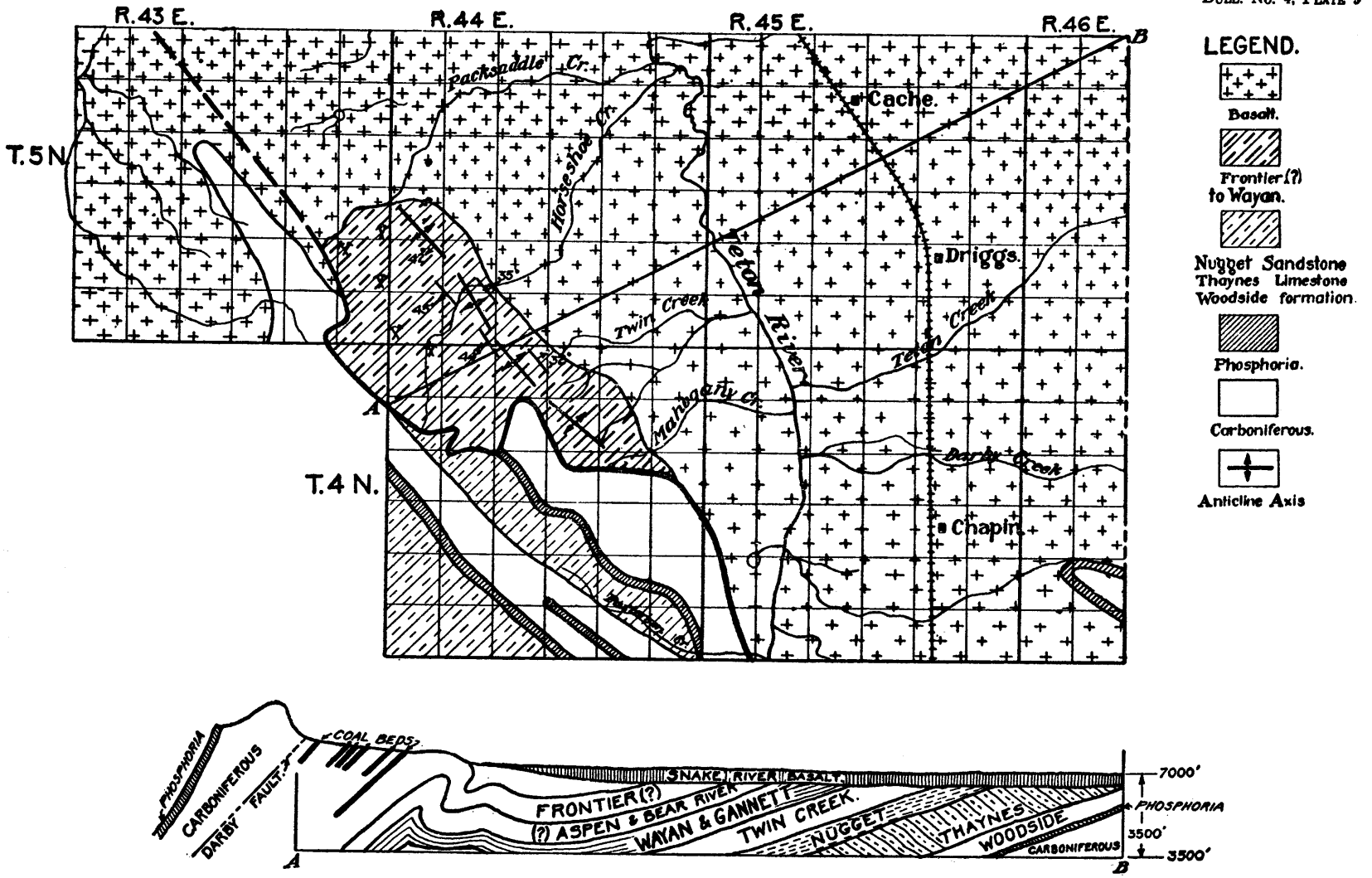
RECONNAISSANCE GEOLOGIC MAP OF T. 9 S., R. 46 E. BORDER AREA



RECONNAISSANCE GEOLOGIC MAP OF T. 11 S., R. 45 E. BORDER AREA



RECONNAISSANCE GEOLOGIC MAP OF T. 8 S., R. 45 E. PHOSPHORIA AREA



RECONNAISSANCE GEOLOGIC MAP OF TETON AREA

CORRELATION OF OIL-PRODUCING FORMATIONS IN WYOMING AND MONTANA, WITH EQUIVALENT FORMATIONS OF SOUTHEASTERN IDAHO

* = oil ‡ = gas • = small production of oil and gas or seeps

System or Series	Group	Southeastern Idaho generalized Mansfield 1921	Southwestern Wyoming generalized Schultz 1920	Rawlins Wyoming	Laramie Basin Wyoming	Central Wyoming	Big Horn Basin Wyoming	Shoshone River Basin Wyoming	Eastern Wyoming generalized	Northeastern Wyoming generalized	Central and Eastern Montana generalized	Northwestern Montana generalized
		FORMATION NAMES										
Cretaceous Unconformity	Colorado		Blair	Frontier (Wall Creek) •	Benton (Frontier) •	Frontier (Wall Creek) •	Frontier (Torchlight Peay) •	Frontier •	(Wall Creek) • Benton (Muddy) • ‡	Greenhorn Graneros	Frontier (Torchlight Peay) Graneros	Frontier (Blackleaf Sandy)
	Lower Cretaceous (?)	Wayan	Baxter							Mowry (Muddy) •	Mowry	
			Frontier •			Mowry •	Mowry •	Mowry •			Thermopolis	
	Lower Cretaceous	Gannett Group	Aspen	Mowry (Muddy) •	Mowry (Muddy) •	Thermopolis	Thermopolis ‡	Thermopolis • ‡				
			Bear River •	Dakota	Cloverly •	Dakota •	Cloverly ‡ (Greybull) •	Cloverly ‡ (Greybull) •	Cloverly •	Dakota • Fuson Lakota •	Dakota Kootenai •	Kootenai
Jurassic	Upper Jurassic Unconformity	Stump	Beckwith	Morrison	Morrison	Morrison •	Morrison • ‡	Morrison ‡	Morrison	Morrison	Morrison	Morrison
	Lower Jurassic	Preuss										
		Twin Creek	Twin Creek	Sundance	Sundance	Sundance •	Sundance	Sundance	Sundance	Sundance	Sundance Ellis •	Sundance Ellis
Triassic	Upper Triassic	Nugget	Nugget	Chugwater	Chugwater	Chugwater • ‡	Chugwater • ‡	Chugwater	Chugwater	Chugwater	Chugwater	Chugwater
		Timothy	Ankareh									
		Portneuf										
	Lower Triassic	Thaynes	Thaynes									
		Woodside	Woodside									
Carboniferous	Permian	Phosphoria	Park City			Embar •	Embar •		Minnekahta Opeche	Minnekahta Opeche	Embar Minnekahta Opeche	
	Pennsylvanian	Wells										
		Braser	Weber	Casper	Forelle Satahka • Casper	Tensleep • Amsden	Tensleep Amsden		Hartville	Minnelusa •	Quadrant • Tensleep • Amsden •	
	Mississippian	Madison	Madison			Madison	Madison		Guernsey	Pahasapa	Pahasapa Madison •	Madison