GEOLOGICAL SURVEY CIRCULAR 152

THE COAL DEPOSITS OF THE ALKALI BUTTE, THE BIG SAND DRAW, AND THE BEAVER CREEK FIELDS FREMONT COUNTY WYOMING

By Raymond M. Thompson and Vincent L. White

Prepared as part of a program of the
Department of the Interior
for development of the
Missouri River Basin

UNITED STATES DEPARTMENT OF THE INTERIOR
Oscar L. Chapman, Secretary

GEOLOGICAL SURVEY
W. E. Wrather, Director

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INTRODUCTION

Large coal reserves are present in three areas located between 12 and 20 miles southeast of Riverton, Fremont County, central Wyoming. Coal in two of these areas, the Alkali Butte coal field and the Big Sand Draw coal field, is exposed on the surface and has been developed to some extent by underground mining. The Beaver Creek coal field is known only from drill cuttings and cores from wells drilled for oil and gas in the Beaver Creek oil and gas field.

These three coal areas can be reached most readily from Riverton, Wyo. State Route 320 crosses Wind River about 1 mile south of Riverton. A few hundred yards south of the river a graveled road branches off the highway and extends south across the Popo Agie River toward Sand Draw oil and gas field. About 8 miles south of the highway along the Sand Draw road, a dirt road bears east and along this road it is about 12 miles to the Bell coal mine in the Alkali Butte coal field. Three miles southeast of the Alkali Butte turn-off, 3 miles of oiled road extends southwest into the Beaver Creek oil and gas field. About 6 miles southeast of the Beaver Creek turn-off, in the valley of Little Sand Draw Creek, a dirt road extends east 1 mile and then southeast 1 mile to the Downey mine in the Big Sand Draw coal field. Location of these coal fields is shown on figure 1 with their relationship to the Wind River basin and other coal fields, place localities, and wells mentioned in this report.

The coal in the Alkali Butte coal field is exposed partly on the Wind River Indian Reservation in Tps. 1 and 2 S., R. 6 E., and partly on public land. Coal in the Beaver Creek and Big Sand Draw coal fields is mainly on public land.

The region has a semiarid climate with rainfall averaging less than 10 in. per year. When rain does fall the sandy-bottomed stream channels fill rapidly and are frequently impassable for a few hours. Beaver Creek, Big Sand Draw, Little Sand Draw, and Kirby Draw and their smaller tributaries drain the area and flow northwestward to the Wind River.

This report is based almost entirely upon geologic investigations made in 1949 as a part of the program of the Department of the Interior for development of the Missouri River basin. Some coal sections were measured in 1950 and the additional information on the Big Sand Draw coal field was obtained in 1951. A geologic map of the Beaver Creek field was not prepared for this report because most of the significant coal occurs below a depth of 1,400 ft and is not exposed on the surface. Mr. George Downey, Lander, Wyo., supplied much helpful information on the Big Sand Draw coal field and the area in general. Topographic contours shown on figures 11, 12, 13, and 14 are from unpublished plane-table sheets made by E. D. Woodruff in 1912.

Previous geologic investigations of the region have been made by E. G. Woodruff and D. E. Winchester (1912), by C. J. Hares (1916), by A. J. Collier (1920), and C. M. Bauer (1934). Except for the work of Woodruff and Winchester, which was an areal examination for the purpose of classifying the public lands, the geological investigations were of a general nature and give little detail of the coal beds. Berryhill (1950) summarizes Woodruff and Winchester's work.

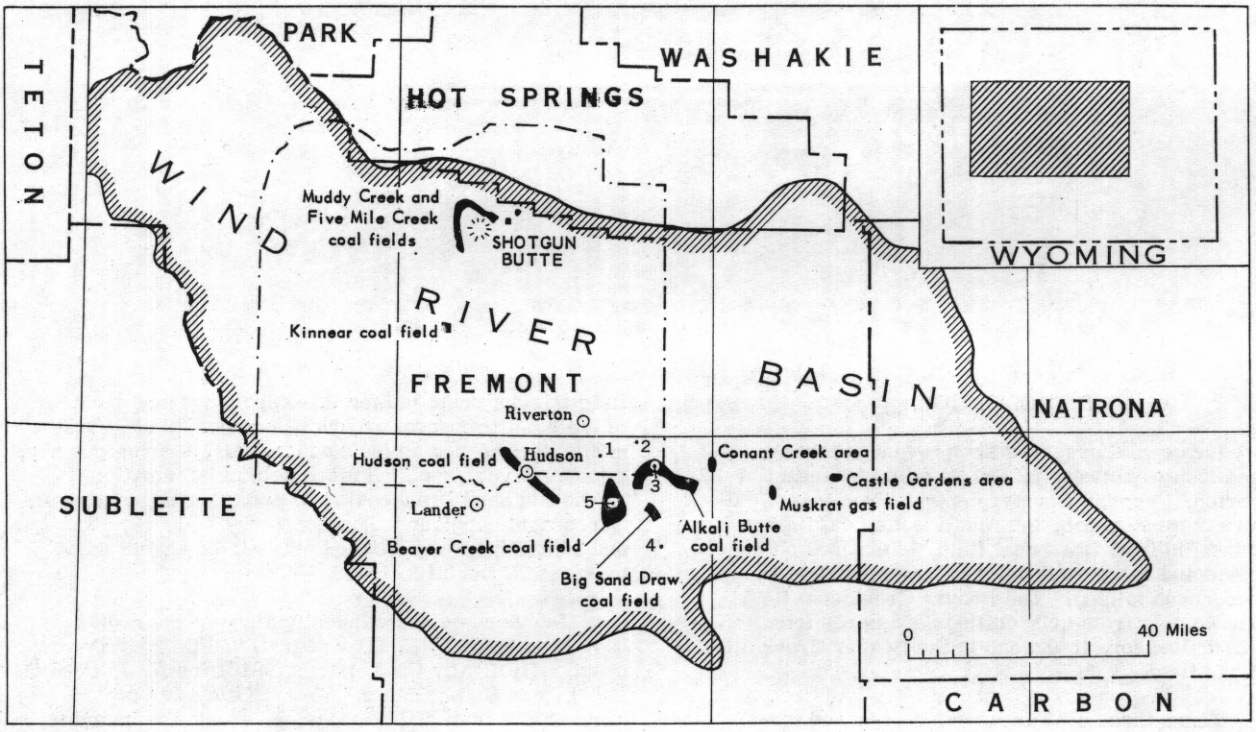
STRATIGRAPHY

The stratigraphy of the area has been adequately described by Love (1947, 1948), Thompson 1/ (1950), and Yenne 2/. The writers of this report and Yenne have recently studied in detail that part of the stratigraphic section in which the coal beds are located. On the surface in the Alkali Butte and Big Sand Draw coal fields the coal is principally in the Mesaverde formation with a lesser amount in the overlying Lance formation. In the subsurface section in the Beaver Creek field most of the coal is in the Mesaverde formation, with smaller amounts in the Lance, Fort Union, and Wind River formations. Detailed stratigraphic sections of coal-bearing rock in the Beaver Creek field, the Alkali Butte coal field, and the Big Sand Draw coal field are presented by Yenne 3/. Figure 4 shows the stratigraphy of the coal-bearing parts of the Mesaverde and Lance formations in the Alkali Butte coal field. Locations of the measured coal sections are shown on figure 2. At the Big Sand Draw coal field outcrops are very poor, with only slightly more than 300 ft of the lower part of the Mesaverde formation exposed. Rocks of the Fort Union or Wind River formations rest with sharp angular unconformity upon the Mesaverde formation. No stratigraphic section was measured at the one mine in the field, because of poor exposures, but as indicated on figure 5, a section was measured 1

[1]Thompson, R. M., and White, V. L., Geology of the Riverton area, Fremont County, Wyo.: U. S. Geol. Survey Oil and Gas Inv. Map, OM---(in preparation).

[2]Yenne, K. A., Stratigraphic sections of Cody shale and younger Cretaceous and Paleocene rocks in western part of Wind River basin, Fremont County, Wyo.: U. S. Geol. Survey Oil and Gas Inv. Chart, OC---(in preparation).

[3]Yenne, op. cit.



1

Riverton Anticline
Atlantic Refining Co.
Tribal 1
SW¼SE¼ sec. 25, T. 1 S., R. 4 E.

2

North Alkali Butte
Stanolind Oil & Gas Co.
Tribal C-1
SW¼SE¼ sec. 1, T. 1 S., R. 5 E.

3

Alkali Butte
Atlantic Refining Co.
Tribal A-1
SE¼SE¼ sec. 29, T. 1 S., R. 6 E.

4

Big Sand Draw
Sinclair-Wyoming Oil Co.
Sand Draw Unit 1
NW¼NW¼ sec. 14, T. 32 N., R. 95 W.

5

Beaver Creek
Stanolind Oil & Gas Co.
Johnson 1
Center, SE¼SE¼ sec. 3, T. 33 N., R. 96 W.

Figure 1.--Index map showing location of Wind River basin, Wyoming, and relationships of coal fields mentioned in report.

mile south of the mine. Distribution of rock units is shown in figure 3. Stratigraphy of the coal-bearing rocks in the Beaver Creek oil and gas field is shown on figure 6.

Details of the stratigraphy of the coal-bearing formations in the three coal fields are presented below in order from oldest to youngest, which is also, by coincidence perhaps, the order of importance from the best coal and the greatest amount to the poorest coal of the least importance.

Mesaverde formation. -- The Mesaverde formation consists of light to dark gray sandstone interbedded with shale, siltstone, ironstone, and coal. The sandstones are much more massive, more resistant, and much cleaner than those of the underlying Cody shale. A typical view of the Mesaverde formation is shown in figure 7.

The Alkali Butte and Big Sand Draw anticlines are flanked by rocks of the Mesaverde formation. Eighteen miles to the northwest in the vicinity of Hudson, the lower part of the formation is extensively exposed (Thompson, 1950). The formation ranges in thickness from 300 to 1,300 ft or more, thickening eastward, with the thickness determined by the magnitude of the unconformity between the Mesaverde formation and younger rocks.

The lithology of the Mesaverde formation of this area and of the Wind River basin in general has little resemblance to the lithology of the formation at its type section. The units are very lenticular; most beds can be traced less than 5 miles, and several for only a few hundred feet. Perhaps the most persistent bed within the formation is a fine-grained white to light-gray sandstone averaging about 50 ft in thickness, which, because of its conspicuousness, is considered to be the basal bed of the formation throughout most of the area covered by this report. In the Alkali Butte coal field, however, this sandstone is somewhat lenticular and directly south of the triangulation station Alkali, it is underlain by about 8 ft of shale and coal, included in Mesaverde because it is lithologically more similar to the overlying rocks than to the underlying Cody shale.

The Mesaverde formation appears to overlie conformably the Cody shale, as illustrated in figure 7, and is overlain unconformably by the Lance, Fort Union, or Wind River formations. The western sections are thinnest where the overlap is by rocks of the Fort Union or the Wind River formation, and in the eastern part of the area the formation is thicker where overlain unconformably by the Lance formation. The maximum angular unconformity observed between rocks of the Mesaverde

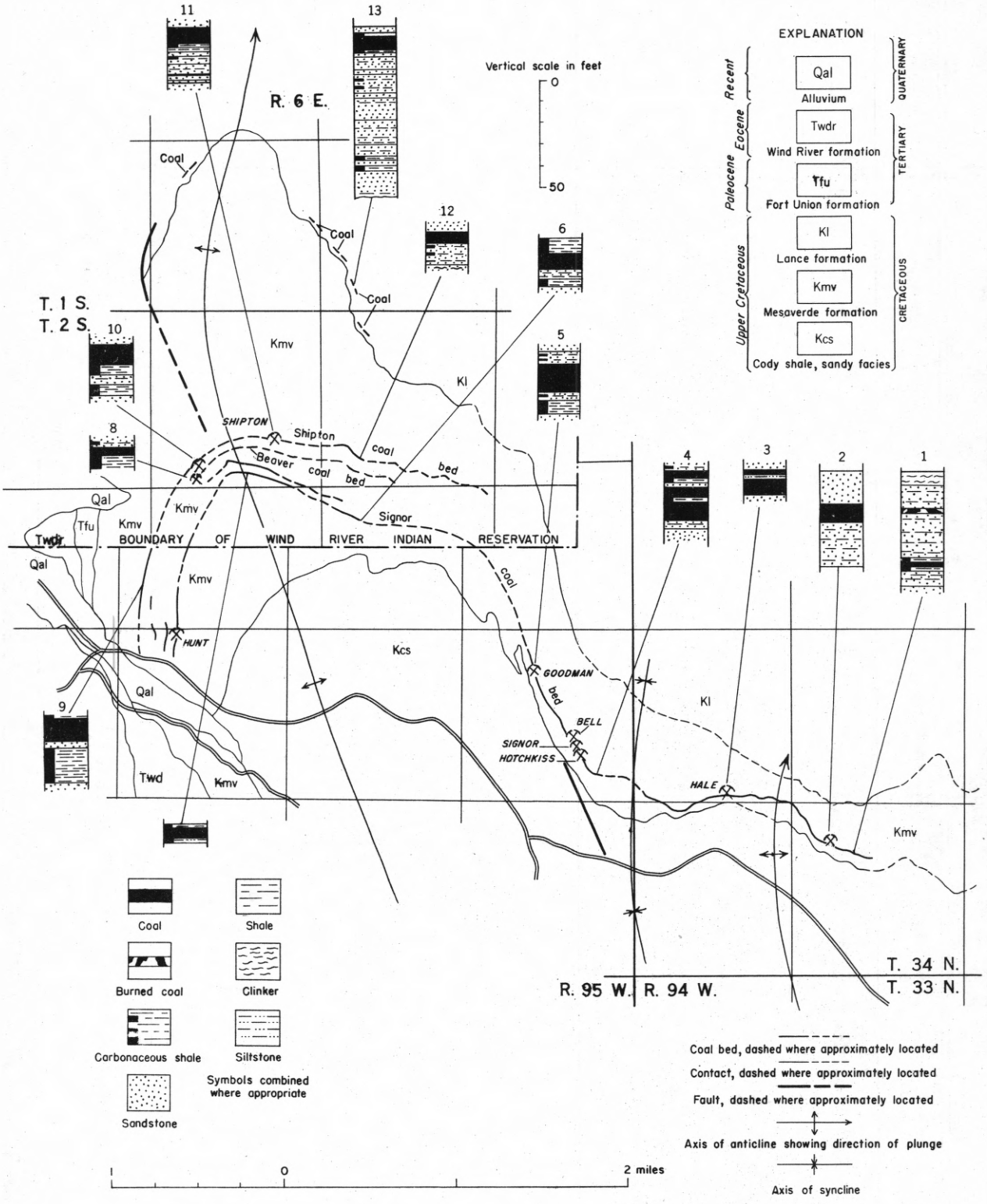


Figure 2. --Alkali Butte coal field, Fremont County, Wyo.

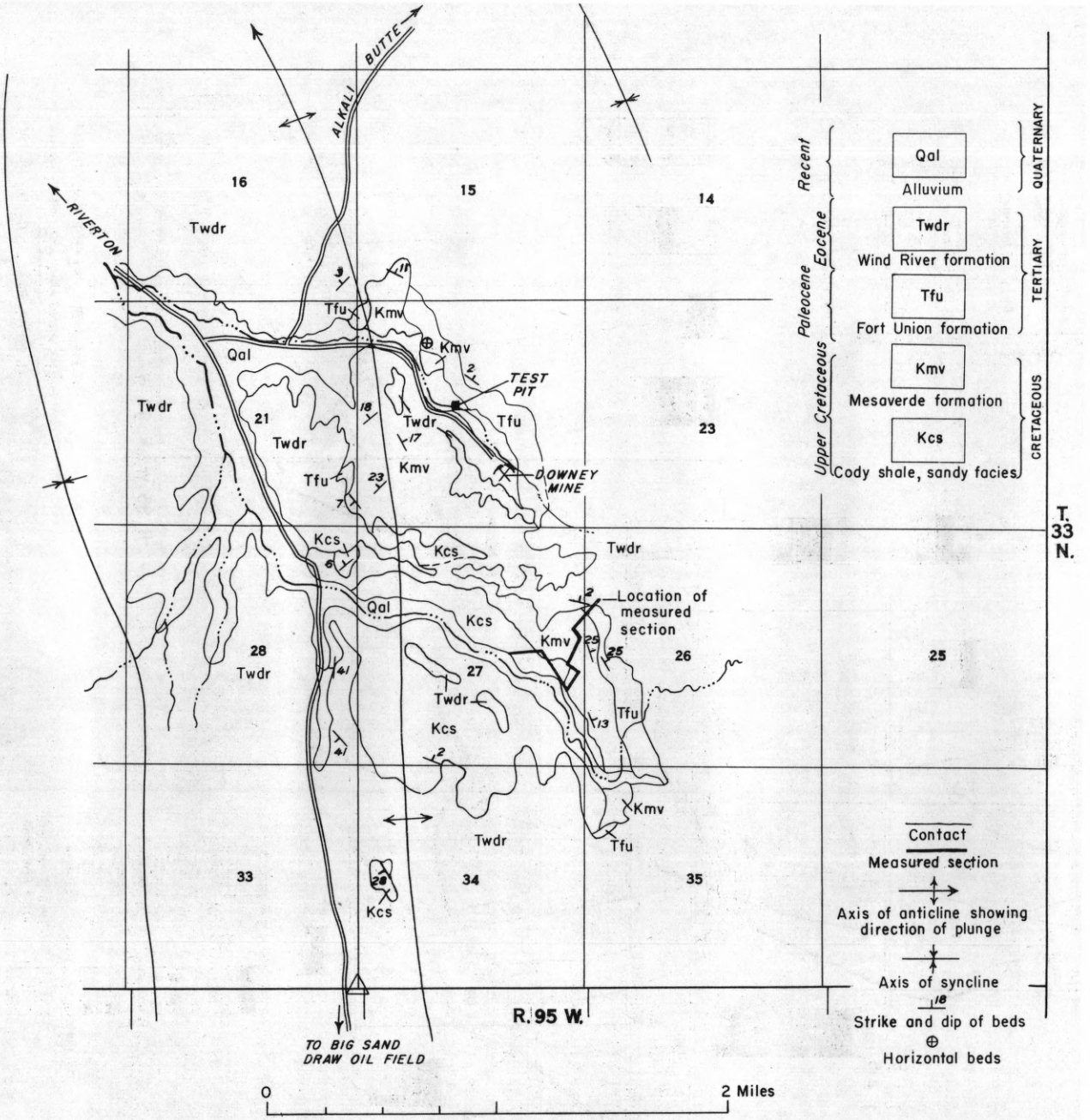


Figure 3. --Big Sand Draw coal field, Fremont County, Wyo.

and Lance formations is about 5°; between the Mesaverde formation and rocks of the Fort Union formation it is 30°; and between rocks of the Mesaverde and Wind River formations about 40°.

Fossils of Eagle age were found at the base of the Mesaverde formation in the Alkali Butte area and nearly 1,000 ft below the base of the Mesaverde in the sandy facies of the Cody shale in the Hudson region 18 miles to the northwest. Fossils of Eagle or possibly Claggett age were found near the top of the Mesaverde formation 6 miles east of the Bell mine, along Conant Creek. The distribution of these faunas points out the problems encountered in studies of Upper Cretaceous rocks throughout the region. The uppermost part of the Mesaverde formation may be somewhat younger than Eagle age but this has not been proven definitely, although a new scaphite fauna found by geologists of the Geological Survey during the 1950 field season in the Conant Creek area and also in the Muskrat Creek area about 8 miles farther to the east suggests strongly that the upper part of the formation may be of Claggett age.

The Mesaverde formation has yielded commercial quantities of coal since 1891, in the Hudson region, where it is still being mined for local consumption. Several mines in the Alkali Butte coal field area have been operated intermittently since opening of the Signor Mines about 1908. In the Big Sand Draw coal field there is only one mine, the Downey and it has been closed for several years. Details of the various coal beds in the area covered by this report, are presented with the description of the field. Coals of the Mesaverde formation have been mined in other parts of the Wind River basin, such as along the Owl Creek Mountains in the Muddy Creek and Sheep Creek areas and in the southeastern part of the Wind River basin (Woodruff and Winchester, 1912).

Lance formation.--The Lance formation is a conspicuous blue-weathering sequence of gray medium-grained sandstones and chocolate-brown, carbonaceous shales. It is the uppermost Cretaceous formation of the region and although sparsely fossiliferous it yields a diagnostic plant, Sequoia reichenbachi, which according to R. W. Brown of the Geological Survey can be used to distinguish the formation from overlying Paleocene or younger strata. At Conant Creek, a 4-foot bed of conglomeratic sandstone within the Lance formation contains gastropods and pelecypods identified by T. C. Yen as Upper Cretaceous. Twenty feet above this bed a single specimen of an Upper Cretaceous leaf, Dryophyllum subfalcatum, was collected. A short distance above this horizon is an unconformity marking the base of the Fort Union formation. The Lance formation ranges in thickness from a wedge-edge on the northwest end of the Alkali Butte anticline to about 500 ft on the east side of the anticline. It is not exposed anywhere in the region west of the wedge-edge. About 65 ft of section is present in the subsurface on the Riverton anticline. The section thickens northeastward to about 870 ft in a subsurface section on the North Alkali Butte anticline. In both these wells, the Lance formation is more shaly and contains more coal than on the surface outcrops.

The lower half of the formation consists of thin gray sandstones weathering to a conspicuous blue-gray and containing numerous dark mineral grains, interbedded with chocolate-brown shales and coal beds as much as 6 ft thick. A white to light-gray sandstone about 15 ft thick commonly marks the base of the formation. It is overlain by a chocolate-brown carbonaceous shale which, in places where the soft basal sandstone is covered, is the lowermost unit visible above the unconformity. In the lower part of the formation a bluish-weathering coal is present, as shown at locality 13 on figure 2. On figure 2 the distribution of the coal is shown. In Stanolind's North Alkali Butte well coal was encountered throughout the Lance formation. One bed of coal occurs in the Lance formation in Atlantic's Riverton Dome wells, according to Yenne 4/. The upper half of the Lance formation contains more sandstone in somewhat thicker beds, averaging from 15 to 30 ft. The upper sandstones are more ferruginous and rarely contain dark mineral grains. The lighter gray sandstones also weather blue-gray. In the Conant Creek area near the top of the formation, a porous, oolitic coarse-grained sandstone as much as 4 ft thick contains both fresh water mollusks and sporadic well-rounded and polished pebbles of black and green chert. Similar thin conglomerates of the pebble-granule type are also present at other horizons. These conglomerates contain in places angular fragments of white siliceous Mowry shale. No fragments of pre-Cambrian rock were observed.

The Lance formation overlaps the Mesaverde with as much as 5° angular unconformity from the Alkali Butte anticline eastward to Conant Creek. On the west side of the Alkali Butte anticline the Lance formation is overlapped and cut out entirely by the Fort Union formation, which rests on older strata with as much as 30° angular discordance. According to R. W. Brown the flora collected from these rocks is of latest Cretaceous age. Diagnostic dinosaur remains were not found. Fresh water gastropods and pelecypods were found in local abundance but all were considered by T. C. Yen to be long-ranging Upper Cretaceous forms. On the basis of the lithology, flora, fauna, and the structural relationships, the unit is considered to be equivalent to the Lance formation of eastern Wyoming.

Fort Union formation.--The name Fort Union is applied to a rock sequence containing, at several places in the area, a flora of Paleocene age. The formation extends from sec. 2, T. 2 N., R. 1 W., near Winkleman Dome, 40 miles northwest of Alkali Butte, southeastward to Beaver Creek. It is present in small isolated outcrops around the north end of Big Sand Draw anticline and in a continuous outcrop from the northwest side of the Alkali Butte anticline eastward beyond the limit of the map area. In most of the area, the formation ranges in thickness from a wedge-edge to about 200 ft or more. In the Alkali Butte section, however, it is about 600 ft thick. In the subsurface the formation is commonly thicker, probably because wells drilled farther out in the basin penetrate less deeply eroded sections.

[4]Yenne, op. cit.

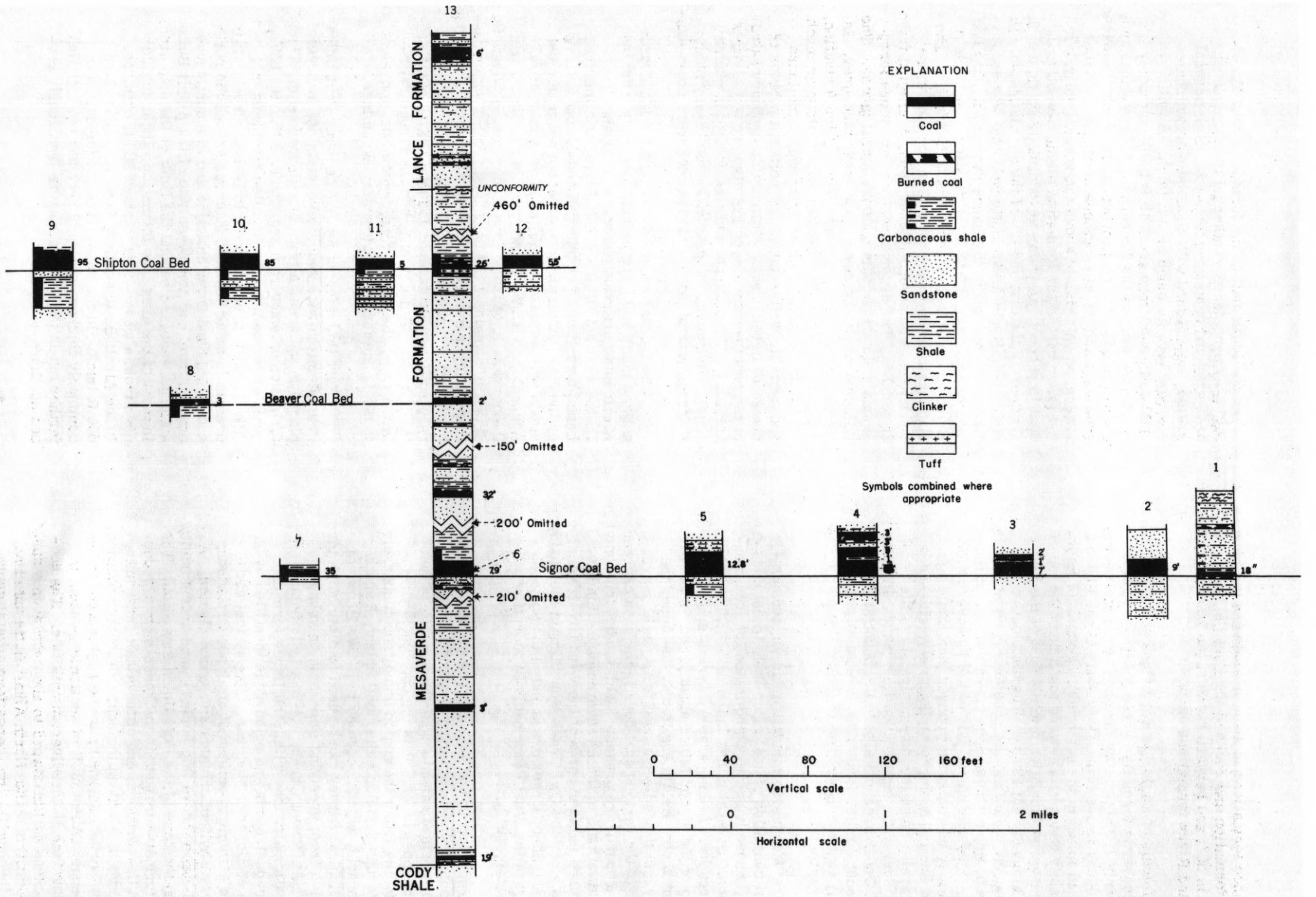
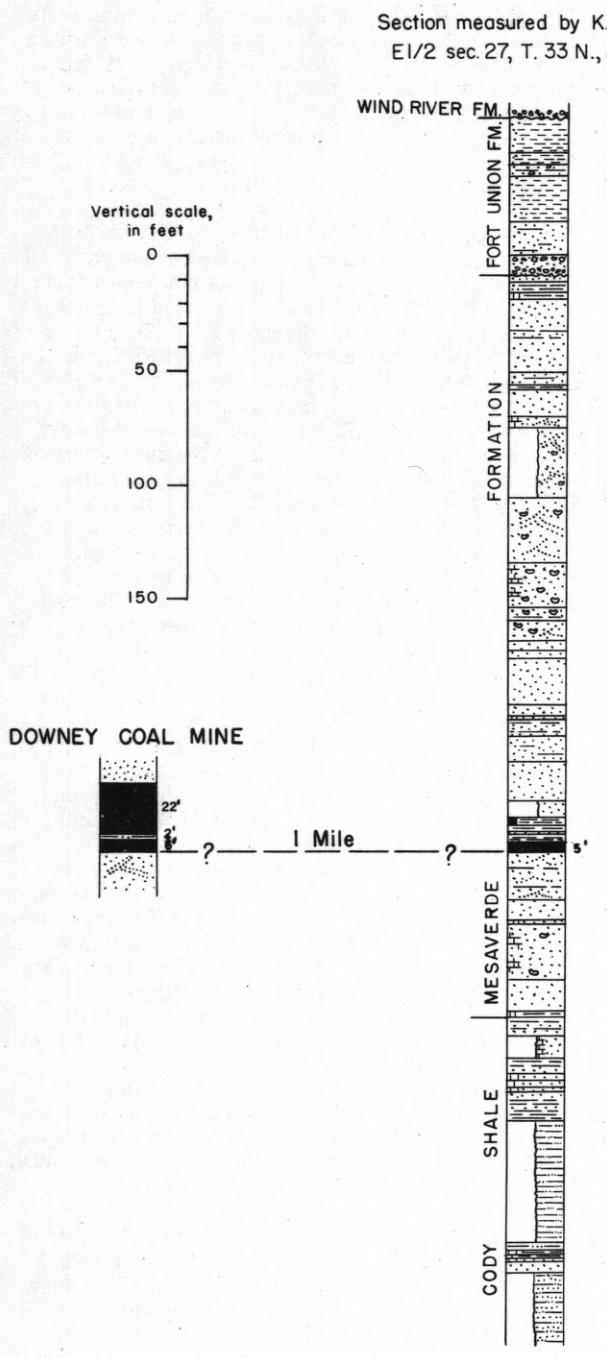


Figure 4. --Stratigraphic sections of Alkali Butte coal field, Fremont County, Wyo.



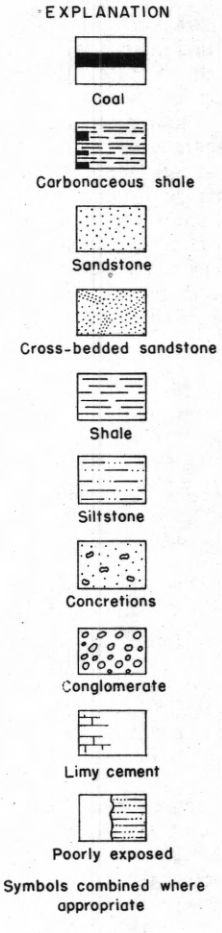


Figure 5. --Stratigraphic sections of Big Sand Draw coal field, Fremont County, Wyo.

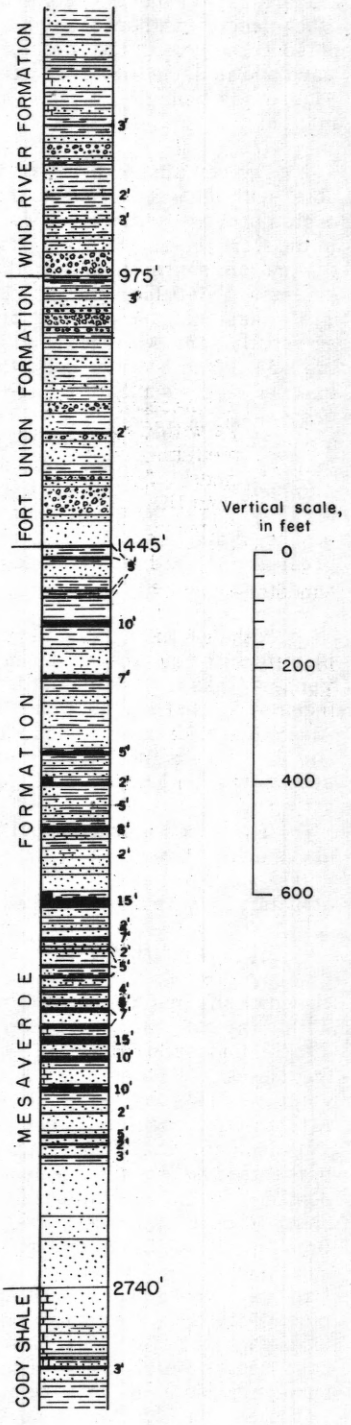


Figure 6. --Stratigraphic sections of Beaver Creek coal field, Fremont County, Wyo.

The sequence is usually marked at the base by a conspicuous light-colored conglomerate composed almost entirely of well-rounded pebbles and cobbles of noncalcareous Paleozoic rocks. Pre-Cambrian igneous material is extremely rare, but in the eastern part of the area some graphic granite and other deeply weathered granite fragments were noted. The size of the fragments decreases eastward and in some areas the conglomerate is absent. Figure 5 is typical of much of the Fort Union formation.

The remainder of the sequence is highly variable, with numerous pebble-granule type conglomerates present. Like the lowermost conglomerate in the Fort Union formation exposed in the area, the predominant rock type in the younger conglomerates is Paleozoic chert, sandstone and quartzite, with limestones and pre-Cambrian igneous material extremely rare. Several coal beds are present in the subsurface sections but either are incompletely exposed on the surface, or are represented by brown carbonaceous shale. In some areas there is a sequence within the formation of soft, white and yellow, medium-grained sandstones; which weather into badlands. Thin, black to brown ironstone beds break up and litter the hillsides giving the hillsides a mottled appearance. In other areas there are great arcuate zones of ironstone in cross-bedded sandstone channels.

Although Fort Union rocks are difficult to identify with certainty in subsurface sections, Yenne 5/ has tentatively distinguished 1,000 ft of these strata in the Stanolind Oil and Gas Co., North Alkali Butte #1, in section 1, T. 1 S., R. 5 E., and 500 ft of beds in Atlantic Refining Co., Unit #1, section 25, T. 1 S., R. 4 E., Riverton Dome.

There is a marked angular unconformity both above and below the Fort Union formation, which makes surface field identification on the basis of structural relationships somewhat easier.

Leaves characteristic of the Fort Union formation have been found in several localities which are shown on the map by Thompson and White 6/. Within the map area, wherever the flora is sufficiently diagnostic, R. W. Brown has determined the age as late Paleocene. A collection from the vicinity of Muskrat gas field, 20 miles east of Alkali Butte, contains an early Paleocene flora. This indicates that at least in one place or another in the area nearly all of Paleocene time is represented . To the northwest in the Shotgun Butte area, about 50 miles northwest of Alkali Butte, the Fort Union has a maximum thickness of about 5,600 ft and there is a prominent unconformity between these Paleocene rocks and the lowest Eocene rocks over most of the area. Although coal is not present in exposed rocks of the Fort Union formation at Big Sand Draw or Alkali Butte it is present in the subsurface in the Beaver Creek coal field, in Atlantic's wells on Riverton Dome and Stanolind's well on North Alkali Butte. About 25 miles east of Alkali Butte coal has been mined in the Castle Gardens area in rocks of the Fort Union formation.

[5]Yenne, op. cit.
[6]Thompson and White, op. cit.

Wind River formation. --The Wind River formation is a variegated sequence of continental beds of early Eocene age which is exposed at the surface throughout most of the Wind River basin. Within the mapped area, the formation is nearly always present in the synclines, in places covers older rocks on the anticlines, but more frequently has been eroded from the tops of them and crops out only around the flanks.

Southeastward from Hudson about 1,000 ft of the Wind River formation is exposed above rocks of the Fort Union formation. Sample studies indicate that 1,000 ft of the Wind River formation is present in the Beaver Creek field, about 2,400 ft in the Riverton field to the north, and about 2,600 ft in the Stanolind No. 1 North Alkali Butte well. The formation thickens rapidly from the south and west margins of the Wind River basin northward toward the trough line of the basin. This trough line trends slightly north of west from a point about 5 miles north of Shoshoni, which lies 25 miles north of Alkali Butte. In this vicinity geophysical data suggest the presence of more than 10,000 ft of early Eocene rocks. That the data may be reliable is supported to some extent by deep wells in the Badwater, Lysite, and West Poison Spider areas.

The Wind River formation is composed chiefly of variegated red, white, pink and brown to greenish-gray claystones and siltstones which commonly form spectacular badlands (fig. 9), and thick zones of lensing, coarse-grained, brown arkosic sandstones. Locally, conglomerates are present and these are characterized by an abundance of igneous rocks of pre-Cambrian age, many of which are partly decomposed. The lowest of several widespread zones is a light-gray acidic tuff which averages about 20 ft in thickness, and extends from the highway near Hudson southeastward for a distance of nearly 9 miles. It is probably present even farther to the southeast but cannot be recognized because of poor exposures. This zone is approximately 1,000 ft stratigraphically above the uppermost outcropping Fort Union rocks. The tuff is slightly radioactive. Analyses of two samples shows 0.002 and 0.003 percent equivalent uranium. It has a large amount of altered feldspar fragments, some of which are 1 cm or more in diameter, much finely divided biotite, and some hornblende.

Above the typical variegated beds of the Wind River formation is a zone of variable thickness (as much as 185 ft) without red layers. This zone appears to be transitional between typical variegated beds of the Wind River below and the lower part of the overlying middle and upper Eocene rocks. East and north of Big Sand Draw anticline a conspicuous grayish-yellow coarse arkose and arkosic mudstone 25 ft thick, at the base of the zone, supports a discontinuous belt of evergreen trees. The base of the overlying sequence is poorly exposed and usually difficult to locate.

The Wind River formation lies unconformably upon rocks of the Cody, Mesaverde, Lance, or Fort Union formations. The angularity of this unconformity is very pronounced in some areas, such as along the west side of the Alkali Butte anticline where it is 40° between the Wind River and

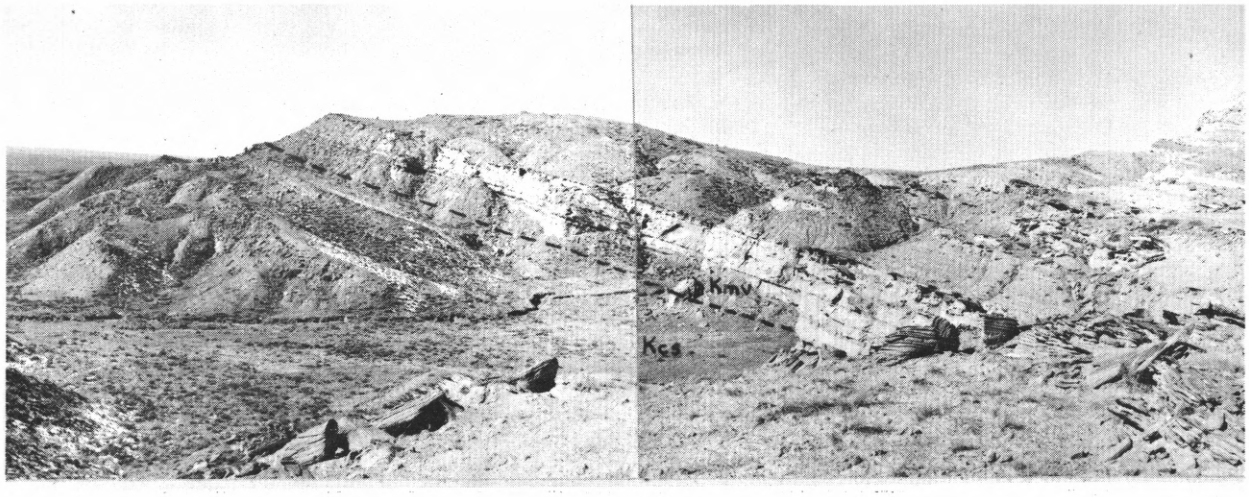


Figure 7. --Mesaverde formation and underlying sandy facies of Cody shale looking west from north-central part of sec. 23, T. 34 N., R. 95 W. Triangulation station Alkali on high point to right. Wind River Mountains in left background.

Mesaverde formations. In places where Wind River rocks lie on the Fort Union formation the angularity is usually 5°-10°. The Wind River formation is conformably overlain by middle and upper Eocene rocks, exposed along the Beaver Divide.

The Wind River formation on the north side of the Wind River basin is divided into two members, the Lysite member overlain by the Lost Cabin member. Both contain mammalian faunas of early Eocene age. In the mapped area, on the south side of the basin, only fossil mammals typical of the Lost Cabin member have been found. Lambdotherium, the most diagnostic fossil mammal in the Lost Cabin member, has been found both above and below the acid tuff in the Beaver Creek area. Here approximately 1,000 ft of Wind River strata underlie the horizon containing the lowest known occurrence of Lambdotherium, in which mammals of Lysite age or older may occur.

On the surface no important coal deposits were found in the Wind River formation although thin lenticular coal beds are present. In the subsurface at the Beaver Creek coal field four coal beds are present in the Wind River formation in beds ranging from 2 to 3 ft thick.

STRUCTURE

Coal-bearing rocks outcrop on the flanks or on the plunging ends of the Alkali Butte and Big Sand Draw anticlines and extend across the top of the Beaver Creek anticline.

Alkali Butte anticline. --The Alkali Butte anticline is strongly asymmetrical with dips as much as 65° on the west side and 15°-30° on the east side. Cody shale is exposed in the center, conspicuously flanked on the east, west, and north by rocks of the Mesaverde, Lance, Fort Union, and Wind River formations, between which angular unconformities are well developed. The anticline plunges about 10° northward. On both sides of the crest line coal is exposed. Several minor faults are present although none were observed which affected the coal beds. A small amount of oil production has been obtained from this anticline.

Big Sand Draw anticline. --Big Sand Draw is an inclusive name which refers to that part of the anticline from which oil and gas have been obtained as well as to the nonproductive North Sand Draw portion of the anticline on which the coal beds are located. The anticline is reflected in poorly exposed rocks of the Wind River formation and the sandy facies of the Cody shale, between which the angular unconformity is pronounced. The North Sand Draw part of the anticline is outlined in Cody, Mesaverde, Fort Union, and Wind River formations.

The crest line, about 8 miles long, is arcuate at the ends. The north end plunges northward. Plunge at the south end is not so apparent on the surface because the crest line passes beneath thicker and less dissected Tertiary rocks. Contoured on the top of the Cloverly formation it appears that the northern portion of the anticline is about 2,000 ft lower structurally and probably has closure independent of the major part of the Big Sand Draw anticline to the south. The North Sand Draw anticline is believed to have south closure against a Wind River or post-Wind River normal fault, down on the north side. This fault has a rather poorly defined surface expression but it is suggested by anomalous dips. There is an active argument among oil men who have mapped the area as to whether actual displacement exists. Thompson and White 7/ have concluded from surface and subsurface studies that the North Sand Draw block was dropped approximately 800 ft.

There is little evidence of faulting on the surface but a study of electric logs reveals numerous

[7] Thompson and White, op. cit.

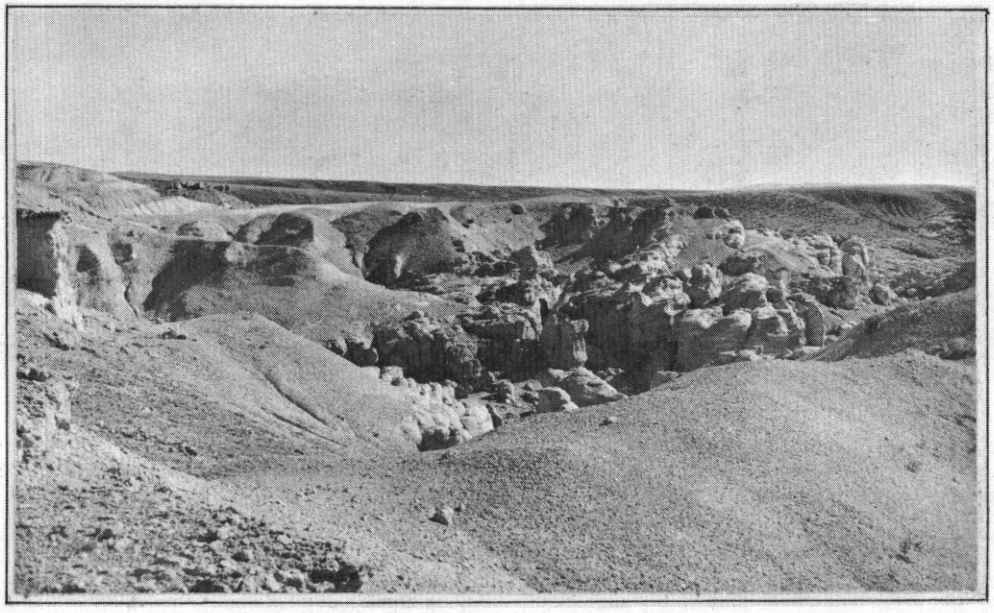


Figure 8. --Oil saturated granule-gravel conglomerate in the Fort Union formation: sec. 17, T. 34 N., R. 92 W., Fremont Co., Wyo.

faults in the subsurface. These are mostly thrust faults. The area around North Sand Draw illustrates the extent of pre-Tertiary erosion of Cretaceous rocks to a remarkable degree. Hills and valleys were apparently well developed prior to the deposition of the Fort Union formation. Fort Union rocks likewise were extensively eroded before deposition of the Wind River formation. Excellent exposures of the angular unconformities between the Mesaverde, Fort Union, and Wind River formations can be seen here. Big Sand Draw anticline has been a prolific producer of oil and gas.

Beaver Creek anticline. --The Beaver Creek anticline is reflected at the surface only in Cenozoic rocks in which it can be traced with ease for 11 miles. In the subsurface it may be 6 miles longer because it is probably continuous with the Riverton Dome. The closed portion of the anticline, as shown by structure contours on the top of the Cloverly formation, is approximately 4 miles long and the amount of closure is about 1,200 ft. This anticline is in the process of being developed for both oil and gas. In the NE¼ sec. 10, T. 33 N., R. 96 W., the crest line divides into a southwest and a southeast component. The southwest fold is about one mile long and in a region of poorly exposed rocks. The southeast fold is well defined and continues about 6 miles beyond the oil-producing area. Unlike most of the anticlines in the Wind River basin the Beaver Creek anticline is steeper on the east side than on the west, dipping eastward about 25° on the Cloverly formation. Geophysical data indicate a depth of more than 12,000 ft to the Cloverly formation in the deep syncline northeast of the field. This depth necessitates only a flattening of the dip to about 16° E.

Two transverse normal faults were mapped in the oil and gas producing area. The acid tuff zone is the key to surface structure in the area. Horizontal offset along the faults is difficult to determine but probably appears greater than it actually is because of the shallow dip of the displaced beds. Stratigraphic displacement of the south fault is probably in the tens of feet. That of the north fault is unknown but presumed to be small. Apparently both faults disappear before reaching the Cloverly formation, because no adjustment of structure contours is indicated from well study. Two normal faults are present about 1 mile north of the Stanolind Camp. Both faults displace the Hudson (?) acid tuff bed approximately 200 ft horizontally and a few tens of feet vertically. A normal fault of very small displacement occurs to the north along the Wind River Indian Reservation boundary. A north-south trending normal fault is present at the north end of the surface axis. A parallel fault was mapped about one-half mile to the west. The graben between is dropped about 50 ft. Within the graben are two minor faults trending east-west. No faulting was apparent on the south end of the fold.

The Beaver Creek anticline has produced large quantities of oil and gas and is still being developed.

ALKALI BUTTE COAL FIELD

Coal characteristics and development.--On the basis of one available analysis adapted from U. S. Bureau of Mines (1931, p. 68), shown in table 1, coal from the Mesaverde formation in the Alkali Butte coal field is classed as subbituminous B. The coal from the Lance formation has not been analyzed. From field observations it is thought to be a low-vitrain type of subbituminous coal. All of the coal is black, and generally contains a large amount of vitrain, especially in the lowermost coal bed of the Mesaverde formation. In general fusain in the coals becomes more abundant upward in the stratigraphic column. On weathering most of the coal breaks down into small pieces, although parts of some beds in the Mesaverde formation tend to be blocky. Most of the coal is relatively clean. Impurities when present consist of bone, shale, carbonaceous shale, and sandstone.

Some evidence of burning of the coal beds is present along the outcrop. The Goodman mine has been burning for several years in the direction of the Bell mine about one-half mile southeast. It is not known how much coal has been destroyed in this area but it is probably a small tonnage, with burning confined to an area along strike at shallow depth. Fracturing of the overburden is confined to a few hundred feet behind the coal outcrop. This fact together with the great amount of water encountered at shallow depths leads to the belief that reserve estimates are not affected by the small amount of burned coal at this locality. None of the mines were in operation at the time of the field investigation. Several places in the area have sufficiently thick coal of high enough quality to permit mining. Development has lagged mainly because of transportation problems. The mines are about 20 miles by dirt road from the nearest railroad, the Chicago and Northwestern, located at Riverton. Those who are familiar with mining in the area consider the water problem in the workings to be critical. In the Bell mine, shown in figure 10, so much water was encountered at 165 ft down dip along the longest entry, that pumping costs were high. Whether the water problem is either more or less acute in other parts of the field is unknown. The topographic position of much of the coal is favorable for gravity drainage at far greater depths than in the Bell mine. No reliable figures were available on the tonnages taken from the area but it is considered to be only a few tens of thousands of tons.

Coal in the Mesaverde formation.--In the lower 880 ft of the formation, as shown in figure 3, there are four main zones of coal, 3 ft or more in thickness, exposed in the Alkali Butte field. The lowermost bed is the thickest, most continuous, and probably the best coal bed in the field has been designated the Signor coal by Thompson and White 8/. This coal lies from about 100 to 350 ft above the base of the formation. A thin unnamed coal bed of local extent lies about 230 ft above the Signor bed. The Beaver coal bed (fig. 4) lies about 430 ft above the Signor coal bed. About 65 ft above the Beaver coal bed is the Shipton coal bed (fig. 4).

Between the named beds there are several thin, discontinuous coal beds as much as 18 in. thick. In the subsurface there are apparently more coal beds than are exposed on the surface. The Atlantic Refining Co. well about 2 miles north of the Shipton Mine encountered several coal beds not seen on the surface in the Alkali Butte coal field. This is likewise true in Stanolind's North Alkali Butte well about 6 miles northwest of the Shipton Mine, and in the Beaver Creek field about 8 miles southwest.

The only analysis available on coal from the Mesaverde formation within either the Big Sand Draw, Alkali Butte, or Beaver Creek coal fields is given in U. S. Bureau of Mines Tech. Paper 484. (See table 1, this report.) The "as received" sample yields the proximate analysis: 26.1 percent moisture, 30.7 percent volatile matter, 38.1 percent fixed carbon, and 5.1 percent ash. The heat value is 8,760 BTU. The sample came from the Signor Mine. Another sample collected at locality 2 (fig. 2) has been transmitted to the U. S. Bureau

[8] Thompson and White, op. cit.

Table 1.--Analysis of coal from the Signor Mine, Alkali Butte, Fremont County, Wyo.

Location of sample: No. 1 south entry, 100 ft in.
Laboratory number: 6710.

Condition of sample: A, analyzed as received; B, analyzed moisture free.

Condition	Proximate				Ultimate					Air Drying Loss	Calorific Value	
	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen		Calories	British Thermal Units
A	26.1	30.7	38.1	5.1	0.6	---	---	---	---	17.3	4,867	8,760
B	----	41.6	51.6	6.8	.8	---	---	---	---	----	6,583	11,850

of Mines as number 9035. No results have been received. The sample was taken near the entry of an old mine, in the NW¼ sec. 31, T. 34 N., R. 94 W., by cleaning the coal section back 1 ft. A channel, 4 in. square, was cut from top to bottom, collected, and split to sample size by the cone and quarter method.

Signor coal bed.--The Signor coal bed, exposed almost continuously for about 7 miles around the plunging north end of the Alkali Butte anticline, is located in portions of three townships as shown on figure 11. Where the coal is not continuously exposed geologic data are sufficient to indicate that it is present with little variation. This bed was measured in detail at localities 1, 2, 3, 4, 5, 6, and 7, and observed at several other localities between, where only an overall thickness was noted. These localities are indicated on figure 2. Where the maximum thickness of 16.5 ft of coal occurs at locality 4, there are two beds separating the coal sequence; one 3-foot bed of sandstone and shale and one bed of carbonaceous shale about 1 ft thick. The coal thins gradually eastward to about 9 ft at locality 3, maintaining this thickness for more than one-half mile east to locality 2. About 1,000 ft east of locality 2 the coal thins to about 18 in., partly as a result of burning but largely because of nondeposition. Beyond this point to the east the bed is largely covered. From locality 4 westward the

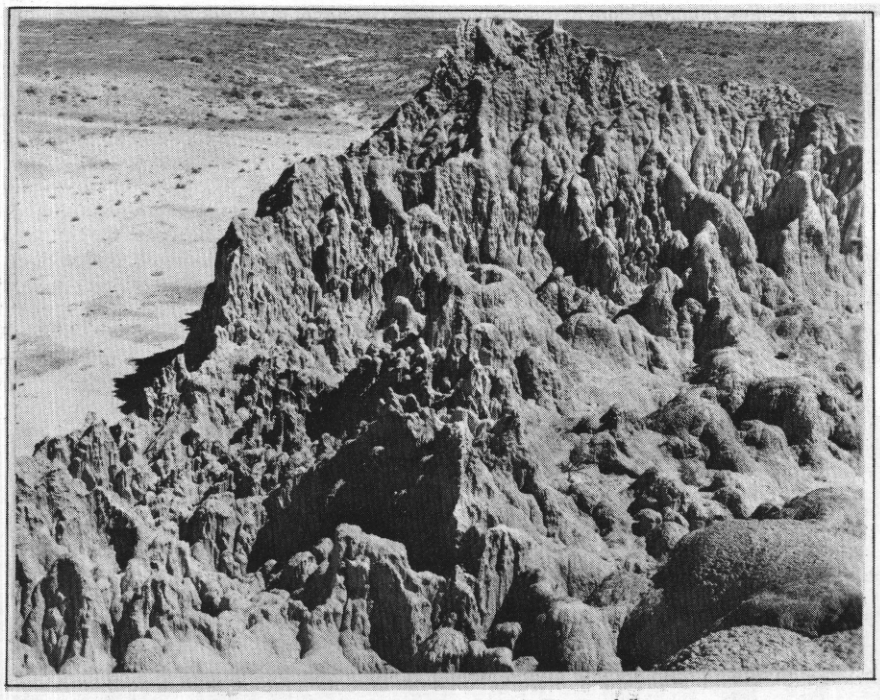


Figure 9.--Typical badlands weathered in the Wind River formation in sec. 24, T. 34 N., R. 94 W.

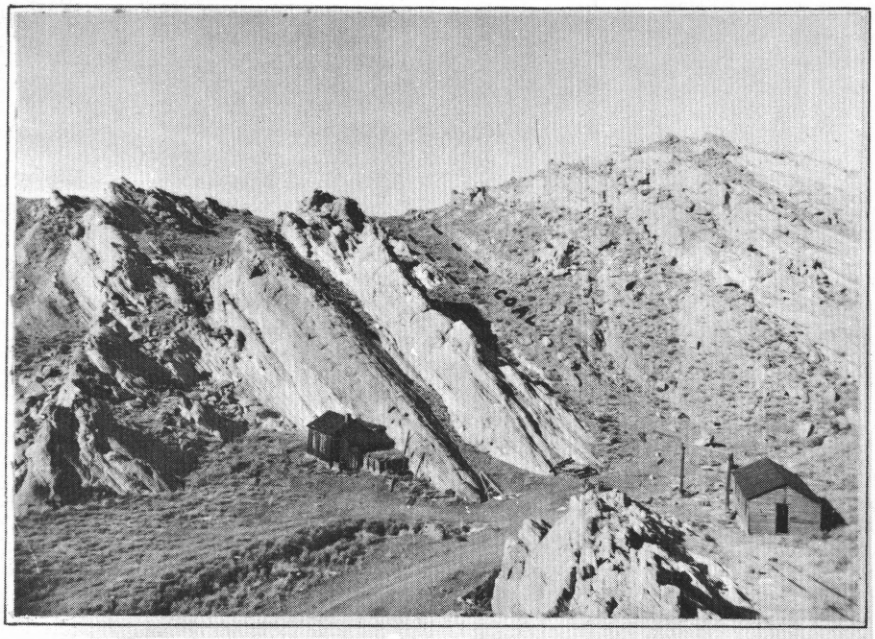


Figure 10.--Sandstones in the lower part of the Mesaverde formation near the Bell Mine on the Signor coal bed.

interbedded sandstone and shale disappears and the coal seldom has even a tiny parting. At the Bell mine 14 ft of clean coal is present. It is reported to thicken eastward underground without partings. It is possible that the partings at locality 4 disappear down dip and underground along strike. At locality 5 the coal is 12.8 ft thick, west of which the seam is largely covered to locality 6, where the coal is 7.9 ft thick. From this position westward the coal is intermittently exposed and thins to 3½-4 ft on the west side of the anticline.

Eight mines have been opened on the Signor coal bed. Prior to 1908 the Big Signor Mine, located on figure 2 as the Signor mine, and the Little Signor Mine were opened. No trace of the Little Signor Mine could be found by the writers but it was probably opened a few hundred feet east of locality 4 where the coal is poorly exposed and slumping has occurred. Since the opening of the Signor Mines, six others were developed with varying success. The Bell Co. mine, figure 10, penetrated only 165 ft down dip. It is the most recently operated mine but has been closed for several years. This mine is probably the largest in the field in amount of underground workings. The Hunt mine on the west side of the anticline illustrates the lensing nature of the coal-bearing rocks. The Signor coal bed contains the largest reserve tonnages in the field, as indicated in table 2.

Sections of coal in Signor bed

(Locality 1)

	Thickness (feet)
Top of section	
Clinker, red	6
Sandstone, gray with minor shale partings	11
Coal, locally burned out	2

(Locality 1).--Continued.

	Thickness (feet)
Sandstone and shale, interbedded, with many minor carbonaceous streaks	21
Shale, gray, carbonaceous, contains many plant fragments	2
Coal, high-vitrain	1.5
Shale, brown, carbonaceous	1
Shale, medium-gray, slightly sandy	1
Sandstone, yellow, fine-grained, interbedded with light- to medium-gray shale	7
Sandstone, light-gray to white, massive	-

(Locality 2)

Top of section	
Sandstone, buff, fine-grained, slabby to massive, lensing	15
Coal, hard, dense in center, lower and upper 2 ft slacks readily and lower vitrain content. Coal sample #9035 taken; 200 ft west of section, coal has several bone and shale partings a few inches thick. Coal thins uniformly eastward to section No. 1	9
Sandstone, gray, and shale, interbedded	20
Sandstone, buff to gray, massive	-

(Locality 3)

Top of section	
Sandstone, light-gray, thin-bedded to massive	-
Coal, uniform for 1,000 ft east	2
Shale, carbonaceous, light-brown, uniform for 1,000 ft east	1
Coal, uniform for 1,000 ft east	7
Sandstone, buff to white, fine-grained, massive	-

(Locality 4)

Top of section	
Sandstone, gray, interbedded with carbonaceous shale and ironstone	3
Coal	3
Shale, brown, carbonaceous	.5
Sandstone, light-gray to buff, fine-grained, contains many plant fragments	2.5
Coal	5
Shale, gray to brown, carbonaceous	1
Coal	8.5
Shale, light- to medium-gray, with thin interbedded sandstone	4.5
Sandstone, brown, fine-grained, thin-bedded	5
Sandstone, white to light-gray, massive	-

(Locality 5)

Top of section	
Sandstone, buff, massive	-
Sandstone, gray, fine-grained, interbedded with shale and carbonaceous shale	5 to 8
Coal	12.8
Sandstone, light-gray, interbedded with medium-gray shale and carbonaceous shale	4
Shale, carbonaceous, lignitic in lower half	6
Sandstone, white	-

(Locality 6)

Top of section	
Shale, chocolate-brown, weathers blue-gray, carbonaceous, abundant plant remains	6.3
Coal, 1,000 ft east it thickens to 9 ft	7.9
Shale, gray and sandstone, gray, fine-grained, noncalcareous	4.8

(Locality 7)

Top of section	
Shale, brown, carbonaceous	3
Coal, slacks easily, half a mile north thickens to 4 ft	3.5
Sandstone, shaly, highly carbonaceous, thin-bedded	2
Covered	-

Beaver coal bed.--The Beaver coal bed, as shown on figure 12, crops out on the north end of the Alkali Butte anticline on both sides of the crest line. It can be traced intermittently for more than a mile in T. 2 S., R. 6 E. The bed is 3 ft thick at locality 8 (fig. 2), where an old caved-in mine was found. It maintains a uniform thickness to the eastern end of the outcrop. Where observed, it appears to be a clean coal with lower vitrain content than the underlying Signor coal. On the western end of the outcrop carbonaceous shale overlies and underlies the coal. There is some indication that the coal may thicken to the southwest for a short distance. However, most of the possible extension has been eroded to stream level and is now too completely covered by alluvial debris to permit study. It is considered probable by the writers that a coal 2½ ft thick, exposed about 1 mile south, near locality 9 (fig. 2), is the same coal. If so, reserve estimates for this bed might be considered two times greater than the tabulation indicates.

Section of coal in the Beaver bed

(Locality 8)

	Thickness (feet)
Top of section	
Sandstone, gray, hard, interbedded with gray carbonaceous shale	-
Coal, directly south of locality 12, coal is same thickness	3
Shale, gray to brown, carbonaceous	-

Shipton coal bed.--The youngest coal bed observed on the outcrops of the Mesaverde formation was named the Shipton coal bed by Thompson and

White 9/. It is second in size of reserves to the Signor coal. As shown on figure 13, the coal is intermittently exposed in T. 2 S., R. 6 E., and extends southward over the Wind River Indian Reservation boundary into T. 34 N., R. 95 W.

At locality 12 (fig. 2) the coal is 5½ ft thick and clean, although of low vitrain content. Here it is separated by 6 in. of white tuff and tuffaceous sandstone. About 500 ft west the coal appears lignitic and is of poor quality. It has several partings and aggregates about 3 ft in thickness. At this locality a hard white tuff about 5 in. thick underlies the main coal. Exposures are very poor but there is some indication of about 1 ft of coal below the tuff. This tuff is also present at locality 11 (fig. 2) in the caved-in Shipton mine, underlying about 5 ft of impure coal. Between localities 10 and 11 the partings disappear and the coal thickens to 8.5 ft. An old mine at locality 10 reveals a thin bentonitic shale about 9 ft below the coal. If this bentonite-tuff-coal sequence has very great lateral extent, it may be a correlation aid in other areas, such as at Beaver Creek 8 miles to the southwest. However, it has not as yet been recognized there. At locality 9 (fig. 2) the coal has thickened to 9.5 ft. It is underlain by 19 ft of carbonaceous shale which may have thin coal seams to the south where exposures are poor.

Sections of coal in Shipton bed

(Locality 9)

	Thickness (feet)
Top of section	
Shale, brown, carbonaceous	-
Coal	9.5
Shale, carbonaceous, upper 3 ft sandy ..	19

[9] Thompson and White, op. cit.

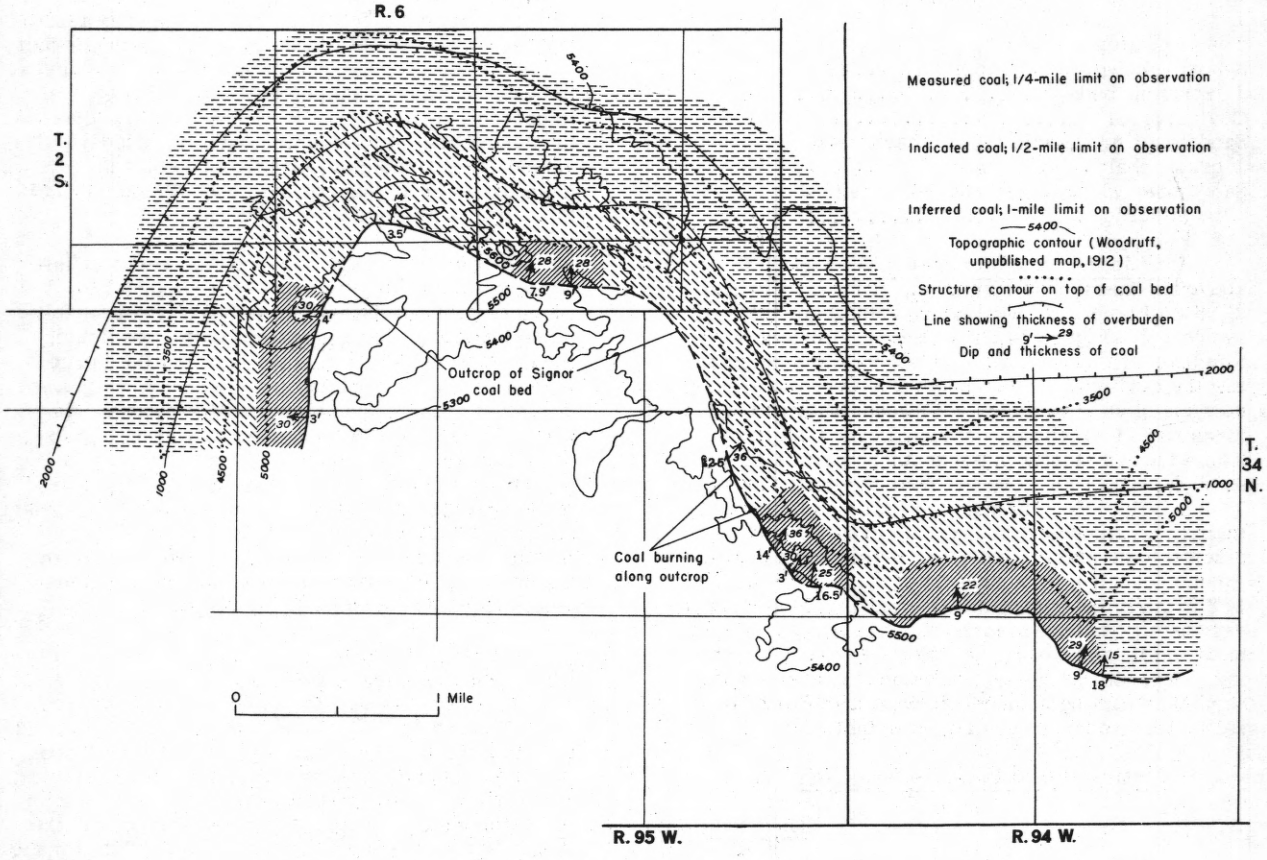


Figure 11. --Map of Signor coal bed.

(Locality 10)

	Thickness (feet)
Top of section	
Sandstone, buff	-
Coal	8.5
Shale, brown, carbonaceous, brittle	5
Sandstone, gray, interbedded with shale	4
Shale, brown, bentonitic, very fissile	1.5
Sandstone and carbonaceous shale	-

(Locality 11)

Top of section	
Sandstone, white to gray	-
Coal, poorly exposed, may be carbonaceous shale near base	7
Tuff, bentonitic, sandy, white, hard, ledgy	.2
Coal, poorly exposed, about 5 ft thick, overlain and underlain by thinly interbedded coal, carbonaceous shale and brown sandstone	14
Sandstone, light-gray	-

(Locality 12)

Top of section	
Sandstone, white, with thin dark-brown ironstone beds	-
Coal	5.5
Sandstone, gray, with thinly interbedded brown shale	10
Sandstone, white to red where colored from burned coal	-

Coal in the Lance formation.--About 60 ft above the Mesaverde formation, at locality 13 (fig. 2), 6 ft of blue-gray weathering subbituminous coal is present. Figure 14 shows the areal extent of this bed. The thickness of stratigraphic section below the coal may vary considerably over the area because of an unconformity between the Lance and Mesaverde formations. The coal crops out in limited areas mostly in the southern part of T. 1 S., R. 6 E., but is also present near the north line of T. 2 S., R. 6 E. Although the coal could not be mapped continuously through this area, it is considered to be present between the isolated outcrops. About one-half mile northwest of locality 13 the coal is 3 ft thick. It is also 3 ft thick at the westernmost exposure. The Lance formation has many lenticular beds and it is probable that the coal is also lenticular. Several thin shale, carbonaceous shale, and sandstone partings occur both west and east of locality 13. Reserves are shown in table 3.

Section of coal in Lance formation

	Thickness (feet)
Top of section	
Sandstone, light-gray, fine-grained, massive, abundant dark minerals	8.0
Shale, chocolate-brown, weathers blue gray, plant remains common	2.8
Sandstone, light-brown, weathers gray, fine-grained	2.8
Shale, brown, carbonaceous, plant remains and Unios (U. S. G. S. #21747)	2.0
Coal, weathers blue gray	6.0
Shale, chocolate-brown, very carbonaceous	1.2
Sandstone, gray to brown, medium-grained, slabby and ledgy, shaly in places	3.2

Reserve calculations.--Because most of the data on the coal in the Alkali Butte and the Big Sand Draw fields were obtained by surface mapping of the coal outcrops, and because of the observed lenticularity of the beds, it was necessary to make certain basic assumptions in calculating coal reserves. Measured coal was defined as coal lying in a block one-fourth mile wide down dip from a well established coal outcrop, along which the coal was believed to be continuous at the stated average thickness. Indicated coal was defined (1) as coal in a block half a mile wide down dip from a less well established coal outcrop, along which observations were more widely spaced, and along which the continuity or thickness of the coal could not be demonstrated as reliably as for measured coal, or (2) as coal in a block one-fourth to one-half mile down dip behind a block of measured coal. Inferred coal was defined as coal in a block one-half to 1 mile down dip behind a block of measured and indicated coal, or behind a block of indicated coal. In general, no coal classed as measured is more than one-fourth mile from the outcrop; no coal classed as indicated is more than one-half mile from the outcrop; and no coal classed as inferred is more than 1 mile from the outcrop

A somewhat more conservative set of definitions was formulated for coal in the Lance bed, which is poorly exposed, more bony, and probably more lenticular than other beds in the two fields. A further consideration is the fact that the Lance formation, which contains the Lance coal bed, was deposited unconformably on the underlying Cretaceous rocks, and the Lance bed may be absent locally owing to erosion during Lance time, or to topographic relief on the Cretaceous rocks. For these reasons the coal in the Lance bed was classed only as indicated or inferred, and coal classed as indicated was projected only one-fourth mile from the outcrop, and coal classed as inferred was projected only one-half mile from the outcrop.

The coal reserves in the Beaver Creek field have been published by Berryhill (1950).

Figures 11, 12, 13, and 14 show the data used to obtain the reserve figures given in tables 2 and 3 for the Signor, Beaver, Shipton, and Lance beds, respectively. Topographic control in the region is not yet available. The topographic contours in the Alkali Butte area were taken from unpublished plane-table mapping by E. G. Woodruff, done in 1912. Some of his elevations were spot-checked from bench marks recently established nearby and found to be accurate within 40 ft. From this information the top of each coal bed was contoured, using the dips indicated on the coal outcrop. Accompanying the dip figure on each map is a figure giving the coal thickness at that point. The 1,000, 2,000, and 3,000-foot overburden lines shown on each map are

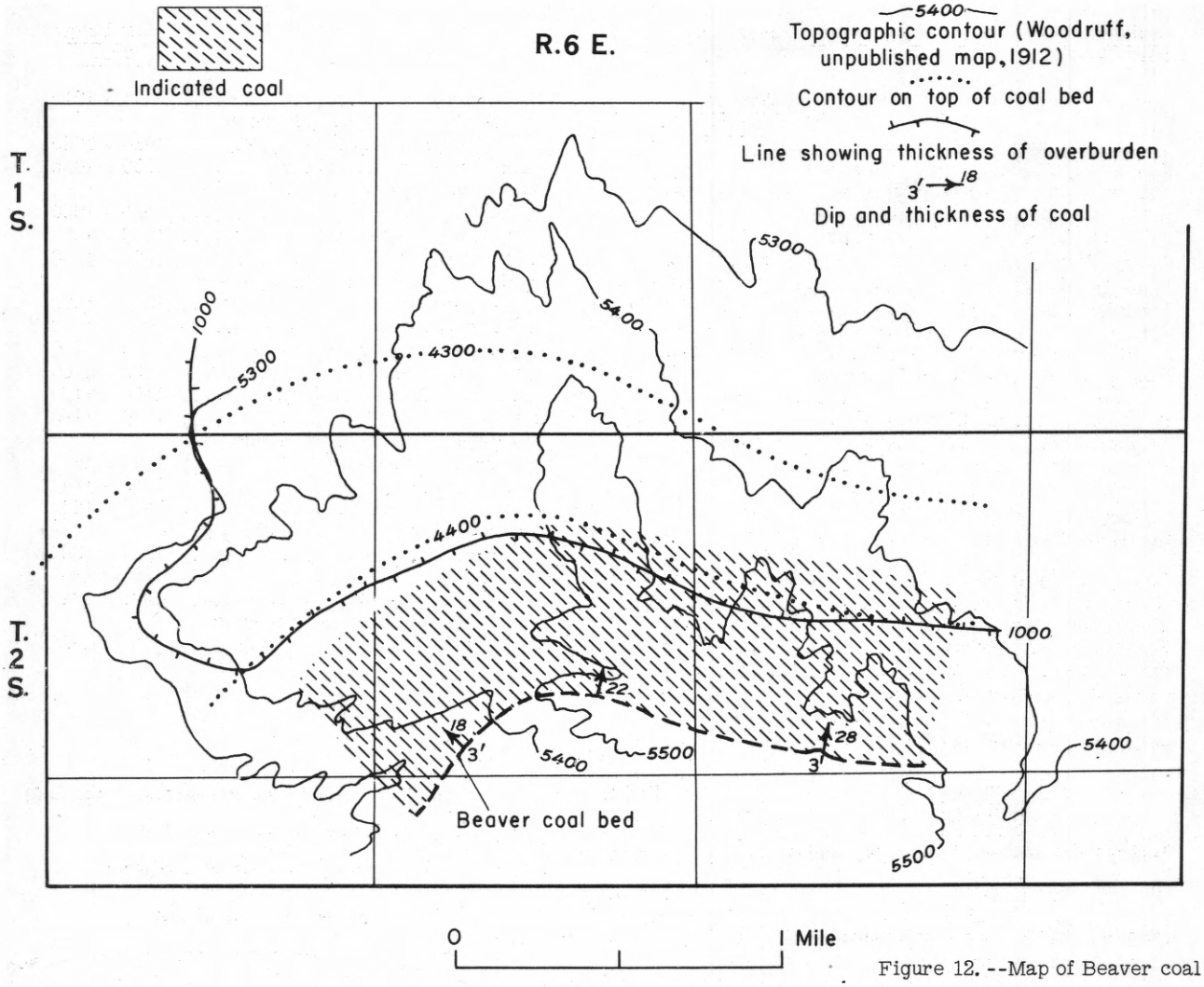


Figure 12. --Map of Beaver coal bed.

considered accurate within 100 ft. Enclosed areas under each category of reserves was measured with a polar planimeter. This area multiplied by the weighted average coal thickness, excluding all known partings in the coal, was considered to be the number of acre-feet of coal. An acre-foot of subbituminous coal was considered to weigh 1,770 short tons.

BEAVER CREEK COAL FIELD

In the Beaver Creek oil and gas field located in Tps. 33 and 34 N., R. 96 W., about 10 miles southwest of Alkali Butte, coal is present in much greater quantity than in the Alkali Butte field. One drill hole in the field (see fig. 6) shows as many as 36 coal beds aggregating 187 ft of coal. Some of the coal beds were cored. Not all the holes encountered as much coal. The coal beds range in thickness from 2.5 to 10 ft or more. The depth ranges from about 1,500 to 3,000 ft or less, depending on whether the hole is on the crest of the fold or on the flanks. The east flank of the anticline dips about 28° E. The logs of these holes and others, such as at Riverton Dome and North Alkali Butte, in the Wind River basin indicate that large reserves are present in the deeper parts of the basin area. Although no analyses are available, the coals in the Beaver Creek coal field are probably subbituminous as they are in the Hudson coal field to the west and in the Alkali Butte coal field to the east. Berryhill (1950) estimated the coal reserves in this field on the basis of drill hole data, and his figures for all classes of reserves combined are given in table 15.

Section of coal-bearing rocks in the Beaver Creek field

[Stanolind Oil and Gas Co., Johnson No. 1, sec. 3, T. 33 N., R. 96 W. From study of samples by J. D. Love]

	Feet below surface
Shale, lead-gray to black	690 - 705
Coal, black, brittle, shiny	705 - 708
Shale, dark-gray, gritty	708 - 725
Sandstone, fine, dark-gray, soft, glauconitic with light oil stain. Cored 730 - 735	725 - 735
Cored sandstone, coarse, pebbly, soft, glauconitic with light oil stain	735 - 760
Sandstone, gray, fine, soft	760 - 770
Shale, dark-gray	770 - 775
Coal, black, shiny	775 - 778
Shale, dark-gray, sandy with coal in streaks	778 - 790
Shale, gray, sandy	790 - 825
Coal, black, shiny	825 - 827
Shale, gray, sandy	827 - 830
Shale, mottled, lead and greenish-gray (poor samples, possibly out of place)	830 - 855

Section of coal-bearing rocks in the Beaver Creek field. --Continued.

	Feet below surface
Sandstone, coarse, white, slightly glauconitic, slightly oil-stained ...	855 - 860
Sandstone, with reddish shale interbedded (poor samples, possibly out of place).....	860 - 875
Coal, black, shiny.....	875 - 878
Sandstone, fine, gray, shaly.....	878 - 900
Sandstone, fine, white, soft, glauconite, with slight oil stain	900 - 910
Sandstone, fine, white, soft, slightly shaly	910 - 930
Sandstone, coarse, with pebbles as much as one half in., rounded, composed of chert, quartz and granite. Near base pebbles are almost all pea size.....	930 - 970
Shale, dark-gray	970 - 975
Base of Wind River formation.	
Coal	975 - 978
Shale, dark-gray	978 - 990
Sandstone, dark-brown, fine, soft...	990 - 1000
Shale, gray	1000 - 1010
Sandstone, fine, gray, glauconitic, soft, slight oil show at 1,020.....	1010 - 1030
Sandstone, coarse, pebbly.....	1030 - 1035
Shale, gray	1000 - 1010
Sandstone, fine, gray, glauconitic, soft, slight oil show at 1,020.....	1010 - 1030
Sandstone, coarse, pebbly.....	1030 - 1035
Pea gravel, composed chiefly of chert.....	1035 - 1060
Sandstone, coarse, pebbly	1060 - 1070
Shale, gray, sandy	1070 - 1080
Sandstone, fine, gray, hard, trace of glauconite, trace of oil stain ..	1080 - 1090
Shale, gray, gritty to smooth.....	1090 - 1110
Sandstone, fine angular, gray.....	1110 - 1130
Shale, gray, sandy	1130 - 1160
Sandstone, fine, dark-gray, shaly..	1160 - 1170
Shale, gray, sandy	1170 - 1190
Pea gravel composed of rounded chert fragments.....	1190 - 1210
Shale, gray, sandy	1210 - 1245
Coal	1245 - 1247
Sandstone, soft, with dark chert pebbles	1247 - 1260
Sandstone, fine, shaly.....	1260 - 1300
Shale, gray	1300 - 1320
Pea gravel interbedded with white sandstone. Cored 1321-1330	1320 - 1330

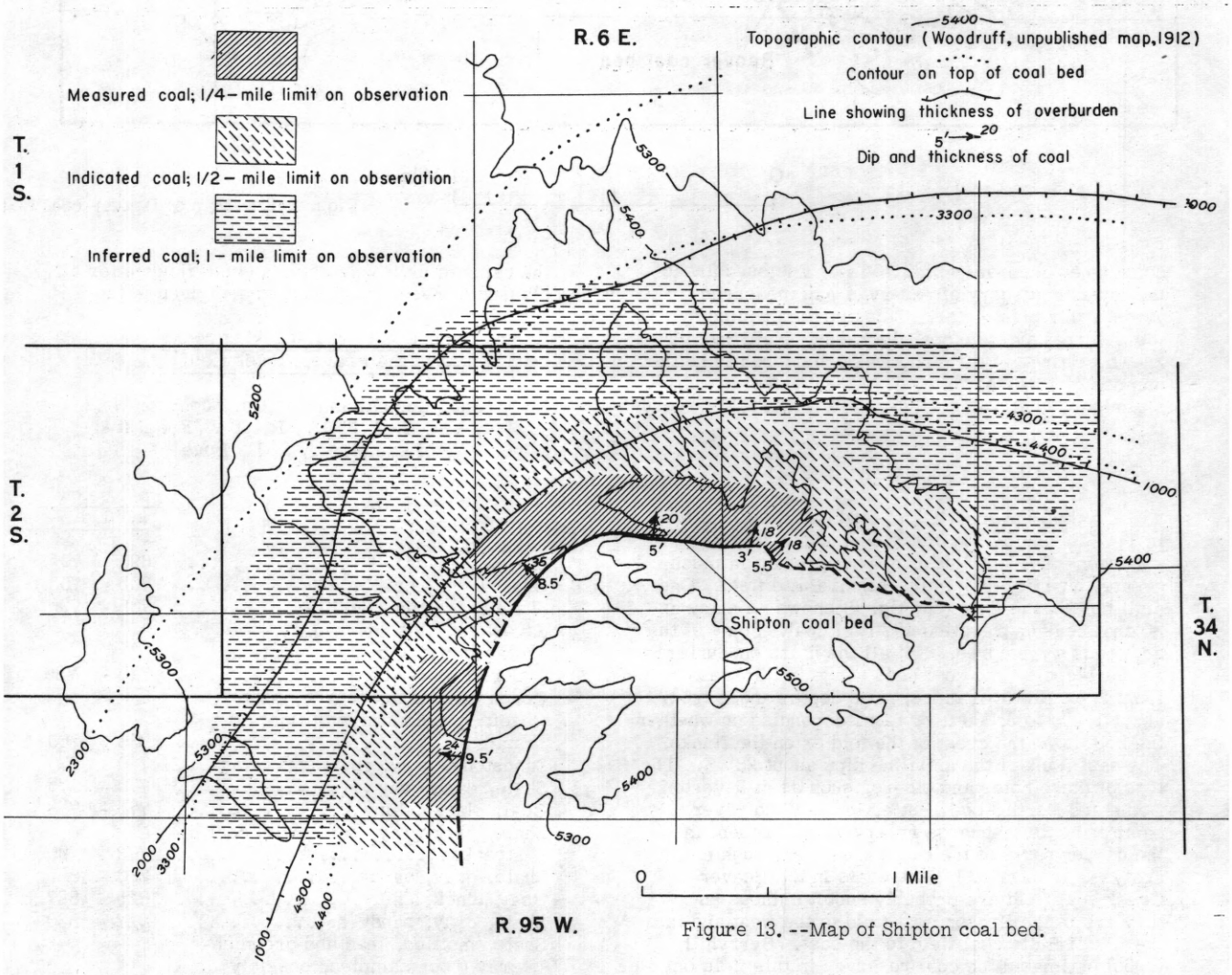


Figure 13. --Map of Shipton coal bed.

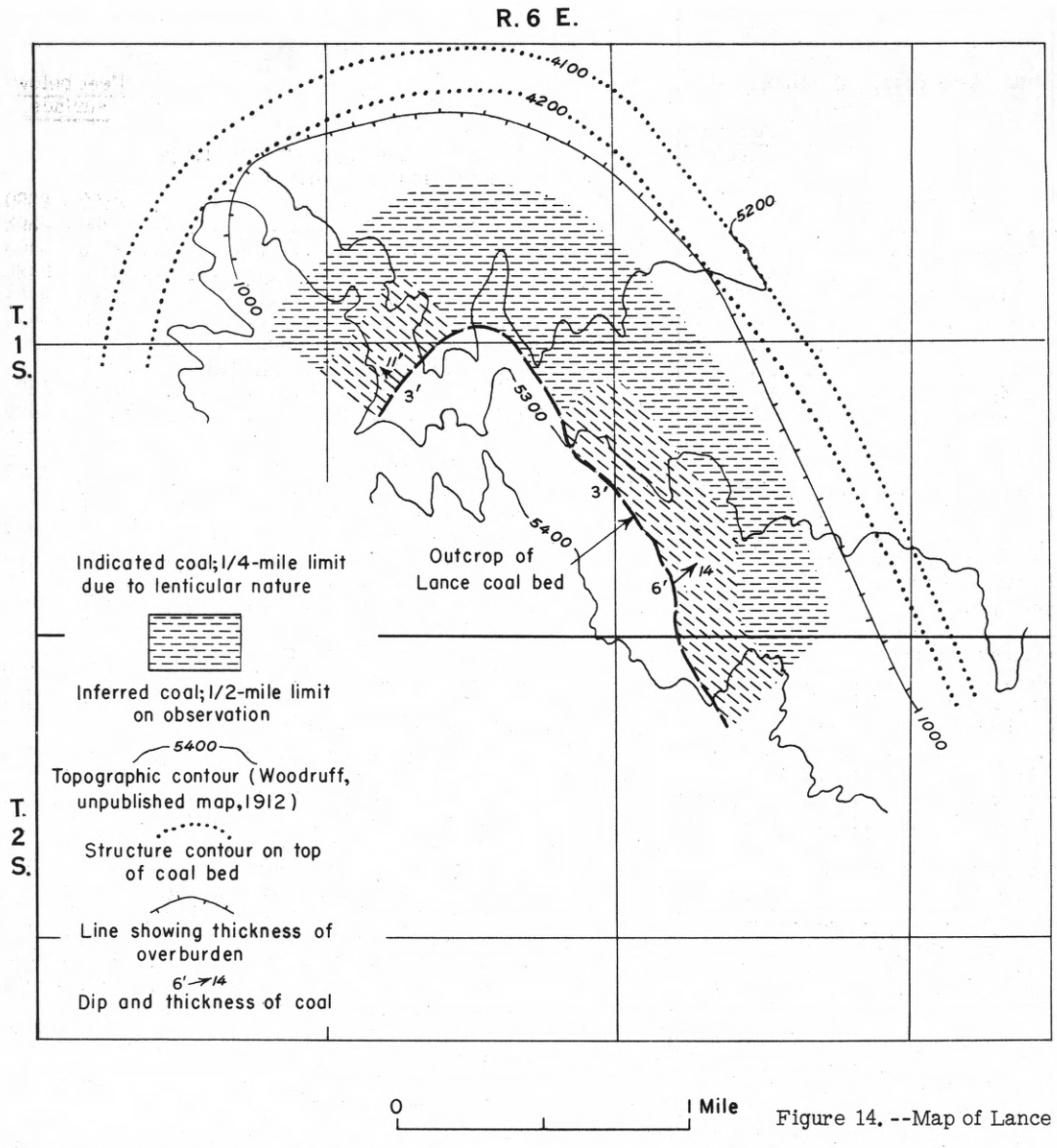


Figure 14. --Map of Lance coal bed.

Base of Wind River formation. --Continued.

	Feet below surface
Sandstone, fine, white. Cored 1330-1340	1330 - 1340
Chert gravel	1340 - 1390
At 1390 is the contact between coarse gravel conglomerate and a fine soft sandstone. Possibly the contact between Cretaceous and Paleocene (?)	
Sandstone, very fine, silty, gritty, gray	1390 - 1400
Sandstone, very fine, gray	1400 - 1445
Base of Fort Union formation	
Coal, brittle, shiny	1445 - 1450
Shale, gray, sandy	1450 - 1465
Coal	1465 - 1470
Black shale	1470 - 1475
Sandstone, pepper and salt, soft	1475 - 1500
Shale, gray, sandy	1500 - 1521
Coal	1521 - 1525
Shale, gray	1525 - 1530
Coal	1530 - 1535
Shale, black, soft, coaly	1535 - 1575
Coal	1575 - 1585
Shale, grayish, slightly gritty	1585 - 1625
Sandstone, gray, pepper and salt, shaly, fine, soft	1625 - 1675
Coal	1675 - 1682
Shale, dark-gray	1682 - 1705
Sandstone, fine, pepper and salt, shaly near base	1705 - 1720
Shale, gray, sandy, with pelecypod shells	1720 - 1765
Sandstone, fine, speckled, shaly	1765 - 1800
Shale, gray	1800 - 1807
Coal	1807 - 1812
Shale, gray	1812 - 1820
Sandstone, shaly	1820 - 1830
Shale, gray	1830 - 1833
Coal	1833 - 1835
Shale, gray	1835 - 1840

Base of Fort Union formation.--Continued.

	Feet below surface
Sandstone, fine, soft, pepper and salt	1840 - 1852
Shale, black, carbonaceous	1852 - 1860
Coal	1860 - 1865
Shale, gray, sandy	1865 - 1883
Coal	1883 - 1885
Shale, gray	1885 - 1890
Sandstone, shaly	1890 - 1900
Shale, gray, sandy	1900 - 1915
Sandstone, fine, gray	1915 - 1923
Shale, gray	1923 - 1937
Coal	1937 - 1945
Shale, gray	1945 - 1950
Sandstone, gray, shaly	1950 - 1960
Shale, gray	1960 - 1975
Sandstone, fine, gray, slightly shaly.	1975 - 1990
Sandstone, very shaly with coal partings from 2,000 to 2,010	1990 - 2010
Cored sandstone, fine, pepper and salt, with abundant carbonized plant remains	2010 - 2020
Cored sandstone as above, slightly coarser with light oil stains from 2025 to 2050	2020 - 2050
Cored shale, dark-gray, fine, gritty, carbonaceous	2050 - 2065
Cored coal, black, shiny	2065 - 2080
Shale, gray, cored	2080 - 2083
Cored sandstone, soft, fine, loose, pepper and salt	2083 - 2095
Cored shale, gray	2095 - 2107
Sandstone, soft, fine, cored 2107-2110	2107 - 2115
Coal	2115 - 2117
Sandstone	2117 - 2130
Coal	2130 - 2137
Sandstone	2137 - 2145
Coal	2145 - 2147
Sandstone	2147 - 2152
Coal	2152 - 2157
Sandstone	2157 - 2160
Shale, gray, sandy	2160 - 2180
Coal	2180 - 2185
Shale, gray, sandy	2185 - 2197
Coal	2197 - 2202
Shale, gray	2202 - 2207
Sandstone	2207 - 2212
Shale, gray	2212 - 2220
Sandstone	2220 - 2223
Coal	2223 - 2227
Shale, gray	2227 - 2233
Sandstone	2233 - 2240
Coal	2240 - 2245
Shale, gray	2245 - 2250
Sandstone, shaly	2250 - 2255
Coal	2255 - 2262
Sandstone, fine, soft, angular, pepper and salt	2262 - 2285
Coal	2285 - 2292
Shale, gray, sandy	2292 - 2305
Coal	2305 - 2320
Sandstone, shaly	2320 - 2330
Shale, gray	2330 - 2340
Coal	2340 - 2350
Shale, gray, sandy	2350 - 2360
Sandstone, fine, soft, slightly limy, pepper and salt, shaly near base	2360 - 2390
Shale, gray	2390 - 2395
Coal	2395 - 2405
Shale, gray	2405 - 2425
Sandstone	2425 - 2438
Coal	2438 - 2440
Sandstone, medium-angular, pepper and salt, with sparse pinkish minerals	2440 - 2470
Sandstone, shaly	2470 - 2478
Coal	2478 - 2482
Sandstone, shaly	2482 - 2493
Coal	2493 - 2495
Shale, gray	2495 - 2500
Sandstone	2500 - 2517
Coal	2517 - 2520
Shale, gray	2520 - 2525
Sandstone, shaly	2525 - 2530
Sandstone, medium-grained, pepper and salt, common pink mineral, soft, angular	2530 - 2620
Same as above, but slightly finer	2620 - 2660
Same as above but medium-grained	2660 - 2745
Base of Mesaverde formation	
Sandstone, fine, gray, quite limy, very even textured. Very abrupt change from medium-grained, angular, soft sandstone with abundant black and red minerals above, to a very homogeneous, fine, gray limy sandstone below	2745 - 2810
Sandstone, shaly, gray	2810 - 2825
Sandstone, pepper and salt, fine, gray, limy	2825 - 2840
Siltstone, very fine, hard, limy, shaly	2840 - 2860
Cored shale, dark-gray, fine, micaceous with abundant carbonized plant fragments	2860 - 2870
Cored sandstone, fine, pepper and salt, carbonaceous	2870 - 2875
Cored shale, black, fine, micaceous, hard	2875 - 2880
Sandstone	2880 - 2885
Coal	2885 - 2888
Sandstone, shaly	2888 - 2910
Shale, lead gray, fine, gritty	2910 - 2975
Sandstone, fine, gray, angular, salt and pepper with pale-green glauconite	2975 - 2985
Shale, gray, gritty and very fine, slightly glauconitic sandstone	2985 - 3070
(Underlying rocks contain no coal).	

BIG SAND DRAW COAL FIELD

Figure 3 is a geologic map of the northern part of Big Sand Draw anticline. A maximum of 320 ft of the lower part of the Mesaverde formation is exposed on the anticline about 1 mile southeast of the Downey mine. Near the base of the formation, coal is present but is poorly exposed. Sections are exposed in the Downey mine located

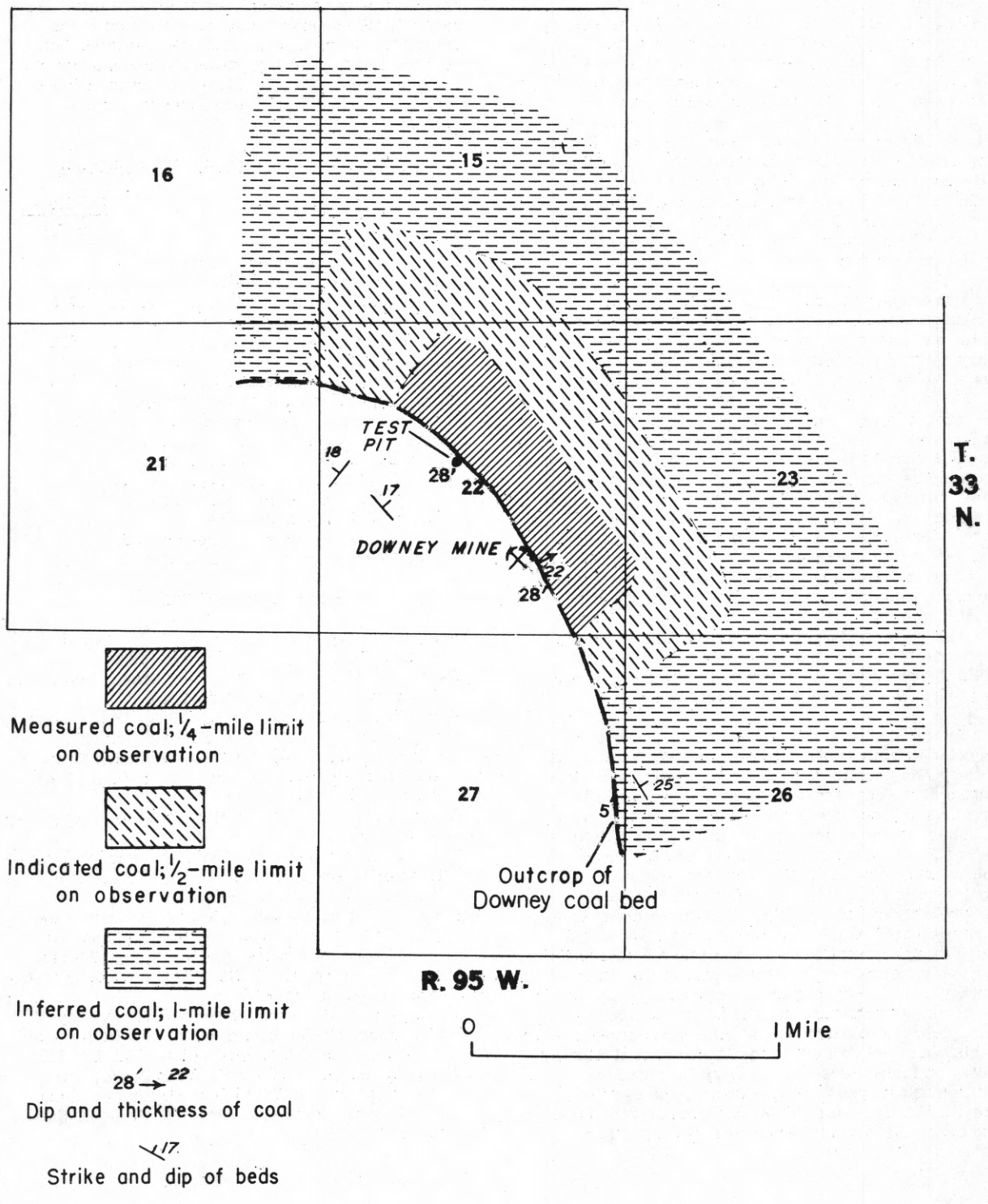


Figure 15. --Map of Downey coal bed.

the SE¼ sec. 22, T. 33 N., R. 95 W., and in SE¼NE¼SE¼ sec. 27, T. 33 N., R. 95 W., where 5 ft of shaly coal, considered equivalent to the lower Downey seam, is exposed. The mine was partially caved and not entirely accessible to the writers who measured 5 ft plus of coal near the mouth of the entry. This coal appears identical with the Signor coal of Alkali Butte. Because the complete section of coal and other data concerning the mine could not be readily ascertained by the writers, the following data were obtained from the mine owner, Mr. George Downey of Lander, Wyo., and both the discussion and estimates of reserves are based on his statements.

The lower bed ranges from 6 to 6.3 ft in thickness in the Downey mine. This was observed by the writers in the upper portion of the mine entry. Overlying this coal is a 2-foot bed of silty shale, above which, Mr. Downey reports, there is 22 ft of coal. The aggregate thickness of 28 ft is the largest in the region. Mr. Downey did not have an analysis of the coal but stated that it did not slack as readily as the Alkali Butte coal. This is probably because of a lower moisture content. The mine, in contrast to the Alkali Butte mines, is dry. The entry dips 23° NE along an incline length of 450 ft. At this depth the coal bed flattens to about 18° NE. Most of the rooms were opened in the area northwest of the entry where the parting between the coal seams decreased to about 1.5 ft. It is estimated that about 10,000 tons were mined. About one-half mile northwest of the mine, Mr. Downey dug a test pit in the creek bottom and reported the same thickness of 28 ft of coal. He did not indicate how thick the parting was in the test pit.

From these data supplied by Mr. Downey, correlation of the measured surface section with the Downey mine section was made. (See fig. 5.) Projection of the coal bed was based upon geologic indications and reserve figures shown in table 4 were calculated in the same manner as for Alkali Butte. Figure 15 was constructed to show how the reserve figures were obtained. The only coal outcrop seen, located on the southern edge of figure 3, is shaly and probably of poor quality. For this reason, data were projected only 500 ft to the south. About 8 ft above this bed, coal partings occur in a 4-foot shale bed, which may be equivalent in part to the upper Downey seam. Because the coal probably thins to the north, a thickness figure of 20 ft was arbitrarily chosen to calculate the inferred reserves. If this coal is equivalent to the Signor coal at Alkali Butte, as the writers suspect from its stratigraphic position and its physical appearance, the 6-mile interval between the fields should contain very large reserves. Above the Downey coal several other coal beds may be present, as at Alkali Butte. Because of the unconformable relationships of the overlying rocks, no coal could be observed, but other beds are probably present at depth north of the mine area. The calculated reserves undoubtedly could be enlarged tremendously by core drilling.

Section of coal 1 mile south of Downey mine

	Thickness (feet)
Top of section	
Sandstone, light-yellowish-green, medium-grained, contains much glauconite, soft, porous	17.5
Sandstone, white, salt and pepper appearance	5.3
Shale, dark-gray to brown, weathering light gray	1.5
Shale, coal streaks, may be equivalent to upper coal in Downey mine	3.5
Shale, gray	2
Sandstone, gray	2
Shale, bituminous	3
Coal, shaly at base, probably same as lower coal in Downey mine	5
Sandstone, white to gray, fine-grained, soft, porous, partly cross-bedded	14.5

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Table 2.--Estimated original coal reserves in the Mesaverde formation in the Alkali Butte field, Fremont County, Wyo., in millions of short tons
[All coal is of subbituminous rank. Computed January 1951]

Bed	Area (acres)	Weighted-average thickness in feet	Overburden	Measured reserves				Indicated reserves				Inferred reserves				Total measured indicated and inferred reserves
				In beds 2½ to 5 ft thick	In beds 5 to 10 ft thick	In beds more than 10 ft thick	Total	In beds 2½ to 5 ft thick	In beds 5 to 10 ft thick	In beds more than 10 ft thick	Total	In beds 2½ to 5 ft thick	In beds 5 to 10 ft thick	In beds more than 10 ft thick	Total	
T. 2 S., R. 6 E. (Partial township)																
Signor	78	8	0-1000	....	1.10	....	1.10	....	....	....	....	....	....	....	....	1.10
Signor	656	6.5	0-1000	....	....	....	....	....	7.53	....	7.53	....	....	....	....	7.53
Signor	104	6	1000-2000	....	....	....	....	....	1.10	....	1.10	....	....	....	....	1.10
Signor	6	7	0-1000	....	....	....	....	....	....	....	....	....	0.74	....	0.74	.74
Signor	922	7	1000-2000	....	....	....	....	....	....	....	....	....	11.42	....	11.42	11.42
Signor	325	7	2000-3000	....	....	....	....	....	....	....	....	....	4.03	....	4.03	4.03
Beaver	557	3	0-1000	....	....	....	....	2.96	....	....	2.96	....	....	....	....	2.96
Beaver	96	3	1000-2000	....	....	....	....	.51	....	....	.51	....	....	....	....	.51
Shipton	219	9	0-1000	....	3.49	....	3.49	....	....	....	....	....	....	....	....	3.49
Shipton	421	9	0-1000	....	....	....	....	....	6.71	....	6.71	....	....	....	....	6.71
Shipton	253	9	1000-2000	....	....	....	....	....	4.03	....	4.03	....	....	....	....	4.03
Shipton	230	9	0-1000	....	....	....	....	....	....	....	....	....	3.66	....	3.66	3.66
Shipton	653	9	1000-2000	....	....	....	....	....	....	....	....	....	10.40	....	10.40	10.40
Shipton	226	9	2000-3000	....	....	....	....	....	....	....	....	....	3.60	....	3.60	3.60
Total					4.59		4.59	3.47	19.37		22.84		33.85		33.85	61.28
T. 1 S., R. 6 E. (Partial township)																
Signor	29	7	2000-3000	....	....	....	....	....	....	....	....	....	0.36	....	0.36	0.36
Shipton	208	5	1000-2000	....	....	....	....	....	....	....	....	1.84	....	....	1.84	1.84
Shipton	38	8	2000-3000	....	....	....	....	....	....	....	....	....	.54	....	.54	.54
Total												1.84	0.90		2.74	2.74
T. 34 N., R. 95 W. (Partial township)																
Signor	50	13	0-1000	....	....	1.15	1.15	....	....	....	....	....	....	....	....	....
Signor	13	13	0-1000	....	....	....	....	....	....	0.29	0.29	....	....	....	....	....
Signor	42	13	1000-2000	....	....	....	....	....	....	.97	.97	....	....	....	....	....
Signor	32	13	1000-2000	....	....	....	....	....	....	....	....	....	....	0.74	0.74	0.74
Signor	83	15	0-1000	....	....	2.20	2.20	....	....	....	....	....	....	....	....	2.20
Signor	107	3.5	0-1000	0.66	....	....	.66	....	....	....	....	....	....	....	....	.66
Signor	14.4	15	0-1000	....	....	....	....	....	....	.38	.38	....	....	....	....	.38
Signor	115	11	0-1000	....	....	....	....	....	....	2.24	2.24	....	....	....	....	2.24
Signor	80	3.5	0-1000	....	....	....	....	.50	....	....	.50	....	....	....	....	.50
Signor	51	9	1000-2000	....	....	....	....	....	0.81	....	.81	....	....	....	....	.81
Signor	53	9	0-1000	....	....	....	....	....	....	....	....	....	0.84	....	.84	.84
Signor	86	9	1000-2000	....	....	....	....	....	....	....	....	....	1.37	....	1.37	1.37
Signor	160	3.5	1000-2000	....	....	....	....	....	....	....	....	0.99	....	....	.99	.99
Signor	130	9	2000-3000	....	....	....	....	....	....	....	....	....	2.07	....	2.07	2.07
Shipton	70	9.5	0-1000	....	1.18	....	1.18	....	....	....	....	....	....	....	....	1.18
Shipton	118	9.5	0-1000	....	....	....	....	....	1.98	....	1.98	....	....	....	....	1.98
Shipton	6	9.5	1000-2000	....	....	....	....	....	.10	....	.10	....	....	....	....	.10
Shipton	16	9.5	0-1000	....	....	....	....	....	....	....	....	....	.27	....	.27	.27
Shipton	149	9.5	1000-2000	....	....	....	....	....	....	....	....	....	2.50	....	2.50	2.50
Shipton	13	9.5	2000-3000	....	....	....	....	....	....	....	....	....	.22	....	.22	.22
Total				0.66	1.18	3.35	5.19	0.50	2.89	3.88	7.27	0.99	7.27	0.74	9.00	21.46
T. 34 N., R. 94 W. (Southwest corner)																
Signor	88	13	1000-2000	....	....	....	....	....	....	....	....	....	....	2.04	....	2.04
Signor	173	9	0-1000	....	2.76	....	2.76	....	....	....	....	....	....	....	....	2.76
Signor	221	9	0-1000	....	....	....	....	....	3.52	....	3.52	....	....	....	....	3.52
Signor	43	9	1000-2000	....	....	....	....	....	.68	....	.68	....	....	....	....	.68
Signor	349	6	0-1000	....	....	....	....	....	....	....	....	....	3.71	....	3.71	3.71
Signor	362	6	1000-2000	....	....	....	....	....	....	....	....	....	3.84	....	3.84	3.84
Signor	70	6	2000-3000	....	....	....	....	....	....	....	....	....	.74	....	.74	.74
Total					2.76		2.76		4.20		4.20		8.29	2.04	10.33	17.29
Grand Total				0.66	8.53	3.35	12.54	3.97	26.46	3.88	34.31	2.83	50.31	2.78	55.92	102.77

Table 3.--Estimated original coal reserves in the Lance formation in the Alkali Butte field, Fremont County, Wyo., in millions of short tons
[computed January 1951]

Bed	Area (acres)	Weighted-average thickness in feet	Overburden	Measured reserves				Indicated reserves				Total measured and indicated reserves
				In beds 2½ to 5 ft thick	In beds 5 to 10 ft thick	In beds more than 10 ft thick	Total	In beds 2½ to 5 ft thick	In beds 5 to 10 ft thick	In beds more than 10 ft thick	Total	
T. 2 S., R. 6 E. (Partial township)												
Lance coal	42	4	0-1000	0.29	....	....	0.29	....	....	....	....	0.29
Lance coal	11	4	0-1000	....	....	....	....	0.08	....	....	0.08	.08
Total				0.29			0.29	0.08			0.08	0.37
T. 1 S., R. 6 E. (Partial township)												
Lance coal	205	4	0-1000	1.45	....	....	1.45	....	....	....	....	1.45
Lance coal	566	4	0-1000	....	....	....	....	3.96	....	....	3.96	3.96
Total				1.45			1.45	3.96			3.96	5.41
Grand Total				1.74			1.74	4.04			4.04	5.78

Table 4.--Estimated original coal reserves in the Mesaverde formation in the Big Sand Draw field, Fremont County, Wyo., in millions of short tons
[All coal is of subbituminous rank. Estimate of 10,000 short tons taken from Downey Mine. Computed February 1951]

Bed	Area (acres)	Weighted-average 1/ thickness in feet	Overburden	Measured reserves		Indicated reserves		Inferred reserves		Total measured, indicated and inferred reserves
				In beds more than 10 ft thick	Total	In beds more than 10 ft thick	Total	In beds more than 10 ft thick	Total	
T. 33 N., R. 6 E.										
Downey	179	28	0-2000	8.87	8.87	....	....	....	....	8.87
	379	28	0-2000--	....	....	18.78	18.78	....	....	18.78
	1248	20	0-3000	....	....	....	....	44.18	44.18	44.18
Total				8.87	8.87	18.78	18.78	44.18	44.18	71.83

1/ Thickness figures supplied by George Downey, February 1951, and not checked by writers because mine was caved in.

Table 5.--Estimated original coal reserves in the Mesaverde and younger formations in the Beaver Creek field, Fremont County, Wyo., in millions of short tons
[All coal is probably subbituminous rank. Data taken from Berryhill and others (1950). Computed September 1950]

Bed	Overburden	All classes of reserves			
		In beds 2½ to 5 ft thick	In beds 5 to 10 ft thick	In beds more than 10 ft thick	Total
T. 33 N., R. 96 W.					
?	1000-2000	32.45	27.11	45.96	105.52
?	2000-3000	69.27	45.72	192.07	307.06
Total		101.72	72.83	238.03	412.58