COAL FIELDS IN A PORTION OF CENTRAL UINTA COUNTY, WYO.

By ALFRED REGINALD SCHULTZ.

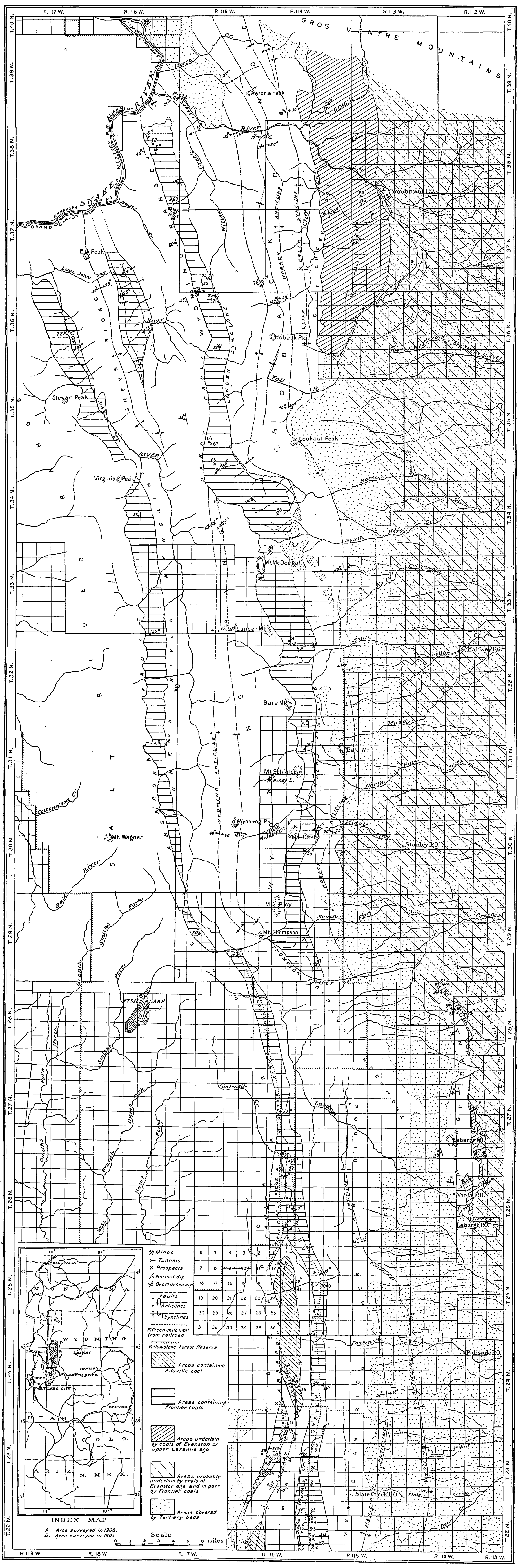
INTRODUCTION.

The present paper comprises a brief preliminary statement of some of the results obtained from surveys made by E. E. Smith, B. A. Iverson, H. C. Schleuter, and the writer during the summer of 1906 in Tps. 23 to 39 N., Rs. 113 to 117 W., inclusive, Uinta County, Wyo.[a] The examination of this region was made primarily for the purpose of determining the outcrop of the various coal-bearing rocks and oil beds and to trace northward the coal formations mapped by A. C. Veatch and the writer in southern Uinta County during the summer of 1905.[b] In carrying on this work the surveys were carefully tied to land corners, and geologic and sketch topographic maps were prepared on a scale of 2 inches to the mile, with a contour interval of 100 feet. The data collected have been compiled into a single base map on the scale of 1 inch to the mile, which shows all the streams, land corners, houses, fences, roads, and trails found in this examination and will accompany the complete report of this area. This map shows the areal and structural geology, the location and depth of the coal beds, the location of the oil-bearing shales, the occurrence of iron and gold, and the regions where they may be found. It is the purpose in this preliminary report to give a short description and summary of the occurrence and distribution of the coal-bearing formations in this field and to point out to what extent development has been carried. The accompanying map (Pl. XIII) is a reduced copy of the base map above mentioned.[c]

[a] A complete detailed report of this work will be issued later as a separate publication of the Geological Survey.

[b] For results of the survey made in 1905 see Prof. Paper U. S. Geol. Survey No. 56 and Bull. U. S. Geol. Survey No. 285, 1906, pp. 331-353.

[c] Recent work has shown that the areas mapped as Evanston on the east side of Labarge Ridge are Adaville and that the contact between them and the older rocks on the west is a fault instead of a depositional contact as shown on the map.



MAP OF THE COAL FIELDS OF CENTRAL UINTA COUNTY WYO.

By A. R. Schultz, assisted by E. E. Smith, 1906. (See footnote, p. 212.)

SURFACE FEATURES.

This region has an elevation ranging from 5,700 feet on Snake River to 11,500 feet along the crest of the mountain ranges. In the vicinity of Sheep Creek, a tributary of John Day River, where the most rugged topography is encountered, there is in some places a difference of elevation of 3,000 feet in less than half a mile. The area is traversed from west of north to east of south by two parallel mountain ranges—Salt River Range and Wyoming Range—and is bounded on the northeast by the Gros Ventre Mountains, which extend in an east-southeast and west-northwest direction. Near the south end of the area mapped the Salt River and Wyoming ranges become lower, passing into Absaroka Ridge and Meridian Ridge, respectively, and they finally lose their topographic identity south of the area, where the rocks of which they are composed are deeply buried by Tertiary deposits. There are numerous ridges or folds rudely parallel to the main ridges, the most important being the Hoback Range, which connects the Wyoming Range and the Gros Ventre Mountains. East of the parallel mountains is the great plainlike basin of Green River, which has a mean elevation of about 7,500 feet. The entire area except this narrow strip along the eastern margin is a succession of rugged mountain peaks and ridges cut by numerous gorges and canyons, whose walls are in places nearly perpendicular. Many of the hills, valleys, and slopes are well timbered with pine, fir, and spruce.

The drainage belongs to three great systems—Snake River, whose waters flow into the Pacific; Green River, whose waters flow into the Gulf of California; and Bear River, whose waters enter the Great Basin. The greater part of the drainage is almost equally divided between Snake and Green rivers, with a margin in favor of Snake River, only a small area in the southwestern portion being drained by the tributaries of Bear River.

STRATIGRAPHY.

The survey of last summer was carried on with special reference to coal, most of the work being restricted to the coal-bearing formations. As much attention as possible was devoted to the formations contiguous to the coal-bearing rocks, and sufficient information regarding their age was obtained to correlate them with similar beds in other parts of the country. The fossils collected by this party and studied by Walcott, Stanton, Girty, Knowlton, and Dall, as well as material collected by former expeditions in this area, particularly those of the Hayden Survey, indicate that the several formations studied and mapped in the field have the geologic time values given in the accompanying table and agree very closely with the sections studied in southern Uinta County during the summer of 1905.

Succession, age, and thickness of beds in central Uinta County, Wyo., to the base of the Cretaceous.

System.	Names used previously or in adjacent regions.	Formation.	Thickness.	Character of strata.	Where exposed.	Economic value.
Quaternary.	Quaternary.		*Feet.* 0-250	Hill wash, valley filling, flood plain deposits and small stream bottoms accompanying river filling.	Throughout area.	Clay deposits derived largely from the weathering of underlying shales in Mammoth Valley have been used for making brick near Glencoe, but are not developed farther north.
			0-150	River terraces.	Snake River and tributaries.	Gold placers worked along Snake River. Similar auriferous-gravel deposits occur both up and down Snake River beyond this area and on some of its tributaries.
		Pleistocene.	1-150	Bowlders, gravels, and ground-moraine material associated with hill wash.	South flank of Gros Ventre Mountains.	
		Unconformity.				
Tertiary.	Green River.	Green River.	[a] 2,000	Thin-bedded shales, sandstones, and limestones, for the most part light colored.	On Green River plain west of Green River and east of Meridian Ridge and Wyoming Range.	
	Wasatch.	Knight.	[b] 500	Beds of red and yellow sandy clays interlaminated with white, gray, and yellow sandstones. Local areas of concretionary limestone.	East of Meridian Ridge, Wyoming and Hoback ranges.	
		Unconformity.				
		Almy.	[c] 2,500	Red and yellowish-white conglomerates, sandstones, and sandy clays.	Snake and Fall rivers south of Gros Ventre Mountains and east of Hoback and Wyoming ranges.	
	Upper Laramie.[d]	Evanston.[e]	[f] 9,500	Gray and yellow shales and clays, with gray and yellow sandstone beds, containing several minor coal beds, none of which are developed. Same age as the Almy coals near Evanston, Wyo., usually called Upper Laramie. Invertebrates common to the Laramie and Fort Union. In this region these beds rest upon Jurassic, Carboniferous, and Cambrian beds.	East of Hoback Range both north and south of Fall River and south of Gros Ventre Mountains; also the beds east of Labarge Mountain north of Labarge Creek. Structurally these beds are Evanston, but they contain typical Adaville fossils and may be Adaville.	Several minor coal beds of workable thickness have been observed. None have been prospected or developed. Coal similar to the Evanston and Almy coals of southwestern Uinta County. At Sayle's mine a 180-foot tunnel has been opened in a 6-foot bed and considerable coal mined for local use. Several other mines supply coal for ranch use.

	Unconformity.						
Cretaceous.	Lower Laramie.		Adaville.	2,800	Gray, yellow, and brown clays and shales with irregularly bedded brown and white sandstones and numerous beds of coal. The lower beds of this formation contain plants and invertebrate remains that are referred to the uppermost Montana; the upper beds contain lower Laramie leaves.	East of Absaroka Ridge and west of Oyster Ridge on South Fontenelle Creek.	Contains many beds of workable coal. A few prospect pits only are opened in this area.
	Montana.						
	Colorado.	Niobrara.	Hilliard.	3,000	Gray and black sandy shales and shaly sandstones that weather readily and afford few exposures. Usually a region of low relief.	Between Oyster Ridge and Absaroka Ridge and east of Wyoming Range on Piny Creek.	
		Benton.	Frontier.	2,400 to 3,800	Alternating beds of gray and yellow clays, shales, and sandstones containing numerous beds of coal. Forms pronounced ridges or hogbacks in southern part of area east of Absaroka Ridge. Near top of formation is a pronounced bed of coarse sandstone, locally conglomeratic, containing numerous large oysters. This is the Oyster Ridge sandstone. Farther north this formation loses its characteristic hogback topography east of Salt River and Wyoming ranges.	East of Absaroka Ridge, Salt River Range, and along the east side of Wyoming Range.	Contains numerous beds of coal throughout the area. Farther south the Kemmerer, Willow Creek, Carter, and Spring Valley coals have been developed. The Kemmerer coals are extensively mined at Frontier, Diamondville, Oakley, Glencoe, and Cumberland. Within this area only Wright's mine and a few prospect pits have been opened, the coal being supplied to ranchers. Contains good building stone.
			Aspen.	1,200 to 1,800	Gray and black shales, shaly sandstone, and beds of compact gray sandstone and bluish limestone containing fish scales; commonly weathers silver-gray and shows little white specks in some of the sandstones.	East of Oyster Ridge, Absaroka Ridge, and Salt River Range, also east of Wyoming Range, north of Piny Creek.	Contains oil developed in wells northeast of Spring Valley, and probable source of oil in Hilliard, Carter, and Fossil oil springs. In this area no prospecting for oil has been carried on.
	Bear River.		Bear River.[g]	800 to 1,500	Black shale, shaly sandstone, and shaly limestone with abundant invertebrate fossils. Several thin beds of coal and bituminous shale.	Between Meridian and Absaroka ridges, Wyoming and Salt River ranges, and Wyoming and Hoback ranges.	Coal beds so far as noted are too thin and impure to be of any value. Oil in this formation southeast of Spring Valley in two wells.

[a] Estimate of Clarence King of maximum thickness in Green River basin southeast of this region; only a portion of the beds occur in this area.
[b] Only a portion of the Wasatch beds present in this area.
[c] Total thickness of beds probably not present in the region.
[d] Near Evanston, Wyo., these beds have been called Wasatch by White and Laramie by Hayden and King.
[e] Evanston as here used is the same as the Evanston formation in southwestern Uinta County. See Contributions to Economic Geology, 1905: Bull. U. S. Geol. Survey No. 285, 1906, pp. 332-335. C. A. White (Eleventh Ann. Rept. U. S. Geog. and Geol. Survey Terr., 1879, pp. 240-241) used the name "Evanston coal series" in referring to the coal-bearing beds of Almy below the Wasatch and above the Bear River. Lesquereux (Sixth Ann. Rept. Geol. Survey Terr., 1873, p. 409) used the term "Evanston deposits."
[f] Upper limit not seen.
[g] The Bear River beds are underlain by marine Jurassic. The beds appear apparently conformable. Other evidence seems to indicate that an unconformity exists between the Bear River and Jurassic beds. The oldest rocks studied in this area are of Cambrian age.

STRUCTURE.

The main disturbance in this area occurred near the close of the Cretaceous period, during the interval marked by the unconformity between the Adaville and Evanston formations. A second and minor disturbance occurred after the deposition of the Evanston beds. The movement during this disturbance was for the most part along several of the old lines of weakness, faulting and tilting the younger beds so that they now dip in some places from 40° to 50° and in an opposite direction to the older underlying beds. An earlier disturbance than these two may have occurred between the deposition of the Jurassic and that of the Bear River. There is some evidence that the Lower Cretaceous and the Dakota of the Upper Cretaceous (unless the Bear River is the equivalent of the Dakota) are wanting in this area, but this has not been proved. There was, however, at that time no great disturbance associated with folding and faulting, for throughout the area the Bear River beds are apparently conformable upon the known Jurassic beds.

The main structural features of this region are parallel to each other and have a north-south trend with a slight westward deflection, which increases toward the north. They are the direct northward continuation of the faults and folds observed in southern Uinta County. The important structural features at the south end of the area, named in order from east to west, are (1) a fairly regular anticline with two or more secondary folds—the Meridian anticline; (2) a rather regular syncline, in places slightly overturned—the Lazeart syncline; (3) a large and persistent faulted anticline, with its downthrow to the east and a displacement of 15,000 to 20,000 feet; (4) a broad syncline—the Fossil syncline—which lies for the most part west of this area. Farther north the structural conditions are more complicated. Several additional folds and faults occur and the entire region is more disturbed, giving rise to the Hoback, Wyoming, and Salt River ranges.

The important structural features at the north end of the area, named in order from east to west, are (1) a rather irregular, complex anticlinorium, which gives rise to the Hoback Range and passes toward the south into a regular anticline, in places slightly overturned—the Hoback anticline; (2) the eastern portion of a synclinorium, the south end of which is a monocline with beds dipping from 25° to 45° W.—the Lander syncline; (3) a faulted anticline with its downthrow to the east and a displacement of about 20,000 feet—the Wyoming anticline; (4) the northward continuation of the Lazeart syncline, which develops a secondary fold in the vicinity of Snake River—the John Day River syncline;[a] (5) the northward

[a] This appears on Pl. XIII as the Greys River syncline, but as the United States Geographic Board has decided that the river should be known as the John Day, the structural feature should carry the same name.

continuation of the Absaroka fault, which here lies along the east base of the Salt River Range. The displacement along this fault is somewhat greater than at the south end of the area, approximating 20,000 feet. The Salt River Range has been uplifted and its component rocks thrown into sharp folds. As most of the range lies west of this area, no detailed sections were made across it, but very probably it exhibits the same type of structure as the Hoback Range. The faulted anticline (3) gives rise to the Wyoming Range, and the fault extends approximately along the east base of the range in much the same manner as the Absaroka fault along the east base of Absaroka Ridge and the Salt River Range. Near the south end of the Wyoming Range the anticline develops into two or more secondary folds. South of the Wyoming Range the fault is connected with the Absaroka fault by a cross break which continues eastward north of Thompson Plateau and in which the downthrow is on the south, with a displacement of about 5,000 feet.

The structural features that are of the greatest importance in the consideration of the coal deposits are the following:

1. The Lazeart syncline and its northward continuation, or John Day River syncline, lying between the Salt River and Wyoming ranges. In places the Lazeart syncline is entirely overturned; the beds of the lower limb dip from 25° to 40° W., and those of the upper or west limb dip from 45° to 90° W., giving an overturn dip of 135°. North of Wrights Ranch the syncline becomes regular; the beds on the east limb dip to the west and those on the west limb dip to the east, but a portion of the west limb is removed by the encroachment of the Absaroka fault. Still farther north the syncline rises, and north of South Fontenelle Creek the beds of the west limb dip 50° to 80° E., while the beds of the east limb dip 25° to 30° W. North of Fontenelle Creek the east limb only remains. Farther north the John Day River syncline shows some complexity, and in the vicinity of Little John Day and Snake rivers a secondary fold parallel to and about halfway between the Wyoming and Salt River ranges is developed.

2. The Lander syncline, lying between the Wyoming Range and the Hoback anticline, to the east. The beds in this syncline are chiefly of Cretaceous age. They are somewhat disturbed, but for the most part they dip toward the west at angles varying from 15° to 50°.

The two structural features just described contain all the best coal beds in this region. East of Hoback and Labarge ranges, on the gently eastward-sloping plain along the western margin of the Green River basin, there is another coal field containing the Labarge Mountain and Fall River coals. The coal beds of this field are of a much later age and they probably extend over a large portion of the Green River basin. Their outcrops, however, are of very small extent, for the Tertiary covering has been removed in only a few localities. The dips are for the most part toward the east and range from 10° to 45°. The coal-bearing formations studied in the Lander syncline west of the Hoback anticline probably occur also along the east side of the anticline, but nothing is known of their distribution outside of a small area in T. 30 N., R. 115 W., in the east-central part of sec. 24, owing to the heavy covering of Tertiary beds, which in many places extend high up on the Hoback Range and completely bury the Hoback anticline. Until drill holes have been put down through the Tertiary cover, the position, distribution, and thickness of these coal beds can only be inferred.

COAL.

GENERAL CONDITIONS.

Geologic study of this region, and particularly of the coal-bearing formations, is of especial economic interest. At present the coals are scarcely known north of Kemmerer and are but little developed. In a few localities enough coal is taken from shallow pits to supply the ranches in the immediate vicinity. Outside of this local mining, no development work is carried on in the region. The talus and heavy growth of timber covering the slopes are obstacles to a thorough investigation, but a considerable number of prospect pits in which the coal beds range from 2 to 20 feet in thickness have been examined. The coal taken from some of these pits resembles the bituminous coals of southern Uinta County, which belongs near the top of the group containing the best bituminous coals of the Rocky Mountain region. Although the mapping of the formations was not continued north and west of Snake River, the coal-bearing rocks extend to the northwest for a considerable distance and probably across the Wyoming State line south of Teton Pass. In the vicinity of Victor, Oasis, and Haden, on the eastern slope of the Pierres Hole (Big Hole) Mountains, in Idaho, occurs a series of coal-bearing rocks that dip from 40° to 50° SW. These rocks, which may be a continuation of the coal-bearing formations south and east of Snake River, are known to contain seven coal beds ranging in thickness from 2 to 20 feet. The coal is of unusually high quality and makes a very desirable fuel for steam and domestic purposes. It also shows coking properties, and some very fine samples of coke have been obtained in laboratory tests.

Thus far coal prospecting in the area here discussed has been carried on in three different coal-bearing beds, which, in descending order, are as follows:

1. The Evanston formation, in which the coals resemble the Evanston and Almy coals of southwestern Uinta County.

2. The Adaville formation, containing coals of uppermost Montana and lower Laramie age.

3. The Frontier formation, containing the Kemmerer, Willow Creek, and lower coals of Benton age.

The oldest rocks in which commercial coal was observed in this field are of Benton age. The Frontier is the important coal-bearing formation, and the coals it contains resemble very closely the Frontier and Cumberland coals of southern Uinta County. Bituminous shale and thin streaks of coal were also observed in the Bear River formation, but no coal of commercial value was seen.

As soon as railroad facilities can be obtained, which at present seems but a few years distant, the coal fields of central and northern Uinta County will probably constitute an important factor in the coal production of the State. For many years Idaho has been supplied with coal principally from the Kemmerer, Diamondville, and Union Pacific mines, in southern Uinta County, Wyo. In busy seasons these mines have been severely taxed to furnish, even at high prices, sufficient coal to meet the demand of the sugar companies and smelting industries. By opening the coal beds in northern Uinta County, as good if not better coal than that of the southern part of the county can be obtained, and the cost of transportation to northern Wyoming and southeastern Idaho can be greatly reduced. These coals are discussed briefly in the following pages, and the approximate outcrop and distribution of the coal-bearing beds are shown in Pl. XIII (p. 212).

KEMMERER, WILLOW CREEK, AND OTHER COALS OF BENTON AGE.

The beds containing the coals of Benton age outcrop throughout the area between Meridian Ridge and the Wyoming Range on the east and Absaroka Ridge and the Salt River Range on the west, in the Lazeart–John Day River syncline, and also between the Hoback and Wyoming ranges, north of Thompson Plateau, in the Lander syncline. In both of these localities the westward extension of the coal-bearing beds terminates against a fault that extends along the east base of the Salt River Range, Absaroka Ridge, and the Wyoming Range. It is not known whether all the coal-bearing formations mentioned in the preceding section extend throughout the field or not, but they are present in the southern part, and they or their equivalents may be found in other parts as further development work progresses. During the present survey most of the coal data could be obtained only from surface exposures or from shallow pits dug a few feet below the surface. The location of these pits and prospects is shown on the accompanying map (Pl. XIII). They are numbered consecutively from 1 to 88, according to township, range, and section, beginning at the southeast corner of the field.

COAL-BEARING BEDS IN THE LAZEART-JOHN DAY RIVER SYNCLINE.

The first important mine to tap the coal beds in the Lazeart syncline was that opened by the Diamond Coal and Coke Company at Diamondville, about 7½ miles south of the south boundary of this area, in 1894. Subsequently mines were opened by the same company at Glencoe and Oakley. In 1897 the mines at Frontier, 5 and 6 miles south of the boundary of this area, were opened by the Kemmerer Coal Company, and in 1900 the Cumberland mines were opened by the Union Pacific Coal Company. These mines and the occurrence of coal in southern Uinta County have been described elsewhere by A. C. Veatch.[a] All these mines developed the main Kemmerer bed, which lies above the Oyster Ridge sandstone. In the mine workings this coal bed ranges in thickness from 5 to 20 feet. At the Frontier mine two other beds have been opened, and one of them, known as the "A" bed, is worked. This coal bed, which lies 35 feet vertically below the main coal bed, is 6 feet thick and has a thin parting about 1 foot from the top. The quality of the coal is about the same as in the main bed. One analysis has been made of this lower coal.[b] About 10 feet vertically below the A bed is another known as the "B" bed. The coal is 6½ feet thick, with a thin parting 17 inches from the top. The intervening material between the A and B beds is a shale too soft to allow working the coal in bed B.

Shortly after opening the mines at Frontier, the Kemmerer Coal Company spent several years in prospecting the coal beds north of that place, on Willow Creek, in an effort to find coking coal. Beside prospecting the coals of the main Kemmerer group some work was also done in the coal beds below the Oyster Ridge sandstone.

The Willow Creek coal is about 550 feet below the main Kemmerer coal and 200 feet below the Oyster Ridge sandstone. In the SW. ¼ NW. ¼ sec. 19, T. 22 N., R. 115 W., where considerable coal was taken out, the bed is 3 feet thick; farther north, in the SW. ¼ SW. ¼ sec. 6, T. 22 N., R. 115 W., where the Kemmerer Coal Company proposes to open a mine, this bed reaches a thickness of 5 feet 8 inches. At both of these prospects small engines were installed and slopes were opened. In 1904 the two places together produced 3,000 tons of coal and about 750 tons of coke were shipped. Since then no development work has been done on the Willow Creek coals, but it is reported to be the intention of the Kemmerer Coal Company to develop this coal in the near future for its coking value. Tests show that the coal yields a coke of fair quality.

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[a] Coal and oil in Uinta County, Wyo.: Bull. U. S. Geol. Survey No. 285, 1906, pp. 331-353; Geography and geology of a portion of southwestern Wyoming, with special reference to coal and oil: Prof. Paper U. S. Geol. Survey, No. 56.

[b] Veatch, A. C., Coal and oil in southern Uinta County, Wyo.: Bull. U. S. Geol. Survey No. 285, 1906, p. 339, analysis No. 8.

Two other prospects have been opened in the Willow Creek horizon, one in the NE. ¼ NW. ¼ sec. 2, T. 23 N., R. 116 W., by Walter C. Wright; the other in the NE. ¼ SE. ¼ sec. 16, T. 25 N., R. 115 W., by Howard M. Holden. At both of these places coal has been taken out for local ranch use. North of Holden's prospect no pits have been opened, and as the country is well covered with timber and exposures are rare, the coal outcrops are seen at few places. Several outcrops were observed at various places as far north as Snake River.

Several prospect pits have been opened in T. 22 N., R. 115 W., along the outcrop of the beds below the Willow Creek coal. The Spring Valley horizon, which is near the base of the Frontier formation, is approximately 1,500 feet stratigraphically below that of the main Kemmerer coal bed, and the Carter coal is approximately 200 feet higher than the Spring Valley bed. These horizons have not been prospected in this locality, and as the beds are everywhere covered by weathered surface material, the coal here, as well as farther south, is not readily seen. As a rule careful prospecting by digging pits or sinking diamond-drill holes is necessary in order to locate the beds. Even when a pit has been opened and a section of the coal exposed, the next year may find all traces of it obliterated and the pit deeply buried by débris from a landslide.

COAL-BEARING BEDS IN THE LANDER SYNCLINE.

The coal beds in the syncline between the Wyoming and Hoback ranges can not be directly correlated with any particular bed in the Lazeart-John Day River syncline. The prominent sandstone that forms Oyster Ridge and serves as a horizon marker is not present in this field, or if present has lost its ridge-making characteristics. The coal-bearing formation is the same and the coals so far as studied resemble very closely the Frontier and Willow Creek coals. A mine was opened in 1906 by Sam Smith east of McDougal Mountain, in unsurveyed territory, the location of which, if subdivided, would be in the SW. ¼ SW. ¼ sec. 33, T. 34 N., R. 115 W. A drift has been run along the strike for a distance of 20 feet, and several loads of coal have been hauled from the mine. A road has been built for this purpose, and it is the intention of Mr. Smith to supply coal to the ranchers in the Green River basin. The coal is of high grade and the bed is 6 feet 2 inches thick.

Farther north, east of the Wyoming Range and near the headwaters of Willow Creek, a tributary of Fall River, some prospecting has been done, but most of the pits have been buried beneath landslide material so that the coals can not be examined without reopening the pits. In the SE. ¼ NW. ¼ sec. 4, T. 36 N., R. 115 W., where the greatest amount of development work has been done, a drift has been run 100 feet and a 6-foot coal bed with three partings has been opened. The analysis of the coal shows it to be the best coal in Uinta County thus far analyzed. The same coal extends northwestward across Snake River, but no study was made of the formations in that region.

ADAVILLE AND TWIN CREEK COALS.

The beds containing the Adaville and Twin Creek coals also lie in the Lazeart syncline, but occur only in its southern part. Since the discovery of these coals in 1876 by Smith and Bell Brothers,[a] who opened in the region of Hodges Pass, on the divide between Twin Creek and Hams Fork, twenty-nine beds of coal ranging in thickness from 1½ to 48 feet and aggregating 315 feet,[b] this coal-bearing formation has been noted for the great number and thickness of its beds. At the Adaville mine, in the NE. ¼ SW. ¼ sec. 20, T. 21 N., R. 116 W., one bed reaches a maximum thickness of 84 feet, with a single parting of clay 2 inches thick.

On account of the rising and pitching of the Lazeart syncline, the beds of this group occupy three basins in southern Uinta County, the northern part of the northernmost basin being shown on the map accompanying this report. Farther north the pitching of the syncline again brings in these beds, and the fourth basin in the series occurs on South Fontenelle Creek. Very little prospecting has been done on the coal beds north of Hams Fork, and thus far only one prospect pit has been opened in the fourth basin, namely, in the SW. ¼ SW. ¼ sec. 17, T. 25 N., R. 115 W., where 3 feet of coal occur under a bed of shale. The base of the coal bed was not seen. This group of coal beds contains a large amount of fuel of a fair quality which will undoubtedly be developed in the near future. The coal is clean and compact, having a bright luster and breaking with a conchoidal fracture, but it crumbles badly on exposure to the air.

COAL BEDS OF LABARGE MOUNTAIN AND FALL RIVER BASIN.

The coals on Labarge Mountain are in the Adaville formation, and those along Fall River are in the Evanston; the coal resembles the Evanston and Almy coals of southwestern Uinta County. Along the east side of Labarge Range several prospect pits have been opened in the Labarge Mountain coal beds, and in two localities coal is being mined for local ranch use. At Sayle's mine, in the SE. ¼ NW. ¼ sec. 7, T. 26 N., R. 113 W., an entry 180 feet long has been

[a] Peale, A. C., Report on the geology of the Green River district: Eleventh Ann. Rept. U. S. Geol. and Geog. Survey Terr. for 1877, p. 535.

[b] Veatch, A. C., Coal and oil in southern Uinta County, Wyo.: Bull. U. S. Geol. Survey No. 285, 1906, p. 337.

driven along the strike of the coal bed, which is here from $5\frac{1}{2}$ to 6 feet thick. As a whole the coal is not good for forge use; by careful selection, however, certain parts of the bed yield a coal which will answer for this purpose. The coal comes from the mine in fair-sized blocks, but slacks readily on exposure to air, breaking with a conchoidal fracture. The coal is used by the neighboring ranchers for fuel, but because it slacks so quickly only small quantities are bought at a time. Near the north end of the Labarge Range, on the east side, a mine has been opened by Mr. Griggs in the SE. $\frac{1}{4}$ SE. $\frac{1}{4}$ sec. 12, T. 28 N., R. 114 W., where 8 feet of coal are exposed without reaching the base of the bed. The coal at this mine is of the same quality as that at the Sayle mine. It is mined only as the near-by ranchers are in need of it. Several prospect pits have been opened between these two mines, as well as north of the Griggs mine. At a number of places from seven to ten beds of coal ranging in thickness from 1 to 5 feet have been examined, and the entire formation shows numerous coal beds. The location of prospect pits and mines is shown on the accompanying map (Pl. XIII, p. 212). The sections of the coal beds at the various prospect pits are recorded in the table on pages 224–229.

In the Fall River basin practically no prospect pits have been dug and knowledge of the coal beds is therefore restricted entirely to surface exposures and bank diggings. These are few in number, inasmuch as throughout most of this area a heavy covering conceals the coal outcrops. Besides the prospects or surface diggings shown on Pl. XIII, coal prospects have been opened and reported on Cliff, Granite, and Shoal creeks by ranchers and prospectors, but these pits were opened some time ago and have since been deeply buried by landslips, so that the coal was not seen.

SECTIONS OF THE COALS.

The location of the various prospect pits that were examined or made during this survey, together with a section of the coal beds, is given in the subjoined table. The mines, prospect pits, and surface diggings are arranged by township, range, and section, being numbered consecutively from 1 to 88, beginning at the southeast corner of the field. The numbers agree with those used on Pl. XIII. The data for prospect pits in T. 22 N., Rs. 115 and 116 W., south of this area, have been added, as some of these have not previously been published. These pits are designated by letters in the table, so as not to interfere with the numbers used on the map.

Numerous test pits have been opened in the coal beds of the Frontier formation, a less number in the Adaville formation, and still less in the Evanston formation. The results of these tests are presented in the following table under numbers corresponding to those used on the map. Some of the surface outcrops are not here listed. In the following table Nos. 25 and 39 are located on Carboniferous beds; No. 60 on Bear River beds; Nos. 1, 38, 41, 43, and 47-56, inclusive, on Adaville beds; Nos. 85, 86, and 88 on Evanston beds, and all the remainder on Frontier beds.

Sections of coal beds in central Uinta County, Wyo.

No. on Pl. XIII.[a]	Location. T.	Location. R.	Location. Sec.	Geologic formation.	Section.	Ft.	in.	Remarks.
1	22	115	6, NW. ¼ NW. ¼.	Frontier.	Shale..... Coal..... Shale..... Coal..... Shale.	 3 4	2 5 3 1	Willow Creek group; prospect pit.
2	22	115	6, NW. ¼ NW. ¼.	Frontier.	Coal...... Shale..... Coal...... Shale.	2 2	4 8 6	Willow Creek group; prospect pit.
3	22	115	6, NW. ¼ NW. ¼.	Frontier.	Shale..... Sandstone Coal (clay parting). Shale..... Coal...... Shale..... Coal...... Shale.	2 2 2 1 2	 2 6 2 8 2 7	Willow Creek group; prospect pit.
4	22	115	6, SW. ¼ NW. ¼.	Frontier.	Coal...... Shale.	5	8	Willow Creek group; prospect pit.
[b] 5	22	115	6, SW. ¼ SW. ¼.	Frontier.	Sandstone Coal...... Shale.	 5	6 8	Willow Creek bed; coal and coke shipped from this point in 1904.
6	22	115	7, SE. ¼ NW. ¼.	Frontier.	Coal...... Shale.	4	5	Willow Creek bed; prospect pit.
7	22	115	7, SE. ¼ SE. ¼.	Frontier.	Shale. Coal......	 3		Below Willow Creek bed; prospect pit.
8	22	115	7, NE. ¼ SW. ¼.	Frontier.	Coal...... Shale.	4	4	Willow Creek bed.
9	22	115	18, NE. ¼ NW. ¼.	Frontier.	Coal......	3	8	Willow Creek bed.
10	22	115	18, NE. ¼ NW. ¼.	Frontier.	Coal......	4		Willow Creek bed.
A	22	115	18, SW. ¼ SE. ¼.	Frontier.	Coal......	2	6	Below Willow Creek bed; surface diggings.
B	22	115	19, NW. ¼ NE. ¼.	Frontier.	Coal......	2	6	Below Willow Creek bed; surface diggings.
C	22	115	19, NW. ¼ NW. ¼.	Frontier.	Coal......	3	2	Willow Creek bed.
[c] D	22	115	19, SW. ¼ NW. ¼.	Frontier.	Coal......	3		Willow Creek bed; small mine; some coal and coke was shipped from this place in 1904.
E	22	115	19, NW. ¼ SW. ¼.	Frontier.	Coal......	3	2	Willow Creek bed.
F	22	115	30, NW. ¼ NW. ¼.	Frontier.	Sandstone Coal...... Clay...... Sandstone.	 4	8 5 8	Willow Creek bed; prospect pit.

[a] Letters in this column refer to prospect pits south of the area mapped.
[b] This coal is identical with that from prospect D. For analysis, see p. 236.
[c] For analysis of coal see p. 236.

Sections of coal beds in central Uinta County, Wyo.—Continued.

No. on Pl. XIII.[a]	Location.			Geologic formation.	Section.	Remarks.
	T.	R.	Sec.		*Ft. in.*	
G	22	115	30, SE. ¼ SW. ¼.	Frontier.	Clay...... 1 Coal...... 4 10 Shale.	Willow Creek group; prospect pit.
11	22	116	1, NW. ¼ SW. ¼.	Frontier.	Coal...... 6	Kemmerer group.
12	22	116	1, NE. ¼ SW. ¼.	Frontier.	Coal...... 4	Kemmerer group.
13	22	116	1, SE. ¼ SW. ¼	Frontier.	Coal...... 8	Kemmerer group.
14	22	116	12, NE. ¼ NW. ¼.	Frontier.	Coal...... 4	Kemmerer groups; three prospects along strike of bed.
15	22	116	13, NW. ¼ NE. ¼.	Frontier.	Coal...... 8	Kemmerer group.
16	22	116	13, SW. ¼ NE. ¼.	Frontier.	Coal...... 8	Kemmerer group.
H	22	116	13, SW. ¼ SE. ¼	Frontier.	Coal...... 3	Kemmerer group.
I	22	116	21, NE. ¼ NW. ¼.	Adaville.	Coal...... 18	Adaville beds.
J	22	116	24, NW. ¼ NE ¼.	Frontier.	Coal...... 4	Kemmerer group.
K	22	116	24, NW. ¼ NE. ¼.	Frontier.	Coal...... 4	Kemmerer group; near southwest corner of tract.
L	22	116	24, SW. ¼ NE. ¼.	Frontier.	Coal...... 4 6	Three beds of Kemmerer group have been exposed at this prospect.
M	22	116	24, SE. ¼ NW. ¼.	Frontier.	Coal...... 3	Kemmerer group; two prospects opened in this 40-acre tract.
N	22	116	24, SW. ¼ SE. ¼.	Frontier.	Coal...... 4 6	Kemmerer group.
O	22	116	25, NW. ¼ NE. ¼.	Frontier.	Coal.	Kemmerer group.
P	22	116	25, NE. ¼ SW. ¼.	Frontier.	Coal.	Kemmerer group.
Q	22	116	25, SE. ¼ SW. ¼.	Frontier.	Coal.	Kemmerer group.
R	22	116	36, SE. ¼ NW. ¼.	Frontier.	Coal.	Kemmerer group.
S	22	116	36, NE. ¼ SW. ¼.	Frontier.		Kemmerer group.
T	22	116	36, SE. ¼ SW. ¼.	Frontier.		Kemmerer group; near center of tract.
U	22	116	36, SE. ¼ SW. ¼.	Frontier.		Kemmerer group; near southeast corner of tract.
V	22	116	36, SW. ¼ SE. ¼.	Frontier.		Kemmerer group; near southwest corner of tract.
17	23	115	6, lot 4.	Frontier.	Coal...... 2 Shale. Coal...... 2 4	Willow Creek group; two prospect pits opened.
18	23	115	7, lot 6.	Frontier.	Coal...... 1 6 Shale..... 2 Coal...... 3 Shale..... 1 Coal...... 3 3 Shale..... 5 Coal...... 2 1 Shale..... 2 Coal...... 1 2 Shale.	Willow Creek group; prospect pit near northeast corner of lot.

[a] Letters in this column refer to prospect pits south of the area mapped.

Sections of coal beds in central Uinta County, Wyo.—Continued.

No. on Pl. XIII.	Location.			Geologic formation.	Section.	Remarks.
	T.	R.	Sec.			
19	23	115	7, lot 6.	Frontier.	*Ft. in.* Coal...... 1 6 Shale..... 2 Coal...... 3 Shale..... 1 Coal...... 3 3 Shale..... 5 Coal...... 2 1 Shale..... 2 Coal...... 1 2 Shale.	Willow Creek group; prospect pit near south center of lot.
20	23	115	18, lot 16.	Frontier.	Coal...... 1 3 Shale..... 2 Coal...... 3 Shale..... 1 Coal...... 3 8 Shale..... 5 Coal...... 2 2 Shale..... 2 Coal...... 1 2 Shale.	Willow Creek group; prospect pit near south center of lot.
21	23	115	19, lot 16.	Frontier.	Coal...... 2 2 Clay...... 2 6 Coal...... 1 4 Shale..... 2 Coal...... 3 Shale..... 1 Coal...... 3 5 Shale..... 1 4 Coal...... 3 2 Clay...... 2 Coal...... 10 Shale.	Willow Creek group; prospect pit near south center of lot.
22	23	115	31, lot 16.	Frontier.	Coal...... 1 10 Clay...... 3 8 Coal...... 2 9 Sandstone 1 8 Coal...... 8 Shale.	Willow Creek group; prospect pit in west part of lot.
[a] 23	23	116	2, SE. ¼ NW. ¼.	Frontier.	Sandstone, white. Shale..... 3 Coal...... 6 5 Shale.	Willow Creek group. Coal is mined at this place for ranch use.
24	23	116	2, SW. ¼ SW. ¼.	Frontier.	Coal.	Willow Creek group; in northwest corner of tract.
25	23	116	9, SE. ¼ SE. ¼.	Park City (Carboniferous).	Shale, bituminous.	Not fully prospected; pits opened by sheepherders.
26	23	116	10, NW. ¼ SE. ¼.	Frontier.	Coal.	Willow Creek group; three coal beds have been opened in this tract.
27	23	116	10, SW. ¼ SE. ¼.	Frontier.	Coal.	Willow Creek group.
28	23	116	12, SW. ¼ SE. ¼.	Frontier.	Coal...... 4	Kemmerer group.
29	23	116	15, SW. ¼ NE. ¼.	Frontier.	Coal...... 4 3	Kemmerer group.
30	23	116	15, NE. ¼ NW. ¼.	Frontier.	Shale. Coal...... 3 2 Shale.	Willow Creek group.
31	23	116	15, SW ¼ NW. ¼.	Frontier.	Coal...... 3 8	Willow Creek group; two prospects opened in this tract.
32	23	116	16, SE. ¼ SE. ¼.	Frontier.	Coal...... 4 2	Willow Creek group; surface diggings.

[a] For analysis of coal see pp. 232, 236.

Sections of coal beds in central Uinta County, Wyo.—Continued.

No. on Pl. XIII.	Location. T.	R.	Sec.	Geologic formation.	Section.	Remarks.
33	23	116	21, NE. ¼ NE. ¼	Frontier.	*Ft. in.* Coal...... 3 6	Willow Creek group.
34	23	116	22, NW. ¼ NW. ¼.	Frontier.	Shale. Coal...... 4 3 Shale.	Kemmerer group; surface diggings.
35	23	116	36, SW. ¼ SW. ¼	Frontier.	Coal...... 8	Kemmerer group; prospect near southeast corner of tract.
36	24	115	19, lot 5.	Frontier.	Coal...... 3	Kemmerer group.
37	24	115	31, lot 18.	Frontier.	Coal...... 1 8 Clay, fine. 3 7 Coal...... 9½ Bone..... 2 Coal...... 3 Bone..... 1 Coal...... 3 2 Sandstone 8 Coal...... 1 10 Shale..... 2 Coal...... 1 2 Sandstone.	Willow Creek group; southeast corner of lot.
38	24	116	24, NE. ¼ SW. ¼.	Adaville....	Coal...... 3	Surface digging.
39	24	116	27, SW. ¼ NE. ¼	Park City (Carboniferous).	Shale, bituminous.	Not fully prospected.
[a] 40	25	115	16, NE. ¼ SE. ¼.	Frontier.	Shale. Coal...... 4 3 Shale.	Willow Creek bed. Some coal mined here for ranchers' use.
[a] 41	25	115	17, SW. ¼ SW. ¼	Adaville.	Shale. Coal...... 3	Adaville group; surface diggings.
42	25	115	23, SE. ¼ SW. ¼.	Frontier.	Coal...... 3 2	Kemmerer group; prospect pit.
43	26	113	7, SW. ¼ NE. ¼.	Adaville.	Shale. Coal...... 3 Shale.	Labarge Mountain coal beds; seven beds of coal noted at this point, ranging in thickness from 1 to 3 feet.
[a] 44	26	113	7, SE. ¼ NW. ¼.	Adaville.	Shale. Coal...... 6 Sandstone.	Labarge Mountain coal beds; mine, 180 feet in depth. Coal is mined here for ranch use. Several prospects made near here.
45	26	116	1, SW. ¼ SE. ¼.	Frontier.	Shale. Coal...... 3 2 Shale.	Kemmerer group; surface diggings.
46	26	116	1, SW. ¼ SW. ¼.	Frontier.	Coal...... 3	Kemmerer group; exposure in west bank of Fontenelle Creek.
[a] 47	27	113	29, SW. ¼ NE. ¼.	Adaville.	Shale. Coal...... 3 6 Shale.	Labarge Mountain coal beds; prospect pit.
48	27	113	32, SE. ¼ SE. ¼.	Adaville.	Coal....... 4 2	Labarge Mountain coal beds; three prospect pits opened in this tract. There are here six coal beds ranging in thickness from 1 foot 6 inches to 4 feet 2 inches.
[a] 49	27	113	32, SE. ¼ SW. ¼.	Adaville.	Shale. Coal...... 8 3 Shale...... 3 2 Coal....... 3 Shale.	Labarge Mountain coal beds; prospect pit. See No. 47.

[a] For analysis of coal see pp. 232, 236, 237.

Sections of coal beds in central Uinta County, Wyo.—Continued.

No. on Pl. XIII.	Location. T.	R.	Sec.	Geologic formation.	Section.	Remarks.
					Ft. in.	
50	28	113	7 SW. ¼ SW. ¼.	Adaville.	Coal....... 2	Labarge Mountain coal beds; prospect pit.
a 51	28	114	1, NE. ¼ NW. ¼.	Adaville.	Sandstone, shaly (fossils). Coal....... 2 4 Shale.	Labarge Mountain coal beds; prospect pit 350 feet east of No. 52.
52	28	114	1, NE. ¼ NW. ¼.	Adaville.	Shale. Coal....... 8 Shale.	Labarge Mountain coal beds; prospect pit 350 feet west of No. 51.
a 53	28	114	1, SW. ¼ NW. ¼.	Adaville.	Sandstone and shale. Coal....... 3 3 Shale.	Labarge Mountain coal beds; drift 210 feet long.
54	28	114	1, SE. ¼ SW. ¼.	Adaville.	Sandstone. Coal....... 4 2	Labarge Mountain coal beds; coal outcrop near crest of hill.
a 55	28	114	12, SE. ¼ SE. ¼.	Adaville.	Coal....... 4 2	Labarge Mountain coal beds; near northwest corner of tract.
a 56	28	114	12, SE. ¼ SE. ¼.	Adaville.	Shale. Coal....... 8	Labarge Mountain coal beds; mine opening 125 feet long. Coal mined here for ranch use.
57	31	115	24, SE. ¼ NE. ¼.	Frontier.	Coal....... 4	Reported by Mr. Springman, postmaster at Stanley, Wyo.
58	31	117	12, SW. ¼ SW. ¼.	Frontier.	Shale. Coal....... 3	Frontier coal; surface diggings.
59	32	115	10, lot 1.	Frontier.	Coal....... 2 8 Sandstone.10 Coal....... 3	Frontier coal; surface diggings.
60	32	117	28, NE. ¼ SE. ¼.	Bear River.	Coal.	Coal reported at this place by old land survey. See surveyor's notes of 14th auxiliary guide meridian.
61	33	115	34, NE. ¼ SE. ¼.	Frontier.	Coal....... 1 2	Frontier coal; surface diggings.
a 62	33	115	34, SE. ¼ SE. ¼.	Frontier.	Sandstone. Coal....... 2 Shale.	Frontier coal; surface diggings.
63	34	115	16, NW. ¼ SE. ¼.	Frontier.	Coal....... 3	Frontier coal; surface diggings.
a 64	34	115	33, NW. ¼ SE. ¼.	Frontier.	Shale. Coal....... 6 2 Shale.	Frontier coal. Coal mined for ranch use in Green River basin; drift opened 20 feet.
a 65	34	116	2, NW. ¼ SE. ¼.	Frontier.	Shale. Coal.......10 2 (?)	Frontier coal; surface diggings.
66	34	116	11, NW. ¼ NE. ¼.	Frontier.	Shale. Coal....... 4 6 (?)	Frontier coal; surface diggings.
a 67	35	116	35, NE. ¼ NW. ¼.	Frontier.	Sandstone, white. Coal....... 6 (?)	Frontier coal; surface diggings; unsurveyed territory near southeast corner of tract.
a 68	35	116	35, NE. ¼ NW. ¼.	Frontier.	Sandstone. Coal....... 4 (?)	Frontier coal; surface diggings; unsurveyed territory near northwest corner of tract.
a 69	36	116	11, NW. ¼ NE. ¼.	Frontier.	Sandstone, white. Shale......10 Coal....... 1 2 Shale...... 8 Coal....... 2 3 Shale.	Frontier coal; surface diggings; unsurveyed territory. This coal bed lies 85 feet stratigraphically below No. 70.

[a] For analysis of coal see pp. 232, 236, 237.

Sections of coal beds in central Uinta County, Wyo.—Continued.

No. on Pl. XIII.	Location. T.	R.	Sec.	Geologic formation.	Section.	Ft.	in.	Remarks.
a 70	36	116	11, NW. ¼ NE. ¼.	Frontier.	Sandstone. Coal....... Shale...... Coal....... Shale.	 2 1	 5 4	Frontier coal; surface diggings; unsurveyed territory. This coal bed lies 85 feet stratigraphically above No. 69.
a 71	36	116	11, SW. ¼ NE. ¼.	Frontier.	Coal.......	6		Frontier coal; unsurveyed territory; 100-foot drift opened; 6-foot coal bed has three partings, the total thickness of which is 18 inches.
a 72	36	118	John Day River.	Frontier.	Coal......	3		Frontier coal.
a 73	37	115	32, NE. ¼ NE. ¼.	Frontier.	Coal......	5	6	Frontier coal; upper 2 feet pure, clean coal; lower 3½ feet coal and shale. From coal bed just above No. 78.
74	37	115	32, SE. ¼ SW. ¼.	Frontier.	Coal......	6		Frontier coal; surface diggings.
a 75	37	115	32, SE. ¼ SW. ¼.	Frontier.	Sandstone, white. Coal......	 2	 6	Frontier coal; surface diggings.
76	37	115	32, SW. ¼ SW. ¼.	Frontier.	Coal......	3		Frontier coal; surface diggings.
77	37	115	32, SW. ¼ SW. ¼.	Frontier.	Coal......	7	6	Frontier coal; surface diggings.
a 78	37	115	33, NW. ¼ NW. ¼.	Frontier.	Coal......	5	6	Frontier coal; lower 2 feet 8 inches fine, clean coal. Coal lies just below No. 73.
a 79	37	116	1, SW. ¼ SE. ¼.	Frontier.	Coal......	3	6	Frontier coal; surface diggings; lower 15 inches dirty coal; upper 2 feet clean coal. Bed lies about 40 feet lower than No. 80.
a 80	37	116	1, SW. ¼ SE. ¼.	Frontier.	Coal......	3	9	Frontier coal; this has a 7-inch parting and lies about 40 feet above No. 79.
81	37	116	1, NW. ¼ SE. ¼	Frontier.	Coal......	4	6	Frontier coal; surface diggings.
82	37	116	1, NW. ¼ SE. ¼.	Frontier.	Coal......	7	6	Frontier coal. Two prospects opened by G. B. Budd at this place.
83	37	116	1, W. ½ SE. ¼.	Frontier.	Coal......	20		Frontier coal; surface diggings.
a 84	37	116	1, SW. ¼ SE. ¼.	Frontier.	Coal and bone.... Clay, white Coal...... Clay...... Coal.	1 1 3	 6 1	Frontier coal; prospect pit.
a 85	38	113	31, NW. ¼ NE. ¼.	Evanston.	Shale. Coal...... Shale.	 1		Fall River coal beds; surface diggings.
a 86	38	113	31, NW. ¼ SE. ¼.	Evanston.	Shale. Coal...... Shale.	 3		Fall River coal beds; surface diggings.
87	38	116	11, NW. ¼ SW. ¼.	Frontier.	Coal......	2	3	Frontier coal; surface diggings.
a 88	40	116	34, SW. ¼ NE. ¼.	(?)	Shale. Coal...... Clay?	 1	 5	Probably same as Fall River coal beds; surface diggings along bank of Snake River.

a For analysis of coal see pp. 232, 236, 237.

QUALITY AND CLASSIFICATION OF COALS.

The coals in this field form two distinct classes. The best coals are comprised in the first class, which includes all the coals of the Frontier formation, of Benton (Cretaceous) age. The second and inferior class includes all the coals of the Adaville formation, of uppermost Montana and lower Laramie age, and those of the Evanston formation, of Tertiary or upper Laramie age.

The coals of the first class, which rank as high-grade bituminous, have much the same physical characteristics throughout the field and are remarkably uniform in their properties. They are black, moderately hard, and usually compact, and for the most part have a bright luster. As a rule they contain small partings of clay and shale and some irregular nodules of pyrite (sulphur balls). The coal as a rule is not so clean as the Adaville coal, but contains much less moisture. Generally the coal does not slack to any appreciable extent on exposure to the weather. In two localities the coking properties of these coals have been tested with fairly good results.

The coals of the second class rank as high-grade subbituminous.[a] They are black and fairly hard, have a bright luster, and break with a conchoidal fracture. When scratched the streak is a dark brown. The coal comes from the mines in fair-sized blocks, but slacks readily on exposure to the air, breaking into small irregular pieces. When a large block of coal is exposed to the air for a few hours the entire block is filled with small cracks owing to the large percentage of moisture given off.

Samples of coal for analysis were collected from the mines and prospect pits in this region. The samples were taken from a clean surface of the whole bed by cutting a channel 3 or 4 inches in width and of even depth so that an equal amount of coal was obtained from each unit of section. The coal so removed was placed on a clean surface and broken to lumps one-half inch or less in diameter and thoroughly mixed. The sample was then quartered and opposite quarters taken and remixed. This process of quartering, selecting, and mixing was continued until the sample was reduced to about 1 quart, which was then placed in a galvanized-iron can with a description of the coal and location of the mine, sealed, and shipped to the United States Geological Survey fuel-testing plant at St. Louis, Mo., for analysis. The sealed can reached the chemical laboratory with its moisture content unchanged. In order to determine the "loss of moisture on air drying," the following method was used:[b]

In order to make determinations of the loosely held moisture more uniform and definite, a special drying oven has been designed and introduced into the laboratory;

[a] The term subbituminous has been adopted by the Geological Survey for the class of coal usually designated "black lignite."

[b] Lord, N. W., Preliminary report on the operations of the fuel-testing plant * * * at St. Louis, Mo., 1905: Bull. U. S. Geol. Survey No. 290, 1906, pp. 29-30.

in this oven samples of several pounds weight can be dried in a gentle current of air raised from 10° to 20° above the temperature of the laboratory. In this way the coal is air dried in an atmosphere with a very low dew-point and not subject to large percentage variations, and the results obtained are considerably more concordant. Another advantage of this method is that it greatly shortens the time of air drying, so that the samples can be prepared in much less time than formerly.

In studying the table of analyses it should be borne in mind that most of the coal samples were collected from surface outcrops or shallow pits, and that the samples were weathered badly and more or less altered, having a high percentage of moisture, as it was not possible within the given time to open up a coal bed so as to get unaltered coal. In some cases where two samples were taken from the same horizon and from the same kind of coal, except that one was partially altered and the other not, the difference in the calorific power is from 2,000 to 3,000 British thermal units. Only eleven samples were obtained that represent fairly well the real values of the coals in their unaltered condition, namely, at localities Nos. 23, 40, 44, 49, 56, 64, 71, 73, 78, 79, and 80. All other samples were collected within the zone of alteration and give, to a greater or less degree, inferior results. No doubt the high percentage of moisture and oxygen in these samples is due in part to the altered condition of the coal. The air-drying loss of the samples is not entirely comparable. This likewise may be due in part to the physical conditions and the changes undergone during the process of weathering. In the following table the coal analyses have been arranged by townships, ranges, and sections, beginning at the southeast corner of the field. The numbers in the first column correspond with the numbers given in the table of sections and on the accompanying map (Pl. XIII, p. 212). The laboratory numbers are those given by the fuel-testing plant and will be used in its publications.

Analyses of samples of coal as received from mines and prospects in central Uinta County, Wyo.

No. on Pl. XIII.[a]	Where sample was collected.	Chemical analyses.												Heating values.		Sampler.
			Proximate.							Ultimate.						
		Laboratory No.	Moisture after air drying.	Air-drying loss.	Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	B. T. U.	
23	Mine shallow	3572	4.36	2.50	6.88	38.05	51.52	3.55	1.76	5.28	70.62	0.99	17.80	7,051	12,692	A. R. Schultz.
40	Prospect pit	3570	3.84	3.90	7.74	34.65	53.31	4.30	.46	5.33	71.51	1.13	17.27	7,051	12,692	B. A. Iverson.
41	....do	3696	9.05	16.50	25.55	33.82	37.61	3.02	.41	5.80	49.29	.94	40.54	4,507	8,113	H. C. Schleuter.
44	Mine, 180-foot drift	3698	10.22	12.70	22.92	34.46	40.14	2.48	.73	6.37	55.71	.94	33.77	5,463	9,833	E. E. Smith, A. R. Schultz.
47	Surface pit	3697	9.72	19.30	29.02	31.34	31.72	7.92	1.35	5.43	38.61	.79	45.90	3,422	6,160	B. A. Iverson.
49	Prospect pit	3693	10.78	11.60	22.38	35.77	38.84	3.01	1.86	6.36	54.60	.91	33.26	5,354	9,637	A. R. Schultz, E. E. Smith.
51	....do	3695	13.10	22.60	35.70	28.85	28.02	7.43	.58	6.31	37.16	.87	47.65	3,247	5,845	A. R. Schultz.
53	Prospect tunnel, 210 feet long	3700	9.46	18.10	27.56	31.00	31.77	9.67	.90	5.69	40.46	1.05	42.23	3,667	6,601	Do.
55	Prospect pit	3694	10.88	21.30	32.18	30.81	31.60	5.41	.48	5.87	38.29	.67	49.28	3,516	6,328	Do.
56	Mine, drift 125 feet long	3699	9.02	10.60	19.62	32.71	42.51	5.16	1.02	6.00	55.47	.97	31.38	5,399	9,718	A. R. Schultz, E. E. Smith.
62	Surface	3778	8.52	5.50	14.02	34.00	49.06	2.92	.60	5.36	61.25	1.51	28.36	6,011	10,820	E. E. Smith.
64	Mine, 20-foot drift	3891	6.50	3.10	9.60	38.71	46.92	4.77	.32	5.49	66.93	1.34	21.15	6,666	11,999	A. R. Schultz.
65	Surface	3890	8.48	12.80	21.28	34.84	39.27	4.61	.24	5.69	53.73	1.16	34.57	5,035	9,063	Do.
67	....do	4004	10.03	10.40	20.43	30.65	42.43	6.49	.42	5.79	53.23	1.30	32.77	5,048	9,086	W. H. Longhurst.
68	....do	4000	9.99	17.20	27.19	30.30	34.54	7.97	.94	5.89	44.67	1.08	39.45	4,176	7,517	Do.
69	....do	4005	10.90	10.70	21.60	29.16	42.34	6.90	.99	5.49	53.04	1.07	32.51	4,962	8,932	A. R. Schultz.
70	....do	4001	3.91	3.00	6.91	31.91	51.86	9.32	1.54	5.01	65.52	1.01	17.60	6,373	11,471	Do.
71	Tunnel, 100-foot drift	4299	2.37	1.30	3.67	36.30	56.59	3.44	.70	5.66	77.17	.84	12.19	7,613	13,703	J. G. Hawkins.
72	Surface	4323	4.20	3.60	7.80	36.25	54.33	1.62	.27	5.35	70.34	1.43	20.99	7,093	12,767	J. D. Livingston.
73	Prospect pit	4300	1.89	1.60	3.49	35.90	50.59	10.02	.92	5.09	69.67	1.01	13.29	7,150	12,870	J. G. Hawkins.
75	....do	4006	8.66	5.70	14.36	32.48	48.73	4.43	3.56	5.33	60.67	1.30	24.71	5,724	10,303	E. E. Smith
78	....do	4303	1.99	3.50	5.49	35.88	55.51	3.12	.91	5.26	74.15	1.26	15.30	7,539	13,570	J. G. Hawkins.
79	....do	4302	4.51	2.30	6.81	33.42	53.59	6.18	.62	4.81	69.45	1.52	17.42	6,752	12,155	Do.
80	....do	4301	4.70	6.00	10.70	30.67	54.35	4.28	.78	5.34	66.18	1.45	21.97	6,357	11,443	Do.
84	....do	4003	5.46	4.60	10.06	32.94	53.30	3.70	.38	5.27	66.94	1.29	22.42	6,464	11,635	E. E. Smith.
85	Surface	3892	10.32	8.70	19.02	39.68	27.83	13.47	2.60	5.26	48.01	1.28	29.38	4,662	8,392	A. R. Schultz.
86	....do	3893	12.21	4.30	16.51	32.67	37.57	13.25	4.35	5.15	49.38	.99	26.88	4,757	8,563	Do.
88	....do	4002	10.37	7.90	18.27	23.19	34.46	24.08	.30	4.12	42.03	.57	28.90	3,693	6,647	H. C. Schleuter.

[a] For location, geologic formation, name of coal bed, and thickness of coal, see table of sections, pp. 224-229.

In order that the analyses of the Uinta County coals may be compared with those of other coals from the Rocky Mountain region, the subjoined table has been prepared. The analyses are separated into groups according to the geologic horizons of the coals. The analyses have been calculated on the basis of the air-dried sample and arranged according to the calorific values as expressed in British thermal units. The ash and sulphur, although accidental impurities varying greatly from place to place in the same bed, are of considerable commercial importance, and it has therefore seemed better to retain these impurities rather than to calculate the analyses on the basis of air-dried ash-free samples. The carbon-hydrogen ratio proposed by M. R. Campbell[a] in 1905 and the carbon-oxygen ratio are given for comparison. The table includes also the ultimate analyses of the ten coal samples collected by A. C. Veatch and party during the summer of 1905 in southern Uinta County, as well as those of the two mine samples and one carload sample collected in 1906 at Adaville, a few miles west of Kemmerer, by inspectors of the Geological Survey fuel-testing plant.

[a] The classification of coals: Trans. Am. Inst. Min. Eng., Washington meeting, May, 1905; Prof. Paper U. S. Geol. Survey No. 48, 1906, pp. 156–173.

Analyses of air-dried samples of Uinta County coals.

FRONTIER COALS OF BENTON AGE.

No. in table of sections (pp. 224-229).	Location.				Coal bed.	Thickness of coal.		Where sample was collected.	Sampler.
	Place.	T.	R.	Sec.		*Ft.*	*in.*		
78	Willow Creek	37	115	33, NW. ¼ NW. ¼	Frontier group	5	6	Prospect pit	J. G. Hawkins.
71	....do	36	116	11, SW. ¼ NE. ¼	....do	6	0	Tunnel, 100 feet	Do.
aD	Oyster Ridge	22	115	19, SW. ¼ NW. ¼	Willow Creek	3	0	Prospect mine	Max A. Pishel.
72	John Day River				Frontier group			Surface	J. D. Livingston.
40	Oyster Ridge	25	115	16, NE. ¼ SE. ¼	Willow Creek group	4	3	Prospect mine	B. A. Iverson.
(a)	Hams Fork	21	116	25, NE. ¼ NW. ¼	Main Kemmerer	7	0	Mine	Max A. Pishel.
73	Willow Creek	37	115	32, NE. ¼ NE. ¼	Frontier group	5	6	Prospect pit	J. G. Hawkins.
(a)	Hams Fork	21	116	12, SE. ¼ NW. ¼	Kemmerer seam A	6	0	Mine	Max A. Pishel.
23	Mammoth Hollow	23	116	2, SW. ¼ SW. ¼	Willow Creek group	6	5	Prospect mine	A. R. Schultz.
(a)	Hams Fork	21	116	12, SE. ¼ NW. ¼	Main Kemmerer	9	0	Mine	Max A. Pishel.
(a)	Cumberland	19	116	31, NE. ¼ SW. ¼	....do	8	0	....do	Do.
79	Willow Creek	37	116	1, SW. ¼ SE. ¼	Frontier group	3	6	Prospect pit	J. G. Hawkins.
64	McDougals Mountain	34	115	33, NW. ¼ SE. ¼	....do	6	2	Prospect mine, 20-foot drift	A. R. Schultz.
84	Willow Creek	37	116	1, SW. ¼ SE. ¼	....do	3	0	Prospect pit	E. E. Smith.
80	....do	37	116	1, SW. ¼ SE. ¼	....do	3	9	....do	J. G. Hawkins.
70	....do	36	116	11, NW. ¼ NE. ¼	....do	3	4	Surface	A. R. Schultz.
(a)	Oyster Ridge	15	118	12, NW. ¼	Spring Valley group	4	0	Mine prospect	Max A. Pishel.
62	Lander Peak	33	115	34, SE. ¼ SE. ¼	Frontier group	2	0	Surface	E. E. Smith.
75	Willow Creek	37	115	32, SE. ¼ SW. ¼	....do	2	6	Prospect pit	Do.
65	Wyoming Range	34	116	2, NW. ¼ SE. ¼	....do	10	2	Surface	A. R. Schultz.
68	....do	35	116	35, NE. ¼ NW. ¼	....do	6	0	....do	W. H. Longhurst.
69	Willow Creek	36	116	11, NW. ¼ NE. ¼	....do	4	3	....do	A. R. Schultz.
67	Wyoming Range	35	116	35, NE. ¼ NW. ¼	....do	2	0	....do	W. H. Longhurst.

ADAVILLE AND LABARGE MOUNTAIN COALS OF UPPER MONTANA AND LOWER LARAMIE AGE.

(b)	Mammoth Hollow	21	116	20, NE. ¼ SW. ¼	Adaville group	84	0	Mine (carload sample)	
(b)	....do	21	116	20, NE. ¼ SW. ¼	....do	84	0	Mine	
(b)	....do	21	116	20, NE. ¼ SW. ¼	....do	84	0	....do	
(a)	....do	21	116	20, NE. ¼ SW. ¼	....do	84	0	....do	Max A. Pishel.
(a)	....do	15	118	8, SE. ¼ SW. ¼	....do	30	0	....do	Do.
41	....do	25	115	17, SW. ¼ SW. ¼	....do	3	0	Prospect pit	H. C. Schleuter.
44	Labarge Range	26	113	7, SE. ¼ NW. ¼	Labarge Mountain group	6	0	Mine, 180-foot drift	E. E. Smith, A. R. Schultz.
49	....do	27	113	32, SE. ¼ SW. ¼	....do	8	3	Prospect pit	Do.
56	....do	28	114	12, SE. ¼ SE. ¼	....do	8	0	Mine, 125-foot drift	Do.
53	....do	28	114	1, SW. ¼ NW. ¼	....do	3	3	Tunnel, 210 feet long	A. R. Schultz.
55	....do	28	114	12, SE. ¼ SE. ¼	....do	4	2	Prospect pit	Do.
47	....do	27	113	29, SW. ¼ NE. ¼	....do	3	6	Surface	B. A. Iverson.
51	....do	28	114	1, NE. ¼ NW. ¼	....do	2	4	Prospect pit	A. R. Schultz.

EVANSTON, ALMY, AND FALL RIVER COALS OF EVANSTON AGE.

(a)	....	....	....	....	Almy	24	0	Mine, 3,000-foot slope	Max A. Pishel.
(a)	....	....	....	....	....	....	....	....	Do.
85	Fall River	38	113	31, NW. ¼ NE. ¼	Fall River group	1	0	Surface	A. R. Schultz.
86	....do	38	113	31, NW. ¼ SE. ¼	....do	3	0	....do	Do.
88	Snake River	40	116	34, SW. ¼ NE. ¼	(?)	1	5	....do	H. C. Schleuter.

[a] Sample collected by A. C. Veatch and party in southern Uinta County in 1905.
[b] Sample collected by U. S. Geol. Survey fuel-testing plant in southern Uinta County in 1906.

Analyses of air-dried samples of Uinta County coals—Continued.

FRONTIER COALS OF BENTON AGE.

No. in table of sections (pp. 224-229).	Chemical analyses.												Heating values.		Ratios.	
		Proximate.						Ultimate.								
	Laboratory No.	Per cent of moisture after air drying.	Air-drying loss.	Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	B. T. U.	$\frac{C}{H}$	$\frac{C}{O}$
78	4303	1.99	3.50	2.06	37.18	57.53	3.23	0.94	5.04	76.84	1.31	12.64	7,812	14,062	15.23	6.08
71	4299	2.37	1.30	2.40	36.79	57.33	3.48	.71	5.59	78.19	.85	11.18	7,713	13,883	13.98	6.99
aD	2285	2.56	1.40	2.59	36.68	55.90	4.83	.78	5.09	77.11	1.33	10.86	7,607	13,694	15.15	6.50
72	4323	4.20	3.60	4.36	37.60	56.36	1.68	.28	5.14	72.97	1.48	18.45	7,358	13,244	14.18	3.95
40	3570	3.84	3.90	4.00	36.06	55.47	4.47	.48	5.10	74.41	1.18	14.36	7,336	13,207	14.60	5.11
(a)	2284	3.83	1.30	3.88	41.04	50.41	4.67	.50	5.56	73.91	1.20	14.16	7,297	13,130	13.29	5.22
73	4300	1.89	1.60	1.92	36.48	51.42	10.18	.93	4.99	70.81	1.03	12.06	7,266	13,079	14.19	5.87
(a)	2286	3.86	2.00	3.95	40.30	52.04	3.72	1.09	5.46	74.45	1.10	14.18	7,247	13,044	13.63	5.25
23	3572	4.36	2.50	4.49	39.03	52.84	3.64	1.81	5.12	72.43	1.02	15.98	7,231	13,017	14.14	4.53
(a)	2287	3.49	2.40	3.57	38.52	50.21	7.70	1.42	5.15	70.18	1.09	14.46	7,039	12,664	13.63	4.85
(a)	2245	4.18	2.60	4.29	40.85	48.69	6.17	.44	5.41	70.85	1.15	15.95	6,997	12,587	13.10	4.43
79	4302	4.51	2.30	4.62	34.20	54.85	6.33	.64	4.65	71.09	1.55	15.74	6,911	12,441	15.28	4.51
64	3891	6.50	3.10	6.71	39.95	48.42	4.92	.33	5.31	69.07	1.38	18.99	6,879	12,383	13.00	3.63
84	4003	5.46	4.60	5.72	34.52	55.88	3.88	.40	4.98	70.17	1.35	19.22	6,776	12,196	14.09	3.64
80	4301	4.70	6.00	5.00	32.63	57.82	4.55	.82	4.98	70.41	1.54	17.70	6,762	12,173	14.14	3.98
70	4001	3.91	3.00	4.03	32.89	53.46	9.61	1.58	4.83	67.54	1.04	15.40	6,569	11,825	13.98	4.38
(a)	2212	4.25	2.60	4.36	36.57	45.03	14.04	.96	4.83	65.61	1.15	13.41	6,473	11,652	13.58	4.82
62	3778	8.52	5.50	9.02	35.98	51.91	3.09	.63	5.02	64.83	1.60	24.83	6,361	11,450	12.90	2.61
75	4006	8.66	5.70	9.18	34.44	51.68	4.70	3.78	4.98	64.34	1.37	20.83	6,070	10,925	12.92	3.09
65	3890	8.48	12.80	9.73	39.95	45.03	5.29	.28	4.89	61.62	1.33	26.59	5,774	10,393	12.60	2.31
68	4000	9.99	17.20	11.19	34.21	47.36	7.24	.47	5.18	59.41	1.45	26.25	5,634	10,141	11.47	2.28
69	4005	10.90	10.70	12.20	32.65	47.42	7.73	1.10	4.83	59.39	1.20	25.75	5,556	10,002	12.27	2.30
67	4004	10.03	10.40	12.06	36.59	41.72	9.63	1.13	4.81	53.94	1.31	29.18	5,043	9,079	11.21	1.85

ADAVILLE AND LABARGE MOUNTAIN COALS OF UPPER MONTANA AND LOWER LARAMIE AGE.

(b)	3390	7.70	11.30	8.69	41.31	46.49	3.51	0.55	5.81	66.95	1.10	22.08	6,455	11,620	11.52	3.03
(b)	3203	10.28	10.60	11.50	40.17	45.46	2.87	.60	......	......	......	......	......	......	......	......
(b)	3202	10.37	10.20	11.55	40.44	45.08	2.93	.57	......	......	......	......	6,333	11,399	......	......
(a)	2283	7.57	14.80	8.88	40.49	47.20	3.43	.58	5.24	65.76	1.03	23.96	6,385	11,493	12.55	2.74
(a)	2211	12.45	6.70	13.34	33.43	41.58	5.65	1.26	5.77	67.12	1.08	25.12	6,035	10,864	10.59	2.43
41	3696	9.05	16.50	10.84	40.50	45.04	3.62	.49	4.75	59.03	1.13	30.98	5,398	9,716	12.42	1.95
44	3698	10.22	12.70	11.71	39.47	45.98	2.84	.84	5.68	63.81	1.08	25.75	6,258	11,263	11.23	2.40
49	3693	10.78	11.60	12.19	40.46	43.94	3.41	2.10	5.74	61.76	1.03	25.96	6,057	10,902	10.76	2.33
56	3699	9.02	10.60	10.09	36.59	47.55	5.77	1.14	5.39	62.05	1.09	24.56	6,039	10,870	11.51	2.52
53	3700	9.46	18.10	11.55	37.85	38.79	11.81	1.10	4.44	49.40	1.28	31.92	4,477	8,060	11.51	2.52
55	3694	10.88	21.30	13.83	39.15	40.15	6.87	.61	4.45	48.65	.85	38.57	4,468	8,042	10.93	1.26
47	3697	9.72	19.30	12.04	38.84	39.31	9.81	1.67	4.07	47.85	.98	35.62	4,240	7,633	11.76	1.34
51	3695	13.10	22.60	16.93	37.27	36.20	9.60	.75	4.91	48.01	1.12	35.61	4,195	7,551	9.77	1.34

EVANSTON, ALMY, AND FALL RIVER COALS OF EVANSTON AGE.

(a)	2325	7.73	6.70	8.29	39.45	44.52	7.74	0.22	4.97	64.28	1.23	21.56	6,220	11,197	12.93	2.98
(a)	2326	7.21	6.90	7.74	37.96	36.95	17.35	4.78	4.86	52.53	.88	19.60	5,261	9,469	10.81	2.68
85	3892	10.32	8.70	11.31	43.46	30.48	14.75	2.85	4.70	52.58	1.40	23.72	5,106	9,192	11.19	2.21
86	3893	12.21	4.30	12.75	34.14	39.26	13.85	4.55	4.88	51.59	1.03	24.10	4,971	8,948	10.57	2.14
88	4002	10.37	7.90	11.26	25.17	37.41	26.16	.33	3.51	45.63	.62	23.75	4,010	7,217	13.00	1.92

[a] Sample collected by A. C. Veatch and party in southern Uinta County in 1905.
[b] Sample collected by U. S. Geol. Survey fuel-testing plant in southern Uinta County in 1906.

On examining the foregoing table it will be observed that the Frontier coals, of Benton age, fall into groups G, H, and I of the classification proposed by Campbell.[a] Three of the samples collected last summer, namely, Nos. 73, 78, and 79, with the carbon-hydrogen ratio ranging from 14.6 to 15.28 per cent, and the Willow Creek coal, D of the table, collected in 1905, with a carbon-hydrogen ratio of 15.15 per cent, fall into group G of the bituminous class, which includes the Pittsburg coal and some of the high-grade coals of West Virginia, Kentucky, and Alabama. All the other samples except the last three (Nos. 67, 68, and 69) fall into group H of the bituminous class and compare favorably with the Indian Territory, Kansas, high-grade Illinois, Iowa, and Missouri, and second-grade Kentucky coals. The last three samples in the table fall into group I, not so much because they are inferior coals, but on account of the altered condition of the coal near the surface, where the samples were collected. If good samples of these coal beds had been obtained, they would unquestionably fall into group H and possibly some of them into group G. The sulphur content of these coals is low, being generally less than 1 per cent; the lowest is 0.28, the highest 3.78, and the average of the 23 analyses 0.93 per cent. The ash content ranges from 1.68 to 14.04 per cent, with an average of 6.12 per cent; the carbon ratios range from 53.98 to 78.19 per cent, with an average of 69.11 per cent.

The Adaville coals of Uinta County fall in part into the bituminous class and in part into the subbituminous class. According to the carbon-hydrogen classification, the chemical analyses place one of these coals in group H, five in group I, and four in group J. Group I, the lowest of the bituminous coals, includes the majority of Illinois, Iowa, Missouri, and Indiana coals and many of the Wyoming, Montana, and Colorado coals; group J includes all the subbituminous coals and lignites. The sulphur content of these coals is low, ranging from 0.49 to 2.10 per cent, with an average of 0.94 per cent for the thirteen samples. The ash ranges from 2.87 to 11.81 per cent, with an average of 5.55 per cent, or a little less than the amount of ash in the Frontier coals. The carbon content ranges from 47.85 to 66.95 per cent, with an average of 58.22 per cent for eleven samples.

The Evanston, Almy, and Fall River coals also fall into the bituminous and subbituminous classes. The chemical analyses place one of the coals in group H, one in group I, and three in group J. These coals contain more sulphur and ash than either the Frontier or the Adaville coals and a somewhat lower per cent of carbon. The sulphur ranges from 0.22 to 4.78 per cent, with an average of 2.55 per cent for five samples. The ash ranges from 7.74 to 26.16 per cent, with an average of 15.97 per cent for the five

[a] Campbell, M. R., Prof. Paper U. S. Geol. Survey No. 48, pt. 1, 1906, pp. 168-170.

samples. The carbon ranges from 45.63 to 64.28 per cent, with an average of 53.32 per cent.

The distinction between the Frontier (Benton) coals, on the one hand, and the Adaville, Labarge Mountain, and Fall River coals, on the other, is largely physical. The last two generally contain more moisture than the Frontier coals, have a lower calorific value, weather more readily on exposure to the atmosphere, and are lighter in weight. The most marked difference between the Frontier and the Adaville and Labarge Mountain coals consists in the rapidity with which the latter break down when exposed to weathering and the peculiar manner in which such breaks occur, the coal seeming to undergo a chemical change which is accompanied with a conchoidal or irregular fracture that does not conform in any way with bedding planes.

In making any comparison with the coals in another field, only 11 analyses (Nos. 4303, 4299, 3570, 4300, 3572, 4302, 3891, 4301, 3698, 3693, and 3699) of the samples collected last summer, together with those of the samples collected in southern Uinta County, should be taken as representative of the coals in their unaltered condition. When compared with the analyses made by the United States Geological Survey fuel-testing plant of samples collected in other parts of the Rocky Mountain region, it will be observed that the coals of Benton age found in Uinta County rank as high as the best bituminous coals in other fields and are much better than some of the Montana, Colorado, Utah, and New Mexico coals, which are about the same in character as the Adaville, Evanston, Labarge Mountain, and Fall River coals of Uinta County. The Benton coals of this county may be said to belong at the top of the group of the best bituminous coals of the Rocky Mountain region. The coals in group G are by far the best thus far prospected in this field. The high quality of these coals in part of central Uinta County is not the result of igneous intrusion, as is often held by local residents, and they are therefore apt to be of a uniform character over a large area. From the preliminary tests thus far made, some of the Benton coals rank as fairly good coking coals, and probably will in the near future be developed for their coking properties.

TRANSPORTATION.

No railroad crosses or enters this area, the nearest being the Oregon Short Line, which passes through Kemmerer, 6 miles south of the southern boundary, and then gradually gets farther away as it skirts the southern and western boundaries on its way to the Snake River valley. The St. Anthony branch of the Oregon Short Line lies about 80 miles west of the northwest corner of this district.

A stage leaves St. Anthony, Idaho, daily, except Sunday, via Teton Pass, for Jackson, Wyo., a distance of about 80 miles. The stage carries mail and supplies to all the small stores and hamlets along the line.

From Kemmerer a stage leaves daily except Sundays for Pinedale, Wyo. This stage line crosses the southeastern part of this area and then skirts the eastern margin along Green River, passing Slate Creek, Palisade, Labarge, Midway, Big Piny, Ball, Daniel, and Burns. The stage carries mail and supplies to the small stores, hamlets, and ranches along the road, thus making Kemmerer the main supply station for all the upper Green River basin and the part of the Fall River basin lying east of the Hoback Range.

There are only three practical railroad routes across this country. The first and best passes south of Meridian and Absaroka ridges and was in part surveyed in 1886 by the Wyoming and Eastern Railway Company, the line going down Big Sandy River, thence across Green River near the mouth of Slate Creek, up that creek a short distance, crossing the southeast corner of this area in T. 22 N., Rs. 113 and 114 W., and connecting with the Oregon Short Line in the vicinity of Old Hams Fork a short distance west of Kemmerer.

A second route which has never been surveyed but which might be utilized at a large expense extends from Green River near the mouth of Labarge Creek, up that creek to a point near its headwaters, thence across the divide at the south end of the Salt River Range into Star Valley; or at a somewhat greater expense the eastern portion of the line might follow somewhat closely the Lander road. This, however, would necessitate another tunnel across the divide between South Piny and Labarge creeks.

It is not probable that a line will ever be built along either of these routes, for so far as the mineral deposits within the southern part of the district are concerned it would be more economical and much more serviceable to build a spur from the Oregon Short Line northward from Kemmerer, up Mammoth Hollow or Willow Creek, along the strike of the coal-bearing beds as far north as the headwaters of Fontenelle Creek or possibly Labarge Creek. A preliminary survey has already been made along this route as far north as the Willow Creek prospect, in the southern part of the district. The coals east of Meridian Ridge along the east base of Labarge Range could best be reached by a spur from some point on the Oregon Short Line or from some other line extending up Green River.

The third route follows Snake River across the northern part of the field and a railroad may soon be built along this line. Whether the line will be built through the northern part of this field, along Fall River, and cross the divide into the Green River basin, or pass north of the Gros Ventre Mountains to Buffalo Fork and connect with the Wyoming and Northwestern Railway, or extend up Gros Ventre

River, cross the Continental Divide, and continue eastward down Wind River, remains to be seen.

In 1890 the Nebraska and Wyoming Railroad Company made a survey along the Fall River route. The survey extended up Green River to the mouth of Middle Beaver Creek, thence up that stream, crossing the divide into the Fall River basin, and thence down Fall and Snake rivers into Idaho. The location of the portion of the line included in this area is shown on Pl. XIII (p. 212) by the single black line along Fall and Snake rivers. Although this involves a steep grade in crossing the divide between Fall and Green rivers, it would make a good road and be within a short distance of all the important coal deposits in the northern part of the area. It would cut directly across the coal-bearing formations on Fall and Snake rivers, and by a few spurs could readily reach all the coals east of the Wyoming Range, including those of Willow Creek, a tributary of Fall River, which rank as high as the Frontier, Willow Creek, and Cumberland coals of southern Uinta County. The coals of John Day River and its tributaries could probably be reached by way of John Day Canyon or by way of Bailey Creek west of the Wyoming Range.

In 1905 the Idaho and Wyoming Railway Company surveyed a line from Jackson, Wyo., down Flat Creek and Snake River, to connect with the St. Anthony branch of the Oregon Short Line just north of Idaho Falls, Idaho. The location of this line is shown on Pl. XIII by a single line along Snake River. If it is built it may be extended northward to connect with the Wyoming and Northwestern Railway near the mouth of Buffalo Fork. In the same year the Wyoming and Northwestern surveyed a line up Wind River and across the divide into Buffalo Fork, thence down that stream to Snake River, and up Snake River to the vicinity of the Yellowstone National Park. The completion of these two projected railroads, which by the most optimistic is expected within the next three or four years, will entirely alter the economic conditions in the northern part of this field, materially increase the population of Jackson Hole, and tend to make it popular as a summer resort as well as a center of mining activities.

If these railroads are completed, the coal fields in the northern part of this area will probably be rapidly developed, owing to the high quality of the coals and their nearness to the great smelting and sugar industries in the Salt Lake valley, the Snake River valley, Anaconda, and Butte. As soon as communication is established with outside markets lumbering will become an important industry in this area, and the abundance of timber in the vicinity of the coal deposits will tend to stimulate and develop coal prospecting and mining.

THE LANDER COAL FIELD, WYOMING.

By E. G. Woodruff.

A bed of coal in the sandstones of the Montana formation in central Wyoming has been worked to a moderate extent in the Popo Agie Valley 8 miles northeast of Lander, Fremont County. In this region the Montana formation consists of a lower member of shale several thousand feet thick and an upper member of sandstones, shales, and conglomerates between 500 and 600 feet thick. The shale has usually been regarded as the Pierre and the overlying sandstones have been supposed to represent the Fox Hills, but it is quite possible that the sandstones are equivalent to the Mesaverde of the Colorado section. The sandstones are extensively exposed on the east slope of a subordinate anticline on the east side of the Wind River uplift from a point due east of Lander to Little Wind River and beyond. To the south and in the greater portion of the Wind River valley they are covered by Tertiary deposits. The coal occurs about 250 feet above the base of the first sandstone, lying upon an irregular deposit of gray conglomerate. The dip is to the northeast at an angle of about 7°. The coal bed has a maximum thickness of 8 feet, but throughout much of its outcrop it is much thinner and in places is too thin and shaly to be of value. Where mined it has no partings. It is exposed at intervals for about 4 miles, mostly on the south side of the Popo Agie along slopes above a sandstone escarpment facing to the west.

Very thin layers of coal occur in the upper sandstone of the Colorado formation near Dallas post-office, 10 miles southeast of Lander, and have been prospected to some extent. They are mostly less than 2 inches in thickness and a few rods in horizontal extent, but at one point one of them attains a thickness of 18 inches. At this point an incline is driven 80 feet along the slope, and while the coal is of good quality the quantity is insufficient.

The principal openings from which coal has been mined in the Lander field are as follows:

Big mine.........NW. ¼ SW. ¼ sec. 3, T. 33 N., R. 98 W.
Little mine......SW. ¼ SE. ¼ sec. 33, T. 34 N., R. 98 W.
Hayne's mine ...NW. ¼ SW. ¼ sec. 33, T. 34 N., R. 98 W.
Small drifts......W. ½ SW. ¼ and SW. ¼ NW. ¼ sec. 28, T. 34 N., R. 98 W.
Small pit........W. ½ NW. ¼ sec. 11, T. 34 N., R. 98 W.
Small slope......E. ½ SW. ¼ SW. ¼ sec. 11, T. 34 N., R. 98 W.

The coal was first opened in 1885 and has been worked at intervals since. The total production in 1905 is estimated at 4,000 short tons. The Lander Coal Company is the chief producer. At the Big mine of this company there is a slope of 500 feet and a working face 8 feet thick. The mine is worked entirely by hand, except that tram cars are brought to the surface by a cable operated by horsepower windlass at the mouth of the mine. The room-and-pillar method of mining is used; and the roof is a sandy shale, which requires but little timbering. There is no water and no gas of any consequence. At the Little mine, three-fourths of a mile away, the conditions are similar, but the bed is only 4 feet thick. There is a 500-foot incline, with numerous rooms. In places in this mine the dip increases locally to 16°. Three miles southeast of the Little mine the coal appears to be represented by a number of thin beds with sandstone partings.

Hayne's mine is a small one, which has produced coal for a number of years. The small opening on the Indian reservation is operated under a lease from the Indians. The coal slacks and rapidly crumbles on exposure to weather, so that it is mined and marketed to meet only the immediate demand and mainly during the winter months. The market is Lander and vicinity, and the price at the mine $2.50 a short ton. During the past summer a branch of the Chicago and Northwestern Railway has been extended across this field to Lander, and probably in future some of the coal may be shipped over this line to more distant points. The following analyses were made in the laboratory of the United States Geological Survey fuel-testing plant at St. Louis by F. M. Stanton. The samples were selected so as to represent the freshly mined coal.

Analyses of coal from R. 98 W., near Lander, Wyo.

	T. 33 N.	T. 34 N.		T. 33 N.	T. 34 N.
Laboratory No.	4354	4355	Loss of moisture on air drying	6.20	6.30
Analysis of sample as received:			Analysis of air-dried sample:		
Prox. Moisture	21.20	22.90	Prox. Moisture	15.99	17.72
Prox. Volatile matter	35.85	38.09	Prox. Volatile matter	38.22	40.65
Prox. Fixed carbon	38.33	35.81	Prox. Fixed carbon	40.86	38.22
Prox./Ult. Ash	4.62	3.20	Prox./Ult. Ash	4.93	3.41
Ult. Sulphur	.53	.47	Ult. Sulphur	.56	.50
Ult. Hydrogen	6.08	....	Ult. Hydrogen	5.75	....
Ult. Carbon	55.25	....	Ult. Carbon	58.90	....
Ult. Nitrogen	1.15	....	Ult. Nitrogen	1.23	....
Ult. Oxygen	32.37	....	Ult. Oxygen	28.63	....
Calorific value determined:			Calorific values determined:		
Calories	5,357	....	Calories	5,711	....
British thermal units	9,643	....	British thermal units	10,280	....

COAL FIELDS OF EAST-CENTRAL CARBON COUNTY, WYO.

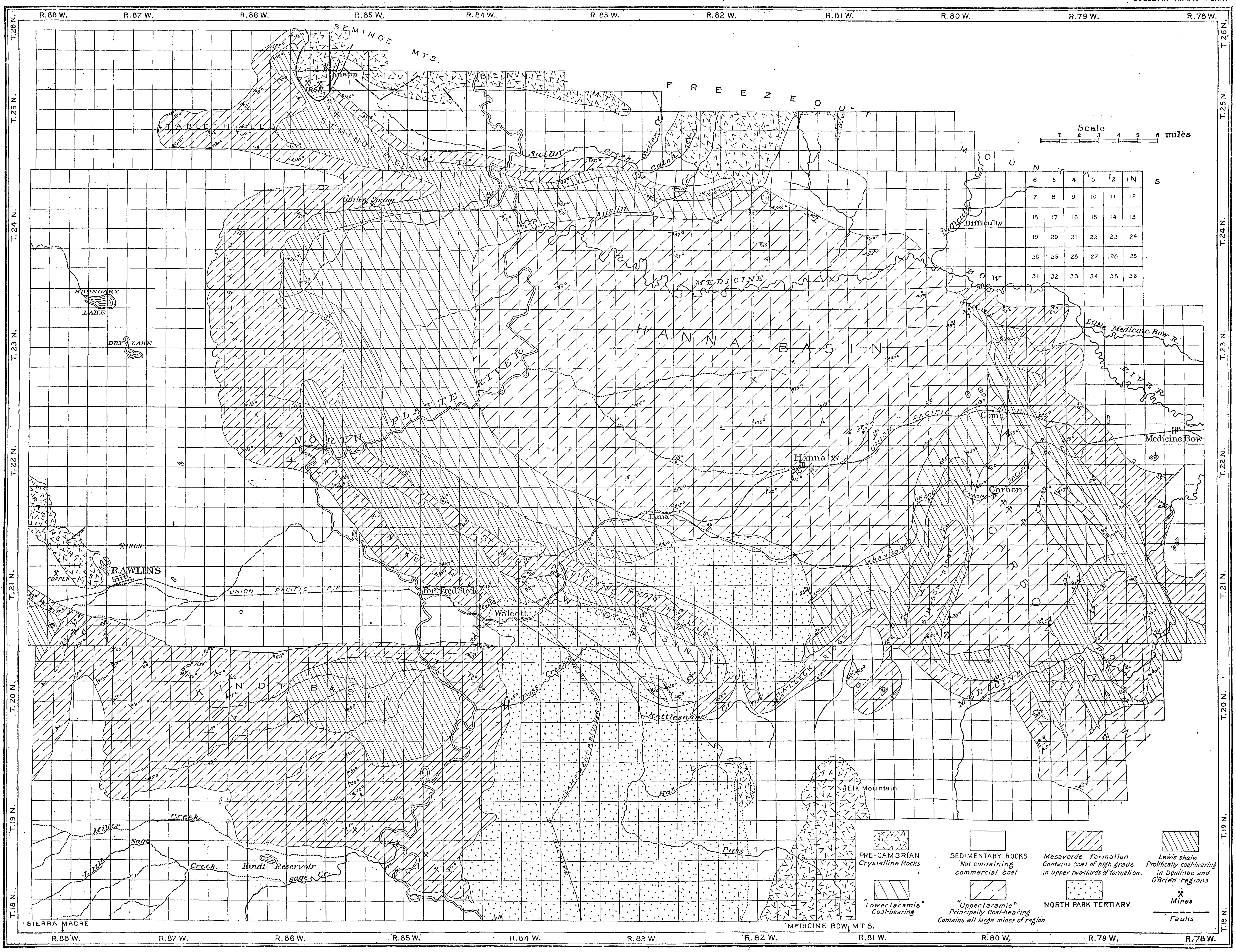
By A. C. Veatch.

INTRODUCTION.

This paper is a preliminary statement of results of surveys made during the summer of 1906 by the writer, with the assistance of Max W. Ball, Max A. Pishel, and Spencer R. Logan. Mr. Logan had charge of the collection of coal samples, and it was due to his energy that so large a number were forwarded to the fuel-testing plant at St. Louis. Messrs. Ball and Pishel assisted in the topographic sketching and in the geologic mapping.

The method of work was in general the same as that used in Uinta County in 1905.[a] The region is covered by the public land surveys, and economic considerations demanded that the work be based primarily on the land-office subdivisions, since in such a region the section and its subdivisions are the units of economic importance in everything except lode claims. All locations were made by pacing section lines or from land corners found by such pacing. Elevations were determined by aneroid-barometer readings checked by hand-level sights and based on railroad surveys and the precise lines of levels of the United States Coast and Geodetic Survey and the United States Geological Survey. The field sheets, on a scale of 2 inches to the mile, contour interval 100 feet, are now being compiled into a base map on the scale of 1 inch to the mile. This will be used in the preparation of the geologic and other maps of the final report. The sketch map (Pl. XIV) accompanying this preliminary report has been hastily prepared from the field sheets, and though approximately correct may be found to disagree in minor particulars with the final large-scale map. The detailed report will probably be ready for distribution in the summer of 1908, and the reader is referred to it for an elaboration and amplification of the points here outlined and of the map here presented.

[a] Bull. U. S. Geol. Survey No. 285, 1906, p. 331; Prof. Paper U. S. Geol. Survey No. 56, 1907, pp. 1-3.



MAP OF COAL FIELDS OF EAST-CENTRAL CARBON COUNTY, WYO.

By A. C. Veatch, assisted by Max W. Ball and Max A. Pishel.

TOPOGRAPHY.

The area under consideration is situated on the western edge of the Rocky Mountains, just east of the great Green River Basin, and includes the western part of what is sometimes called the Laramie Plains. With reference to the general mountain uplift, the district is situated at the point where the collection of ranges known as the Rocky Mountains turn from the north-south course characteristic in Colorado and swing westward across Wyoming to the Yellowstone National Park. At this point of change of direction the mountains are broken into a number of dome and lozenge shaped uplifts of greater or less extent and of considerable variation in axial trend, and the coal area is thus a topographic and geologic basin with an average altitude between 6,500 and 7,000 feet, almost completely rimmed by uplifts ranging in elevation from 7,500 to over 11,000 feet. On the south it is limited by the abrupt north ends of the north-south Sierra Madre, or Park Range, and the Medicine Bow Mountains, and on the north by the east-west Freezeout, Bennett, Seminoe, and Ferris ranges. On the west the Rawlins Hills, an elongate dome with a granite core, together with the northern extension of the Sierra Madre, all but separate the coal basin from the eastern edge of the great Green River coal field. On the northeast and east are a few low domes, without much topographic importance, and to the southeast the area merges into the plains region, to which the name Laramie Plains is now usually restricted.

Within the basin area the principal topographic expression is due to the hard, resistant sandstones of the Mesaverde, which make notable ranges of hills, usually separated from the more elevated areas of older rocks by belts of low relief underlain by the soft shale of the lower Pierre. A group of these Mesaverde ridges, the Table, Haystack, and Rattlesnake hills, and Mead Ridge topographically connect the north end of the Medicine Bow Mountains with the Seminoe Mountains, and were thus, in the early history of the country, naturally taken as the western limit of the Laramie Plains.[a]

GEOLOGY.

OUTLINE OF GEOLOGIC SUCCESSION.

The general character and succession of the Cretaceous and Tertiary rocks in this area, together with their economic importance, are shown in the accompanying table.

[a] U. S. War Dept. map of western Territories, sheet 3, scale 1: 2,000,000, 1876. Also earlier maps of the War Department.

Generalized section of Cretaceous and Tertiary rocks of central Carbon County, Wyo.

System.	Group.	Formation.	Thickness. (feet.)	Characteristics.	Economic value.
Tertiary.		North Park.	4,500	White volcanic-ash beds, cherty bands; base conglomeratic.	May yield artesian water.
Tertiary.		Unconformity.			
Tertiary.		Fort Union.	±1,200	Dark-colored shales and shaly sandstones.	
Tertiary.	Laramie—hitherto so called.	"Upper Laramie."	±6,800	Dark-colored shales and gray to brown, irregularly bedded sandstones; coal bearing. Contains conglomerate at base composed largely of pebbles derived from the underlying Cretaceous rocks. Fresh-water fauna.	**Prolifically coal bearing** throughout. Contains coal worked at the Carbon, Dana, and Hanna mines.
	Laramie—hitherto so called.	Unconformity.			
Cretaceous.	Laramie—hitherto so called.	"Lower Laramie."	6,500	Dark-colored shales and gray to brown, irregularly bedded sandstones; coal bearing. Fresh-water fauna.	**Coal bearing.** Beds thinner and not so numerous as in overlying formations. Local mines at several points.
Cretaceous.	Montana.	Lewis.	1,800–3,000	Shales and shaly sandstones. Coal bearing. Has in parts of field a very persistent white sandstone near top. Marine and brackish-water faunas.	**Coal bearing.** Numerous important beds in region of Seminoe Mountains and O'Brien Spring. No development work of importance at other points.
Cretaceous.	Montana.	Mesaverde.	1,500–3,200	White to yellow sandstones and interbedded shales, coal bearing, producing areas of marked relief. Heaviest sandstones are grouped near top and at base of formation, and thus produce, under favorable conditions, two terraces or hogbacks.	**Coal bearing** above basal group of sandstones. Coal beds thin and rather irregular, but coal of high grade. Principal mines on Platte River 13 miles south of Fort Fred Steele. Basal sandstones quarried for building and sold commercially as "Rawlins sandstone."
Cretaceous.	Montana.	Pierre shale.[a]	3,000–3,500	Dark-gray to brown, sandy, concretionary shale and thin, soft shaly sandstones, producing areas of low relief.	
Cretaceous.	Colorado.	Niobrara.	750–850	Dark-colored, very calcareous shale, weathering light gray.	
Cretaceous.	Colorado.	Benton.	150	Black shale.	
Cretaceous.	Colorado.	Benton. Frontier.	400–800	Brown sandstones and shales, producing marked ridges.	
Cretaceous.	Colorado.	Benton. Mowry.	300 750	Black fish-scale shale, weathering silver-gray.	
Cretaceous.	Colorado.	Benton.	10–15	Yellow quartzitic sandstone, resembling the Dakota.	
Cretaceous.	Colorado.	Benton.	60–150	Black shale, with thin coal beds.	
Cretaceous.		Dakota.	80–125	Coarse conglomeratic sandstones.	Important artesian-water horizon.

[a] It is the belief of Dr. T. W. Stanton that the Mesaverde and part of the Lewis also belong to the Pierre, as that formation is developed east of the Rocky Mountains. A local name will therefore probably be applied to this lowest division of the Montana in this region.

COAL-BEARING FORMATIONS.

LOWER COLORADO.

The oldest beds containing coal in this area are in the lower part of the Cretaceous as here developed. At this horizon black shale, occurring between typical Dakota sandstone and the Mowry fish-scale shale and tentatively referred to the Colorado, contains beds of dirty coal a few inches thick. The occurrence is of scientific interest only, and suggests the coal in the Bear River formation of Uinta County, Wyo., and the Lakota coals of the Black Hills region, though apparently higher than the latter. The overlying Frontier formation, which is the important coal-bearing formation in Uinta County, is apparently barren here.

MESAVERDE FORMATION.

The first important coal-bearing formation in this section is the Mesaverde, of lower Montana (Cretaceous) age. The basal 500 to 1,500 feet of this formation consist of heavy ridge-making sandstones, which, so far as known, are not coal bearing. Coal beds occur irregularly throughout the remainder of the formation. The individual beds are irregular and not persistent. The coal is, however, of high grade, and at the Larson mine a bed 16 inches thick has been worked and the product hauled to Saratoga. In T. 19 N., Rs. 85–86 W., there has been considerable prospecting done on the Kindt coal bed and several mines opened which exhibit the following sections:

Sections of coal beds in Mesaverde formation.

Location.			Section.		
T.	R.	Sec.		*Ft.*	*in.*
19	86	14, SW. ¼ SE. ¼.	Coal	1	6
			Shale		9
			Bone		6
			Coal	1	1
				3	10
19	86	14, SE. ¼ SE. ¼.	Coal	6	
19	85	19, SW. ¼ NW. ¼.	Coal	2	2
			Shale		9
			Coal	1	6
				4	5
19	85	19, SE. ¼ NW. ¼.	Coal	5	3
19	85	19, NE. ¼ SE. ¼.	Coal		7
			Shale		8
			Coal	4	8
				5	11
19	85	19, NE. ¼ SE. ¼.	Coal	2	
			Shale		10
			Coal	1	
				3	10
19	85	20, NW. ¼ SW. ¼.	Coal	1	10
			Shale	1	6
			Coal	1	4
				4	8
19	85	20, NW. ¼ SE. ¼.	Coal	2	
			Shale	4	6
			Coal	1	
				7	6

Mines have been opened in secs. 22 and 36, T. 21 N., R. 88 W., in beds just below the upper escarpment and 500 feet or more above the beds worked at the Larson and Petty mines. Workable beds have been found in the same horizon in sec. 13, T. 20 N., R. 87 W., and sec. 19, T. 20 N., R. 86 W. At O'Brien Spring, in sec. 9, T. 24 N., R. 85 W., coal is found in the upper group of sandstones. At the Fieldhouse opening, in sec. 23, T. 25 N., R. 86 W., and on upper Medicine Bow River, in sec. 34, T. 21 N., R. 79 W., coal is found immediately overlying the upper sandstones in the uppermost part of the Mesaverde or basal portion of the Lewis. The character and thickness of the coal beds in the middle and upper parts of the coal-bearing portion of the Mesaverde are shown in the following sections:

Sections of coal beds in Mesaverde formation.

Location.			Section.		
T.	R.	Sec.		Ft.	in.
21	88	22, SW. ¼ SE. ¼.	Coal........	3	0
			Sandstone..		2
			Coal........	3	
			Coal, dirty..		2
			Coal........	1	6
				7	10
21	88	36, NE. ¼ NW. ¼ (Dillon mine).	Coal........	2	10
			Coal, dirty..		2
			Coal........	1	6
				4	6
20	87	Line between NE. ¼ NE. ¼ sec. 24 and SE. ¼ SE. ¼ sec. 13.	Coal........	4	6
20	86	19, NW. ¼ NW. ¼.	Coal........		7
			Coal, dirty..		½
			Coal........		7
			Coal, dirty..		9
			Coal........	2	3
				4	2½
25	86	23, SE. ¼ NE. ¼ (Fieldhouse mine).	Coal.......		8
			Shale......		1
			Coal.......	3	6
			Coal, dirty.	3	8
				7	11
24	85	9, NE. ¼ SW. ¼ (O'Brien Spring mine).	Coal, dirty.		5
			Sandstone.		8
			Coal.......	1	2
			Bone......		7
			Coal.......		8
			Coal, dirty.		8
			Coal.......		10
				5	
21	79	34, SE. ¼ NW. ¼.	Shale, black.		
			Coal.......	1	6
			Dirt.......		½
			Coal.......	2	...
			Dirt.......		¾
			Coal.......	1	...
			Shale, black.	4	7¼

LEWIS FORMATION.

The Lewis formation, which overlies the Mesaverde, is distinguished from that formation on lithologic grounds only. The Mesaverde contains many sandstones which produce a hilly region, but the Lewis is composed of shale and soft shaly sandstone which produce a region of low relief, contrasting markedly with the hilly area of the Mesaverde. This formation has been found prolifically coal bearing in the region south of Knapp and west of O'Brien Spring, where the following sections were measured.

Sections of coal beds in Lewis formation.

Location: T.	R.	Sec.	Section	Ft.	in.
24	86	26, NE. ¼ NW. ¼.	Coal, with less of fire clay near center...		10
24	86	26, SE. ¼ NW. ¼.	Coal.......	2	10
			Shale......		1
			Coal.......	2	6
				5	5
25	85	20, NW. ¼ NW. ¼.	Coal.......	3	6
			Shale......		1
			Coal.......	1	3
				4	10
25	85	20, NE. ¼ NW. ¼ (Penn, Wyoming mine).	Coal.......	4	10
25	85	17, NW. ¼ SW. ¼ (outer, Kronkheit mine).	Coal.......	8	6
25	85	17, NW. ¼ SW. ¼ (inner, Kronkheit mine).	Coal.......	5	
25	85	35, NE. ¼ SW. ¼ (Miller mine).	Coal.......	4	
			Coal, bony.	1	
			Coal.......	6	6
				11	6

At Knapp the beds are overthrust by the iron-bearing metamorphic pre-Cambrian rocks, and the Seminoe hematite deposits are thus underlain by coal. The beds here occur in a syncline, the north limb of which is overturned and dips at angles of 110° to 150° NE. The south limb is comparatively flat, dipping from 10° to 15° (Pl. XIV).

"LOWER LARAMIE."

The "Lower Laramie" beds are similar to the Lewis beds in every way, and like them are coal bearing. Their separation from the Lewis is of scientific interest only, and is based on the absence of marine fossils in the "Lower Laramie" and their presence in the Lewis. Coal has been found in this formation at many points, as shown by the following sections, but has not been extensively developed because of the overshadowing importance of the coal in the "Upper Laramie."

Sections of coal beds in "Lower Laramie" formation.

Location: T.	R.	Sec.	Section	Ft.	in.
24	83	11, SW. ¼ NE. ¼.	Coal........	4	3
			Shale.......		½
			Coal........	1	2
				5	5½
24	83	7, NW. ¼ NW. ¼.	Coal........	4	4
			Shale.......	1	6
			Sandstone..	1	2
			Coal........	4	8
				11	8
20	83	1, NW. ¼ SE. ¼.	Coal, dirty..	1	9
			Coal........	7	3
				9	
21	84	14, SE. ¼ SW. ¼ (Buckley & Ryan mine).	Coal, dirty..		8
			Coal........	4	
				4	8
21	84	24, NE. ¼ SE. ¼.	Coal, bony..	1	3
			Coal........	3	9
				5	
22	85	2, NE. ¼ NW. ¼.	Coal........	3	8

"UPPER LARAMIE."

The "Upper Laramie" is separated from the "Lower Laramie" by a great unconformity, which marks one of the important episodes in the geologic history of this region. This formation is prolifically coal bearing, some of the coal beds reaching a thickness of more than 30 feet. The following sections illustrate the thickness of the "Upper Laramie" coal beds:

Sections of coal beds in "Upper Laramie" formation.

Location. T.	Location. R.	Location. Sec.	Section.	Ft.	in.
22	81	16 (Hanna mine No. 1).	Coal	6	7
			Coal, bony	1	2
			Coal	8	
			Coal, bony	1	4
			Coal	5	
				22	1
22	82	32, SE. ¼.	Coal	5	
			Shale		¼
			Coal	7	7
				12	7¼
24	81	33, NE. ¼ SE. ¼ (Rock Crossing mine).	Coal, dirty	2	6
			Shale		2
			Coal		7
			Coal, dirty		6
			Shale		2
			Coal		6
				4	5
22	80	36, SE. ¼ SE. ¼ (mine No. 7, Carbon).	Coal	3	
			Shale		1
			Coal	2	2
			Coal, dirty		6
			Coal	2	
				7	9
21	80	28, SW. ¼ NW. ¼.	Coal	4	
			Shale		2
			Coal	7	
				11	2
21	80	32, SE. ¼ NE. ¼ (Finch mine).	Coal, dirty	4	
			Coal, fair	4	6
			Coal, good	2	6
				11	
22	81	18, SE. ¼ (bed worked at Hanna mine No. 2).	Coal, soft, dirty.	5	
			Coal, good	1	9
			Bone		7
			Coal, clean, hard.	19	6
			Bone		6
			Coal, clean, hard.	7	
			Coal and shale.	4	6
				38	10

STRUCTURE OF THE COAL FIELDS.

The coal-bearing rocks in this area occur in two basins, the second of which is separated into several subordinate basins. The first, called the Kindt Basin, is really but a projecting portion of the great Green River Basin lying to the west, from which it is all but separated by the northward-plunging anticline of the Sierra Madre uplift and the Rawlins uplift. This basin has very steep dips, 45° to 75°, on the north side, and much lower dips on the south. It is somewhat broken by minor folds, such as that producing the marked reentrant in the southern border of the Mesaverde formation in T. 19 N., R. 87 W. (Pl. XIV, p. 244). The eastern edge of the basin is buried beneath Tertiary deposits, but there are many reasons for believing that the coal-bearing beds are entirely separated from those in the basin to the east.

The second of the two larger coal basins of this area includes the region rimmed in on the west by the Table, Haystack, and Rattlesnake hills. It is separated by the Simpson Ridge anticline into two major parts, the western of which is called the Hanna Basin and the eastern the Carbon Basin. The Hanna Basin is in a general way a broad trough 40 miles long and 25 miles wide, which shows minor folds and faults in the center and near its edges some marked irregular plunging anticlines, such as (1) the St. Mary anticline, extending northward from Elk Mountain to the Haystacks, just inside of and parallel to the southwest side of the basin, and separating the Walcott basin of "Lower Laramie" coals from the main field; (2) the O'Brien Spring anticline, which produces the semi-isolation of the Seminoe field, and (3) the Simpson Ridge anticline, which separates nearly all of this basin from the Carbon Basin.

The Carbon Basin is more irregular than the Hanna Basin. Its southern limit was not determined by the work of this party, but has been shown by the work of parties under N. H. Darton to lie just north of Rock Creek. This basin is very irregular in outline and is broken near its center by a slightly elongate dome, which brings up the Mesaverde strata.

QUALITY OF COALS.

METHOD OF TAKING SAMPLES.

Representative samples of coals were collected throughout the field and were sent in air-tight cans to the fuel-testing plant at St. Louis, where they were analyzed under the direction of F. M. Stanton.

In order that the results from the samples collected by many persons might be entirely comparable, all sampling was done in accordance with the general plan adopted by the fuel-testing plant and described by M. R. Campbell in a letter of instructions, as follows:

All mine samples should be obtained by cutting a channel across a clean face of the coal bed, or across such bench or benches as it is desirable to test, including everything except partings and binders over one-fourth inch in thickness and lenses and concretions greater than 2 inches in diameter and one-half inch in thickness. The channels should be of such a size as to furnish about 5 pounds of coal per foot of bed, and the material thus obtained should be caught upon a blanket of canvas or oilcloth to keep out dirt and excess moisture.

In order to preserve the original moisture content unchanged the gross sample should be pulverized in the mine as rapidly as possible until none of the fragments exceed one-half inch in diameter. The fine coal should then be mixed thoroughly and divided into four equal quarters. Opposite quarters should be thrown out and the remaining portions thoroughly mixed and again quartered, throwing out opposite quarters as before. This process should be continued until the sample is reduced to about 1 quart. The sample should then be placed in a can, and the latter sealed air-tight before leaving the mine. The geologist or sampler should always go provided with a small roll of adhesive tape for this purpose, so that there can be no excuse for leaving the sample unsealed.

METHOD OF MAKING ANALYSES.

It is evident that beyond the moisture natural or inherent to a coal, if this indeed be a definite quantity, samples from a wet mine hermetically sealed in the mine will contain a great deal more moisture than the same coal from a dry mine. In order that the coals may be readily compared it is necessary to reduce the different samples to something approaching the same moisture content. In the early work of the fuel-testing plant this was done by exposing the pulverized sample to the air of the laboratory for twenty-four hours, or until its weight became relatively uniform, and the loss on drying was called the "air-drying loss." This method proved unsatisfactory because of the varying humidity of the room and a new method was adopted, which has been briefly described by N. W. Lord as follows:[a]

> In order to make determinations of the loosely held moisture more uniform and definite, a special drying oven has been designed and introduced into the laboratory; in this oven samples of several pounds weight can be dried in a gentle current of air raised from 10° to 20° above the temperature of the laboratory. In this way the coal is air dried in an atmosphere with a very low dew-point and not subject to large percentage variations, and the results obtained are considerably more concordant. Another advantage of this method is that it greatly shortens the time of air drying, so that the samples can be prepared in much less time than formerly.

In other respects the chemical analyses here reported were made in the same general way as those described in the first report of the fuel-testing plant.[b]

ANALYSES.

The analytical results are presented below in two sets—one giving the result of analysis of samples as received in the laboratory, containing all the moisture; the second, which is calculated from the first, giving the result expressed in terms of the air-dried sample, that is, one lacking the moisture which in that particular sample, under the conditions of the analysis, was lost in air drying. The analyses are grouped according to the geologic age of the beds sampled.

[a] Bull. U. S. Geol. Survey No. 290, 1906, pp. 29, 30.
[b] Prof. Paper U S. Geol. Survey No. 48, pt. 1, 1906, pp. 174-192.

Analyses of coal from east-central Carbon County, Wyo.

SAMPLES AS RECEIVED.

No.	Geologic horizon of coal.		Thickness of coal represented by sample.		Locality.	Laboratory No.	Proximate.				Ultimate.					Loss of moisture on air drying.	Calorific value.	
							Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.		Calories.	B. T. U.
			Ft.	*in.*														
1	Mesaverde.	Lower.	5	2	Fort Steele, 13 miles south of, SW. ¼ SW. ¼ sec. 19, T. 19 N., R. 85 W	3480	8.85	36.58	50.99	3.58	0.92	5.76	68.68	1.73	19.33	3.60	6,701	12,062
2	Mesaverde.	Lower.	4	6	Fort Steele, 13 miles south of, SW. ¼ NW. ¼ sec. 19, T. 19 N., R. 85 W	3481	9.87	36.27	51.88	1.98	.90	....	....	....	....	4.10	....	....
3	Mesaverde.	Lower.	2	6	Fort Steele, 13 miles south of, NW. ¼ SW. ¼ sec. 26, T. 19 N., R. 85 W	3509	7.51	37.80	48.81	5.88	.86	5.28	67.62	1.76	18.60	1.90	6,631	11,936
4	Mesaverde.	Lower.	1	4	Fort Steele, 13 miles south of, NE. ¼ NE. ¼ sec. 28, T. 19 N., R. 85 W	3501	7.55	40.13	49.59	2.73	.74	....	....	....	....	1.80	....	....
5	Mesaverde.	Lower.	2	8	Fort Steele, 14 miles south of, SW. ¼ NE. ¼ sec. 35, T. 19 N., R. 85 W	3507	6.87	43.51	45.15	4.47	.89	....	....	....	....	.80	....	....
6	Mesaverde.	Middle.	1	4	Fort Steele, 14 miles south of, NW. ¼ SW. ¼ sec. 36, T. 19 N., R. 85 W	3508	20.19	33.48	38.92	7.41	.70	....	....	....	....	7.70	....	....
7	Mesaverde.	Middle.	4	6	Rawlins, 4 miles southwest of, NE. ¼ NW. ¼ sec. 36, T. 21 N., R. 88 W	3477	13.23	33.57	46.37	6.83	.63	....	....	....	....	6.70	....	....
8	Mesaverde.	Middle.	4	6	Same	3478	14.12	32.95	46.37	6.56	.49	....	....	....	....	7.30	....	....
9	Mesaverde.	Middle.	4	6	Rawlins, 8 miles southeast of, NE. ¼ NW. ¼ sec. 24, T. 20 N., R. 87 W.; surface sample	3479	28.09	27.04	34.55	10.32	.29	....	....	....	....	21.20	....	....
10	Mesaverde.	Upper.	3	4	Fort Steele, 20 miles north of, NE. ¼ SW. ¼ sec. 9, T. 24 N., R. 85 W	3921	13.54	32.01	48.34	6.11	.50	....	....	....	....	7.00	....	....
11	Mesaverde.	Upper.	4	1	Fort Steele, 13 miles northwest of, SE. ¼ NE. ¼ sec. 18, T. 23 N., R. 85 W.; surface sample	3931	19.26	31.79	44.62	4.33	.53	....	....	....	....	11.00	....	....
12	Mesaverde.	Upper.	4	2	Fort Steele, 25 miles northwest of, SE. ¼ NE. ¼ sec. 23, T. 25 N., R. 86 W.; upper part of bed 7 feet 10 inches thick	3925	14.04	33.79	45.58	6.59	.40	....	....	....	....	5.20	....	....
13	Lewis.		4	6	Carbon, 9 miles southeast of, SE. ¼ NW. ¼ sec. 34, T. 21 N., R. 79 W	3649	14.53	36.84	44.40	4.23	.53	....	....	....	....	5.30	....	....
14	Lewis.		4		Fort Steele, 18 miles northwest of, NE. ¼ NW. ¼ sec. 26, T. 24 N., R. 86 W.; upper part of 10-foot bed	3928	19.19	28.39	43.59	8.83	.48	....	....	....	....	11.90	....	....
15	Lewis.		5		Same; lower part of 10-foot bed	3926	32.63	25.93	30.52	10.92	.28	....	....	....	....	23.30	....	....
16	Lewis.		5	8	Fort Steele, 18 miles northwest of, SW. ¼ SE. ¼ sec. 23, T. 24 N., R. 86 W.; upper part of 10-foot bed	3930	31.72	29.75	34.94	3.59	.44	....	....	....	....	21.90	....	....
17	Lewis.		10	6	Fort Steele, 22 miles north of, NE. ¼ SW. ¼ sec. 35, T. 25 N., R. 85 W.; upper bed	3917	15.46	36.16	44.86	3.52	.79	5.60	58.87	1.44	29.78	7.40	5,843	10,517
18	Lewis.		6	6	Same; lower part of upper bed	3918	14.52	36.13	46.57	2.78	.45	....	....	....	....	6.70	....	....
19	Lewis.		2	6	Same; lower bed	3915	13.97	34.13	48.57	3.33	.47	....	....	....	....	5.80	....	....
20	Lewis.		8		Fort Steele, 25 miles northwest of, NW. ¼ SW. ¼ sec. 17, T. 25 N., R. 85 W.; lower bed	3922	13.90	36.16	45.75	4.19	.36	5.45	59.98	1.35	28.67	5.70	5,846	10,523

Analyses of coal from east-central Carbon County, Wyo.—Continued.

SAMPLES AS RECEIVED.

No.	Geologic horizon of coal.	Thickness of coal represented by sample.		Locality.	Laboratory No.	Proximate.				Ultimate.					Loss of moisture on air drying.	Calorific value.	
		Ft.	in.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.		Calories.	B. T. U.
21	Lewis.	8	6	Same; upper bed	3920	12.31	36.06	46.47	5.16	0.33	5.54	61.65	1.34	25.98	4.60	5,925	10,665
22		5	3	Fort Steele, 24 miles northwest of, SW. ¼ NE. ¼ sec. 20, T. 25 N., R. 85 W	3916	33.81	30.45	32.37	3.37	.15	....	....	....	....	24.30	....	....
23		4	9	Fort Steele, 24 miles northwest of, SE. ¼ SE. ¼ sec. 20, T. 25 N., R. 85 W	3923	33.64	31.90	30.59	3.87	.27	....	....	....	....	24.20	....	....
24		4	10	Fort Steele, 24 miles northwest of, SW. ¼ SE. ¼ sec. 20, T. 25 N., R. 85 W	3919	18.41	34.50	43.38	3.71	.28	5.52	53.87	1.29	35.33	10.00	5,072	9,131
25	"Lower Laramie."	4	4	Hanna, 19 miles northwest of, NW. ¼ NW. ¼ sec. 7, T. 24 N., R. 83 W.; separated from No. 26 by 2 feet 10 inches of shale and sandstone; surface sample	3824	39.07	29.31	27.94	3.68	.63	....	....	....	....	30.50	....	....
26		4	8	Same	3807	39.40	27.67	29.39	3.54	.30	....	....	....	....	30.00	....	....
27		5	6	Hanna, 16 miles northwest of, SW. ¼ NE. ¼ sec. 11, T. 24 N., R. 83 W	3790	13.06	35.11	48.86	2.97	1.10	5.52	61.72	1.38	27.31	3.70	6,041	10,874
28		4		Walcott, 25 miles north of, SE. ¼ SW. ¼ sec. 14, T. 21 N., R. 84 W	3538	12.08	35.40	49.68	2.84	.47	....	....	....	....	3.10	....	....
29		4		Same; but at different point in mine	3544	11.17	35.42	50.57	2.84	.50	....	....	....	....	2.50	....	....
30		7	3	Walcott, 9 miles southeast of, NW. ¼ SE. ¼ sec. 1, T. 20 N., R. 83 W	3548	10.96	38.04	48.59	2.41	.29	5.37	62.25	1.59	28.09	.80	5,902	10,624
31		3	8	Fort Steele, 8 miles north of, NE. ¼ NW. ¼ sec. 2, T. 22 N., R. 85 W.; surface sample	3929	20.41	37.64	37.31	4.64	.25	....	....	....	....	9.10	....	....
32		8	6	Carbon, 6 miles southeast of, SE. ¼ SE. ¼ sec. 20, T. 21 N., R. 79 W	3347	18.71	36.38	38.46	6.45	.47	....	....	....	....	8.10	....	....
33		4	10	Carbon, 9 miles southwest of, lot No. 2, sec. 6, T. 20 N., R. 80 W.; upper part of a 14½-foot bed	3651	30.13	31.38	35.52	2.97	.33	....	....	....	....	16.70	....	....
34		5		Same; lower 5 feet of same bed	3650	14.66	35.71	44.41	5.22	.38	....	....	....	....	6.20	....	....
35		4		Carbon, 6½ miles southwest of, SW. ¼ NW. ¼ sec. 28, T. 20 N., R. 80 W.; upper part of 12-foot seam	3648	6.79	45.80	41.10	6.31	.63	....	....	....	....	1.40	....	....
36		6		Same; lower part of same bed	3645	9.21	41.56	44.86	4.37	.67	....	....	....	....	2.90	....	....
37		7		Carbon, 7½ miles south of, lot No. 3, sec. 4, T. 20 N., R. 80 W.; lower part of 14½-foot bed	3644	13.28	37.54	42.53	6.65	.48	....	....	....	....	5.00	....	....
38		7		Carbon, SW. ¼ SE. ¼ sec. 26, T. 22 N., R. 80 W.; coal weathered	3735	9.20	41.10	44.16	5.54	1.01	....	....	....	....	3.10	....	....
39		4		Same; 150 feet from mouth of slope, lower part of 7-foot bed	3739	8.31	39.85	42.34	9.50	.92	....	....	....	....	3.00	....	....
40		7		Same; 225 feet from mouth of slope	3664	8.77	39.74	45.52	5.97	1.00	....	....	....	....	1.10	....	....

41	"Upper Laramie."	4	9	Carbon, ½ mile west of, NE. ¼ SE. ¼ sec. 27, T. 22 N., R. 80 W	3740	11.92	36.37	46.18	5.53	1.71					4.10		
42		4	9	Same	3741	13.24	35.71	43.59	7.46	1.39					5.20		
43		7	2	Carbon, SW. ¼ SE. ¼ sec. 36, T. 22 N., R. 80 W	3743	10.23	38.14	42.45	9.18	1.16					3.80		
44		8		Same	3742	11.55	33.78	44.41	10.26	1.23					4.90		
45		7	6	Walcott, 12 miles north of, NW. ¼ SW. ¼ sec. 25, T. 23 N., R. 84 W	3808	13.59	31.77	49.35	5.29	.33	5.22	61.06	.83	27.28	4.30	5,785	10,413
46		7		Walcott, 12 miles north of, SE. ¼ SW. ¼ sec. 25, T. 23 N., R. 84 W	3826	13.19	31.70	50.23	4.88	.24					2.30		
47		7		Same; surface sample	3806	24.54	32.45	37.38	5.63	.24					5.10		
48		10		Walcott, 11 miles north of, SW. ¼ SW. ¼ sec. 36, T. 23 N., R. 84 W.; upper part of bed of undetermined thickness; surface sample	3927	29.96	29.55	36.93	3.56	.16					21.00		
49		5		Walcott, 11 miles north of, NW. ¼ NE. ¼ sec. 2, T. 22 N., R. 84 W.; upper part of bed of undetermined thickness; surface sample	3924	27.39	32.52	33.31	6.78	.35					18.70		
50		4		Hanna, 11 miles northeast of, sec. 35, T. 24 N., R. 81 W	3780	15.33	33.63	45.34	5.70	2.27	6.04	57.02	1.63	27.34	5.80	5,690	10,242
51		4		Hanna, 11 miles northeast of, NE. ¼ SE. ¼ sec. 33, T. 24 N., R. 81 W	3781	12.33	35.05	46.21	6.41	2.78					4.40		
52		4		Same	3779	12.89	34.34	44.07	8.70	2.97					4.40		
53		5		Hanna, 4 miles north of, NW. ¼ NW. ¼ sec. 31, T. 23 N., R. 81 W.; surface sample	3822	16.93	32.38	48.08	2.61	.53					7.90		
54		6		Como, 2 miles west of, SW. ¼ NW. ¼ sec. 32, T. 23 N., R. 80 W	3736	24.58	31.43	41.93	2.06	.88					11.80		
55		6		Como, 2 miles west of, SE. ¼ NW. ¼ sec. 32, T. 23 N., R. 80 W.; upper part of 12-foot bed; surface sample	3738	18.43	35.09	42.90	3.58	.83					9.20		
56		6		Same; lower part of 12-foot bed; surface sample	3737	20.33	32.29	44.63	2.75	.62					8.80		
57		3	6	Hanna, 1 mile southwest of, SE. ¼ NW. ¼ sec. 24, T. 22 N., R. 82 W.; part of bed just below Hanna No. 2	3616	13.12	41.42	39.78	5.68	.45					3.30		
58		8		Hanna, lower bench of No. 2 seam	3610	11.45	42.58	39.33	6.64	.38	5.27	59.66	.94	27.11	2.50	6,050	10,890
59		8		Hanna, upper part of middle bench of No. 2 seam	3611	12.34	40.71	42.42	4.53	.23					2.60		
60		7		Hanna, prospect on No. 2 seam; sample represents middle bench	3617	13.04	40.60	41.80	4.56	.22					3.40		
61		5		Hanna, prospect on seam between Nos. 1 and 2, SW. ¼ sec. 17, T. 22 N., R. 81 W	3615	11.89	43.21	38.80	6.10	.56					2.60		
62		5	3	Hanna, middle bench of No. 1 seam, 19 to 25 feet thick	3612	11.21	42.59	42.03	4.17	.33					2.10		
63		6	2	Same; middle bench of No. 1 seam	3613	11.82	41.78	42.11	4.29	.29					3.10		
64		7	3	Same; middle bench of No. 1 seam	3614	12.29	42.11	41.11	4.49	.33					3.30		
65		5		Hanna, lower part of top bench of No. 1 seam	3605	10.09	41.01	41.91	6.99	.49	5.53	62.66	1.26	23.07	2.20	6,279	11,302
66		9	4	Same; middle bench of No. 1 seam	3606	9.57	42.69	40.44	7.30	.39	5.50	62.82	1.31	22.68	1.40	6,249	11,248
67		4		Same; bottom bench of No. 1 seam	3607	11.80	41.66	40.25	6.29	.44	5.79	62.45	.99	24.04	2.20	6,150	11,070
68		5		Same; upper part of middle bench of No. 1 seam	3608	9.81	43.39	40.68	6.12	.51					1.90		
69		8		Same; middle bench of No. 1 seam	3609	10.65	40.79	41.41	7.15	.39					2.20		

Analyses of coal from east-central Carbon County, Wyo.—Continued.

AIR-DRIED SAMPLES.

No.	Geologic horizon of coal.		Thickness of coal represented by sample.		Locality.	Laboratory No.	Proximate.				Ultimate.					Percentage of water to be added to convert to sample as received.	Calorific value.	
							Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.		Calories.	B. T. U.
			Ft.	*in.*														
1	Mesaverde.	Lower.	5	2	Fort Steele, 13 miles south of, SW. ¼ SW. ¼ sec. 19, T. 19 N., R. 85 W.	3480	5.45	37.95	52.89	3.71	0.95	5.56	71.24	1.79	16.73	3.73	6,951	12,512
2	Mesaverde.	Lower.	4	6	Fort Steele, 13 miles south of, SW. ¼ NW. ¼ sec. 19, T. 19 N., R. 85 W.	3481	6.02	37.82	54.10	2.06	.94	......	......	......	......	4.28	......	......
3	Mesaverde.	Lower.	2	6	Fort Steele, 13 miles south of, NW. ¼ SW. ¼ sec. 26, T. 19, R. 85 W.	3509	5.72	38.53	49.76	5.99	.88	5.17	68.93	1.79	17.24	1.94	6,759	12,167
4	Mesaverde.	Lower.	1	4	Fort Steele, 13 miles south of, NE. ¼ NE. ¼ sec. 28, T. 19 N., R. 85 W.	3501	5.86	40.87	50.50	2.78	.75	......	......	......	......	1.83	......	......
5	Mesaverde.	Lower.	2	8	Fort Steele, 14 miles south of, SW. ¼ NE. ¼ sec. 35, T. 19 N., R. 85 W.	3507	6.12	43.86	45.51	4.51	.90	......	......	......	......	.81	......	......
6	Mesaverde.	Lower.	1	4	Fort Steele, 14 miles south of, NW. ¼ SW. ¼ sec. 36, T. 19 N., R. 85 W.	3508	13.53	36.27	42.17	8.03	.76	......	......	......	......	8.34	......	......
7	Mesaverde.	Middle.	4	6	Rawlins, 4 miles southwest of, NE. ¼ NW. ¼ sec. 36, T. 21 N., R. 88 W.	3477	7.00	35.98	49.69	7.32	.67	......	......	......	......	7.18	......	......
8	Mesaverde.	Middle.	4	6	Same	3478	7.36	35.54	50.02	7.08	.53	......	......	......	......	7.87	......	......
9	Mesaverde.	Middle.	4	6	Rawlins, 8 miles southeast of, NE. ¼ NW. ¼ sec. 24, T. 20 N., R. 87 W.; surface sample	3479	8.74	34.31	43.85	13.10	.37	......	......	......	......	26.90	......	......
10	Mesaverde.	Upper.	3	4	Fort Steele, 20 miles north of, NE. ¼ SW. ¼ sec. 9, T. 24 N., R. 85 W.	3921	7.03	34.42	51.98	6.57	.54	......	......	......	......	7.53	......	......
11	Mesaverde.	Upper.	4	1	Fort Steele, 13 miles northwest of, SE. ¼ NE. ¼ sec. 18, T. 23 N., R. 85 W.; surface sample	3931	9.28	35.72	50.13	4.87	.60	......	......	......	......	12.36	......	......
12	Mesaverde.	Upper.	4	2	Fort Steele, 25 miles northwest of, SE. ¼ NE. ¼ sec. 23, T. 25 N., R. 86 W.; upper part of a bed 7 feet 10 inches thick	3925	9.32	35.64	48.08	6.95	.42	......	......	......	......	5.49	......	......
13	Mesaverde.	Upper.	4	6	Carbon, 9 miles southeast of, SE. ¼ NW. ¼ sec. 34, T. 21 N., R. 79 W.	3649	9.75	38.90	46.88	4.47	.56	......	......	......	......	5.60	......	......
14	Lewis.		4		Fort Steele, 18 miles northwest of, NE. ¼ NW. ¼ sec. 26, T. 24 N., R. 86 W.; upper part of 10-foot bed	3928	8.27	32.22	49.48	10.02	.54	......	......	......	......	13.51	......	......
15	Lewis.		5		Same; lower part of 10-foot bed	3926	12.16	33.81	39.79	14.24	.37	......	......	......	......	30.38	......	......
16	Lewis.		5	8	Fort Steele, 18 miles northwest of, SW. ¼ SE. ¼ sec. 23, T. 24 N., R. 86 W.; upper part of 10-foot bed	3930	12.57	38.09	44.74	4.60	.56	......	......	......	......	28.04	......	......
17	Lewis.		10	6	Fort Steele, 22 miles north of, NE. ¼ SW. ¼ sec. 35, T. 25 N., R. 85 W.; upper bed	3917	8.70	39.05	48.44	3.80	.85	5.16	63.57	1.56	25.05	7.99	6,310	11,357
18	Lewis.		6	6	Same; lower part of upper bed	3918	8.38	38.72	49.91	2.98	.48	......	......	......	......	7.18	......	......
19	Lewis.		2	6	Same; lower bed	3915	8.67	36.23	51.56	3.54	.50	......	......	......	......	6.16	......	......
20	Lewis.		8		Fort Steele, 25 miles northwest of, NW. ¼ SW. ¼ sec. 17, T. 25 N., R. 85 W.; lower bed	3922	8.70	38.35	48.52	4.44	.38	5.11	63.61	1.43	25.03	6.04	6,199	11,159

21	Lewis.	8	6	Same; upper bed	3920	8.08	37.80	48.71	5.41	.35	5.27	64.62	1.39	22.95	4.82	6,211	11,179
22		5	3	Fort Steele, 24 miles northwest of, SW. ¼ NE. ¼ sec. 20, T. 25 N., R. 85 W	3916	12.56	40.22	42.76	4.45	.20					32.10		
23		4	9	Fort Steele, 24 miles northwest of, SE. ¼ SE. ¼ sec. 20, T. 25 N., R. 85 W	3923	12.45	42.08	40.36	5.11	.36					31.93		
24		4	10	Fort Steele, 24 miles northwest of, SW. ¼ SE. ¼ sec. 20, T. 25 N., R. 85 W	3919	9.34	38.33	48.20	4.12	.31	4.90	59.86	1.43	29.39	11.11	5,636	10,144
25	"Lower Laramie."	4	4	Hanna, 19 miles northwest of NW. ¼ NW. ¼ sec. 7, T. 24 N., R. 83 W.; separated from No. 26 by 2 feet 10 inches of shale and sandstone; surface sample	3824	12.33	42.17	40.20	5.29	.91					43.88		
26		4	8	Same	3807	13.43	39.53	41.98	5.06	.43					42.86		
27		5	6	Hanna, 16 miles northwest of, SW. ¼ NE. ¼ sec. 11, T. 24 N., R. 83 W	3790	9.72	36.46	50.74	3.08	1.14	5.31	64.09	1.43	24.95	3.84	6,273	11,292
28		4		Walcott, 2 miles north of, entry No. 4, SE. ¼ SW. ¼ sec. 14, T. 21 N., R. 84 W	3538	9.27	36.53	51.27	2.93	.49					3.20		
29		4		Same, but at different point in mine	3544	8.89	36.33	51.87	2.91	.51					2.56		
30		7	3	Walcott, 9 miles southeast of, NW. ¼ SE. ¼ sec. 1, T. 20 N., R. 83 W	3548	10.24	38.35	48.98	2.43	.29	5.32	62.75	1.60	27.60	.81	5,950	10,710
31		3	8	Fort Steele, 8 miles north of, NE. ¼ NW. ¼ sec. 2, T. 22 N., R. 85 W.; surface sample	3929	12.44	41.41	41.05	5.10	.28					10.01		
32	"Upper Laramie."	8	6	Carbon, 6 miles southeast of, SE. ¼ SE. ¼ sec. 20, T. 21 N., R. 79 W	3647	11.54	39.59	41.85	7.02	.51					8.81		
33		4	10	Carbon, 9 miles southwest of, lot No. 2, sec. 6, T. 20 N., R. 80 W.; upper part of a 14½-foot bed	3651	16.12	37.67	42.64	3.57	.40					20.05		
34		5		Same; lower 5 feet of same bed	3650	9.02	38.07	47.35	5.56	.40					6.61		
35		4		Carbon, 6½ miles southwest of, SW. ¼ NW. ¼ sec. 28, T. 20 N., R. 80 W.; upper part of 12-foot seam	3648	5.47	46.45	41.68	6.40	.64					1.42		
36		6		Same; lower part of same bed	3645	6.50	42.80	46.20	4.50	.69					2.99		
37		7		Carbon, 7½ miles south of, lot No. 3, sec. 4, T. 20 N., R. 80 W.; lower part of 14½-foot bed	3644	8.71	39.52	44.77	7.00	.51					5.26		
38		7		Carbon, SW. ¼ SE. ¼ sec. 26, T. 22 N., R. 80 W.; coal weathered	3735	6.29	42.41	45.57	5.72	1.04					3.20		
39		4		Same; 150 feet from mouth of slope; lower part of 7-foot bed	3739	5.47	41.08	43.65	9.79	.95					3.09		
40		7		Same; 225 feet from mouth of slope	3664	7.76	40.18	46.03	6.04	1.01					1.11		
41		4	9	Carbon, ½ mile west of, NE. ¼ SE. ¼ sec. 27, T. 22 N., R. 80 W	3740	8.15	37.92	48.15	5.77	1.78					4.28		
42		4	9	Same	3741	8.48	37.67	45.98	7.87	1.47					5.49		
43		7	2	Carbon, SW. ¼ SE. ¼ sec. 36, T. 22 N., R. 80 W	3743	6.68	39.65	44.13	9.54	1.21					3.95		
44		8		Same	3742	6.99	35.52	46.70	10.79	1.29					5.15		
45		7	6	Walcott, 12 miles north of, NW. ¼ SW. ¼ sec. 25, T. 23 N., R. 84 W	3808	9.71	33.20	51.57	5.53	.34	4.95	63.80	.87	24.51	4.49	6,045	10,881
46		7		Walcott, 12 miles north of, SE. ¼ SW. ¼ sec. 25, T. 23 N., R. 84 W	3826	11.15	32.45	51.41	4.99	.25					2.35		
47		7		Same; surface sample	3806	20.48	34.19	39.39	5.93	.25					5.37		
48		10		Walcott, 11 miles north of, SW. ¼ SW. ¼ sec. 36, T. 23 N., R. 84 W.; upper part of bed of undetermined thickness; surface sample	3927	11.34	37.41	46.75	4.51	.20					26.58		

Analyses of coal from east-central Carbon County, Wyo.—Continued.

AIR-DRIED SAMPLES—Continued.

No.	Geologic horizon of coal.	Thickness of coal represented by sample.	Locality.	Laboratory No.	Proximate.				Ultimate.					Percentage of water to be added to convert to sample as received.	Calorific value.	
					Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.		Calories.	B. T. U.
		Ft. in.														
49	"Upper Laramie."	5	Walcott, 11 miles north of, NW. ¼ NE. ¼ sec. 2, T. 22 N., R. 84 W.; upper part of bed of undetermined thickness; surface sample.	3924	10.69	40.00	40.97	8.34	0.43					23.00		
50		4	Hanna, 11 miles northeast of, sec. 35, T. 24 N., R. 81 W.	3780	10.12	35.70	48.13	6.05	2.41	5.73	60.53	1.73	23.55	6.16	6,040	10,873
51		4	Hanna, 11 miles northeast of, NE. ¼ SE. ¼ sec. 33, T. 24 N., R. 81 W.	3781	8.29	36.66	48.34	6.71	2.91					4.60		
52		4	Same	3779	8.88	35.92	46.10	9.10	3.11					4.60		
53		5	Hanna, 4 miles north of, NW. ¼ NW. ¼ sec. 31, T. 23 N., R. 81 W.; surface sample.	3822	9.80	35.16	52.20	2.83	.58					8.58		
54		6	Como, 2 miles west of, SW. ¼ NW. ¼ sec. 32, T. 23 N., R. 80 W.	3736	14.49	35.63	47.54	2.34	1.00					13.38		
55		6	Como, 2 miles west of, SE. ¼ NW. ¼ sec. 32, T. 23 N., R. 80 W.; upper part of 12-foot bed; surface sample.	3738	10.16	38.65	47.25	3.94	.91					10.13		
56		6	Same; lower part of 12-foot bed; surface sample.	3737	12.64	35.41	48.94	3.01	.68					9.65		
57		3 6	Hanna, 1 mile southwest of, SE. ¼ NW. ¼ sec. 24, T. 22 N., R. 82 W.; part of bed just below Hanna No. 2.	3616	10.15	42.83	41.14	5.87	.46					3.41		
58		8	Hanna, lower bench of No. 2 seam	3610	9.18	43.67	40.34	6.81	.39	5.12	61.19	.96	25.53	2.56	6,205	11,169
59		8	Hanna, upper part of middle bench of No. 2 seam.	3611	10.00	41.80	43.55	4.65	.24					2.67		
60		7	Hanna, prospect on No. 2 seam; sample represents middle bench.	3617	9.98	42.03	43.27	4.72	.23					3.52		
61		5	Hanna, prospect on seam between Nos. 1 and 2, SW. ¼ sec. 17, T. 22 N., R. 81 W.	3615	9.54	44.36	39.84	6.26	.57					2.67		
62		5 3	Hanna, middle bench of No. 1 seam 19 to 25 feet thick.	3612	9.31	43.50	42.93	4.26	.34					2.15		
63		6 2	Same; middle bench of No. 1 seam	3613	9.00	43.11	43.46	4.43	.30					3.20		
64		7 3	Same; middle bench of No. 1 seam	3614	9.30	43.55	42.51	4.64	.34					3.41		
65		5	Hanna, lower part of top bench of No. 1 seam	3605	8.07	41.93	42.85	7.14	.50	5.41	64.07	1.29	21.58	2.24	6,420	11,556
66		9 4	Same; middle bench of No. 1 seam	3606	8.29	43.30	41.01	7.40	.40	5.42	63.71	1.33	21.74	2.25	6,338	11,408
67		4	Same; bottom bench of No. 1 seam	3607	9.82	42.59	41.15	6.43	.45	5.67	63.85	1.01	22.58	1.42	6,288	11,319
68		5	Same; upper part of middle bench of No. 1 seam.	3608	8.06	44.23	41.47	6.24	.52					1.94		
69		8	Same; middle bench of No. 1 seam	3609	8.64	41.71	42.34	7.31	.40					2.25		

COMPARATIVE VALUE OF COALS.

The coals of this field range from poor to high-grade bituminous. They are as a rule bright, brittle, and noncoking. The best coals in the area are found in the Mesaverde formation, which contains the high-grade coals of the Routt County, Colo., field. These Mesaverde coals are not so good as the Benton coals of Uinta County, Wyo., mined at Cumberland, Diamondville, and Frontier, and are perhaps inferior to the coal at Rock Springs, Wyo. The coals of the "Upper Laramie," extensively mined at Carbon and Dana, are distinctly inferior to the Cumberland and Rock Springs coal, though superior to much of the coal of Laramie age in northeastern Wyoming and eastern Montana. The coal mined at Carbon was rather dirty, and the much cleaner coal at Dana proved so light that in the forced draft of the railroad locomotive it nearly all went out of the smokestack, covering the cars with showers of sparks. After several years, in which it suffered many disastrous car fires, the railroad was forced to abandon the use of coal from this mine. The Hanna coal is now extensively and satisfactorily used in the locomotives of the Union Pacific Railroad.

HISTORY OF DEVELOPMENT.

Coal was found in this area by Frémont in 1843 on Platte River, near the mouth of Sage Creek, at the point now known as Coal Bluffs.[a] In 1856 Lieut. F. T. Bryan, of the topographic corps of the United States Army, surveyed a road from Fort Riley to Bridger Pass. He was accompanied by H. Engelmann, geologist, and they reported coal not only on Platte River but north of the present village of Elk Mountain, near Medicine Bow River. Bryan reports that on August 18, 1856, they encamped for a few days on an island in Platte River, "to rest our animals and burn coal for the forge."[b] The coal beds opened at this time were mined in a desultory way by emigrants and by the Overland Stage Company, whose stage ran across the southern portion of this territory from the summer of 1862 until a short time after the completion of the Union Pacific Railroad.

Regarding the commercial development of coal in this region, George R. Black, superintendent of the Union Pacific Coal Company, states:

> The first mines opened in Carbon County, Wyo., and worked to any extent, were opened by this company in 1868 at and near the town of Carbon, the last one being abandoned in 1902. There were seven of them. While the coal is not of the best, it is quite certain the mines in that vicinity would still be working had not the main line of the Union Pacific Railroad passing through Carbon been vacated and taken

[a] Frémont, J. C., Rept. Expl. Exped. Rocky Mts. in 1842, and to Oregon and North California in 1843 and 1844, Washington, 1845, p. 126.

[b] Thirty-fifth Cong., 1st sess., House Ex. Doc., vol. 2, No. 2, 1858, p. 462.

farther to the north, where it passes through the Hanna coal. The mines at Dana, Carbon County, were opened in 1889 and abandoned in 1891 on account of the coal sparking too badly lor locomotive use. Hanna mines were opened in 1890 and are still in operation.

ECONOMIC CONDITIONS.

Coal-mining operations in Carbon County are at present conducted almost wholly for the purpose of supplying coal to the Union Pacific Railroad, it being stated that of the yearly output of the Hanna mines, 350,000 to 400,000 tons, 90 per cent or more is consumed by the railroad. The natural commercial market for coal from this section is limited on the east by Omaha, on the west by Rawlins, on the north by the Black Hills, and on the south by Denver. The western outlet is to a large degree blocked to-day by the higher-grade coals of Sweetwater and Uinta counties. At Denver the Carbon County coals come into competition with the Colorado coals, at Omaha with the Interior basin Carboniferous coals, and at the Black Hills with the Newcastle and Sheridan coals.

During 1906 the Hanna mines shipped three or four carloads of dust a week (including all that passed through a $\frac{3}{8}$-inch screen) to brick manufacturers in the neighborhood of Omaha. This dust is mixed with the brick clay and is reported not only to aid in the proper burning of the brick, but to result in decreasing the weight of the finished product.

The only prospective local demand for coal is in connection with the development of the metalliferous deposits in the surrounding ranges, and in this respect the coal is something of an untried quantity. The iron deposits in the Seminoe region are very favorably situated with reference to coal deposits, and with railroad facilities will undoubtedly be developed. It is not anticipated that the coal will make high-grade coke. The development of the precious-metal deposits in the Seminoe and Ferris mountains promises some day to make a local fuel market. The Encampment region is at present supplied with coal from the field which lies just west of the Sierra Madre, but with the completion of the railway from Walcott to Encampment easy transportation of coal from the central Carbon County field will be afforded.

COAL OF LARAMIE BASIN, WYOMING.

By C. E. Siebenthal.

The western portion of the Laramie Basin is occupied largely by shales and sandstones which include several beds of coal. This coal has been mined to a small extent for local use and may in future have greater economic importance. The beds are not well exposed, for much of the region is overlain by Quaternary and Tertiary deposits, so that the extent and stratigraphy of the coal-bearing rocks could not be fully ascertained. The coal beds range in thickness from a few inches to 6 feet or more and occur at several horizons. They appear, however, to be irregular in their distribution, in many localities giving place to carbonaceous shale or thinning out entirely.

One of the first mines in Wyoming was opened by the stage company in 1865, near the old overland trail crossing Rock Creek. The coal was used for blacksmithing in the vicinity of the opening and also carried to other places for the same purpose.

On Rock Creek the Diamond Cattle Company has an opening in sec. 7, T. 19 N., R. 78 W., in 6 feet of coal. The product in 1904 was 200 tons, which sold at $2 a ton.

The massive sandstone of Pine Ridge is overlain by a bed of coal which has been opened in a number of localities and at one place mined somewhat extensively. The easternmost opening on this bed is in the SE. ¼ sec. 7, T. 20 N., R. 75 W., on the continuation of Pine Ridge and just east of the old location of the Union Pacific Railroad, 2 miles northeast of Harper. The coal bed is reported to have a thickness of 5 feet. Nothing could be learned as to the amount mined or the quality of the coal.

Another bed of coal has been prospected a mile northwest of Harper station, at a horizon several hundred feet above that of the Pine Ridge coal, but apparently the results were not satisfactory, for no mining was done.

Coal shows at intervals along Pine Ridge west of Harper, and it was worked to a small extent in the SE. ¼ sec. 16, T. 20 N., R. 76 W. Here the coal has about the same thickness and quality as in other openings on this bed. The dip of all the outcrops in this area is to the south at angles of 10° to 15°.

Coal is exposed near the middle of the north side of sec. 21, T. 20 N., R. 77 W., dipping southward at an angle of 5° to 8°. It is more than 7 feet thick and appears to be a bright, clean coal. Apparently it is at a horizon several hundred feet below the coal bed in Pine Ridge. Coal is reported 1 mile north of this place in the bluff on the north side of Rock Creek. It is associated with a heavy white sandstone which forms a short ridge similar to the main Pine Ridge. The beds dip to the north, as they are on the north side of the Rock River anticline. This coal is believed to be at the same horizon as that in Pine Ridge.

The following section is reported in a well on the Empire ranch on Dutton Creek, in the NE. ¼ SW. ¼ sec. 27, T. 19 N., R. 77 W. It was sunk for Judson Sutphin & Co. in 1889.

Log of well at Empire ranch.

	Feet.
Sand and gravel	43
Soapstone, sand, and gravel in layers 10 to 25 feet thick	332
Sandstone with two small beds of coal	60
Soapstone	40
Coal	8
Sandstone	13
Slate	4
Coal	8
Slate	2½
Coal	7½

Doubtless the coal beds reported in this well are those mined 2½ miles farther northwest. The coal borings from this well were analyzed by M. Delafontaine in 1890, with the following results:

Analysis of coal borings from well at Empire ranch.

Specific gravity, 1.51.	
Water (at 212° F.)	4.84
Volatile matter; bright, long flame	37.10
Fixed carbon	50.54
Ash, light-fawn color	7.52
	100.00

The coal is noncoking. The large amount of ash appears to be due to some slate fragments intermixed.

In the NE. ¼ sec. 18, T. 19 N., R. 77 W., is the abandoned Terry Fee mine, the "Dutton or Cooper Creek mine" of the early reports. The coal worked here is said to have ranged from 6 to 7 feet in thickness and was a good bright coal, burning with much white ash but no cinders. The roof is of white sandstone with a few inches of shale just over the coal. The dip as measured from present exposures is 8° E. The workings extend into the hill 400 to 500 feet, but the mine has long been abandoned. It is claimed that beneath this coal bed and separated from it by 8 feet of shale there is another bed 7 feet thick. This is in accord with the succession reported in the log of the Empire ranch well, located 2½ miles farther southeast.

Several outcrops of coal are reported 2 miles northeast of the Terry Fee mine, in sec. 4, T. 19 N., R. 77 W., in the valley of Coalbank Creek. The Monarch mine, which is worked from time to time, is situated in the SW. ¼ sec. 8, T. 19 N., R. 77 W. The coal was found to be 5 feet thick and dips south of east at an angle of about 4°. The coal appears to be of good quality. The roof is of shale and stands well. The entry was driven about 200 feet into the hill, and several rooms were turned off from it. The chief market for the product of this mine and that of the Terry Fee mine was for local use on ranches and in the town of Laramie.[a] A production of 500 tons, which sold at $2 a ton, was reported in 1904.

Coal outcrops near the center of sec. 20, T. 19 N., R. 77 W. The deposit is 2 to 3 feet thick and consists of several 8-inch to 10-inch beds of coal separated by bone. The dip is 15° SE. This bed appears to be at a somewhat higher horizon than the coal of Pine Ridge and possibly may be correlated with the unsuccessful prospect a mile northwest of Harper station.

An anticline trends due south from the mines above mentioned, forming sharp north-south ridges in the vicinity of Cooper Creek Cove. In the southeast corner of sec. 17, T. 18 N., R. 77 W., on the east side of this anticline, a heavy white sandstone outcrops with a dip of 40° E., which probably is the same bed as that which constitutes Pine Ridge. No coal, however, has been reported in the vicinity of this sandstone.

About 3 miles farther southwest, on the west side of this anticline, in the NE. ¼ sec. 6, T. 17 N., R. 77 W., coal outcrops along the road. It dips to the west beneath the ridge and may be either one of the coals above the sandstone of Pine Ridge. It is reported that coal outcrops appear at intervals along this line to Centennial Valley, but none of them were definitely located.

In digging a deep well at Mill Brook coal was encountered at 300 feet in two beds, one 6 feet and the other 3 feet thick.

The following are the available analyses of coal from this region:

Reported analyses of coals in the Laramie Basin.

Locality.	Water.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.
Brown mine, Dutton Creek	11.25	36.85	45.00	6.00	1.13
Do	11.85	34.65	47.30	6.20	1.25
Chase mine, Mill Creek	14.50	34.50	44.75	6.25	1.03
Rock Creek mine	14.40	34.90	39.70	11.00	....
Rock Creek mine, 1904	11.50	32.40	49.70	6.40	....

[a] Trumbull, L. W., Coal resources of Wyoming: Bull. Univ. Wyoming, No. 7, 1905.