Geology and Mineral Fuels of Parts of Routt and Moffat Counties, Colorado

By N. WOOD BASS, J. BRIAN EBY, *and* MARIUS R. CAMPBELL

A CONTRIBUTION TO ECONOMIC GEOLOGY

GEOLOGICAL SURVEY BULLETIN 1027-D

A study of coal, oil, and gas in the Mount Harris, Pilot Knob, Elkhead Creek, and Daton Peak quadrangles

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1955

UNITED STATES DEPARTMENT OF THE INTERIOR

Douglas McKay, *Secretary*

GEOLOGICAL SURVEY

W. E. Wrather, *Director*

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C.

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By N. Wood Bass, J. Brian Eby, and Marius R. Campbell

ABSTRACT

The Mount Harris, Pilot Knob, Elkhead Creek, and Daton Peak quadrangles comprise an area of about 1,000 square miles in northwestern Colorado. Most of the area is in Routt County, and the rest is in Moffat County. The largest river is the Yampa, which flows westward across the middle of the area. Much of the land has a rolling surface, and some is rugged, particularly that in the north and south parts of the area.

The mapped area lies in the southeastern synclinical prong of the Washakie structural basin of central Wyoming and northern Colorado. In Colorado the syncline is bordered on the east by the Park Range, a large anticline, and on the southwest by the Axial Basin anticline. The axis of the syncline extends southeastward across the mapped area, passing near Hayden. The regional synclinal structure is modified by many folds, particularly in the eastern and southern parts of the mapped area. The largest of these is the Tow Creek anticline. Others are the Wolf Creek dome, 3 miles northwest of the Tow Creek anticline; the Chimney Creek dome in the northeastern part; the Williams Park and the Beaver Creek anticlines and the Pagoda dome, near the southern margin; the Hart syncline in the southwestern part; and the Twentymile Basin in the eastern part of the mapped area.

A stratigraphic sequence of Upper Cretaceous and Tertiary rocks, which are about 13,000 feet thick, is present. The Mancos shale, the oldest formation cropping out in the area, is about 4,900 feet thick; all but the lowermost 300 feet is exposed. It consists primarily of homogeneous dark-gray shale, much of which is limy. A thick sequence of very limy shale and thin chalky limestone of Niobrara age is present in the lower part of the formation, and beds of thin, silty ledge-forming sandstone occur in the upper 1,000 feet. The Mesaverde group, which is divided into the Iles and Williams Fork formations, is about 3,000 feet thick and consists of interbedded ledge-forming sandstone, sandy shale, shale, and coal beds. Two thick white sandstone members form conspicuous key beds—the Trout Creek sandstone near the middle of the group and the Twentymile sandstone in the upper part. The Lewis shale, which overlies the Mesaverde group, is a marine sequence of dark-gray shale, 1,500 to 1,900 feet thick. The Lance and Fort Union formations overlie the Lewis shale. Each is about 1,400 feet thick and consists of thick sandstone beds, sandy shale, and some coal beds. The Wasatch formation, which overlies the Fort Union formation, is about 1,000 feet thick and consists of beds of coarse brown sandstone, or grits, interbedded with gray and red clay shale.

Thick flows of basalt interbedded with ash are present on the south margin of the area. Dikes, sills, and plugs of igneous rock occur chiefly in the northeastern quarter of the area.

The strata include many thick beds of bituminous and subbituminous coal. Anthracite and semianthracite are present locally in the northeastern part of the area where the coal has been metamorphosed by thick sills of basalt. Slightly more than 9 billion tons of coal of all ranks is estimated to be present between the surfaces and a depth of 3,000 feet. The Mesaverde group contains three principal groups of coal beds—the lower, middle, and upper. The coal of the lower and middle groups is here referred to as bituminous; and that of the upper group is referred to as subbituminous, although it is on the margin between bituminous and subbituminous ranks. Lenticular beds of subbituminous coal, some of which are thick, are present in the Lance and Fort Union formations. The Mesaverde coal is mined near Oak Creek, Milner, Mount Harris, and Hayden, which are accessible by a railroad and paved roads. Two fairly large strip coal mines are operated, one near Oak Creek and the other near Milner. The other mines in the area are underground.

Oil is produced at Tow Creek and was produced for a short time at Oak Creek. Gas is present at Pagoda, Williams Park, and Chimney Creek. The Pagoda and Williams Park fields contain shut-in gas wells. The wells on Chimney Creek yielded shows of considerable gas but were not completed for commercial production.

INTRODUCTION

LOCATION

Deposits of coal, oil, and gas are present in the Mount Harris, Pilot Knob, Elkhead Creek, and Daton Peak quadrangles in northwestern Colorado. Most of this area is in southwestern Routt County, and the rest is in southeastern Moffat County (fig. 38). The area is known to the coal industry as the eastern part of the Yampa coalfield. It comprises about 1,000 square miles, including all or parts of Tps. 3 to 9 N., Rs. 85 to 90 W.

ACCESSIBILITY

The Denver & Rio Grande Western Railroad (formerly the Denver & Salt Lake Railroad) crosses the center of the area from east to west in the Yampa River valley. Its western terminal is Craig, 2½ miles west of the area. The railroad passes producing coal mines at Mount Harris, McGregor, and near Oak Creek and Hayden, and passes through the Tow Creek oilfield. The oil well near Oak Creek connects with it by a short pipeline.

U. S. 40, a hard-surfaced road, crosses the area by the same route as the railroad. Another hard-surfaced road from Oak Creek to U. S. 40 passes through the coal-mining towns north of Oak Creek. A gravel-surfaced road in Williams Fork valley connects with U. S. 40 at Hayden by another gravel-surfaced road that passes up Hayden Gulch and Dry Creek, where several coal mines are located. Graded dirt roads, and truck trails that lead to sheep and cattle camps, cross most of the area; the Pagoda gasfield in the south-central part of the area is accessible by a truck trail. Most of the rugged country is accessible only by horse trails.

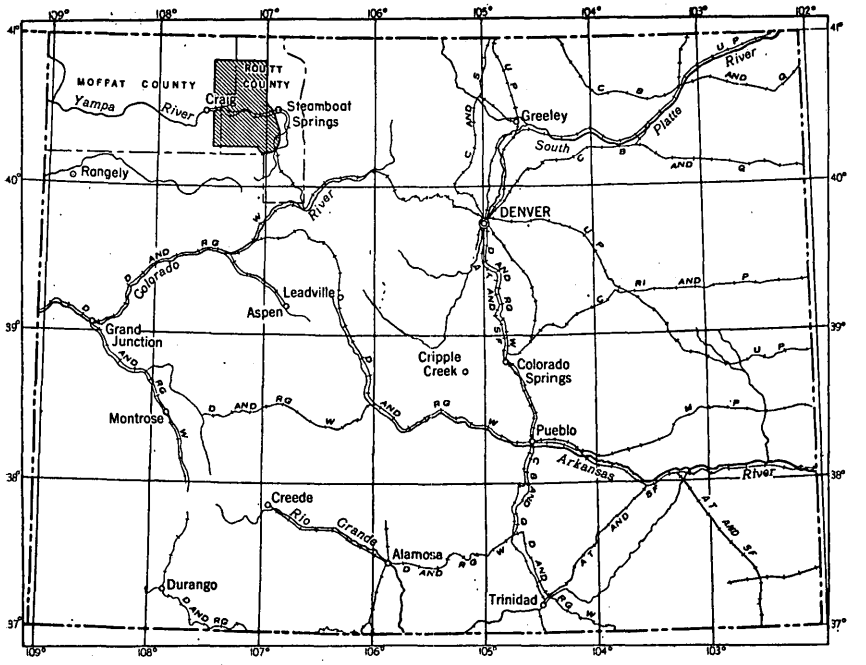


FIGURE 38.—Index map of Colorado showing location of the mapped area.

SETTLEMENT

Craig, the county seat of Moffat County, is 2½ miles west of the area. It has a population of more than 3,000 and is the supply center for ranchers, coal miners, and for oil exploration in the western part of the mapped area and in a large area adjacent to it on the west. Steamboat Springs (population about 2,000), the seat of Routt County, is on the railroad and U. S. 40, nine miles east of the area. It is the source of supply for much of the ranching and the coal and oil industry of Routt County. Oak Creek (population 1,500), which is in the southeastern part of the mapped area, and Mount Harris, which is a few miles east of the center, are important coal-mining communities. Hayden, at the center of the area, is a source of supply for ranching and coal mining in that vicinity. Milner is a small town near the east margin of the area, and Phippsburg is at the extreme southeast corner. McGregor, which is three-fourths of a mile southwest of Milner, was at one time the site of several coal mines but now supports only one operation, a strip mine; it is also the site of the power plant that supplies electricity to towns in Yampa River valley. Bear River, about 1 mile northeast of Mount Harris, was formerly a coal-mining town. It was abandoned and the buildings were dismantled in 1940, following the shutdown of the Bear River coal mine. Coal View, 1½ miles southeast of Bear River, was abandoned many years ago. Habro is a coal-mining town 2½ miles north of Oak Creek.

Many stock ranches are in the valleys of Yampa River, Williams Fork, South Fork, Willow Creek, Oak Creek, Trout Creek, Fortification Creek, and Elkhead Creek, and a few ranches are elsewhere in the mapped area.

CLIMATE

The climate of the mapped area is semiarid. The average annual precipitation ranges between 15 and 22 inches (Colorado State Planning Commission, 1951, map showing distribution of precipitation in Colorado). A broad belt of country that extends from the west-central part of the area to the southeast corner receives an average annual precipitation of less than 20 inches. The precipitation is greatest in the high country in the northeastern part and in the extreme southern part. Even in the belt of country having the least precipitation there is sufficient moisture for raising crops by dry farming. Seasonal precipitation records for Craig, 2½ miles west of the area, and for Steamboat Springs, 9 miles east of the area, differ greatly. At Craig the period of least precipitation is from November through February, and at Steamboat Springs it is from June through September. The average annual snowfall at Craig and Steamboat Springs is 57 and 159 inches, respectively. At Hayden, in the center of the mapped area, the average annual precipitation is 16.23 inches, which is fairly evenly distributed throughout the year. Of this total, 1.47 inches falls in April, 1.56 inches in May, 1.18 inches in June, 1.32 inches in July, 1.42 inches in August, and 1.57 inches in September.

During the summer the days are warm and the nights cool. Winters are relatively cold. The average dates of the first and last killing frosts at Hayden are September 14 and June 10, respectively.

DRAINAGE

The principal river of the area is the Yampa, which flows westward across the middle of the area. Williams Fork and its tributaries drain the southernmost part, and Oak, Trout, Middle, Foidel, and Fish Creeks drain the southeasternmost part. The principal streams from east to west in the north half of the area are Wolf, Elkhead, and Fortification Creeks.

SURFACE FEATURES

The eastern margin of the area lies less than 10 miles west of the Park Range, which reaches altitudes of 12,000 feet above sea level. Altitudes within the mapped area range from 10,600 feet on Sand Mountain near the northeast corner, to 6,200 feet on Yampa River at the west edge. An area characterized by a rugged surface extends northward from Yampa River valley across the northeastern part of the area and includes Wolf Mountain, Pilot Knob, the Rim Rocks, and Sand Mountain. A mountainous country in the north-central and

northwestern parts includes Quaker Mountain, Agner Mountain, Sugarloaf Mountain, Pinnacle Mountain, and Little Buck Mountain. The central and west-central parts are characterized by rough rolling surfaces; this country lies west and southwest of the Pilot Knob-Wolf Mountain ridge and extends from a short distance south of Agner Mountain southward to within a few miles of the crest of the Williams Fork Mountains. Twentymile Park in the southeastern part of the area is gently rolling, and Williams Park in the south-central part is roughly rolling. Rugged southwestward-facing cliffs (pl. 16A), deeply incised by gulches, extend from points northeast of the Williams Fork River in the southwestern part of the area to the southeast corner. The western portion of this rugged country is called the Williams Fork Mountains.

The northernmost prongs of the Flat Tops reach the south margin of the area. Rugged, boulder-capped slopes descend northward from these mountains and merge with the roughly rolling country lying south of the Williams Fork Mountains.

MINERAL DEPOSITS

Many thick beds of bituminous and subbituminous coal are present in the Mesaverde group in the eastern and southern parts of the area, and many beds of subbituminous coal, some of which are thick, are present in the Lance and Fort Union formations in the northwestern part. Coal, whose rank varies locally from bituminous to anthracite, is present in the Mesaverde group in the northeastern part of the area. Mesaverde coal is mined extensively at Oak Creek, Mount Harris, and south of Hayden; a few small mines are operated intermittently in Lance and Fort Union coal in the northwestern part of the area. Routt County, which includes much of the eastern part of the Yampa coalfield, ranks third in the production of coal in Colorado. Moreover, interest in possible new coal-mining operations in Routt and Moffat Counties is currently centered in areas where the coal can be mined by stripping.

The Tow Creek oilfield, which was discovered in 1924 and now yields about 100 barrels of oil a day, and the abandoned north Tow Creek oil pool, are in the east-central part of the area. Oil was discovered in 1949 near Oak Creek, near the southeastern corner of the area, and the well is reported to have yielded more than 100 barrels of oil a day for a short time. The Pagoda and Williams Park gas pools are in the south-central part of the area; both pools are shut-in. Some gas was found in wells in the east-central part of the area, but the wells were noncommercial. Deeper sands than those already tested are prospectively valuable for oil and gas on a few anticlines.

PREVIOUS GEOLOGIC WORK

The general region was traversed and mapped geologically by S. F. Emmons (1877), geologist with the 40th parallel survey in 1872, 4 years before Colorado was granted statehood. A geologic description, including a map, is given in his report of the region. Four years later the region was visited by C. A. White (1878 and 1889), a geologist with the Hayden survey. Topographic and geologic maps and descriptions, which are contained in reports of that survey, call attention to extensive coal deposits.

In the late eighties and early nineties, rumors that a railroad would be built into this region stimulated exploration, immigration, and settlement. Geologists and mining engineers employed by the proposed Denver, Northwestern & Pacific (later the Moffat) Railroad investigated the resources of the area. From 1886 to 1905 several articles about the coal in the area were published. These included papers by F. F. Chisholm (1887), L. S. Storrs (1902, p. 435–436), G. C. Hewett (1889, p. 376), R. C. Hills (1893, p. 354–358), H. F. Parsons and C. A. Liddell (1903), and W. Weston (1904?, 1909, and 1914). A geologic report describing the coal deposits of the area was published by the U. S. Geological Survey in 1906 (Fenneman and Gale, 1906). Exploitation of the coal on a relatively large scale followed the arrival of the railroad in 1906. The coal in and near Twentymile Park was described by Campbell (1923).

FIELD WORK FOR THIS REPORT

This report includes the results of fieldwork done by several geologists. M. R. Campbell spent several months between 1918 and 1930 working in various parts of the mapped area, particularly in the Mount Harris quadrangle. Only the part of his work that was done early in this period has been published (Campbell, 1923). In 1923 and 1924, J. B. Eby worked in the Elkhead Creek quadrangle, the west half of the Pilot Knob quadrangle, and the Williams Fork Mountains. In 1925, 1937, and 1940, N. W. Bass worked in the Pilot Knob and Daton Peak quadrangles. In 1909, J. A. Davis and Frank R. Clark mapped and measured the coal beds in the western part of the Williams Fork Mountains in the Daton Peak quadrangle. E. T. Hancock, D. E. Winchester, and J. D. Sears examined small areas. In 1943, J. W. Huddle and N. D. Raman mapped the Williams Park anticline. Frank D. Spencer had charge of core drilling in the west-central part of the Daton Peak quadrangle in 1948 and 1949. Much of the data on the coal revealed by the core drilling were compiled by Spencer. Data included in reports on the Yampa coalfield by Fenneman and Gale (1906) and M. R. Campbell (1923) were used in the preparation of this report.

Most of the geologic boundaries and key beds that appear on the maps of this report were drawn in the field on Geological Survey topographic maps. Topographic maps were also used to locate outcrops of coal beds and most prospect holes and mines; however, some of the prospect holes and mines were located by planetable mapping by the topographers at the time of their fieldwork.

The coal-bearing rocks in Tps. 4 and 5 N., R. 89 W., and T. 5 N., R. 90 W., in the Williams Fork Mountains, were mapped in 1909 by the Davis and Clark party, and the coal beds were trenched with pick and shovel. Later, land surveys were made by the General Land Office, and topographic mapping was done by the Geological Survey. In 1923, the Eby party located on the new base maps the outcrops of the coal beds greater than 5 feet in thickness that Davis and Clark had described. The coal beds were trenched and measured at the places shown on the present map. The coal beds of the middle and lower coal groups, in T. 5 N., Rs. 89 and 90 W., were prospected in 1948 and 1949 by core drilling.

Coal beds in the lower and middle coal groups were identified by measuring the intervals between the top of the Trout Creek sandstone member of the Iles formation and the individual coal beds. The coal beds in the upper coal group were identified by measuring the intervals between the top of the Twentymile sandstone member of the Williams Park formation and the individual coal beds. However, correlation of the coal beds by this method, particularly of the beds that are separated by only thin intervals, is tentative. Errors are expected because the tops of the members probably are not at the same horizons throughout the area, and because the intervals between them and the coal beds are not constant. Therefore, little confidence can be placed in the identification of coal in this area, except in a few places where a sequence of several coal beds is exposed.

The geologic map of the area is shown on the topographic base, which was mapped in 1915, 1916, 1923, and 1924. The positions of several roads and small mining communities have been changed since the maps were issued.

ACKNOWLEDGMENTS

Officials of several coal companies, including the Moffat Coal Co., Colorado and Utah Coal Co., Victor-American Fuel Co., McNeil Coal Co., Curtis Coal Co., Bear River Coal Co., and Habro Coal Co., furnished core-drill records, mine maps, and other data and courtesies that are gratefully acknowledged. Many individual coal operators and other persons provided information about mines and prospects, particularly H. I. Hoklas, George T. Rolfs, J. B. Burns, H. C. Marchant, A. E. Falney, Gower Reese, H. C. Johnson, Ramsey Harris, Jack Mills, Frank Coryell, Earl Rice, R. W. Hendricks, S. B. Pruitt,

Alexander Walker, W. C. Hammond, T. P. Greenhalgh, and the late Kasper Weberskirch.

The Texas Co., through H. A. Stewart and H. E. Christensen, furnished much geologic information about the Tow Creek anticline and oilfield, and the Williams Park anticline and gasfield. The General Petroleum Corp., through J. E. Keenan, furnished geologic data about the Pagoda gasfield.

M. R. Campbell was assisted in the field by A. A. Baker, K. K. Landes, and N. W. Bass; J. B. Eby was assisted by N. C. Beck and W. H. Newhouse; N. W. Bass was assisted by K. H. Eddy of Hayden, Colorado. J. W. Huddle and N. D. Raman mapped several square miles in the south-central part of the area, including the Williams Park anticline. Mining engineers J. J. Bourquin, K. V. Cammack, and C. M. McConnell supplied many data on coal mines. J. B. Reeside, Jr., visited the Eby party in the field during two or more field seasons and made fossil collections and identifications that are the basis for much of the stratigraphic classification. Work done from 1923 to 1926 was under the general supervision of W. T. Thom, Jr., and from 1928 to 1947 under the general supervision of H. D. Miser.

STRATIGRAPHY

The exposed rock sequence, 13,500 feet thick, is of Late Cretaceous and Tertiary age, and includes chiefly thick formations of shale and of interbedded sandstone, shale, and coal. A generalized columnar section of the sedimentary rocks is shown in plate 18. The formations are described in ascending order.

CRETACEOUS (UPPER CRETACEOUS) ROCKS

MANCOS SHALE

The Mancos shale conformably overlies the Dakota sandstone and conformably underlies the Mesaverde group. It is about 4,900 feet thick and consists chiefly of homogeneous dark-gray marine shale. The basal beds of the formation are exposed at two places on Yampa River—at the west edge of Steamboat Springs, 9 miles east of the mapped area, and in T. 6 N., R. 94 W., 23 miles west of the mapped area. Exposures at the second locality are described by Hancock (1925, p. 11) as

> consisting of at least 75 feet of bluish and dark-grayish shale, which weathers out into more or less rectangular masses. The rocks exposed for some distance farther east and higher in the formation than those just described consist largely of dark-gray shale and calcareous sandstone. The following fossils were collected at this locality and are said by T. W. Stanton to belong to the Benton fauna, in the lower part of the Mancos shale:
>
> *Inoceramus fragilis* Hall and Meek.
> *Inoceramus* sp., near *I. deformis* Meek.
> *Prionocyclus wyomingensis* Meek.

Scaphites warreni Meek and Hayden.
Shark teeth.

On the south side of Yampa River in sec. 16, T. 6 N., R. 94 W., these dark calcareous and fossiliferous shale beds usually appear moist on the fracture planes and emit the odor of petroleum to a marked degree.

The lowest beds of Mancos shale that crop out in the mapped area lie about 300 feet above the base of the formation; they are exposed on the Williams Park anticline in the south-central part of the area and consist of dark-gray shale. Thin-bedded, fine-grained, fossiliferous, limy sandstone, estimated to be about 50 feet in thickness, crops out in Williams Park about 330 feet above the base of the formation. This sandstone is probably equivalent to some part of the Frontier sandstone. It is overlain by a sequence of limy shale interbedded with thin beds of platy, fossiliferous limestone, which is 1,300 feet thick where it crops out in Williams Park and about 1,100 feet thick in the wells on the Tow Creek anticline. Although this sequence was not differentiated on the geologic map, it probably represents the Niobrara formation. Parts of the sequence are exposed in road cuts on U. S. 40 about midway between Steamboat Springs and Milner, as well as on Chimney Creek dome in Tps. 7 and 8 N., R. 86 W. On Chimney Creek dome the beds consist of chalky, thin-bedded to platy, very light-gray limestone to shaly limestone. This rock weathers into very light gray limestone chips which lie strewn on one or more of the low ridges that nearly encircle the crest of the dome. Included in the limestone are many fragments of a thin-shelled fossil, presumably an *Inoceramus*, cemented to which are shells of *Ostrea congesta*. These beds of Niobrara age yield shows of gas, and they yield the oil that is being produced in the Tow Creek oilfield.

Most of the Mancos shale above the beds of Niobrara age consist of gray to dark-gray shale. However, several thin-bedded silty tan sandstone units, each 40 to 75 or slightly more feet thick, and some interbedded sandy shale and shale are included in the uppermost 1,000 feet. The number of beds of sandy shale and sandstone increases upward within this 1,000-foot sequence. The main sandstone units form conspicuous ledges and hogbacks low in the slope below the sandstone cliffs of the basal part of the Iles formation. Although two or three such sandstone units are present everywhere along the outcrop of the upper part of the Mancos shale, the individual units are believed not to persist throughout the area. Near Hamilton, 5 miles west of the mapped area, one of these sandstone units, which lies 800 feet below the top of the Mancos according to Hancock (1925, p. 11) and 930 feet below the top according to Sears (1924, p. 288), was named by Hancock (1925, p. 12) "the Morapos sandstone member" of the Mancos shale. This member was not positively identified in the mapped area, however.

The sandstone units in the upper part of the Mancos shale are silty, in part shaly, very fine grained, and thin bedded, in contrast to the massive, less silty sandstone units of the overlying Mesaverde group. Moreover, the Tow Creek sandstone member—the basal unit of the Iles formation of the Mesaverde group—appears to persist as a zone throughout the area; although this member is somewhat variable, it is a key bed lying directly above the contact of the two formations. A massive light-grayish-tan sandstone, which lies from 100 to 200 feet below the Tow Creek sandstone member and is particularly thick and well exposed north of Yampa River, is included in the Mancos shale. It is well exposed on the northwest side of Wolf Creek in the E½ sec. 23, T. 7 N., R. 87 W.; there it is 210 feet below the Tow Creek sandstone member and 50 feet or slightly more in thickness. This sandstone is conspicuously exposed on the east side of Tow Creek in the E½W½ sec. 32, T. 7 N., R. 86 W.

Fenneman and Gale (1906, p. 22, pl. 2), Campbell (1923, p. 7), and Crawford, Willson and Perini (1920, p. 34–36) have included in the Mesaverde group the top 750 to 900 feet of beds assigned herein to the Mancos shale. However, in the adjacent area to the west, Hancock (1925, p. 15–17) placed these beds in the Mancos shale.

The Mancos shale crops out in a broad southeastward-trending belt of country along Williams Fork, which is south of the rugged country containing the Mesaverde group, and in a large tract in the northeastern part of the mapped area, which is a few miles east of the Wolf Mountain–Pilot Knob ridge. The area occupied by the Mancos is characterized by a roughly rolling topography.

MESAVERDE GROUP

The Mesaverde group conformably overlies the Mancos shale. It consists of thick beds of light-brown sandstone and some thick key beds of white sandstone interbedded with gray shale, sandy shale, and coal beds. The thickness of the group ranges from 2,750 feet in the eastern part of the mapped area to 3,450 feet in the western part. Its westward increase in thickness is due chiefly to a change of facies of the beds in the lower part of the Lewis shale, which directly overlies the Mesaverde. These beds consist of marine shale in the eastern half of the area, where they are placed in the Lewis shale, and they change westward into interbedded sandstone, sandy shale, and coal, and there are included in the Mesaverde group.

In the area adjacent on the west to the mapped area, the Mesaverde group was divided into two formations by Hancock (1925, p. 14), the Iles formation below and the Williams Fork formation above. The two formations and their members are readily recognizable in the mapped area. The Iles formation contains a thick sequence of ledge-forming sandstone beds (pl. 16A) interbedded with sandy shale, shale,

and coal beds, and at its top, a prominent ledge-forming white sandstone—the Trout Creek sandstone member (pl. 16B). The Williams Fork formation is similar in general composition to the Iles formation, but its sandstone units are distributed differently. Its most prominent member is the Twentymile sandstone, which lies 900 to 1,100 feet above the Trout Creek sandstone member of the Iles formation. Thick ledge-forming units of closely associated beds of sandstone characterize the entire Mesaverde group. Several of these persist throughout the mapped area. The sandstone beds consist chiefly of fairly well to well-sorted fine grains of quartz. Most of them also contain many very fine grains and some clay. The bedding is generally regular, and long wedge-shaped units of crossbedded sandstone are common.

Most of the persistent sandstone units appear to have been deposited on beaches or in shallow water near the margin of a large body of water. The thick white sandstone beds, such as the Trout Creek and Twentymile members, particularly, have features common to sands deposited on beaches. These two sandstone members and beds closely associated with them occur in sequences that are remarkably similar. At the base of each sequence is dark-gray to nearly black shale containing marine or brackish-water invertebrates. Above this is the main sandstone unit, a thick, light-gray to white, fine-grained, massive sandstone, 100 to 200 feet thick. This is overlain by a relatively thin unit, 10 to 30 feet thick, of interbedded sandy shale, carbonaceous shale, and locally, a thin bed or beds of coal. Next above is a white, massive sandstone similar in composition to the main sandstone unit, but commonly only 20 to 35 feet thick. It is overlain by a sequence of gray shale and sandy shale containing a bed of oyster coquina ranging from 1 to 3 feet thick. More interbedded shale and sandy shale are next above.

Fossil collections (Hancock, 1925, p. 17–20) show that marine, brackish-water, and fresh-water environments alternated during the time of deposition of the Mesaverde group. Such alternation suggests that oil or gas should occur in beds of the Mesaverde group in or near the mapped area where these rocks are deeply buried.

The Mesaverde group forms steep slopes and cliffs with bare ledges of sandstone. In many places the slopes and cliffs rise abruptly 1,000 feet or more above the adjacent lowlands formed on the Mancos shale. Upward from the lower slopes and cliffs, lesser steep slopes and cliffs continue step-like to the top of the group. These features are particularly well developed in the Daton Peak quadrangle northeast of Williams Fork River (pl. 16A). There a strip of rugged country, 2½ to 3½ miles wide, developed on the Mesaverde group, trends southeastward across the quadrangle and is called the Williams Fork Mountains. The rugged country continues from the Daton Peak quandrangle southeastward to the southeastern corner of the mapped area, then trends northward across the eastern part of the mapped

area. Several large anticlines greatly modify the trend of the strip of rugged country, because they control the trend of the outcrop of the Mesaverde group. For example, in the south-central part of the mapped area a strip of rugged country swings several miles northward around the Sage Creek and Fish Creek anticlines, and in the east-central part it swings 12 miles or more southward around the Tow Creek anticline.

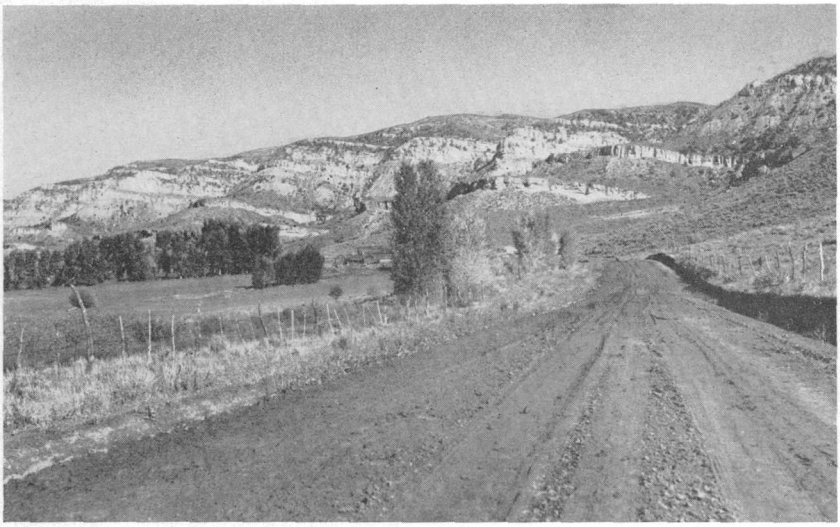
ILES FORMATION

The Iles formation, in the lower part of the Mesaverde group, consists of a sequence of rocks about 1,500 feet thick. It is conformable with the Mancos shale below and the Williams Fork formation above.

The lower two-thirds of the formation, 1,000 to 1,100 feet thick, consists of massive ledge-forming beds of light-brown, light-gray, and white sandstone interbedded with gray sandy shale, shale, and, in its upper part, coal beds. This sequence forms rugged cliffs that rise high above the broad lowland formed on the Mancos shale. Such cliffs are particularly prominent in the Williams Fork Mountains north of the Williams Fork River (pl. 16A). Most of the coal beds that are assigned to the lower coal group of the Mesaverde are in the upper part of this sequence. The thicknesses and composition of individual beds of sandstone within the sequence vary greatly laterally, but some sandstone units, or zones, persist throughout the mapped area. The composition and physical expression of the sandstone units are so similar that identification of individual beds within the sequence was possible only by measuring stratigraphic sections in canyons spaced only a few miles apart.

The upper one-third of the Iles formation consists of a shale sequence capped by a cliff-forming sandstone, which together are about 400 to 600 feet thick. Coal of the lower coal group is distributed throughout the middle and upper parts of the formation. Four persistent sandstone beds in the Iles formation deserve special mention as guides to correlation within the mapped area. They are (1) the Tow Creek sandstone member at the base, (2) a double ledge-forming sandstone sequence 400 feet or more above the base, (3) a light-gray sandstone sequence of variable composition associated with the upper (no. 3) coal of the lower group and situated about 900 to 1,000 feet above the base, and (4) the Trout Creek sandstone member at the top of the formation. Only the last of these has been separately mapped for this report.

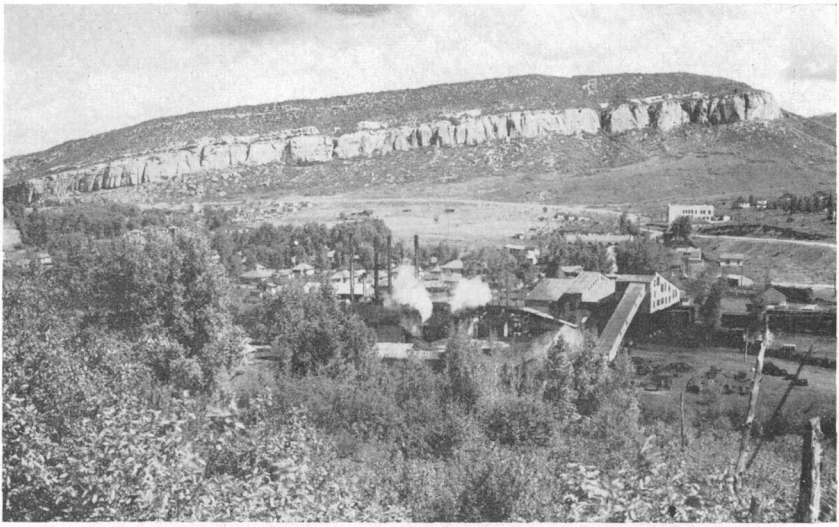
A stratigraphic section of the formation was measured in almost every gulch in the Daton Peak quadrangle that trends southward across the formation and enters Williams Fork. In some gulches the sections were measured by planetable surveys, and in others they were merely sketched and the thickness of stratigraphic units was estimated. Exposures of the formation are relatively good in this



A. LEDGES IN LOWER PART OF ILES FORMATION.
North of Williams Fork near Pagoda, Colo.

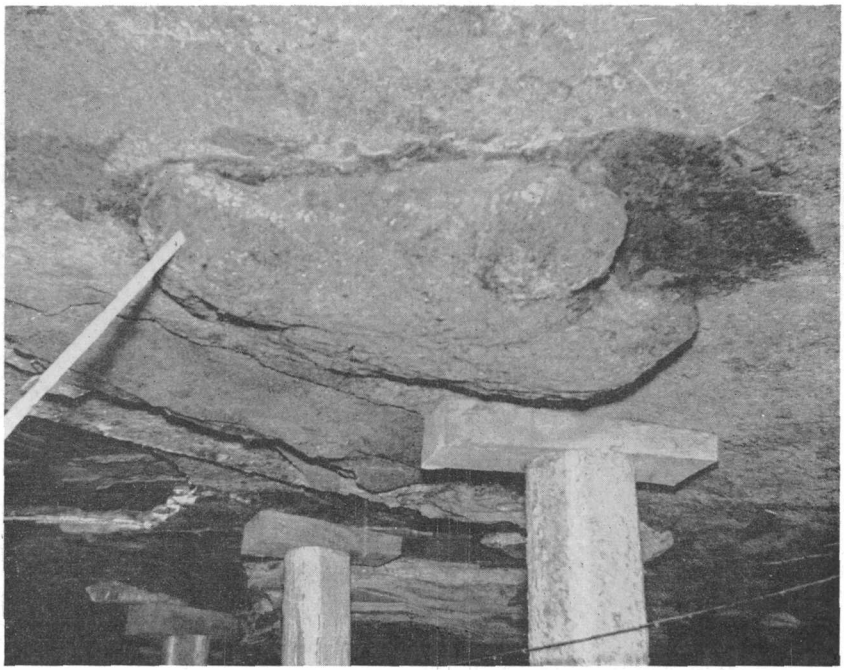
B. LEDGE OF THE TROUT CREEK SANDSTONE MEMBER.
North of Hayden Gulch in secs. 35 and 36, T. 5 N., R. 89 W., Colorado.

SANDSTONE LEDGES OF THE ILES FORMATION



A. VIEW OF MOUNT HARRIS, COLO., LOOKING NORTHEAST ACROSS YAMPA RIVER VALLEY.

The ledge of the Twentymile sandstone member of the Williams Fork formation appears in upper part of photograph.



B. CAST OF A DINOSAUR FOOTPRINT.

In the roof of the Wadge coal mine of the Victor-American Fuel Co. at Mount Harris, Colo.

part of the mapped area, and correlations of units from gulch to gulch were made with confidence. Good exposures of the formation in Jeffway, Berry, Hayden, and Long's Gulches, and in a few others, are accessible by roads.

Other stratigraphic sections were measured in the south part of the Mount Harris quadrangle, but these were spaced 4 to 8 miles apart. Those in Sage Creek and Fish Creek canyons are particularly well exposed and accessible. Following the measurement of these stratigraphic sections, others were measured near Oak Creek, near Bear River on the Tow Creek anticline, and on Wolf Creek where the units in the formation are somewhat different in character from those in the southern part of the mapped area. A few distinctive sandstone beds and some unique sequences of beds, however, occur here as well as in the southern part of the mapped area, making possible the identification of the several parts of the formation. The stratigraphic position of coal beds at Bear River and elsewhere, relative to the thick beds of coal in the lower coal group in the Oak Creek vicinity, was determined by comparing the graphs of the many measured sections. Beginning about 5 miles north of Yampa River and extending northward across the Pilot Knob quadrangle, the Iles formation and the overlying Williams Fork formation are poorly and only partly exposed. The sequences were identified by comparing plotted sections of the parts of the formations exposed with the full-length sections measured in the area to the south. Most of the identifications are reasonably certain.

The upper one-third of the formation consists mostly of a poorly exposed shale unit, 275 or slightly more feet thick, containing some sandy shale, soft sandstone, and coal beds. The base of this sequence lies 1,000 to 1,100 feet above the base of the Iles formation. Throughout the mapped area the shale unit lies between the ridges of underlying sandstone beds and the prominent ledge of the overlying Trout Creek sandstone, which marks the top of the formation. It forms a soil-covered lowland and is, therefore, not much exposed. Its general character and composition was determined from the character of the surface formed on it and from records of core drilling near Oak Creek, Mount Harris, and in the Williams Fork Mountains.

Tow Creek sandstone member.—The Tow Creek sandstone member, a massive, cliff-forming, light-brown rock, is the basal unit of the Iles formation. It is fine grained, well sorted, tightly cemented, and slightly calcareous, and its thickness ranges from 35 to slightly more than 125 feet. The rock is particularly prominent in Hayden Gulch, near the junction of the Hayden Gulch and Williams Fork roads. Here it is 125 feet thick. Huge blocks, 20 feet or more in diameter, have broken from the main ledge and are strewn on the floor of the gulch. This sandstone member forms a prominent brown ledge, or

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series of ledges, in all gulches that cut through it directly northeast of Williams Fork. However, it is not everywhere a single, massive bed. In some places it consists of two or more beds separated by units of shale and sandy shale. The rock becomes so shaly in the vicinity of Oak Creek that its identity there as Tow Creek sandstone is questionable. The member forms a prominent ledge capping steep slopes on both sides of the Tow Creek anticline; it was here that Willson (Crawford, Willson, and Perini, 1920, p. 4–36) named the member "Tow Creek sandstone."

Double-ledge-forming light-gray and white sandstone.—A light-gray and white sandstone 400 feet or more above the base of the Iles formation appears as a double white ledge high in the rugged slopes of the Williams Fork Mountains; it is particularly conspicuous in the northeastern part of T. 4 N., R. 88 W. It served as an identifiable sequence in all complete sections of the formation that were measured. In Searcy Gulch, in T. 5 N., R. 90 W., this sandstone unit is 130 or slightly more feet thick and is 460 feet above the base of the Iles formation. It forms two prominent ledges in the slopes on the north side of the gulch. In Hayden Gulch it is 225 feet thick, 400 feet above the base of the formation, and forms three prominent ledges in the south-facing slopes. In Fish Creek canyon, it is conspicuously exposed on the north side of the canyon where it is 250 feet thick and 415 feet above the base of the formation. The unit forms a single light-gray to white ledge in the flatiron-shaped hill east of Cheney Creek, a little more than 1 mile north of Milner, and is conspicuous as viewed from U. S. 40. Here it is the key bed for determining the amount of displacement along a northwestward-trending fault that passes a few hundred feet south of the flatiron-shaped hill (pl. 19).

Sandstone sequence associated with the no. 3 coal beds of the lower group.—A sandstone sequence about 1,000 feet above the base of the Iles formation is probably the most useful preliminary guide to coal within the Iles formation, because valuable coal beds are associated with it. It is generally light gray to white and forms fairly conspicuous ledges throughout much of the area. At many places in the Williams Fork Mountains the sandstone unit consists of two to three thick beds of light-gray to white sandstone, whose total thickness is 150 feet or more. It is exposed in Hayden Gulch as several massive light-gray beds, each about 10 to 40 feet thick and separated by interbedded soft sandstone and shale. Two massive beds are particularly conspicuous here. The coal bed mined at the Rice (old Weber) mine, on the east side of the Hayden Gulch road, is above the uppermost massive sandstone bed, and the coal bed mined at the Sun (old Green) mine, on the west side of the road, is below the lower massive sandstone bed (see pls. 20 and 21). Ledge-forming

white sandstone beds appear at about these positions in nearly all gulches where stratigraphic sections were measured. However, the number of sandstone beds, and the position of the most conspicuous bed relative to other beds in the sequence, varies from place to place. Accordingly, less confidence is placed in the precise correlation of this sandstone sequence, bed for bed, throughout the mapped area than in the correlations of some of the others.

A thick sandstone in about the same stratigraphic position as the one in Hayden Gulch forms a prominent hogback 425 feet below the top of the Trout Creek sandstone member in Fish Creek canyon. There it is underlain by two coal beds in which small mines were opened years ago. A white sandstone, in about the same stratigraphic position, is exposed in the steep slopes on the west side of Oak Creek, about 600 feet below the top of the Trout Creek sandstone member, and above the several coal beds in the lower coal group. At Bear River, a white sandstone about 30 feet thick that probably represents a part of the same sandstone zone, crops out about 480 feet below the top of the Trout Creek sandstone member and about 70 feet above the thick coal bed that was mined in the abandoned Bear River mine.

Trout Creek sandstone member.—The Trout Creek sandstone member of the Iles formation is the most reliable key bed in the entire stratigraphic sequence that is exposed in the mapped area. It is a fine-grained, massive, cliff-forming, white sandstone about 100 feet thick. Except for large tracts of the Pilot Knob quadrangle that contain only a few outcrops, the Trout Creek member has been identified throughout the mapped area and far beyond. It is typically exposed on the north side of U. S. 40 at Bear River, on both sides of the road in Hayden Gulch (pl. 16B), and at many other places. Its top is the horizon on which the structure contours are drawn in plate 19. Hancock (1925, p. 13–14) identifies the Trout Creek sandstone member throughout the Axial and Monument Butte quadrangles, which are adjacent on the west. The "white rock" that was identified by Gale (1910) along the Grand Hogback from a locality near Meeker, Colo., to Newcastle is equivalent to the Trout Creek member, according to Hancock (1925, p. 13–14). The Trout Creek sandstone member was named by Fenneman and Gale (1906, p. 26) from exposures near Trout Creek on the northeast side of Twentymile Park, which is in the eastern part of the area.

WILLIAMS FORK FORMATION

The Williams Fork formation includes all beds between the top of the Trout Creek sandstone member and the base of the Lewis shale. The formation is conformable at its base and top. Its thickness ranges from 1,100 feet near Mount Harris to nearly 2,000 feet at the west margin of the area. The formation includes a lower unit about

1,000 feet thick, consisting chiefly of shale, thin sandstone beds, sandy shale, and the several coal beds of the middle coal group; a middle unit of massive white cliff-forming sandstone about 100 to 200 feet thick, called the Twentymile sandstone member; and an upper unit of interbedded sandstone, sandy shale, shale, sandstone, and the coal beds of the upper coal group.

Lower unit.—The lower unit of the Williams Fork formation is important because it contains several thick coal beds of the middle coal group. These beds include the Wolf Creek, Wadge, and Lennox beds in the Mount Harris and Oak Creek districts, and 3 to 5 beds that are greater than 5 feet thick and other thinner beds in the Williams Fork Mountains district. Logs of core holes and outcrops show that much of the lower half of the unit consists chiefly of soft sandstone, thin-bedded sandstone, sandy shale, coal beds, and thin beds of dark-gray to black shale. Although the upper half of the unit contains a few beds of sandstone, it consists chiefly of shale. In most places the coal-bearing part of the unit commonly forms fairly steep slopes above the Trout Creek sandstone member. In the Williams Fork Mountains area these beds form red, rocky slopes (the color results from the natural burning of the outcropping coal). At several places in the mapped area, long dip slopes are formed by interbedded thin sandstone and sandy shale beds that lie 50 to 75 feet above the Wadge coal bed. At these places it may be possible to mine the Wadge and Lennox beds by stripping. In most places the upper half of the unit forms a broad lowland between the coal-bearing beds below and the ledge-forming Twentymile sandstone member above.

Twentymile sandstone member.—The Twentymile sandstone member of the Williams Fork formation is similar in composition, color, and habit of outcrop to the Trout Creek sandstone member of the Iles formation, from which it is separated by 900 to 1,100 feet of beds. It is a massive, white, ledge-forming sandstone about 100 to 200 feet thick and forms a prominent white ledge at the top of a steep slope rising above the broad lowland. The surface of the lowland is characteristic of that which forms on beds underlying the sandstone (pl. 17A). Throughout most of the area, the Twentymile and Trout Creek sandstone members form two excellent key beds for mapping. In the western part, however, the Twentymile sandstone member is divided into several beds, and is closely associated with other ledge-forming white and light-buff sandstones.

Upper unit.—The upper unit of the Williams Fork formation lies above the Twentymile sandstone member. It has the greatest range in thickness of any part of the formation. In the vicinity of Mount Harris, Twentymile Park, and Fish Creek, the thickness of the unit

is about 200 feet. Here the unit consists of beds of sandstone, sandy shale, dark-gray shale, and one coal bed about 3 feet in thickness. It is overlain by gray shale beds of the Lewis shale. Westward, however, the unit thickens by additions to its top, and at the western edge of the mapped area it is about 850 feet in thickness. The lowermost beds of shale of the Lewis change westward to sandy shale, sandstone, and coal beds, and are there included in the Williams Fork formation. At Dry Creek, for example, several workable coal beds, including the thick Dry Creek coal bed, are present in this upper unit of the formation. In places, the upper unit includes several massive white sandstone beds that resemble the Twentymile member. One of these, which lies about 25 to 50 feet above the Twentymile member, is well exposed on Dry Creek. Another, near the top of the unit, forms conspicuous ledges near the west margin of the area and extends many miles beyond the area; it is particularly well exposed in T. 6 N., R. 92 W. (Hancock, 1925, pl. 2A).

LEWIS SHALE

The Lewis shale consists chiefly of dark-gray to bluish, homogeneous marine shale. It is conformable with the underlying and overlying formations. The formation crops out in a wide, curving strip of rolling, treeless country that crosses the north-central and west-central parts of the area, and in a narrow, curving neck that connects the main area with Twentymile Park in the southeastern part of the area. The thickness of the formation is difficult to determine accurately, because the beds have a low dip and the outcrops of the basal and tops beds are many miles apart. North of Yampa River in the north-central part of the area the thickness is estimated to be 1,900 feet, and in the western part it is about 1,500 feet or less.

The lower and upper boundaries of the formation are not sharply defined and vary in stratigraphic position across the area. In the eastern part of the mapped area the lower boundary of the Lewis shale is drawn about 200 feet above the top of the Twentymile sandstone member of the Williams Fork formation, and at the west margin of the area it is drawn about 850 feet above the Twentymile member. The boundary between the Williams Fork formation and the Lewis shale is drawn at the contact of beds that consist dominantly of sandstone, sandy shale and coal below with beds that are dominantly gray shale above. Inasmuch as the lowermost beds of the Lewis shale change progressively westward from relatively homogeneous shale to sandstone, sandy shale and coal beds, the boundary rises stratigraphically westward.

The upper boundary of the Lewis shale shown on the map is based on Eby's field investigation in 1923 and 1924. According to Eby, this boundary near the west edge of the mapped area is probably

higher, stratigraphically, than it is north of Yampa River in the north-central part of the area. In the westernmost part of the area the boundary is drawn below a massive sandstone that forms a rim rock. This rim rock is conspicuous half a mile north of Craig. North of Yampa River in the central part of the mapped area, a sequence about 500 feet thick, consisting of beds of lenticular sandstone, sandy shale, shale, coal, and coaly shale, forms a transition zone above the main body of marine shale of the Lewis shale. Much of this sequence lies stratigraphically below the rim rock sandstone of the western part of the area, according to Eby's tentative correlations. The boundary between the Lewis shale and Lance formation north of Yampa River was drawn at the base of a coarse-grained sandstone, which is at the base of the sequence and 50 feet below a thick coal bed locally called the Lorella coal. The boundary was drawn arbitrarily because lenticular beds of sandstone and sandy shale are present below it. Marine invertebrates collected from the Lewis shale in the area adjacent on the west to the mapped area were identified by T. W. Stanton as probably equivalent in age to the upper part of the Montana (Hancock, 1925, p. 21).

LANCE FORMATION

The Lance formation, which is about 1,050 to 1,500 feet thick, conformably overlies the Lewis shale. The formation crops out in the northwestern quarter of the mapped area, where it was investigated by Eby. It consists of interbedded gray shale, light-buff and light-tan, soft, fine-grained sandstone, and a few coal beds. Of the coal beds, the Kimberley is the only one in the formation that is of much economic value. In the westernmost part of the area a thick, ledge-forming, white to gray sandstone lies at the base of the formation, and a thick, coarse-grained white sandstone is at the top. The basal sandstone forms a rim rock half a mile north of Craig, and the upper sandstone forms a rim rock 3 miles north of Craig. North of Yampa River, in the north-central part of the mapped area, the Lance formation extends stratigraphically lower than in the westernmost part. This relationship is discussed with the description of the Lewis shale.

The position of the upper boundary of the formation, as shown on the geologic map, is uncertain because the boundary is concealed nearly everywhere. Little data as to the attitude of the rocks are available. Eby drew a nearly straight northeastward-trending line across the map to represent the approximate position of the boundary. Although the line was later adjusted to the topography, its position is largely hypothetical.

Marine invertebrates of Fox Hills age collected at the top of the basal sandstone by Hancock and T. W. Stanton, and later by Reeside and Eby, indicate that at least the lower 250 feet of the formation is

more closely related to the Lewis shale than to the overlying freshwater deposits. For convenience in field mapping, however, the boundary between the Lewis shale and Lance formation was drawn at the base of the sandstone in the western part of the area, and at the base of the transition beds near Hayden, as discussed in the description of the Lewis shale.

TERTIARY ROCKS

FORT UNION FORMATION (PALEOCENE)

The Fort Union formation overlies the Lance formation and consists of interbedded brown sandstone, gray shale, and coal beds. The formation is similar to the Lance in general aspect, but differs from it considerably in details. The sandstone beds are coarser, the shale is prevailingly a lighter gray, and there are more ferruginous layers in the Fort Union than in the Lance. Fresh surfaces of the sandstone are speckled with white. At several horizons coal beds are present and some are locally quite thick. A conglomerate lies at the contact with the Lance formation; however, there is little clear local evidence of erosion. The age of the formation is indicated by fossil leaves.

The thickness of the Fort Union formation cannot be directly measured anywhere in the area, but on the basis of data assembled during the mapping it is estimated to be about 1,400 feet.

The position of the upper and lower boundaries, as shown on the geologic map, are tentative. Because the boundaries are concealed in most places, Eby drew nearly straight lines across the map to indicate them. Later, the lines were adjusted to the topography.

WASATCH FORMATION (EOCENE)

The Wasatch formation consists of coarse brown sandstone, or grit, interbedded with gray and red clay shale. The contact with the older beds is not exposed in the area studied, and its character can only be surmised. North of the area, in Colorado and southern Wyoming, the contact of the Fort Union and Wasatch formations is sharp and unconformable. The highly colored beds of the Wasatch contrast greatly with the more somber strata of the underlying Fort Union. The thickness of the Wasatch formation cannot be determined in the mapped area, although it was estimated by Eby to be somewhat greater than 1,000 feet.

BROWNS PARK FORMATION(?) (MIOCENE OR PLIOCENE)

A deposit of semiconsolidated white tuffaceous sand covers much of the area above 8,500 feet. Most of the material is coarse sand, but beds consisting of rounded pebbles and cobbles as much as 2 inches or slightly more in diameter are present. Although no measurement was made, the sand was estimated to be 200 to 300 feet thick

on the south margin of the area. None of these deposits is shown on the geologic map. The general composition and character of the white sand deposits are similar to the Browns Park formation of late Miocene or Pliocene age. The Browns Park formation is widespread in northwestern Colorado and has been mapped only about 5 miles west of the area near Craig (Sears, 1924, pl. 35, p. 295).

QUATERNARY(?) ROCKS, UNCONSOLIDATED SURFICIAL DEPOSITS

Unconsolidated white sand, resulting from the disintegration of the Browns Park formation(?), has been transported down the slopes and now covers much country at lower levels, particularly in the northwestern and southwestern parts of the area. In a few places the sand is fairly well consolidated and appears as bedded rock. The most conspicuous occurrence of this type is in the valleys of Smith and Dry Creeks near the center of T. 8 N., R. 86 W., and is shown on the geologic map. A similar occurrence of coarse white sand overlying Mancos shale has been cut through by Yampa River half a mile south of Phippsburg.

Basalt boulders intermingled with white sand and cobbles of a great variety of rock form a thin veneer on most high divides, particularly in the southwestern and northern third of the mapped area. Slide rock occupies the surface at many places; it is particularly extensive on the northern slopes of the Flat Tops near the south margin of the area, and in the SW¼ sec. 3, T. 3 N., R. 89 W., includes a prominent hill capped by basalt. These deposits are not shown on the geologic map.

A rolling upland is present in the vicinity of Eddy School in the northwestern part of T. 5 N., R. 85 W., and the southwestern part of T. 6 N., R. 85 W., in which the bedrock is covered by a mantle, at least 75 feet thick, of boulders and gravel of granite, gneiss, schist, quartz, and other rocks (Fenneman and Gale, 1906, p. 31). Most of this material is unconsolidated. Some beds of micaceous clay and sandstone are interbedded with the boulders and gravel. The age of the deposit is uncertain, but it is not unlikely that it is of Pleistocene age.

Silt, sand, and boulder deposits form terraces in the valleys at several altitudes above the larger streams; these terraces are not shown on the geologic map. All of the streams are bordered by a narrow belt of boulders, gravel, sand, and silt. It is shown as alluvium, on the geologic map, along the courses of the larger streams where the belt is wide enough to be mapped conveniently on the scale of the map. Such deposits occupy the flood plains of the streams.

IGNEOUS ROCKS

GENERAL FEATURES

Igneous rocks of the area consist of dikes that are 2 to 50 feet thick, sills that are a few feet to 300 feet thick, and a few plugs. Basalt flows cap the Flat Tops, whose northern margin occupies two small tracts at the south boundary of the mapped area. Most of the dikes, sills, and plugs are in the northeastern quarter of the area. The most prominent are Sand Mountain in T. 7 N., Rs. 86 and 87 W., Pilot Knob in T. 8 N., R. 87 W., Hooker Mountain in T. 7 N., Rs. 87 and 88 W., Wolf Mountain in T. 7 N., R. 87 W., the Rim Rocks in Tps. 8 and 9 N., R. 86 W., and Sand Mountain in T. 9 N., R. 86 W. In the western part of the area, Breeze Mountain in T. 6 N., R. 90 W., is prominent. Daton Peak in T. 5 N., R. 89 W., is capped by a basalt flow.

C. S. Ross of the Geological Survey, who examined specimens of the dikes, sills, and plugs, has grouped the rocks into three general types: basalt, latite-trachyte, and lamprophyre. The most widespread rock is olivine basalt, according to Ross, although olivine-analcite basalt and olivine-free basalt also occur. Olivine basalt forms the main mass of Pilot Knob and the dikes and sills associated with it, the mass on Hooker Mountain, the main northwest-trending dike of Wolf Mountain, the Rim Rocks sill, the sills on Elkhead Creek and in Agner Mountain, and most other dikes and many of the sills. In general, the sills are somewhat coarser in texture than the dikes. The sills on the Chimney Creek dome in Tps. 7 and 8 N., R. 86 W., are 2 to 8 feet thick and consist of olivine-free basalt. The olivine-free basalt is lower in ferro-magnesian minerals and is lighter gray than the olivine basalt, which is dark gray to black.

The latite-trachyte rocks constitute the main mass of Sand Mountain in T. 7 N., Rs. 86 and 87 W., and also form Sand Mountain in T. 9 N., R. 86 W., near the northeast corner of the area. The thick sill in Quaker Mountain in secs. 27, 28, 33, and 34, T. 9 N., R. 87 W., is of similar composition. The three short dikes northwest of Elkhead River in secs. 16 and 17, T. 9 N., R. 87 W., the two dikes in secs. 22 and 23, T. 9 N., R. 87 W., the small plug in sec. 10, and the dike in secs. 10 and 14, T. 7 N., R. 86 W., are lamprophyres.

Late in 1949 a well that was drilled on Chimney Creek dome in sec. 4, T. 7 N., R. 86 W., entered igneous rock, possibly a sill, at a depth of 1,797 feet, and was drilled 181 feet into it. A cored sample obtained 11 feet above the bottom of the hole was examined in 1950 by C. S. Ross, and he reported that the rock "has a very fine grained groundmass; it contains about 45 percent of plagioclase and 24 percent of potassic feldspar. The rock contains 71.85 percent of SiO_2, indicating that it is rather silicic, and so must be moderately high in quartz.

The rock would, therefore, seem to be best described as a granodiorite or perhaps as a quartz diorite."

METAMORPHISM

Contacts of the larger igneous bodies with sedimentary rocks were not observed, but at some places strata within a few feet of dikes that are 4 to 15 feet thick show only a slightly increased induration. At other places the alteration is somewhat more pronounced. Beds in the Lewis shale, which overlie basalt sills 6 to 8 feet thick in sec. 1, T. 7 N., R. 88 W., have been indurated through a thickness of 5 to 8 feet. Sills of olivine-free basalt, 2 to 8 feet or more thick, that crop out on the Chimney Creek dome have altered the adjacent shale to a reddish-brown color throughout a zone 2 to 10 feet thick. The material very near the contact weathers into hard, glazed chips. Shale is somewhat altered for a distance of 2 to 3 feet on each side of a thin dike in the SE¼ sec. 14, T. 8 N., R. 88 W. A thin dike of basalt, which was not observed at the surface but which cuts the Wadge coal bed in the Victor-American Fuel Co.'s Wadge mine in sec. 9, T. 6 N., R. 87 W., has coked the coal for 9 feet on each side of the dike.

In the middle 1920's, the Moffat Coal Co. prospected, by core drilling and by driving tunnels, a fairly large tract on Cottonwood Creek in T. 8 N., R. 87 W., that contains thick sills of basalt closely associated stratigraphically with the coal beds of the middle coal group. Many of the results of this investigation were described by G. C. McFarlane (1929), chief engineer for the Moffat Coal Co., and the following data were obtained from his report.

The core drilling showed that the thickness of the sills in the area prospected ranges from 10 to 300 feet. In the middle of a sill the basalt is homogeneous and appears to represent a single intrusion; in places near the margin the sill is split into several thin sheets. In general, the sills are parallel with the bedding, but in places cut across the bedding.

McFarlane cites the record of a core-drill hole that penetrated a sill 225 feet thick, lying between the Wadge and Wolf Creek coal beds, and the records of seven drill holes located within a radius of three-quarters of a mile of this hole. The seven holes penetrated the sequence containing these two coal beds, but did not enter basalt. The interval between the two coal beds in the seven drill holes containing undisturbed strata ranges from 132 to 147 feet, and in the drill hole containing the sill, 374 feet; the sill accounts for 225 feet of this thickness. If the thickness of the sill is subtracted from the total interval found in this hole, the thickness of the sedimentary sequence between the two coal beds is 149 feet, which is 2 feet more than its thickest development in the seven holes containing no basalt.

In another core-drill hole, the basalt sill is split into six thin layers lying within the sedimentary sequence between the Wolf Creek coal bed and a lower coal bed, known locally as the small anthracite bed. This hole penetrated a total thickness of 84 feet of basalt and 26 feet of sedimentary rocks. The thickness of the sedimentary rocks between the two coal beds ranges from 35 to 41 feet in six drill holes containing no basalt that were bored in the adjacent area. Thus, except for 9 to 15 feet, the increased interval between the two coal beds appears to be accounted for by the presence of the sill; possibly the basalt assimilated a total thickness of 9 to 15 feet of the adjacent sedimentary rock. The interval between the two coal beds, however, varies 6 feet in the six drill holes that penetrated no basalt. It is possible, therefore, that the 9- to 15-foot thickness represents a normal variation of the interval between the two coal beds. McFarlane identified in the records of several core-drill holes the small anthracite coal bed and the upper Block mine coal bed which underlies it. In three holes that penetrated no basalt the interval between these two coal beds is 46 feet, and in one hole that penetrated a sill 142 feet thick the interval is 184 feet. The total thickness of sedimentary rocks between the two coal beds in the hole containing the sill is 42 feet, which is only 4 feet less than in the holes that penetrated no basalt.

These data suggest that the sills intruded the sedimentary sequence chiefly by spreading apart the strata rather than by assimilating the sedimentary rocks.

The metamorphic effect of the sills on the coal is variable, particularly near the margins of the sills. The least variation was noted above and below the main bodies or central parts of the sills. Here, in general, the coal beds lying above and below the sills in sequences ranging from one-fourth to one-third the thickness of the sills were changed from bituminous rank to anthracite. For example, the record of a core-drill hole near the east margin of a sill, 307 feet thick, shows a coal bed 30 feet below the sill that was altered only slightly. McFarlane suggested that here the basalt "was near the end of its journey" when it had intruded to this point and had perhaps already partly cooled.

Where drill holes show the thick Wolf Creek coal bed to be only a short distance above or below a thick sill, the coal of this bed was metamorphosed to a meta-anthracite. The meta-anthracite appears to have been a poor conductor of heat, for where the Wolf Creek meta-anthracite is directly above a sill, the coal beds that lie above the Wolf Creek bed were altered less than coal at the same distance below the sill; and where the Wolf Creek meta-anthracite is directly below the sill, coal beds that lie below the Wolf Creek were altered

less than coal beds at the same distance above the sill. Analyses of the coal suggest that sandstone and shale are much better conductors of heat than coal.

The core-drill holes revealed that anthracite is present as far below the central area of a sill as above it, but evidence of metamorphism extends farther upward than downward. The best anthracite was found at a distance above and below a sill equal to one-seventh the thickness of the sill. One coal bed occurring at this distance above a sill has a heating value of 13,733 Btu; another, occurring at this distance below the sill, is the strongest coal found, having a compressive strength of 8,142 pounds per square inch. The compressive strength of unaltered coal from the middle coal group is 3,664 pounds per square inch. It is noteworthy that the coal having the high compressive strength has "nearly the same proximate analysis as anthracite from the Mammoth bed, Lansford, Pennsylvania, and also the same specific gravity, 1.563. Both these coals carry only 0.6 percent of moisture on the air-dried basis." (McFarlane, 1929, p. 3.)

The coal beds penetrated by the core drill showed a progressive increase in density as a sill was approached.

Temperature tests were made by McFarlane and the U. S. Bureau of Standards on samples of metamorphosed and unaltered coal from this area and from other coalfields. These data and comparisons made with the coal associated with the basalt sills on Cottonwood Creek suggest that a coal bed situated 1 foot from a basalt sill probably reached a temperature of 1,000°C, that high-grade anthracite having 94.5 percent fixed carbon probably reached a temperature of 600°C, that semianthracite reached a temperature between 350°C and 400°C, and that the bituminous coal of the area probably remained unaltered until its temperature exceeded 160°C.

McFarlane compiled and compared thicknesses of unmetamorphosed and metamorphosed coal from the same beds. His data suggest that a coal bed shrinks in thickness from 29 to 33 percent when it passes from bituminous rank to anthracite, and that it shrinks in thickness 50 percent when it passes from bituminous rank to meta-anthracite.

Many of the data from the extensive investigation made by the Moffat Coal Co. on Cottonwood Creek are summarized graphically by McFarlane in a columnar section which is reproduced in part herein as figure 39. The column is generalized; actually, metamorphism in individual coal beds varies considerably from place to place. For example, the vertical zonation, a metamorphic effect of the basalt sills, is not nearly as uniform as suggested in the section. Prospect tunnels driven in metamorphosed coal on Cottonwood Creek showed that the metamorphism of a coal bed is not uniform. The rank of the coal changes laterally in short distances.

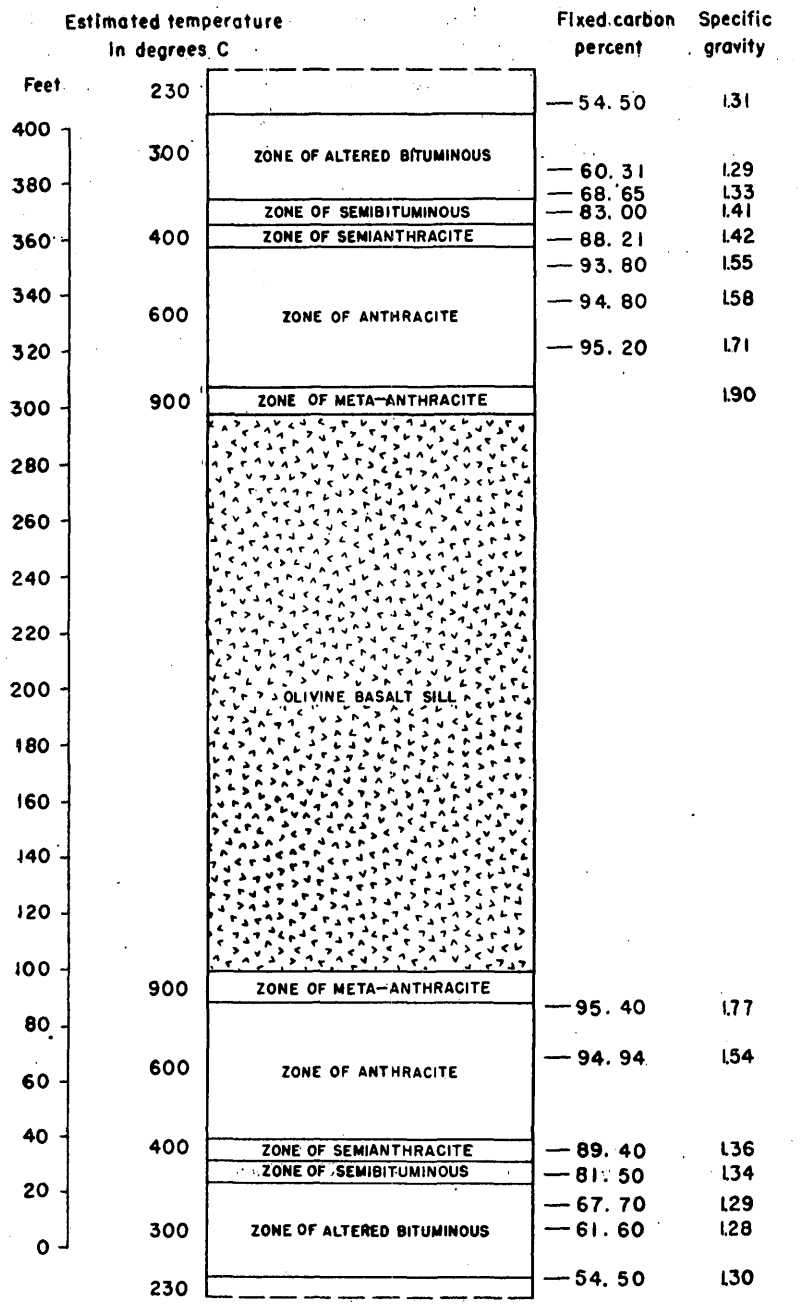

FIGURE 39.—Generalized columnar section showing zones of metamorphism of coal above and below a sill in the Cottonwood Creek area, Colorado.

Prospecting by drilling and by driving tunnels in coal was carried on in the area of the Rim Rocks in Tps. 8 and 9 N., R. 86 W., in the 1890's, many years before the prospecting on Cottonwood Creek. The outcropping edge of the sill at Rim Rock suggests that the sill ranges from 75 to 100 feet or slightly more in thickness. The coal beds that were investigated lie above the sill. Detailed data concerning the results of this prospecting are not available, but the meager information contained in drillers' logs of the holes indicates that metamorphism extends upward from the sill with variable effect through 70 to 80 feet of strata. Only the lowest beds of coal were changed to semianthracite or anthracite rank.

The downward metamorphic effect of a thick sill on Elkhead Creek in sec. 25, T. 9 N., R. 88 W., was investigated by Eby (1925, p. 250). Here a bed of coal, 26 feet below the base of the sill, which is about 200 feet in thickness, has been altered from subbituminous rank to anthracite; a bed of coal 44 feet below the base of the sill has been altered to semianthracite.

It is possible that the large Sand Mountain intrusion on Tow Creek has altered the crude oil in the north Tow Creek pool. The north Tow Creek pool is only 3,000 feet southwest, and the south Tow Creek pool is 2 miles southwest of the outcrop of the intrusive body. Analyses of the crude oils from the pools, made by the Bureau of Mines Hempel method, show as follows:[1] "The crude in the north Tow Creek pool contains much more naphthenic and aromatic compounds than the crude in the south pool. The average of the correlation index numbers of the crude from the north pool is 39 contrasted with an average of 31 for the crude from the south pool. The gasoline and naphtha content of the north pool's crude is 15 percent and of the south pool's crude is 30 percent."

The API gravity, sulfur content, and residuum of the oil from the north Tow Creek pool is 27.2 degrees, 0.32 percent, and 39.5 percent, respectively, and these features of the oil from the south pool are 36.2 degrees, 0.18 percent, and 23.3 percent, respectively. "The large difference in the composition of the crudes in the south and north pools of the Tow Creek field is noteworthy inasmuch as the two pools occur in the same formation, the Niobrara shale, on the same anticline and are only 1½ miles apart."[2] The reservoir beds of Niobrara age, in these two pools, consist of limy shale and shaly limestone. It was suggested by these authors that it may be that the crude of the north pool was at one time similar to that of the south pool, and that its lighter, more volatile constituents were driven off

[1] Bass, N. W., Smith, H. M., and Christenson, H. E., Geologic relationship of crude oils in the Tow Creek, Wilson Creek, Iles, and Moffat fields, Colorado. Unpublished paper presented at annual meeting of Am. Assoc. Petroleum Geologists at Denver, 1942.

[2] Bass, N. W., Smith, H. M., and Christenson, H. E., op. cit.

by the heat from the intrusive body that occupies a large area about half a mile north of the oil pool.

"However, the difference in composition between the crudes of these two pools is not so great as the differences between crudes in closely spaced pools * * * in oil-bearing zones in a region containing no intrusions in Oklahoma." [3]

STRUCTURE

The area described in this report lies in the southeast synclinal prong of the Washakie structural basin of south-central Wyoming. In Colorado, the syncline is bordered on the east by the Park Range—a large anticline—and on the southwest by the Axial Basin anticline (American Association of Petroleum Geologists, 1944). The axis of the syncline extends southeastward across the area mapped, passing half a mile east of Hayden.

The general structure of the rocks is shown by reconnaissance structure contours on plate 19. The regional synclinal structure is modified by many folds, particularly in the eastern and southern parts of the mapped area. The largest of these is the Tow Creek anticline, an asymmetrical fold that trends northeastward in the east-central part of the area. The small Tow Creek oil pool and the abandoned north Tow Creek pool are on the anticline. Most of the faults shown on the anticline are revealed by the outcropping beds of sandstone in the Mesaverde group and in the upper part of the Mancos shale. Many of the faults near Bear River and Mount Harris have been located through the mining of the coal beds.

The Wolf Creek dome, 3 miles northwest of the Tow Creek anticline, is on an extension of the Tow Creek anticlinal axis but is separated from the anticline by a structural saddle. A mass of igneous rock that forms Sand Mountain has been intruded into the sedimentary rocks on the south flank of the Wolf Creek dome, and several dikes are present in other parts of the dome. The attitude of the beds near their contact with the igneous mass, and the fact that the crest of the dome is some distance from the igneous body, suggest that the dome was formed before the intrusion. The Chimney Creek dome, in Tps. 7 and 8 N., R. 86 W., is noteworthy because of its quaquaversal structure and because of the presence of several sills, 2 to 8 feet thick, within the sedimentary sequence. The sills and associated sedimentary beds form prominent ridges that nearly encircle the crest of the dome. A well drilled in 1949 on the dome penetrated igneous rock that may be a sill at a depth of 1,797 feet.

A relatively small dome is present in the valley of Trout Creek in the southeast part of T. 6 N., R. 86 W. The amount of its structural closure was not determined because the bedrock is concealed in the valley, and mapping was not extended farther east.

[3] Bass, N. W., Smith, H. M., and Christenson, H. E., op. cit.

The Twentymile Park syncline, in the southeastern part of the mapped area, contains in and near Twentymile Park a broad structural basin which has probably more than 600 feet of structural relief. The syncline extends southeastward from Twentymile Park, forming the dominant structural feature of the coalfield west of Oak Creek and Phippsburg.

The faults in Tps. 4 and 5 N., Rs. 86 and 87 W., are noteworthy because they have disturbed the many thick coal beds there. They were mapped in the field by Campbell and were later somewhat modified by Bass. It is probable that only the more evident faults were observed and that coal mining in the area will reveal many more.

A steeply folded anticline on Sage Creek, chiefly in T. 5 N., R. 88 W., and another on Fish Creek, in Tps. 4 and 5 N., R. 87 W., may coalesce southward to form the Williams Park anticline, whose crest is near the corner common to Tps. 3 and 4 N., Rs. 87 and 88 W. Little confidence can be placed in the designated positions of the structure contours in much of the west half of T. 4 N., R. 87 W., however, because the surface is formed on the Mancos shale, and few reliable structural data are available.

The Beaver Creek anticline is a large asymmetrical fold trending northwestward across the southwestern part of the area and for many miles beyond (Hancock, 1925, pl. 19, p. 33–34). The anticline, as shown on plate 19, merges at its southeastern end with the Pagoda dome. South of the country occupied by the Mesaverde group the position of the structure contours on the north flank of the two anticlines is in most places tentative, because much of the bedrock in the area is concealed and only a few reliable structural data in the Mancos shale are available. For example, south-dipping beds in the Mancos shale exposed in a road cut along the South Fork road in sec. 17, T. 4 N., R. 89 W., in the bed of South Fork and in the west bank of the stream in the same vicinity, and south-dipping beds of sandstone in the north slope of the hill in the S½ sec. 36, T. 5 N., R. 90 W., have been interpreted on some structure contour maps as indicating a sharp northwest-trending anticline near Pagoda. On the present map, however, the attitude of these beds was interpreted as being the result of landslides in the Mancos shale and, therefore, not indicative of the true structure of the bedrock.

The Hart syncline, which lies southwest of the Beaver Creek anticline, is noteworthy because it accounts for the part of the Mesaverde group that contains the lower coal group and much of the middle coal group.

The Buck Peak anticline in T. 6 N., R. 90 W., appears to be the southeastward extension of the Breeze anticline of the Monument Butte quadrangle (Hancock, 1925, pl. 19; Sears, 1924, pl. 35). Most

of the bedrock of the Buck Peak anticline is concealed; thus the position of the contours is tentative. The position of the northwest-trending fault that crosses the anticline is revealed by a fault scarp near the west margin of the mapped area. The fault is suggested on aerial photographs throughout its length and is shown on the geologic map (pl. 19). The amount of displacement shown along the fault is hypothetical.

Although the strata adjacent to the many dikes of the area are poorly exposed, the dikes appear to have disturbed the strata only slightly. An exception is the dike extending southwestward for a distance of 2 miles from Pilot Knob. It is only a few feet wide, but the beds on its southwest side are bent sharply upward against the dike wall; the beds on the northeast side, although poorly exposed, appear to be in their normal attitude but displaced downward a few feet relative to those on the southwest side. The data described in the section on metamorphism suggest that the thick sills have raised the overlying strata rather than assimilating the beds with which they came in contact.

COAL

Workable coal beds are present in the Iles, Williams Fork, Lance, and Fort Union formations, but most of the coal mines have exploited beds in the Iles and Williams Fork formations. The coal in these two formations has been divided into lower, middle, and upper groups by Fenneman and Gale (1906, p. 23–28). Stratigraphic sections of the coal beds are shown in plates 22–25.

LOWER COAL GROUP

The lower coal group includes all coal beds beginning about 400 feet or slightly less above the base of the Iles formation, as herein defined, and extending upward to the Trout Creek sandstone member. The coal beds in the lower part of the group are mined most extensively in the Oak Creek district. These beds thin northward and westward from the Oak Creek district, as shown in plate 20. Available data indicate that they probably do not extend with a continuous workable thickness as far north as Yampa River or far west of the Oak Creek district. Some lenticular coal beds at the position of the lower group are present in the Williams Fork Mountains, however, and a few miles west of the area herein described (Hancock, 1925, pl. 18). Coal beds in the upper part of the lower coal group are relatively thin in the Oak Creek district, but thicken and increase in number northward and westward. This coal has been mined extensively at Bear River and on Butcherknife Gulch north of Yampa River, and has been prospected from Butcherknife Gulch nearly to the north boundary of the area. At Bear River the top of the coal-bearing zone lies about 400 feet below the top of the Trout Creek sandstone member.

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The three principal coal beds recognized by Fenneman and Gale (1906, p. 42) in the lower coal group at Oak Creek are known, in ascending order, as beds 1, 2, and 3 (Campbell, 1923, p. 38–39). The interval between beds 1 and 2 given by these authors is about 50 feet, and between beds 2 and 3, about 180 feet.

Mining in the Oak Creek district has shown that the coal beds of the lower group are irregular in thickness, and that the thickest beds split into two or more benches as they are followed underground by mining operations. Therefore, nos. 1, 2, and 3, although referred to as beds, actually represent coal zones, each of which includes several coal beds. The intervals between the zones are about 150 and 200 feet, respectively.

The main bed of no. 2 was mined in the Pinnacle mine of the Victor-American Fuel Co., where it is known as the Pinnacle bed. This bed was mined extensively in the Oak Hills mine (known also as mines 1 and 2) of the Moffat Coal Co., where, throughout much of the mined area, it is split into two beds. The Moffat Coal Co.'s mine was originally opened on the no. 1 bed, and in the later years of its operation the no. 3 bed was mined simultaneously with the two benches of the no. 2 bed. The lower bench of no. 2 bed is mined at the Keystone mine, location 17, and was worked for many years at the Hayden mine, location 15. In 1940 and later years a bed that is assumed to be the no. 1 bed has been worked in the Hayden mine. Although it lies at a greater distance below the no. 2 bed than does the no. 1 bed at the Moffat Coal Co.'s Oak Hills mine, the general character of the coal and the presence of 1 foot or slightly more of dirty coal at the top of the bed at each place (McConnell, C. M., 1950, personal communication) suggest that the beds are equivalent.

Coal of the lower coal group has been worked by truck mines on Oak Creek southwest of the town of Oak Creek; on a high mesa 2 miles northwest of Phippsburg, where strip mining has been done; and on Trout Creek, in sec. 22, T. 4 N., R. 86 W. (the Apex mine, location 52), where a bed ranging from 4 feet to 4 feet 8 inches in thickness, at about the position of the no. 2 coal, has been mined.

A bed in the upper part of the lower group was mined from 1938 to 1940 by the late Casper Weberskirch at location 156 on Fish Creek near the center of the west line, NW¼ sec. 11, T. 4 N., R. 87 W., where it is 5 feet 6 inches thick and lies 90 feet below the top of a massive white sandstone. Coal bed *A*, 7 feet 7 inches thick, is worked at the Sun mine, location 264 in Hayden Gulch in sec. 12, T. 4 N., R. 89 W. This coal is about 600 feet below the top of the Trout Creek sandstone member, whereas the interval between the top of the Trout Creek member and the no. 3 coal at Oak Creek is about 750 feet. The Rice mine in Hayden Gulch is in bed *C*, which is 9 feet 10 inches thick and 130 feet stratigraphically above the coal worked at the Sun mine.

The records of several old prospects in the Williams Fork Mountains west of Hayden Gulch indicate the presence of five workable coal beds in the lower coal group. These beds are designated *A* to *E* in ascending order (pl. 20, column 1A). However, the logs of core holes drilled in 1948 and 1949 reveal only a few thin beds in the lower group (see pl. 21), indicating that the beds are extremely lenticular.

MIDDLE COAL GROUP

The middle coal group includes the coal beds between the Trout Creek and Twentymile sandstone members. Throughout the eastern half of the area the principal coal beds of the group are, in ascending order, the Wolf Creek, Wadge, and Lennox. These beds occur in a sequence of rocks, about 400 feet thick, immediately above the Trout Creek sandstone member. Of the three coal beds, the Wadge is the most uniformly good in quality and workable thickness, and is mined most extensively. The Wolf Creek bed is irregular in thickness and generally contains thick lenses of bone and clay and a large amount of ash. The Lennox bed is only 3 to 4 feet thick in most places, but is 5 feet thick at the Edna strip mine near Oak Creek.

The two large mining operations at Mount Harris—the Colorado and Utah Coal Co.'s Harris mine on the south side of Yampa River and the Victor-American Fuel Co.'s Wadge mine (pl. 17B), recently abandoned, on the north side of the river—are in the Wadge bed, which is 8 to 9½ feet thick. This bed derived its name from a rancher who opened a small mine in the bed on the south side of Yampa River opposite the present site of Mount Harris (Fenneman and Gale, 1906, p. 65). North of Mount Harris the principal beds of the middle coal group have been prospected in the central part of T. 7 N., R. 87 W., and on Cottonwood Creek in T. 8 N., R. 87 W., where the Wadge bed is more than 7 feet thick and the Wolf Creek bed is 13 to 15 feet thick. The Wadge bed on Grassy Creek and its tributaries south of Mount Harris is from 8½ to 10 feet thick in several truck mines, and in the relatively large Grassy Creek mine at location 189 in sec. 34, T. 6 N., R. 87 W., which was developed and then shut down several years ago. The Wadge bed is about 8 feet thick in a strip mine that was opened recently south of McGregor. A coal bed 11 feet 9 inches thick that may be the Wadge or a bed 100 feet below it has been worked by a truck mine at location 160 in Fish Creek canyon in sec. 34, T. 5 N., R. 87 W.

An upper bench of the Wolf Creek bed, 12 feet thick, has been worked at a truck mine, at location 46 on Middle Creek in the NE corner of the NW¼ sec. 10, T. 4 N., R. 86 W.

The Davis and Clark party of the Geological Survey mapped a total of 19 coal beds of the middle coal group in the Williams Fork Mountains in Rs. 88 to 90 W. Six or more of these beds, whose

thickness is greater than 5 feet, were also located by the Eby party in 1923 but were not correlated throughout the area. Most thick beds lie in the interval, about 400 feet thick, overlying the Trout Creek sandstone member. This coal-bearing sequence was penetrated in 1948 and 1949 by core-drill holes of the Geological Survey in Dunstan, Berry, Peck, and Jeffway Gulches. The data revealed by the cores, together with the data obtained from outcrops by the Davis and Clark and the Eby field parties, show the presence of three main zones of coal beds in the sequence. These zones are herein designated *F*, *G*, and *H* (see pls. 20 and 21). Plate 21 shows 1 to 2 coal beds in zone *F*, 2 to 5 beds in zone *G*, and in most places 2 thick beds in zone *H*. The core drilling revealed a thick coal bed between zones *G* and *H* in Dunstan and Jeffway Gulches. Coal bed *I* (pl. 20, column 1A), which is exposed at locations 387 and 385 near the west margin of the area, lies about 600 feet above the Trout Creek sandstone member. Coal bed *J*, 12 or more feet thick and a little more than 700 feet above the Trout Creek member, was worked many years ago at the Jim Dunn mine (location 275) in the NW¼ sec. 18, T. 5 N., R. 89 W., and either the same bed or another bed 50 to 100 feet below it (called the Searcy Gulch bed) was exploited later in a truck mine at location 388 in the SW¼ sec. 12, T. 5 N., R. 90 W. No data were obtained that indicate how far this bed, or these two beds, extend from the two localities. However, the hypothetical outcrop of a single bed at this horizon was sketched on the map (pl. 19) for a distance of 1 to 2 miles on each side of the two mines.

The data available suggest that the number of thick coal beds in the middle coal group increases westward in the Williams Fork Mountains. Moreover, on Yampa River, 7 miles west of the mapped area, Hancock (1925, pl. 18) uncovered 12 coal beds in the middle coal group, 8 of which are each greater than 4 feet in thickness; the total thickness of the 12 beds is 77 feet.

UPPER COAL GROUP

The upper coal group includes the coal beds of the Williams Fork formation that are in the sequence of rocks 650 feet thick, or slightly less, immediately overlying the Twentymile sandstone member. A compiled section (pl. 20, column 1A) of the coal beds of the upper coal group that were prospected by the Davis and Clark and the Eby field parties suggests the presence of 9 beds, herein designated beds *K* to *S* in ascending order; however, detailed geologic work may reveal that the number of beds actually present is fewer. Westward from Sage Creek, which is in T. 6 N., R. 88 W., in the Williams Fork Mountains, the beds increase in number and thickness apparently to a point beyond the west boundary of the mapped area, for Hancock (1925, pl. 18) reported the presence of 16 coal beds in the upper coal group

on Yampa River in Tps. 5 and 6 N., R. 91 W. However, thick coal beds of the upper group probably do not extend many miles east of Sage Creek.

A coal bed 3 feet or less in thickness crops out at many places along Fish Creek in the southeastern part of T. 5 N., R. 87 W. The Dry Creek bed, which is 10 feet thick and about 400 feet above the Twentymile sandstone member, is worked by several mines on Dry Creek in T. 5 N., R. 88 W.; and a 4½-foot bed, 240 feet below the Dry Creek bed, was formerly mined. Several other coal beds in the group are reported to have been prospected and penetrated by drill holes on Dry Creek many years ago, but they were not exposed at the time of the field investigation for this report.

Davis and Clark, in 1909, and Eby, in 1923 and 1924, uncovered at least 6 thick coal beds and at least 12 thin coal beds in the upper coal group, chiefly in T. 5 N., Rs. 89 and 90 W., in the Williams Fork Mountains. Most of the beds more than 5 feet thick are located from 200 to 400 feet above the Twentymile sandstone member. At least one thick bed is present below this zone, and a few others are present above it.

COAL BEDS IN THE LANCE AND FORT UNION FORMATIONS

The coal in the Lance and Fort Union formations is of subbituminous rank and has a heating value, as mined, of about 9,700 Btu. Small wagon mines in the hills 1 to 2 miles north of Hayden were worked in the early twenties in the Lorella coal bed, a lenticular bed 3 to 10 feet thick and about 50 feet above the base of the Lance formation. At about the same time several small wagon mines, two of which were in sec. 33, T. 7 N., R. 90 W., north of U. S. 40, were worked in the Kimberley bed in the lower one-third of the formation. The abandoned White mine, worked in 1923, and two prospect tunnels driven in 1946 at location 334 in the NE¼ sec. 4, T. 6 N., R. 89 W., are probably in the Kimberley bed.

Two beds of coal of subbituminous rank, separated by 30 to 45 feet of shale, are present about 375 feet above the base of the Fort Union formation in secs. 25 and 26, T. 7 N., R. 90 W., and sec. 30, T. 7 N., R. 89 W., a short distance north of U. S. 40; each bed ranges from 4 to 6 feet in thickness. A coal bed about 17 feet thick, 250 feet below the top of the Fort Union formation, is exposed at many places, and has been worked by several truck mines on Dry Fork of Little Bear Creek in the western part of T. 8 N., R. 89 W.

QUALITY

Analyses of representative samples from the three groups of coal in the Iles and Williams Fork formations, and of somewhat less reliable coal samples from the Lance and Fort Union formations, are shown in table 1. The reliability of the samples from the Lance and Fort Union

formations, which were obtained from wagon and truck mines, is uncertain because some of the samples were taken under thin overburden from beds that may have been somewhat weathered. Table 2 shows averages of several analyses of coal from the lower, middle, and upper coal groups, and from the Lance and Fort Union formations. These analyses show that the moisture content increases and the heating value decreases from older to younger coal.

All of the coal is noncoking. As was pointed out by Campbell (1923, p. 68), the coal of the Iles and Williams Fork formations of this region is hard and shiny, breaks in large lumps and blocks when mined, withstands transportation to distant markets, and is clean to handle. Coal of the lower and middle groups is of bituminous rank. Coal of the upper group contains slightly more moisture and less volatile matter and has a lower heating value than coal of the middle and lower groups; it is on the margin between subbituminous and bituminous rank, but is here classed as subbituminous. Coal in the Lance and Fort Union formations contains considerably more moisture than the older coal, and so is not suitable for shipping long distances. It is of subbituminous rank, has a shiny luster, and is mined without much slack.

RESERVES

Slightly more than 9 billion tons of coal is present in the mapped area at depths of less than 3,000 feet, according to calculations of coal reserves made by Frank D. Spencer for this report. About 82 percent of this total reserve is coal of bituminous rank and 18 percent is coal of subbituminous rank. Slightly less than 100 million tons has been mined or lost in mining. The calculations were necessarily based on data obtained from natural exposures of coal beds, from measurements in the few mines and prospects in the area, and from core-drill records in a few relatively small tracts. Undoubtedly, much more coal than the 9 billion tons disclosed by these methods is present. For example, data revealed by core drilling by the Geological Survey in the Williams Fork Mountains in 1948 and 1949 revealed the presence of much more coal in the middle coal group of the Williams Fork formation than was known before.

Moreover, although no coal beds lying at depths greater than 3,000 feet have been included in the calculations, geologic information on the region including the mapped area indicates that much coal is present below that depth, principally in the northwestern third of the mapped area.

The coal reserves reported in tables 3–9 are categorized by rank, reliability of data used to calculate reserves, thickness of beds, and thickness of overburden. Reserves in these categories are reported by individual coal beds and by townships. Summaries by township and county, and the grand totals for the mapped area, are shown in table 9.

The coal ranks reported are bituminous and subbituminous. Coal of anthracite rank has not been differentiated in the tables because it occurs only in local areas near intrusions and the reserves are relatively small (however, some of the deposits might be large enough to warrant development of the anthracite as special fuels). Coal of the lower and middle coal groups of the Iles and Williams Fork formations is of bituminous rank. Coal of the upper coal group of the Williams Fork formation is on the borderline between bituminous and subbituminous ranks. Analyses of some samples from the upper coal group (table 1) indicate bituminous rank, and analyses of other samples indicate subbituminous rank; for simplicity, all coal in the upper coal group is classed as subbituminous. Coal in the Lance and Fort Union formations is subbituminous.

In calculating the coal reserves in the areas containing coal of bituminous rank, lines were drawn on a copy of the geologic map (pl. 19) through points where the coal beds are 14, 28, and 42 inches thick. These lines form boundaries of areas within which the coal is assumed to be 14 to 28 inches, 28 to 42 inches, and more than 42 inches thick. In calculating reserves in the areas containing subbituminous coal, lines were drawn on the geologic map through points where the coal beds are 2.5, 5, and 10 feet thick. These lines are assumed to form boundaries of areas within which the coal is from 2.5 to 5 feet, 5 to 10 feet, and more than 10 feet thick. These thickness categories correspond with those recommended by the National Bituminous Coal Advisory Council for reporting coal reserves.

The reliability of data used to calculate reserves is indicated as follows: coal within 2 miles of an outcrop, a prospect or mine opening, or a drill hole is classed as measured and indicated, undifferentiated; and coal lying not more than 2 miles outside the areas containing measured and indicated coal is classed as inferred.

Data supplied by mining, core drilling, and prospecting indicate that certain coal beds in the middle and upper coal groups of the Williams Fork formation are persistent for at least 2 miles. Therefore, an estimate of inferred coal was made for these beds. On the other hand, the coal beds in the lower coal group of the Iles formation are known from mining operations, prospecting, and core drilling to be lenticular; and coal beds in the Lance and Fort Union formations are known from observations on the outcrops and prospects to be lenticular. Consequently, no inferred reserve was calculated for this coal even though it is probable that coal beds having classifiable thickness are present outside of the areas shown to contain measured and indicated, undifferentiated, coal.

Information on the amount of overburden was obtained from the geologic map by using the structure contours in conjunction with the topographic contours. Reserves have been reported in the following

overburden categories: less than 1,000 feet, between 1,000 and 2,000 feet, and between 2,000 and 3,000 feet. Estimates of coal reserves at shallow depths, which would be of possible interest to strip miners, were not prepared owing to lack of data.

OIL AND GAS

The Tow Creek, north Tow Creek, and Oak Creek oil pools, and the Pagoda and Williams Park gas pools are within the mapped area. The Tow Creek oilfield was discovered in 1924. Its total yield to January 1, 1952, was 2,151,174 barrels of oil (Goodin and others, 1952 p. 91). The oilfield contains the Tow Creek and north Tow Creek pools near the crest of the large asymmetrical Tow Creek anticline. The two pools, about 1½ miles apart, are separated by an area that has yielded no producing oil wells. All wells in the north pool were abandoned several years ago. Most producing wells in the pools are a short distance east of the axis of the anticline.

The available evidence indicates that the oil is present in fracture zones in limy shale, shaly limestone, and limestone beds of Niobrara age. Gas shows are common in a unit about 300 feet thick that constitutes the uppermost beds of Niobrara age, and most of the oil is present in the next underlying 500 feet of beds; a few wells have produced oil from the lowermost 300 feet of the Niobrara. The entire sequence of oil- and gas-bearing beds is devoid of water. About half of the 40 wells failed to produce oil. Moreover, many of the dry holes are distributed irregularly among the oil-producing wells, and some wells that are situated 400 to 500 feet from oil-producing wells appear to have tapped the same fracture zone as the producers, for the yield of the old wells declined abruptly when the new wells began producing.

Ten or more wells on the Tow Creek anticline tested the Frontier sandstone, which yielded water, and five of these reached the Dakota sandstone, which yielded hot water. The Texas Co.'s Belle Dennis no. 4 in the SE¼NE¼SE¼ sec. 7, T. 6 N., R. 86 W., near the crest of the anticline, reached basement rocks at a depth of 5,307 feet. This well penetrated beds of sandstone at depths of 4,000 to 4,135 feet, which yielded hot water, and beds of sandy limestone and red rock that may be equivalent to the uppermost beds of the Sundance formation at depths of 4,303 and 4,313 feet, which yielded shows of oil and gas. Below 4,313 feet, the drill penetrated 60 feet of sandstone and conglomerate, 70 feet of brown sandstone and sandy limestone, 60 feet of gray sandy limestone, 480 feet of red rock containing thin beds of limestone, and 407 feet of shale, sandy shale, and thin beds of conglomerate reported to contain fossils of lower Pennsylvanian (Des Moines) age. The basal 57 feet of the lowest unit is sandy shale and

rests on gneiss. A second well drilled in 1949 in the NE¼NW¼SE¼ sec. 7, T. 6 N., R. 86 W., to a depth of 5,627 feet, reached pre-Cambrian rocks.

Oil that seeps from beds in the upper part of the Mancos shale east of Tow Creek in the SE¼NW¼ sec. 32, T. 7 N., R. 86 W., was used as a lubricant by local ranchers and coal miners 40 to 50 years ago (Fenneman and Gale, 1906, p. 79). In 1919, oil-saturated sandstone and sandy shale in the upper part of the Mancos shale was mined on Tow Creek in the W½ sec. 32, T. 7 N., R. 86 W., and heated in small retorts (Crawford, Willson, and Perini, 1920, p. 47–48) in a commercial effort to extract oil from the shale.

In 1942, a well was drilled to a depth of 3,250 feet on the Wolf Creek dome in the SE¼SW¼ sec. 18, T. 7 N., R. 86 W. Most of the rock that was penetrated was calcareous shale of the Mancos shale, and the well bottomed in igneous rock. An 80-foot thickness of igneous rock between depths of 2,060 and 2,140 feet suggests that the igneous rock at the total depth may represent a sill rather than the main mass of Sand Mountain.

Five wells have been drilled on the Chimney Creek dome in the NW¼ sec. 4, T. 7 N., R. 86 W. The first well, drilled in 1920 by the Plateau Oil Co., reached a depth of 1,360 feet, 10 feet below the top of the Morrison formation. Gas was present at several depths, and some of the sands, including the Dakota sandstone, yielded water. Two dry holes near the first well were drilled in 1927 and 1928 by the Elk Head Development Co. to depths of 900 and 1,200 feet. In 1929, the Midwest Refining Co. drilled a well in the same locality to a depth of 1,735 feet. It penetrated 55 feet into the Entrada sandstone, which yielded water that rose 1,320 feet in the hole. A well was drilled in 1949 in the NW¼NE¼NW¼ sec. 4, T. 7 N., R. 86 W., to a depth of 2,078 feet, penetrating igneous rock, possibly a sill, at a depth of 1,797 feet, below 77 feet of Triassic redbeds.

In about 1920, two gas wells were drilled in the Williams Park gas pool on the crest of the Williams Park anticline in T. 4 N., Rs. 87 and 88 W., near the south margin of the area; one is capped and the other is abandoned. The first test hole on the anticline was drilled in 1919 and 1920 by the Twentymile Oil and Gas Co. in the SW corner of the NW¼SE¼SW¼ sec. 30, T. 4 N., R. 87 W. It is reported that a show of oil was obtained in the Frontier sandstone at a depth of 1,310 feet, and that water, oil, and gas were yielded by the Dakota sandstone between depths of 1,710 and 1,725 feet, the total depth. Well no. 2 of the Twentymile Oil and Gas Co., drilled in 1919 in the SE¼SE¼ sec. 36, T. 4 N., R. 88 W., is reported to have obtained several million cubic feet of gas per day from the Dakota sandstone between depths of 320 and 453 feet; the well is capped. Well no. 3, drilled in 1919 and 1920 in the SW¼NW¼NW¼SW¼ sec. 31, T. 4 N.,

R. 87 W., is reported to have yielded initially 10 million cubic feet of gas per day from the Dakota sandstone between depths of 350 and 530 feet, the total depth, and to have been plugged.

Well no. 4 was drilled in 1920 by the Producers and Refiners Corp. in the center of the north line of the S½NE¼SE¼ sec. 36, T. 4 N., R. 88 W. It is reported that water and a show of oil were obtained at a depth of 85 feet in the Frontier sandstone; gas at 525 and 580 feet in the Dakota sandstone, and at 990 feet; gas and hot water at 1,085 feet in sandstone that may be the Entrada sandstone, and gas in the same sandstone at 1,125 feet. The driller's log suggests that the well penetrated, in descending order, the lowermost few hundred feet of the Mancos shale and the Dakota sandstone, Morrison formation, Curtis formation, Entrada sandstone (between 1,050 and 1,140 feet), and 420 feet of redbeds (to a depth of 1,159 feet), possibly of Triassic age, much of which may be equivalent to the Chinle formation. The bottom few feet of the hole is reported on the driller's log to be in reddish-gray granite, but considerable doubt exists that granite was penetrated. Drill cuttings from a depth of 1,516 feet, which is only 43 feet less than the total depth of the hole, contained red arkose according to F. F. Hintze (written communication, about 1945) who examined the cuttings while the wall was being drilled.

The discovery well in the Oak Creek pool in sec. 2, T. 3 N., R. 86 W. was completed in 1949 and is reported to have yielded 250 barrels of oil a day from the Shinarump conglomerate. The well was drilled to a depth of 6,747 feet and penetrated the upper part of the Moenkopi formation of Triassic age. Following this, two dry holes were drilled in sec. 2, one to a depth of 6,856 feet and the other to a depth of 7,135 feet.

Two gas wells were completed in 1948 and 1949 in sec. 34, T. 4 N., R. 89 W., on the Pogoda dome. Both yielded gas from the Shinarump conglomerate of Jurassic age, which was penetrated at a depth of about 3,900 feet. The first well was drilled to a total depth of 4,900 feet and penetrated the Weber sandstone and the uppermost beds of the Morgan formation of the Pennsylvanian system. This well is reported to have yielded 7,700,000 cubic feet of gas per day; and the second well, 1,930,000 cubic feet of gas per day. Both wells are shut in.

Three test wells have been drilled in the SW¼ sec. 32, T. 4 N., R. 89 W., on the Beaver Creek anticline. The first well was drilled in 1924 and reached the upper part of the Morrison formation; it yielded water in the Frontier and Dakota sandstones. The second well was drilled in 1943 and penetrated the top few feet of a redbed unit that is probably the Chinle formation. Many cores obtained in the basal 1,000 feet of the hole showed that the beds were dipping at a high angle. The third well was drilled in 1946 at the northeast corner

of the SW¼ sec. 32, a little more than a quarter of a mile north and northeast of the first two holes and, therefore, higher on the crest of the anticline. The well reached a total depth of 5,801 feet and is reported to have penetrated the uppermost 552 feet of the Pennsylvanian system, the uppermost 120 feet of the Pennsylvanian rocks being identified by some geologists as the Weber sandstone.

A dry hole was completed in 1950 in sec. 24, T. 4 N., R. 90 W., on the Beaver Creek anticline. It was abandoned at a depth of 5,853 feet after penetrating the Dakota sandstone, Entrada sandstone, Shinarump conglomerate, and the Weber sandstone, all of which yield oil and gas in some places in northwestern Colorado.

Analyses of the gas from the Tow Creek and Williams Park gas-fields are shown in table 10, and analyses of the crude oil from the Tow Creek and Oak Creek fields are shown in table 11. Analyses of the gas from the Niobrara shale of the Tow Creek field show a heating value that ranges from 1,047 to 1,264 Btu per cubic foot, which is high, and show large variations in amounts of carbon dioxide, methane, and ethane, which possibly are due to local metamorphic effects of igneous intrusions. Analyses of gas from the Dakota sandstone of the Williams Park field show a lower heating value—794 Btu per cubic foot; the principal constituents are methane and nitrogen, but about 1 percent helium is also contained.

Analyses of crude oil from the Niobrara shale of the north and south Tow Creek pools (see p. 168, 169, and table 11) show a considerable difference in composition of oil from the two pools, possibly due to local metamorphic effects of igneous intrusions.

The Buck Peak anticline in T. 6 N., R. 90 W. is an eastern extension of the Breeze anticline of the Monument Butte quadrangle (Hancock, 1925, pl. 19). Little confidence can be placed in the position of the structure contours showing the Buck Peak ancicline, because the bedrock is concealed in most of the area. No test well has been drilled on the anticline. The data on plate 19 indicate that if a test well were drilled near the east quarter corner of sec. 26, T. 6 N., R. 90 W., it should penetrate the Dakota sandstone at a depth of about 7,900 feet.

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TABLES 1–11

TABLE 1.—*Analyses of coal samples from parts of Routt and Moffat Counties, Colo.*

[Made at the Pittsburgh laboratory of the U. S. Bureau of Mines. Form of analysis: A, as received; B, air dried; C, moisture free; D, moisture and ash free]

Mine and location	No. on map	Location in mine	Coal bed and group	Formation	Lab. no	Air-drying loss	Form of analysis	Proximate			Ultimate						Heating value	
								Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu
Argo mine of Moffat Coal Co., 1 mile northwest of Oak Creek, NW¼, sec. 31, T. 4 N., R. 85 W.	20	Face of south entry	No. 2, lower coal group.	Iles	31130	3.5	A	8.5	39.1	49.2	3.2	.47	----	----	----	----	6,895	12,410
							B	5.2	40.5	51.0	3.3	.49	----	----	----	----	7,140	12,860
							C	----	42.7	53.8	3.5	.51	----	----	----	----	7,535	13,560
							D	----	44.2	55.8	----	.53	----	----	----	----	7,810	14,060
Do	20	Left rib, no. 9 slope, 120 ft from south entry.	do	do	31131	3.8	A	9.3	39.3	48.2	3.2	.48	----	----	----	----	6,800	12,250
							B	5.7	40.8	50.1	3.4	.50	----	----	----	----	7,070	12,720
							C	----	43.3	53.1	3.6	.53	----	----	----	----	7,500	13,500
							D	----	44.9	55.1	----	.55	----	----	----	----	7,775	14,000
Do	20	South slope, 375 ft below not level.	do	do	31132	3.4	A	8.0	39.0	46.6	6.4	.44	----	----	----	----	6,675	12,020
							B	4.8	40.4	48.2	6.6	.46	----	----	----	----	6,910	12,440
							C	----	42.4	50.6	7.0	.48	----	----	----	----	7,255	13,060
							D	----	45.6	54.4	----	.52	----	----	----	----	7,800	14,040
Do	20	Face of no. 3 level, 2,100 ft from south slope.	do	do	31133	3.4	A	8.9	38.8	48.3	4.0	.46	----	----	----	----	6,785	12,220
							B	5.7	40.2	50.0	4.1	.47	----	----	----	----	7,025	12,650
							C	----	42.6	53.0	4.4	.49	----	----	----	----	7,450	13,410
							D	----	44.5	55.5	----	.51	----	----	----	----	7,790	14,030
Do	20	Composite of lab. nos. 31130–31133.	do	do	31134	3.5	A	8.6	39.1	48.0	4.25	.41	5.75	69.41	1.50	18.68	6.785	12.220
							B	5.3	40.6	49.7	4.40	.43	5.56	71.93	1.55	16.13	7,035	12,660
							C	----	42.8	52.5	4.65	.45	5.24	75.96	1.64	12.06	7,425	13,370
							D	----	44.9	55.1	----	.47	5.50	79.67	1.72	12.64	7.790	14,020
Old Schuster mine, Oak Creek, S½ sec. 30, T. 4 N., R. 85 W.	19	----	No. 1, lower coal group.	do	1,799	2.3	A	8.8	36.1	50.2	4.90	1.51	5.69	68.59	1.54	17.77	6,755	12,160
							B	----	39.6	55.0	5.38	1.66	5.17	75.25	1.69	10.85	7,410	13,340
							C	----	41.8	58.2	----	1.75	5.46	79.52	1.79	11.48	7,835	14,100
							D	----	----	----	----	----	5.56	80.94	1.82	11.68	7,935	14,280
Mine of Brad Hastings, 3½ miles west of Phippsburg, S½ sec. 11, T. 3 N., R. 86 W.	37	Main slope	No. 2, lower coal group.	do	94621	5.2	A	8.9	36.5	48.5	6.1	.7	----	----	----	----	6,665	12,000
							B	4.0	38.5	51.1	6.4	.8	----	----	----	----	7,030	12,650
							C	----	40.1	53.2	6.7	.8	----	----	----	----	7,320	13,120
							D	----	43.0	57.0	----	.9	----	----	----	----	7,845	14,180
Pinnacle mine of Victor-American Fuel Co., SE¼ sec. 36 T. 4 N., R. 86 W.	78	Average of 41 car samples	do	do	115	----	A	8.1	36.8	50.0	5.1	.65	----	----	----	----	----	12,200
							C	----	40.1	54.4	5.5	.71	----	----	----	----	----	13,270
							D	----	42.4	57.6	----	.75	----	----	----	----	----	14,050

Pinnacle no. 1, SE ¼ sec. 36, T. 4 N., R. 86 W.	78	Face of no. 3 south entry, top split.	do	do	A13684	2.9	A	9.2	36.9	46.6	7.3	1.2					6,444	11,600
							B														
							C														
							D														
Do	78	Face of no. 5 south entry, bottom split.	do	do	A13685	3.4	A	9.2	37.2	48.2	5.4	.7					6,611	11,900
							B														
							D														
							D														
Do	78	Face of no. 4 room, *A* slope, back entry.	do	do	A13686	2.7	A	8.3	39.1	49.0	3.6	.7					6,833	12,300
							B														
							C														
							D														
Do	78	Face of no. 24 room, *A* ½ slope, back entry.	do	do	A13687	3.1	A	9.2	37.8	49.6	3.4	.6					6,800	12,240
							B														
							C														
							D														
Do	78	Composite of lab. nos. A13684–A13687.	do	do	A13688	3.0	A	8.9	37.8	48.4	4.9	.8	5.8	68.2	1.5	18.8	6,656	11.980
							C		41.5	53.1	5.4	.9	5.3	74.8	1.6	12.0	7,306	13,150
							D		43.9	56.1		1.0	5.6	79.1	1.7	12.6	7,722	13,900
Do	78	No. 1 room, *A* slope, back entry.	do	do	A34979	3.4	A	9.2	35.9	52.3	2.6	.5	6.0	69.7	1.5	19.7	6,911	12,440
							C		39.5	57.6	2.9	.6	5.5	76.8	1.7	12.5	7,606	13,690
							D		40.7	59.3		.6	5.7	79.1	1.8	12.8	7,833	14,100
Pinnacle no. 2, SE¼ sec. 36, T. 4 N., R. 86 W.	78	Face of no. 5 room, *D* slope, back entry.	do	do	A13683	3.6	A	9.6	37.5	49.1	3.8	.6					6,733	12,120
							C		41.5	54.3	4.2	.7					7,444	13,400
Keystone mine, Keystone Coal Co., SE¼ sec. 19, T. 4 N., R. 85 W.	17	No. 4 north entry, 350 ft off no. 2 dip entry.	do	do	B13141	4.0	A	8.0	37.	150.	54.4	.6						12,350
							B	4.2	38.6	52.6	4.6	.6						12,860
							C		40.3	54.9	4.8	.6						13,420
							D		42.4	57.6								14,100
Do	17	No. 2 dip entry, 150 ft in by no. 6 north entry.	do	do	B13142	3.9	A	7.5	38.4	50.1	4.0	.6						12,440
							B	3.8	40.0	52.1	4.1	.6						12,950
							C		41.6	54.1	4.3	.7						13,450
							D		43.4	56.6		.7						14,050
Do	17	No. 5 north entry, 150 ft off no. 2 dip entry.	do	do	B13143	4.1	A	8.1	36.9	49.7	5.3	.7						12,230
							B	4.2	38.5	51.7	5.6	.8						12,750
							C		40.2	54.0	5.8	.8						13,310
							D		42.7	57.3		.8						14,130
Do	17	Composite of lab. nos. B13141–B13143.	do	do		4.0	A	7.9	37.5	50.0	4.6	.7	5.8	69.5	1.6	17.8		12,340
							B	4.1	39.1	52.0	4.8	.7	5.6	72.4	1.6	14.9		12,850
							C		40.8	54.2	5.0	.7	5.3	75.4	1.7	11.9		13,400
							D		42.9	57.1		.8	5.6	79.4	1.8	12.4		14,090

TABLE 1.—*Analyses of coal samples from parts of Routt and Moffat Counties, Colo.*—Continued

Mine and location	No. on map	Location in mine	Coal bed and group	Formation	Lab. no	Air-drying loss	Form of analysis	Proximate				Ultimate					Heating value	
								Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu
Hayden no. 3, Hayden Bros. Coal Corp., SE¼ sec. 18, T. 4 N., R. 85 W.	15	Left rib at face no. 1 north entry, 4,500 ft N. 30° W. of shaft.	No. 2, lower coal group.	Iles	A72340	2.0	A	7.0	34.7	54.6	3.7	.5	5.8	71.1	1.5	17.4	6,972	12,550
							B	5.1	35.4	55.8	3.7	.5	5.7	72.5	1.6	16.0	7,117	12,810
							C	----	37.3	58.8	3.9	.5	5.4	76.4	1.7	12.1	7,500	13,500
							D	----	38.8	61.2	-----	.5	5.7	79.6	1.7	12.5	7,806	14,050
Edna strip mine, Edna Coal Co., SE¼ sec. 24, T. 4 N., R. 86 W.	57a	Face of strip pit, 480 ft west, 1,670 ft south of center sec. 24.	Wadge, middle coal group.	Williams Fork	C55348	5.3	A	11.0	36.5	47.7	4.8	.5	5.9	65.8	1.3	21.7	-----	11,640
							B	6.0	38.6	50.3	5.1	.5	5.6	69.5	1.4	17.9	-----	12,290
							C	----	41.0	53.6	5.4	.6	5.2	73.9	1.5	13.4	-----	13,070
							D	----	43.4	56.6	-----	.6	5.5	78.1	1.5	14.3	-----	13,820
Do	57a	Tipple sample	----------	----------	C77517	1.7	A	10.1	36.4	47.1	6.4	.6	5.8	65.0	1.4	20.8	-----	11,400
							B	8.5	37.1	47.9	6.5	.7	5.7	66.1	1.5	19.5	-----	11,600
							C	----	40.5	52.4	7.1	.7	5.2	72.3	1.6	13.1	-----	12,670
							D	----	43.6	56.4	-----	.8	5.6	77.8	1.7	14.1	-----	13,640
Do	57a	Tipple sample (45 tons)	Lennox, middle coal group.	do	D56918	5.2	A	9.9	39.9	46.2	4.0	2.5	----	-----	----	-----	-----	------
							B	5.0	42.1	48.6	4.3	2.6	----	-----	----	-----	-----	------
							C	----	44.3	51.2	4.5	2.9	----	-----	----	-----	-----	------
							D	----	46.4	53.6	-----	----	----	-----	----	-----	-----	------
Arthur mine (later known as Edna) of John Arthur, SW¼ sec. 24, T. 4 N., R. 86 W.	57	Face of left entry, 425 ft from mouth.	Wadge, middle coal group.	do	A34345	2.7	A	10.1	38.4	43.5	8.0	.6	5.9	63.0	1.4	21.1	6,228	11,210
							B	7.5	39.5	44.8	8.2	.7	5.7	64.7	1.5	19.2	6,400	11,520
							C	----	42.7	48.4	8.9	.7	5.3	70.0	1.6	13.5	6,922	12,460
							D	----	46.9	53.1	-----	.8	5.8	76.8	1.8	14.8	7,600	13,680
Johnnie's mine, NE¼ sec. 33, T. 4 N., R. 86 W.	68	Tipple sample (5 tons)	Lower coal group.	Iles	C78023	1.4	A	8.4	39.0	48.8	3.8	.5	5.8	70.1	1.5	18.3	-----	12,360
							B	7.1	39.6	49.5	3.8	.5	5.8	71.1	1.5	17.3	-----	12,540
							C	----	42.5	53.4	4.1	.5	5.4	76.5	1.7	11.8	-----	13,490
							D	----	44.4	55.6	-----	.5	5.6	79.8	1.7	12.4	-----	14,070
Mine of Ernest Gwynn (Seven Point mine), 2½ miles west of Phippsburg, SE¼ sec. 12, T. 3 N., R. 86 W.	42	Main entry, 197 ft from mine mouth.	No. 2, lower coal group.	do	A2699	5.7	A	10.0	35.7	50.3	4.0	.7	----	-----	----	-----	6,705	12,070
							B	4.6	37.8	53.3	4.3	.8	----	-----	----	-----	7,110	12,800
							C	----	39.6	55.9	4.5	.8	----	-----	----	-----	7,450	13,410
							D	----	41.5	58.5	-----	.8	----	-----	----	-----	7,800	14,040
Do	42	Main heading, 100 ft in entry.	do	do	94620	5.2	A	9.9	37.6	49.1	3.4	.6	----	-----	----	-----	6,740	12,130
							B	5.0	39.7	51.8	3.5	.6	----	-----	----	-----	7,110	12,800
							C	----	41.8	54.5	3.7	.6	----	-----	----	-----	7,480	13,460
							D	----	43.4	56.6	-----	.7	----	-----	----	-----	7,770	13,990

Seven Point mine of Blue Flame Coal Co., SE¼ sec. 12, T. 3 N., R. 86 W.	42	Face of north dip off main entry, 1,200 ft from mouth.	do	do	B17623	3.9	A	8.7	37.9	48.9	4.5	.6					12,160
							B	5.0	39.4	50.9	4.7	.6					12,650
							C		41.5	53.5	5.0	.7					13,310
							D		43.7	56.3		.7					14,000
Do	42	25 ft from face on left rib of main entry, 1,200 ft from mouth.	do	do	B17624	3.9	A	8.8	36.9	49.3	5.0	.6					12,000
							B	5.1	38.4	51.3	5.2	.7					12,480
							C		40.4	54.1	5.5	.7					13,150
							D		42.7	57.3		.7					13,910
Do	42	Composite of lab. nos. B17623 and B17624.	do	do		3.9	A	8.9	37.0	49.4	4.7	.7	5.7	68.5	1.5	18.9	12,030
							B	5.3	38.5	51.3	4.9	.7	5.5	71.3	1.6	16.0	12,520
							C		40.7	54.1	5.2	.7	5.2	75.2	1.7	12.0	13,210
							D		42.9	57.1			5.5	79.3	1.8	12.6	13,930
Middle Creek mine of Frank Gould, NW¼ sec. 10, T. 4 N., R. 86 W.	46	Face of main entry, 390 ft from portal.	Wolf Creek, upper bench, middle coal group.	Williams Fork	C58119	2.7	A	7.7	40.9	45.3	6.1	.6	5.7	67.4	1.5	18.7	11,940
							B	5.2	42.0	46.5	6.3	.6	5.5	69.3	1.5	16.8	12,270
							C		44.3	49.0	6.7	.6	5.2	73.1	1.6	12.8	12,940
							D		47.5	52.5		.7	5.6	78.3	1.7	13.7	13,860
Do	46	do	Wolf Creek, lower bench, middle coal group.	do	C58120	2.5	A	7.8	39.4	43.9	8.9	.4	5.5	64.5	1.3	19.4	11,440
							B	5.4	40.4	45.0	9.2	.4	5.4	66.2	1.4	17.4	11,730
							C		42.7	47.6	9.7	.4	5.1	70.0	1.5	13.3	12,400
							D		47.3	52.7		.5	5.6	77.5	1.6	14.8	13,740
Apex mine, SW¼ sec. 22, T. 4 N., R. 86 W.	52	600 ft north, 150 ft west of portal; 25 ft in by room no. 6.	No. 2?, lower coal group.	Iles	B34464	3.5	A	7.7	36.4	50.1	5.8	.6	5.7	68.7	1.5	17.7	12,150
							B	4.4	37.7	51.9	6.0	.6	5.5	71.2	1.6	15.1	12,590
							C		39.4	54.4	6.2	.7	5.2	74.4	1.6	11.9	13,160
							D		42.0	58.0		.7	5.5	79.4	1.7	12.7	14,040
Greenhalgh prospect, face of drift 54 ft from portal, NE¼ sec. 32, T. 5 N., R. 86 W.	99a	Strip mine	Wadge	Williams Fork	C73282	5.6	A	10.1	35.7	48.4	5.8	.5					11,670
							B	4.7	37.9	51.3	6.1	.5					12,360
							C		39.7	53.9	6.4	.5					12,970
							D		42.5	57.5		.5					13,860
Greenhalgh shaft, NE¼ sec. 32, T. 5 N., R. 86 W.	99b		do	do	E74290	5.0	A	11.1	35.0	47.5	6.4	.5					11,380
							B	6.4	36.8	50.1	6.7	.5					11,980
							C		39.4	53.5	7.1	.6					12,800
							D		42.4	57.6		.6					13,790
Hutchinson mine, 6 miles southeast of Milner, SE¼ sec. 12, T. 5 N., R. 86 W.	89	10 ft from surface	Wadge, middle coal group.	do	1832	6.2	A	12.5	35.2	46.9	5.4	.42	5.83	63.25	1.43	23.63	6,135	11,050
							B	6.7	37.5	50.0	5.8	.45	5.48	67.43	1.52	19.32	6,545	11,780
							C		40.2	53.6	6.2	.48	5.07	72.29	1.63	14.31	7,015	12,630
							D		42.8	57.2		.51	5.41	77.08	1.74	15.26	7,480	13,460
Hutchinson mine of Tom Chergo, 6 miles southeast of Milner, NW¼NE¼ sec. 13, T. 5 N., R. 86 W.	90		do	do	31038	4.0	A	12.8	37.2	44.4	5.6	.43	5.77	63.26	1.49	23.46	6,130	11,030
							B	9.2	38.7	46.3	5.8	.45	5.54	65.90	1.55	20.74	6,386	11,500
							C		42.6	51.0	6.4	.49	4.99	72.67	1.71	13.83	7,030	12,660
							D		45.5	54.5		.52	5.33	77.54	1.83	14.78	7,515	13,530

TABLE 1.—*Analyses of coal samples from parts of Routt and Moffat Counties, Colo.*—Continued

Mine and location	No. on map	Location in mine	Coal bed and group	Formation	Lab. no	Air-drying loss	Form of analysis	Proximate				Ultimate					Heating value	
								Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu
Mine of Z. McCroskey, 1 mile west of Milner, SE¼ SW¼ sec. 9, T. 6 N., R. 86 W.	116		Wolf Creek, middle coal group.	Williams Fork	1843	4.4	A	12.0	34.5	42.8	10.7	.5						
							B	8.0	36.1	44.8	11.1	.5						
							C		39.2	48.7	12.1	.5						
							D		44.6	55.4		.6						
Do	116		do	do	1991	3.4	A	12.4	36.0	43.2	8.4	.5						
							B	9.3	37.3	44.7	8.7	.5						
							C		41.1	49.3	9.6	.6						
							D		45.5	54.5		.7						
Mine no. 1 of Curtis Coal Co., 2 miles south of Milner, sec. 22, T. 6 N., R. 86 W.	136	Face of main entry, 270 ft from mine mouth.	Brooks, lower coal group.	Iles	22750	2.8	A	11.8	37.0	43.7	7.5	.6					6,130	11,040
							B	9.2	38.1	45.0	7.7	.7					6,305	11,350
							C		41.9	49.6	8.5	.7					6,945	12,500
							D		45.8	54.2		.8					7,595	13,670
Mine of Elk Creek Mining Co., 3 miles south of Milner, SE¼ sec. 21, T. 6 N., R. 86 W.	129	1,000 ft northwest of mine mouth, upper bench.	Wolf Creek middle, coal group.	Williams Fork	32971	3.4	A	12.2	34.6	41.8	11.4	.5					5,665	10,200
							B	9.1	35.8	43.3	11.8	.5					5,860	10,550
							C		39.4	47.6	13.0	.5					6,450	11,610
							D		45.3	54.7		.6					7,410	13,340
Do	129	1,000 ft northwest of mine mouth, lower bench.	do	do	32972	3.4	A	12.5	36.7	43.4	7.4	.4					6,000	10,800
							B	9.4	38.0	45.0	7.6	.4					6,210	11,180
							C		41.9	49.7	8.4	.5					6,855	12,340
							D		45.8	54.2		.5					7,485	13,480
Do	129	Composite of Lab. nos. 32971 and 32972.	do	do	32973	3.4	A	12.2	35.5	42.9	9.4	.42	5.42	60.02	1.34	23.38	5,845	10,520
							B	9.2	36.7	44.4	9.7	.43	5.23	62.11	1.39	21.09	6,045	10,880
							C		40.4	48.9	10.7	.48	4.63	68.40	1.53	14.22	6,660	11,990
							D		45.3	54.7		.54	5.19	76.73	1.71	15.93	7,460	13,430
Mine no. 1 of McNeil Coal Co. at McGregor, SE¼ sec. 16, T. 6 N., R. 86 W.	122	Working face, 1,600 ft south of mine mouth.	do	do	32974	3.0	A	11.8	35.7	41.8	10.7	.47	5.39	59.37	1.28	22.84	5,675	10,210
							B	9.1	36.8	43.1	11.0	.48	5.22	61.20	1.32	20.80	5,850	10,530
							C		40.5	47.4	12.1	.53	4.63	67.31	1.45	14.01	6,430	11,580
							D		46.1	53.9		.60	5.27	76.55	1.65	15.93	7,315	13,170
Mine no. 3 of McNeil Coal Co. at McGregor, SE¼ sec. 16, T. 6 N., R. 86 W.	123	Face of main entry, 385 ft from mine mouth.	Wadge, middle coal group.	do	32975	4.3	A	13.8	36.3	43.5	6.4	.63	5.68	61.06	1.53	24.67	5,615	10,110
							B	9.9	38.0	45.4	6.7	.66	5.44	64.83	1.60	21.75	5,870	10,570
							C		42.1	50.4	7.5	.73	4.81	70.83	1.77	14.40	6,515	11,730
							D		45.5	54.5		.795	.207	6.541	.91	15.56	7,040	12,670

Tow Creek mine of Tow Creek Coal Co., 1 mile west of Milner, NE¼ sec. 17, T. 6 N., R. 86 W.	124	Main entry, 150 ft from mouth.	Lower coal group.	Iles	B57508	7.8	A	13.3	33.8	49.1	3.8	.5	6.0	64.8	1.4	23.5	----	11,470
							B	6.0	36.6	53.3	4.1	.5	5.6	70.2	1.5	18.1	----	12,430
							C	----	38.9	56.7	4.4	.6	5.3	74.7	1.6	13.4	----	13,220
							D	----	40.7	59.3	----	.6	5.5	78.1	1.7	14.1	----	13,830
Mine of Schmidt brothers, 1¼ miles northwest of McGregor, SE¼NE¼ sec. 8, T. 6 N., R. 86 W.	117a	Face of main entry, 15 ft north of rock tunnel.	Unnamed, lower coal group.	do	A2698	6.0	A	12.3	35.1	48.6	4.0	1.2	----	----	----	----	6,300	11,340
							B	6.7	37.4	51.7	4.2	1.2	----	----	----	----	6,700	12,060
							C	----	40.1	55.4	4.5	1.3	----	----	----	----	7,185	12,930
							D	----	42.0	58.0	----	1.4	----	----	----	----	7,520	13,540
Amos McCroskey mine, 2 miles north of McGregor, NW¼ sec. 4, T. 6 N., R. 86 W.	113	Southeast wall, 125 ft northeast of mine mouth.	do	do	A3336	5.0	A	10.7	34.7	49.1	5.5	.5	----	----	----	----	6,390	11,500
							B	6.1	36.5	51.6	5.8	.5	----	----	----	----	6,720	12,100
							C	----	38.8	55.0	6.2	.6	----	----	----	----	7,155	12,880
							D	----	41.4	58.6	----	.6	----	----	----	----	7,620	13,720
Do	113	Right rib, no. 4 room, 170 ft off main entry.	do	do	A72343	4.4	A	10.9	32.2	51.2	5.7	.6	5.8	65.3	1.4	21.2	6,372	11,470
							B	----	36.1	57.5	6.4	.6	5.1	73.3	1.5	13.1	7,150	12,870
							C	----	38.6	61.4	----	.7	5.5	78.3	1.7	13.8	7,639	13,750
							D	----	----	----	----	----	----	----	----	----	----	----
Do	114	Face of main entry, 240 ft from mine mouth.	do	do	A4949	7.4	A	11.7	35.8	47.1	5.4	.5	5.9	64.5	1.4	22.3	6,270	11,290
							B	4.7	38.7	50.8	5.8	.6	5.4	69.6	1.5	17.1	6,770	12,190
							C	----	40.6	53.3	6.1	.6	5.1	73.0	1.6	13.6	7,105	12,790
							D	----	43.2	56.8	----	.6	5.5	77.8	1.7	14.4	7,565	13,620
Rice mine, 2 miles northeast of Bear River, NW¼ sec. 1, T. 6 N., R. 87 W.	163	Old face, 300 ft southwest of mine mouth (old mine).	do	do	A2394	5.6	A	10.7	37.8	47.0	4.5	.7	----	----	----	----	6,420	11,560
							B	5.3	40.1	49.8	4.8	.7	----	----	----	----	6,805	12,250
							C	----	42.3	52.7	5.0	.8	----	----	----	----	7,195	12,950
							D	----	44.6	55.4	----	.8	----	----	----	----	7,570	13,630
Do	163	Face of main entry, 155 ft from mine mouth.	do	do	A42971	1.7	A	9.9	38.3	46.1	5.7	.6	5.9	65.2	1.4	21.2	6,439	11,590
							C	----	42.5	51.2	6.3	.7	5.3	72.3	1.5	13.9	7,144	12,860
							D	----	45.3	54.7	----	.7	5.6	77.1	1.6	15.0	7,622	13,720
Old Butcher Knife mine, 2 miles northeast of Bear River, NW¼ sec. 1, T. 6 N., R. 87 W.	164	200 ft southwest of mine mouth.	do	do	A2395	6.6	A	11.6	36.1	48.0	4.3	.6	----	----	----	----	6,360	11,450
							B	5.4	38.6	51.4	4.6	.7	----	----	----	----	6,815	12,270
							C	----	40.8	54.3	4.9	.7	----	----	----	----	7,200	12,960
							D	----	42.9	57.1	----	.8	----	----	----	----	7,570	13,630
No 1 mine of Bear River Coal Co., Bear River, SW¼ sec. 11, T. 6 N., M. 87 W.	170	375 ft west of mine mouth.	Bear River, lower coal group.	do	22724	3.3	A	10.5	37.4	47.1	5.0	.5	----	----	----	----	6,515	11,730
							B	7.4	38.7	48.7	5.2	.5	----	----	----	----	6,735	12,120
							C	----	41.8	52.6	5.6	.6	----	----	----	----	7,275	13,100
							D	----	44.3	55.7	----	.6	----	----	----	----	7,710	13,880
Do	170	Face of *A* panel, no. 4 south entry.	do	do	A2187	5.1	A	9.9	35.8	49.3	5.0	.5	----	----	----	----	6,550	11,790
							B	5.0	37.8	51.9	5.3	.5	----	----	----	----	6,900	12,420
							C	----	39.7	54.8	5.5	.5	----	----	----	----	7,260	13,070
							D	----	42.1	57.9	----	.6	----	----	----	----	7,690	13,840
Do	170	Face of no. 4 north entry.	do	do	A2188	5.4	A	9.7	36.1	49.0	5.2	.3	----	----	----	----	6,555	11,800
							B	4.5	38.2	51.8	5.5	.3	----	----	----	----	6,935	12,480
							C	----	40.0	54.3	5.7	.3	----	----	----	----	7,260	13,070
							D	----	42.4	57.6	----	.3	----	----	----	----	7,700	13,860

TABLE 1.—*Analyses of coal samples from parts of Routt and Moffat Counties, Colo.*—Continued

Mine and location	No. on map	Location in mine	Coal bed and group	Formation	Lab. no	Air-drying loss	Form of analysis	Proximate				Ultimate					Heating value	
								Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu
No. 1 mine of Bear River Coal Co., Bear River, SW¼ sec. 11, T. 6 N., M. 87 W.	170	60 ft from D panel, no. 4 moth entry.	Bear River, lower coal group.	Iles	A2189	4.5	A	9.1	36.0	48.4	6.5	.3	----	----	----	----	6,520	11,740
							B	4.8	37.7	50.7	6.8	.3	----	----	----	----	6,835	12,300
							C	----	39.6	53.2	7.2	.3	----	----	----	----	7,180	12,920
							D	----	42.6	57.4	----	.4	----	----	----	----	7,735	13,920
Do	170	No. 1 room, *F* panel, no. 2 opening.	---do	---do	A2190	4.9	A	10.1	36.4	48.3	5.2	.6	----	----	----	----	6,505	11,710
							B	5.5	38.2	50.8	5.5	.7	----	----	----	----	6,845	12,320
							C	----	40.4	53.8	5.8	.7	----	----	----	----	7,240	13,030
							D	----	42.9	57.1	----	.7	----	----	----	----	7,685	13,830
Do	170	Composite of lab. nos. A2187–A2190.	---do	---do	A2191	5.0	A	9.7	36.4	48.5	5.4	.5	5.7	66.9	1.3	20.2	6,550	11,790
							B	5.0	38.4	50.9	5.7	.5	5.5	70.4	1.4	16.5	6,890	12,400
							C	----	40.4	53.7	5.9	.5	5.2	74.1	1.5	12.8	7,250	13,050
							D	----	42.9	57.1	----	.6	5.5	78.7	1.6	13.6	7,710	13,880
Do	170	Face of drift entry, 750 ft of main slope.	---do	---do	B13146	4.6	A	9.3	36.0	50.7	4.0	1.0	----	----	----	----	6,728	12,110
							B	4.9	37.7	53.2	4.2	1.1	----	----	----	----	7,056	12,700
							C	----	39.7	55.9	4.4	1.1	----	----	----	----	7,417	13,350
							D	----	41.5	58.5	----	1.2	----	----	----	----	7,756	13,960
Do	170	Room no. 1 off upper *A* entry, 1,000 ft from slope mouth.	---do	---do	B13147	5.0	A	9.5	35.6	50.1	4.8	.5	----	----	----	----	6,672	12,010
							B	4.7	37.5	52.7	5.1	.6	----	----	----	----	7,022	12,640
							C	----	39.4	55.3	5.3	.6	----	----	----	----	7,367	13,260
							D	----	41.6	58.4	----	.6	----	----	----	----	7,783	14,010
Do	170	130 ft south of main prospect slope and 1,500 ft from mouth.	---do	---do	B13148	4.8	A	9.4	35.9	49.9	4.8	.6	----	----	----	----	6,650	11,970
							B	4.9	37.7	52.4	5.0	.6	----	----	----	----	6,989	12,580
							C	----	39.7	55.1	5.2	.6	----	----	----	----	7,344	13,220
							D	----	41.9	58.1	----	.6	----	----	----	----	7,750	13,950
Do	170	Composite of lab. nos. B13146–B13148.	---do	---do	----	4.8	A	9.4	35.7	50.3	4.6	.7	5.8	68.9	1.3	18.7	6,689	12,040
							B	4.9	37.5	52.8	4.8	.8	5.5	72.4	1.4	15.1	7,022	12,640
							C	----	39.5	55.4	5.1	.8	5.2	76.1	1.5	11.3	7,383	13,290
							D	----	41.6	58.4	----	----	5.5	80.1	1.5	12.1	7,778	14,000
Abandoned mine, ½ mile south of Bear River, on south bank of Yampa River, sec. 14, T. 6 N., R. 87 W.	172	Face of drift, 100 ft from opening.	---do	---do	A2483	4.6	A	10.1	36.3	45.4	8.2	.6	----	----	----	----	6,285	11,310
							B	5.7	38.1	47.6	8.6	.6	----	----	----	----	6,590	11,860
							C	----	40.4	50.5	9.1	.7	----	----	----	----	6,990	12,580
							D	----	44.4	55.6	----	.7	----	----	----	----	7,685	13,830

Allen prospect, ¾ mile south of Bear River, sec. 14, T. 6 N., R. 87 W.	171a	300 ft from mine mouth	do	do	A2480	7.1	A	12.9	33.3	47.3	6.5	.5							6,140	11,050
							B	6.3	35.9	50.8	7.0	.5							6,610	11,900
							C		38.3	54.2	7.5	.5							7,055	12,700
							D		41.4	58.6		.6							7,620	13,720
Allen or Hawkeye prospect, 1 mile south of Bear River, sec. 23, T. 6 N., R. 87 W.	173	500 ft from mine mouth	Bear River (?), lower coal group.	do	A2481	3.6	A	9.1	35.8	50.1	5.0	.5							6,610	11,900
							B	5.8	37.1	51.9	5.2	.5							6,860	12,350
							C		39.4	55.1	5.5	.5							7,280	13,100
							D		41.7	58.3		.6							7,705	13,870
Indian Creek mine of Routt Pinnacle Coal Co., at Coalview, NE¼ sec. 23, T. 6 N., R. 87 W.	182	Face of no. 5 room, *B* slope	Lower coal group.	do	32,987	3.9	A	9.3	38.0	45.6	7.1	.49	5.46	65.13	1.30	20.51	6,420	11,550
							B	5.7	39.5	47.4	7.4	.51	5.23	67.75	1.35	17.76	6,675	12,020
							C		41.9	50.3	7.8	.54	4.88	71.81	1.43	13.50	7,075	12,740
							D		45.5	54.5		.59	5.30	77.92	1.55	14.64	7,680	13,820
Do	182	Face of no. 4 room, *B* raise	do	do	A2482	5.0	A	9.9	36.6	48.0	5.5	.5					6,505	11,710
							B	5.2	38.6	50.4	5.8	.5					6,850	12,330
							C		40.7	53.2	6.1	.5					7,220	13,000
							D		43.3	56.7		.6					7,690	13,840
Mount Harris district																				
Harris mine of Colorado and Utah Coal Co., Mt. Harris, SW¼SW¼ sec. 15, T. 6 N., R. 87 W.	177	Main entry, 2,600 ft south of mine mouth.	Wadge, middle coal group.	Williams Fork	22737	2.7	A	10.6	38.4	45.9	5.1	.4					6,460	11,620
							B	8.1	39.5	47.2	5.2	.4					6,640	11,950
							C		43.0	51.3	5.7	.5					7,230	13,010
							D		45.6	54.4		.5					7,660	13,790
Do	177	Main dip entry, 1,700 ft southwest of mine mouth.	do	do	22738	2.5	A	10.3	37.8	45.6	6.3	.4					6,400	11,520
							B	8.0	38.7	46.8	6.5	.4					6,565	11,820
							C		42.1	50.9	7.0	.5					7,135	12,850
							D		45.3	54.7		.5					7,680	13,820
Do	177	Hill entry, 800 ft southeast of mine mouth.	do	do	22739	2.9	A	10.4	38.5	43.8	7.3	.5					6,285	11,310
							B	7.7	39.7	45.1	7.5	.5					6,470	11,650
							C		43.0	48.9	8.1	.5					7,015	12,630
							D		46.8	53.2		.6					7,635	13,750
Do	177	Composite of lab. nos. 22737–22739.	do	do	22740	2.7	A	10.4	37.9	45.5	6.2	.42	5.85	64.87	1.59	21.05	6,370	11,470
							B	7.9	39.0	46.7	6.4	.43	5.70	66.68	1.63	19.17	6,550	11,790
							C		42.3	50.8	6.9	.47	5.24	72.39	1.77	13.19	7,110	12,800
							D		45.4	54.6		.51	5.63	77.79	1.90	14.17	7,640	13,750
Do	177	Face of *U* raise, 2,500 ft above main south entry, 8,000 ft south of mine mouth.	do	do	C26467	2.0	A	10.3	36.6	44.5	8.6	.4	5.7	63.2	1.5	20.6		11,030
							B	8.5	37.3	45.4	8.8	.5	5.6	64.5	1.6	19.0		11,260
							C		40.8	49.6	9.6	.5	5.1	70.4	1.7	12.7		12,300
							D		45.1	54.9			5.6	77.9	1.9	14.1		13,610
Do	177	Left rib, 20 ft from no. 10 south entry.	do	do	31199	5.5	A	10.4	38.2	46.5	4.9	.4					6,475	11,660
							B	5.2	40.4	49.2	5.2	.4					6,855	12,340
							C		42.6	51.9	5.5	.5					7,225	13,010
							D		45.1	54.9		.5					7,650	13,770

TABLE 1.—*Analyses of coal samples from parts of Routt and Moffat Counties, Colo.*—Continued

Mine and location	No. on map	Location in mine	Coal bed and group	Formation	Lab. no	Air-drying loss	Form of analysis	Proximate				Ultimate					Heating value	
								Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu
Mount Harris district—Continued																		
Harris mine of Colorado and Utah Coal Co., Mt. Harris SW ¼ SW ¼ sec. 15 T. 6 N., R. 87 W.	177	No. 3 east entry, main south slope.	Wadge, middle coal group.	Williams Fork	31200	7.1	A	12.4	37.6	44.2	5.8	.4	----	----	----	----	6,210	11,180
							B	5.7	40.5	47.6	6.2	.5	----	----	----	----	6,685	12,040
							C	----	42.9	50.5	6.6	.5	----	----	----	----	7,090	12,770
							D	----	46.0	54.0	----	.5	----	----	----	----	7,590	13,670
Do	177	*G* slope, left rib, main south entry.	do	do	31201	5.8	A	10.6	37.6	46.2	5.6	.4	----	----	----	----	6,415	11,550
							B	5.2	39.8	49.0	6.0	.4	----	----	----	----	6,810	12,260
							C	----	42.0	51.7	6.3	.5	----	----	----	----	7,180	12,920
							D	----	44.8	55.2	----	.5	----	----	----	----	7,665	13,790
Do	177	Face of no. 7 east back entry, no. 2 south entry.	do	do	31202	6.4	A	11.4	37.2	45.4	6.0	.4	----	----	----	----	6,275	11,300
							B	5.4	39.7	48.5	6.4	.4	----	----	----	----	6,700	12,060
							C	----	42.0	51.3	6.7	.5	----	----	----	----	7,085	12,760
							D	----	45.0	55.0	----	.5	----	----	----	----	7,600	13,680
Do	177	No. 10 east entry, main south entry.	do	do	31203	5.4	A	10.8	37.2	45.3	6.7	.4	----	----	----	----	6,255	11,260
							B	5.7	39.3	48.0	7.0	.4	----	----	----	----	6,610	11,900
							C	----	41.7	50.8	7.5	.5	----	----	----	----	7,015	12,620
							D	----	45.0	55.0	----	.5	----	----	----	----	7,580	13,640
Do	177	Left rib, last crosscut in *A* slope.	do	do	31204	5.0	A	9.9	38.0	46.3	5.8	.4	----	----	----	----	6,445	11,600
							B	5.2	40.0	48.7	6.1	.4	----	----	----	----	6,785	12,210
							C	----	42.2	51.4	6.4	.4	----	----	----	----	7,150	12,870
							D	----	45.1	54.9	----	.5	----	----	----	----	7,645	13,760
Do	177	Left rib, main south entry.	do	do	31205	6.0	A	11.3	38.3	46.4	4.0	.4	----	----	----	----	6,465	11,640
							B	5.6	40.8	49.4	4.2	.4	----	----	----	----	6,880	12,380
							C	----	43.2	52.3	4.5	.4	----	----	----	----	7,290	13,120
							D	----	45.2	54.8	----	.5	----	----	----	----	7,630	13,730
Do	177	Rib of main dip entry	do	do	31206	5.8	A	10.8	37.8	45.3	6.1	.4	----	----	----	----	6,355	11,440
							B	5.3	40.1	48.1	6.5	.5	----	----	----	----	6,750	12,150
							C	----	42.4	50.8	6.8	.5	----	----	----	----	7,125	12,820
							D	----	45.5	54.5	----	.5	----	----	----	----	7,645	13,770
Do	177	Composite of lab. nos. 31199–31206.	do	do	31207	5.9	A	11.0	37.7	45.7	5.6	.41	5.76	65.31	1.63	21.26	6,365	11,460
							B	5.4	40.0	48.6	6.0	.44	5.43	69.39	1.73	17.03	6,760	12,170
							C	----	42.3	51.4	6.3	.46	5.10	73.36	1.83	12.93	7,150	12,870
							D	----	45.2	54.8	----	.49	5.44	78.31	1.95	13.81	7,630	13,730

Do	177	Bottom of *A* slope	do	do	A2179	5.4	A	9.2	37.0	47.7	6.1	.5					6,500	11,700
							B	4.0	39.1	50.5	6.4	.5					6,865	12,360
							C		40.7	52.6	6.7	.5					7,150	12,870
							D		43.6	56.4		.5					7,665	13,800
Do	177	Face of main south entry	do	do	A2180	5.9	A	10.1	36.8	46.9	6.2	.4					6,410	11,540
							B	4.5	39.1	49.8	6.6	.4					6,810	12,260
							C		41.0	52.1	6.9	.5					7,135	12,840
							D		44.0	56.0		.5					7,660	13,790
Do	177	Face of slope entry	do	do	A2181	4.9	A	9.8	36.7	47.3	6.2	.4					6,370	11,470
							B	5.1	38.6	49.8	6.5	.5					6,700	12,060
							C		40.6	52.5	6.9	.5					7,060	12,710
							D		43.6	56.4		.5					7,585	13,650
Do	177	Head of main diagonal entry.	do	do	A2182	5.1	A	8.9	36.8	46.7	7.6	.5					6,430	11,570
							B	4.0	38.8	49.1	8.1	.5					6,770	12,190
							C		40.4	51.2	8.4	.5					7,055	12,700
							D		44.1	55.9		.6					7,700	13,860
Do	177	Composite of lab. nos. A2179–A2182.	do	do	A2183	5.3	A	9.7	36.9	46.9	6.5	.5	5.8	65.5	1.6	20.1	6,450	11,610
							B	4.7	39.0	49.4	6.9	.5	5.5	69.2	1.7	16.2	6,810	12,260
							C		40.9	51.9	7.2	.5	5.2	72.6	1.8	12.7	7,145	12,860
							D		44.1	55.9		.6	5.6	78.2	1.9	13.7	7,700	13,860
Do	177	Left rib, no. 10 south entry	do	do	A72339	1.9	A	8.9	38.4	47.7	5.0	.4	6.0	67.5	1.6	19.5	6,661	11,990
							C		42.1	52.4	5.5	.5	5.5	74.0	1.7	12.8	7,311	13,160
							D		44.6	55.4		.5	5.8	78.4	1.8	13.5	7,739	13,930
Colorado & Utah Coal Co.'s prospect mine, Sec. 15, T. 6 N., R. 87 W.	177	Face of main entry, upper bench.	Wolf Creek, middle coal group.	Iles	A2184	3.7	A	7.7	36.9	45.9	9.5	.4					6,355	11,440
							B	4.1	38.3	47.7	9.9	.4					6,600	11,880
							C		39.9	49.8	10.3	.4					6,885	12,390
							D		44.5	55.5		.5					7,670	13,810
Do	177	Face of main entry, lower bench.	do	do	A2185	5.3	A	9.3	36.2	45.2	9.3	.4					6,230	11,210
							B	4.2	38.3	47.7	9.8	.4					6,580	11,840
							C		39.9	49.8	10.3	.4					6,865	12,360
							D		44.5	55.5		.5					7,650	13,770
Do	177	Composite of lab nos. A2184 and A2185.	do	do	A2186	4.5	A	8.7	36.7	45.1	9.5	.4	5.6	64.4	1.3	18.8	6,295	11,330
							B	4.4	38.5	47.2	9.9	.4	5.3	67.4	1.3	15.7	6,595	11,870
							C		40.2	49.4	10.4	.5	5.0	70.5	1.4	12.2	6,895	12,410
							D		44.9	55.1		.5	5.6	78.7	1.5	13.7	7,690	13,840

TABLE 1.—*Analyses of coal samples from parts of Routt and Moffat Counties, Colo.*—Continued

Mine and location	No. on map	Location in mine	Coal bed and group	Formation	Lab. no	Air-drying loss	Form of analysis	Proximate				Ultimate					Heating value	
								Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu
Mount Harris district—Continued																		
No. 1 Wadge mine of Victor-American Fuel Co., Mt. Harris, sec. 15, T. 6 N., R. 87 W.	175	Face of no. 3 north entry, main entry.	Wadge, middle coal group.	Williams Fork	31233	6.9	A	11.5	37.8	45.9	4.8	.4	----	----	----	----	6,390	11,500
							B	5.0	40.5	49.3	5.2	.4	----	----	----	----	6,860	12,350
							C	----	42.7	51.9	5.4	.5	----	----	----	----	7,215	12,990
							D	----	45.1	54.9	----	.5	----	----	----	----	7,630	11,740
Do	175	Face of no. 1 north entry, main entry.	....do	....do	31234	6.3	A	11.0	37.9	45.4	5.7	.5	----	----	----	----	6,350	11,430
							B	4.9	40.5	48.5	6.1	.5	----	----	----	----	6,780	12,210
							C	----	42.6	51.0	6.4	.5	----	----	----	----	7,135	12,840
							D	----	45.5	54.5	----	.6	----	----	----	----	7,630	13,730
Do	175	Composite of lab Nos. 31233 and 31234.	....do	....do	31235	6.6	A	11.3	37.6	45.8	5.3	.45	5.75	64.99	1.54	21.95	6,370	11,460
							B	5.0	40.3	49.0	5.7	.48	5.38	69.59	1.65	17.20	6,820	12,270
							C	----	42.4	51.6	6.0	.51	5.07	73.24	1.74	13.44	7,175	12,920
							D	----	45.1	54.9	----	.54	5.39	77.91	1.85	14.31	7,635	13,740
Do	175	Face of no. 2 east entry	....do	....do	A2484	4.6	A	11.0	36.9	46.9	5.2	.4	----	----	----	----	6,405	11,530
							B	6.7	38.7	49.1	5.5	.5	----	----	----	----	6,715	12,090
							C	----	41.5	52.6	5.9	.5	----	----	----	----	7,200	12,960
							D	----	44.1	55.9	----	.5	----	----	----	----	7,650	13,770
No. 2 Wadge mine of Victor-American Coal Co., Mt. Harris, sec. 15, T. 6 N., R. 87 W.	176	Face of no. 6 east entry, no. 7 north entry.	....do	....do	A2485	4.1	A	11.3	37.0	46.4	5.3	.5	----	----	----	----	6,430	11,570
							B	7.5	38.6	48.3	5.6	.6	----	----	----	----	6,700	12,060
							C	----	41.7	52.3	6.0	.6	----	----	----	----	7,240	13,030
							D	----	44.4	55.6	----	.6	----	----	----	----	7,700	13,860
Do	176	25 ft. from face of main slope.	....do	....do	A2486	3.9	A	10.3	37.0	48.5	4.2	.5	----	----	----	----	6,645	11,960
							B	6.7	38.5	50.4	4.4	.5	----	----	----	----	6,910	12,440
							C	----	41.3	54.0	4.7	.5	----	----	----	----	7,405	13,330
							D	----	43.3	56.7	----	.5	----	----	----	----	7,770	13,990
Do	176	Face of no. 6 room *B* panel	....do	....do	A2487	3.9	A	10.8	36.0	46.5	6.7	.6	----	----	----	----	6,305	11,350
							B	7.1	37.4	48.5	7.0	.6	----	----	----	----	6,565	11,820
							C	----	40.3	52.2	7.5	.7	----	----	----	----	7,065	12,720
							D	----	43.6	56.4	----	.7	----	----	----	----	7,645	13,760
Do	176	Composite of A2485–A2487.	....do	....do	A2488	4.0	A	10.7	36.9	46.9	5.5	.5	5.8	66.0	1.6	20.6	6,460	11,630
							B	7.0	38.4	48.9	5.7	.5	5.6	68.7	1.7	17.8	6,730	12,110
							C	----	41.3	52.6	6.1	.5	5.2	73.8	1.8	12.6	7,235	13,020
							D	----	44.0	56.0	----	.6	5.5	78.7	1.9	13.3	7,705	13,870

Do	176	Face of no. 11 north entry	do	do	A34977	3.2	A	10.5	35.4	49.8	4.3	.4	5.9	66.6	1.7	21.1	6,511	11,720
							B											
							C											
							D											
No. 1 mine of International Coal Co., ½ mile northeast of Mt. Harris, sec. 15, T. 6 N., R. 87 W.	174	Air course, 300 ft. from mine mouth.	Wolf Creek, middle coal group.	do	22736	2.6	A	9.8	36.8	40.8	12.6	.4					5,945	10,700
							B	7.4	37.8	41.9	12.9	.5					6,105	10,990
							C		40.8	45.2	14.0	.5					6,595	11,870
							D		47.5	52.5		.6					7,665	13,800
Do	174	No. 4 room, no. 1 entry, slant slope, lower bench.	do	do	81684	2.1	A	10.1	36.6	44.7	8.6	.6					6,195	11,150
							B	8.2	37.4	45.6	8.8	.6					6,325	11,390
							C		40.7	49.7	9.6	.7					6,891	12,400
							D		45.0	55.0		.7					7,620	13,720
Do	174	No. 4 room, no. 1 entry, slant slope, upper bench.	do	do	81685	2.5	A	9.7	35.1	40.5	14.7	.5					5,685	10,240
							B	7.4	36.1	41.5	15.0	.5					5,830	10,500
							C		38.9	44.8	16.3	.6					6,295	11,330
							D		46.5	53.5		.7					7,515	13,530
Do	174	Face of *A* entry	do	do	81686	2.4	A	9.9	35.6	43.5	11.0	.5					6,030	10,850
							B	7.8	36.5	44.5	11.2	.5					6,175	11,120
							C		39.5	48.3	12.2	.6					6,695	12,050
							D		45.0	55.0		.6					7,625	13,720
Do	174	Composite of lab. nos. 81684–81686.	do	do	81687	2.3	A	9.8	36.4	42.2	11.6	.54	5.46	60.99	1.14	20.31	6,975	10,760
							B	7.7	37.3	43.2	11.8	.55	5.32	62.44	1.17	18.69	6,120	11,010
							C		40.4	46.8	12.8	.60	4.85	67.63	1.26	12.84	6,625	11,930
							D		46.3	53.7		.69	5.56	77.57	1.45	14.73	7,600	13,680
Moorehouse mine, 6 miles north of Mt. Harris, sec. 27, T. 7 N., R. 87 W.	197	Face of no. 1 room, left of main heading.	Lower coal group.	Iles	A3031	5.9	A	11.2	36.3	48.3	4.2	.6					6,485	11,670
							B	5.7	38.5	51.3	4.5	.7					6,890	12,400
							C		40.8	54.5	4.7	.7					7,300	13,140
							D		42.9	57.1		.7					7,665	13,800
Do	197	Face of main heading, new opening.	do	do	A3032	6.9	A	11.6	35.8	47.5	5.1	.6					6,380	11,480
							B	5.0	38.5	51.0	5.5	.6					6,850	12,330
							C		40.5	53.8	5.7	.7					7,210	12,980
							D		43.0	57.0		.7					7,650	13,770
Do	197	Composite of lab. nos. A3031 and A3032.	do	do	A3033	6.4	A	11.4	36.4	47.6	4.6	.6	5.8	65.8	1.4	21.8	6,440	11,590
							B	5.4	38.9	50.8	4.9	.7	5.5	70.3	1.5	17.1	6,880	12,380
							C		41.1	53.7	5.2	.7	5.1	74.3	1.6	13.1	7,265	13,080
							D		43.3	56.7		.8	5.4	78.4	1.7	13.7	7,665	13,800
Moauro mine, NE.¼ sec. 10, T. 6 N., R. 87 W.	168a	Face of main drift, 340 ft from mouth.	Wadge, middle coal group.	Williams Fork	A72852	1.7	A	11.1	33.3	49.2	6.4	.5	5.9	64.1	1.6	21.5	6,211	11,180
							B	9.6	33.9	50.0	6.5	.5	5.8	65.2	1.6	20.4	6,317	11,370
							C		37.4	55.4	7.2	.6	5.3	72.1	1.8	13.0	6,989	12,580
							D		40.4	59.6		.6	5.7	77.7	1.9	14.1	7,533	13,560

TABLE 1.—*Analyses of coal samples from parts of Routt and Moffat Counties, Colo.*—Continued

Mine and location	No. on map	Location in mine	Coal bed and group	Formation	Lab. no	Air-drying loss	Form of analysis	Proximate				Ultimate					Heating value	
								Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu
Pilot Knob district																		
No. 1 prospect of Moffat Coal Co., on Crawford tract, 12 miles NE. of Hayden, sec. 27, T. 8 N., R. 87 W.	212	Face of main heading, lower bench, 200 ft in from mouth.	Wolf Creek, middle coal group.	Williams Fork	A3035	2.8	A	4.1	23.0	65.1	7.8	.7	----	----	----	----	7,260	13,070
							B	1.4	23.7	66.9	8.0	.7	----	----	----	----	7,470	13,450
							C	----	24.0	67.9	8.1	.8	----	----	----	----	7,570	13,630
							D	----	26.1	73.9	----	.8	----	----	----	----	8,245	14,840
Do	212	Heading of old entry, top bench, 200 ft in from mouth.	do	do	A3036	4.7	A	8.7	32.9	42.5	15.9	.6	----	----	----	----	5,715	10,290
							B	4.2	34.5	44.6	16.7	.6	----	----	----	----	6,000	10,800
							C	----	36.0	46.5	17.5	.6	----	----	----	----	6,260	11,270
							D	----	43.7	56.3	----	.7	----	----	----	----	7,585	13,650
Do	212	Heading of old entry, lower bench, 200 ft in from mouth.	do	do	A3037	3.9	A	5.2	26.2	60.4	8.2	.7	----	----	----	----	7,165	12,900
							B	1.4	27.2	62.8	8.6	.7	----	----	----	----	7,455	13,420
							C	----	27.6	63.7	8.7	.7	----	----	----	----	7,560	13,610
							D	----	30.3	69.7	----	.8	----	----	----	----	8,285	14,910
Do	212	Composite of lab. nos. A3035-A3037.	do	do	A3038	3.8	A	6.1	27.4	55.7	10.8	.6	----	----	----	----	6,720	12,100
							B	2.4	28.5	57.9	11.2	.7	4.9	71.6	1.4	10.2	6,990	12,580
							C	----	29.2	59.3	11.5	.7	4.7	73.3	1.5	8.3	7,160	12,890
							D	----	32.9	67.1	----	.8	5.3	82.8	1.7	9.4	8,090	14,560
No. 2 prospect of Moffat Coal Co., on Crawford tract, 12 miles NE. of Hayden, sec. 27, T. 8 N., R. 87 W.	211	Grab sample of natural coke near contact with dike, 335 ft from mine mouth.	do	do	A3042	8.0	A	11.3	2.6	68.3	17.8	.6	----	----	----	----	5,650	10,170
							B	3.6	2.8	74.3	19.3	.7	----	----	----	----	6,140	11,050
							C	----	2.9	77.1	20.0	.7	----	----	----	----	6,365	11,460
							D	----	3.7	96.3	----	.9	----	----	----	----	7,960	14,330
Do	211	15 ft from dike, 320 ft from mine mouth.	do	do	A3043	6.9	A	8.2	5.5	74.8	11.5	1.0	----	----	----	----	6,690	12,040
							B	1.3	5.9	80.5	12.3	1.1	----	----	----	----	7,185	12,930
							C	----	6.0	81.5	12.5	1.1	----	----	----	----	7,285	13,110
							D	----	6.8	93.2	----	1.2	----	----	----	----	8,320	14,980
Do	211	40 ft from dike, 295 ft from mine mouth.	do	Williams Fork	A3044	5.7	A	6.7	5.5	77.1	10.7	.8	----	----	----	----	6,905	12,430
							B	1.1	5.8	81.7	11.4	.8	----	----	----	----	7,320	13,180
							C	----	5.8	82.7	11.5	.8	----	----	----	----	7,405	13,330
							D	----	6.6	93.4	----	.9	----	----	----	----	8,365	15,060

Do	211	75 ft from dike, 260 ft from mine mouth.	do	do	A3045	5.2	A	6.3	5.2	77.9	10.6	.7							6,945	12,500
							B	1.2	5.5	82.1	11.2	.8							7,320	13,180
							C		5.6	83.1	11.3	.8							7,405	13,330
							D		6.3	93.7		.9							8,355	15,040
Do	211	140 ft from dike, 195 ft from mine mouth.	do	do	A3046	6.3	A	8.1	7.7	70.1	14.1	.7							6,355	11,440
							B	1.8	8.2	75.0	15.0	.7							6,790	12,220
							C		8.4	76.3	15.3	.7							6,910	12,440
							D		9.9	90.1		.8							8,165	14,700
Do	211	175 ft from mine mouth	do	do	A3047	10.1	A	14.0	15.0	59.8	11.2	.6							5,565	10,020
							B	4.4	16.7	66.5	12.4	.7							6,190	11,140
							C		17.5	69.5	13.0	.7							6,480	11,660
							D		20.1	79.9		.8							7,445	13,400
Do	211	Composite of lab. nos. A3043–A3046.	do	do	A3048		A	7.3	5.6	75.4	11.7	.7	3.2	74.1	1.3	9.0			6,755	12,160
							B	1.3	6.0	80.2	12.5	.8	2.7	78.9	1.3	3.8			7,190	12,840
							C		6.1	81.3	12.6	.8	2.6	80.0	1.4	2.6			7,285	13,110
							D		7.0	93.0		.9	2.9	91.5	1.6	3.1			8,340	15,010
No. 3 prospect of Moffat Coal Co., on Craswford tract, 12 miles NE. of Hayden, NE¼ sec. 27, T. 8 N., R. 87 W.	210	Main heading, 125 ft north of mine mouth.	Wolf Creek(?), Middle coal group.	do	A3039	4.9	A	7.0	6.3	72.2	14.5	.6							6,415	11,550
							B	2.3	6.6	75.8	15.3	.7							6,745	12,140
							C		6.8	77.6	15.6	.7							6,900	12,420
							D		8.0	92.0		.8							8,180	14,720
Do	210	Small room, east wall of entry, 95 ft from mouth.	do	do	A3040	6.6	A	12.4	11.7	62.3	13.6	.5							5,550	9,990
							B	6.3	12.6	66.6	14.5	.5							5,945	10,700
							C		13.4	71.1	15.5	.5							6,340	11,410
							D		15.8	84.2		.6							7,500	13,500
Monger and Grey mine, 3½ miles north of Milner, SE¼ sec. 28, T. 7 N., R. 86 W.	141	300 ft east of mine mouth	Lower coal group	Iles	A3337	5.3	A	10.8	35.6	49.0	4.6	.6							6,480	11,660
							B	5.7	37.6	51.9	4.8	.6							6,845	12,320
							C		39.9	55.0	5.1	.7							7,260	13,070
							D		42.1	57.9		.7							7,650	13,770
Franz or Old Block mine, 3 miles south of Pilot Knob Mtn., SW¼ sec. 36, T. 8 N., R. 87 W.	219	Heading, 1,000 ft northeast of mine mouth.	do	do	A3049	6.8	A	11.7	35.4	49.1	3.8	.7							6,440	11,590
							B	5.2	38.0	52.7	4.1	.8							6,910	12,440
							C		40.1	55.6	4.3	.8							7,290	13,120
							D		41.9	58.1		.8							7,615	13,710
Keitel mine, Miller Gulch, 1 mile south of Pilot Knob Mtn., SW¼ sec. 24, T. 8 N., R. 87 W.	207	Main entry, 50 ft from mine mouth.	do	do	1946	5.7	A	10.8	34.3	49.4	5.5	.6								
							B	5.4	36.4	52.4	5.8	.6								
							C		38.5	55.4	6.1	.7								
							D		41.0	59.0		.7								
New Ducey mine, 1 mile southwest of Pilot Knob, NE¼ sec. 24, T. 8 N., R. 87 W.	205	100 ft north of mine mouth	do	do	A3034	5.9	A	12.0	34.4	50.7	2.9	.9							6,485	11,670
							B	6.5	36.6	53.8	3.1	1.0							6,895	12,410
							C		39.1	57.6	3.3	1.0							7,365	13,260
							D		40.4	59.6		1.1							7,615	13,710

TABLE 1.—*Analyses of coal samples from parts of Routt and Moffat Counties, Colo.*—Continued

Mine and location	No. on map	Location in mine	Coal bed and group	Formation	Lab. no	Air-drying loss	Form of analysis	Proximate				Ultimate					Heating value	
								Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu
Pilot Knob district—Continued																		
Block mine, NE¼ sec. 24. T 8 N., R. 87 W.	-----	Main west entry, 1,000 ft north of main entrance.	Lower coal group	Iles	A72345	4.4	A	11.4	33.4	52.4	2.8	.6	6.0	67.0	1.4	22.2	6,572	11,830
							B	7.3	34.9	54.9	2.9	.6	5.7	70.0	1.4	19.4	6,872	12,370
							C	----	37.6	59.2	3.2	.7	5.3	75.5	1.5	13.8	7,417	13,350
							D	----	38.9	61.1	-----	.7	5.5	78.0	1.6	14.2	7,661	13,790
Prospect on Shelton tract, 7 miles north of Deep Creek, SE¼ sec. 3, T. 9 N., R. 87 W.	152	25 ft from mouth of prospect pit.	do	do	A3051	5.8	A	8.5	13.4	72.1	6.0	.7	----	-----	----	-----	6,670	12,010
							B	2.8	14.2	76.6	6.4	.7	----	-----	----	-----	7,085	12,750
							C	----	14.6	78.8	6.6	.8	----	-----	----	-----	7,290	13,120
							D	----	15.7	84.3	-----	.8	----	-----	----	-----	7,800	14,040
Hayden district																		
Babson mine, on Dry Creek, 7 miles south of Hayden, NE¼ sec. 4, T. 5 N., R. 88 W.	229	Left drift, 150 ft southwest of mine mouth.	Dry Creek, upper coal group.	Williams Fork	93303	2.9	A	16.0	32.8	47.8	3.4	.4	----	-----	----	-----	6,065	10,920
							B	13.5	33.7	49.3	3.5	.4	----	-----	----	-----	6,245	11,240
							C	----	39.0	57.0	4.0	.5	----	-----	----	-----	7,215	12,990
							D	----	40.6	59.4	-----	.5	----	-----	----	-----	7,520	13,540
Do	229	No. 13 room, 500 ft from mine mouth, 100 ft north of main slope.	do	do	B57509	7.5	A	15.6	31.7	48.7	4.0	.3	6.1	62.2	1.7	25.7	-----	10,930
							B	8.8	34.3	52.6	4.3	.3	5.6	67.3	1.9	20.6	-----	11,830
							C	----	37.6	57.7	4.7	.4	5.1	73.8	2.0	14.0	-----	12,960
							D	----	39.5	60.5	-----	.4	5.4	77.4	2.1	14.7	-----	13,600
Do	229	No. 7 room south, main slope.	do	do	A34975	5.0	A	16.1	32.9	48.1	2.9	.4	6.1	62.9	1.7	26.0	6,044	10,880
							C	----	39.3	57.2	3.5	.5	5.1	75.1	2.1	13.8	7,211	12,980
							D	----	40.7	59.3	-----	.5	5.3	77.7	2.1	14.4	7,467	13,440
Dry Creek mine, Cryell Coal Co., on Dry Creek, 7 miles south of Hayden, NE¼ sec. 4, T. 5 N., R. 88 W.	230	600 ft from mouth, No. 5 room south, 200 ft south of main slope.	do	do	B57510	6.4	A	15.0	31.3	49.6	4.1	.3	6.0	62.4	1.6	25.6	-----	10,920
							B	9.2	33.5	52.9	4.4	.3	5.6	66.6	1.8	21.3	-----	11,670
							C	----	36.9	58.3	4.8	.4	5.1	73.4	1.9	14.4	-----	12,850
							D	----	38.7	61.3	-----	.4	5.3	77.1	2.0	15.2	-----	13,500
Do	230	North entry, 500 ft west of mine mouth.	do	do	93305	2.4	A	14.2	32.4	48.4	5.0	.4	----	-----	----	-----	6,065	10,920
							B	12.1	33.2	49.5	5.2	.4	----	-----	----	-----	6,215	11,190
							C	----	37.8	56.3	5.9	.4	----	-----	----	-----	7,070	12,730
							D	----	40.2	59.8	-----	.5	----	-----	----	-----	7,515	13,530

Crow Bar Mine, Dry Creek Coal Co., SE¼ sec. 4, T. 4 N., R. 88 W.	231	Tipple sample (50 tons)	do	do	D54454	7.6	A	15.0	33.2	47.3	4.5	.3						10,880	10,880
							B	8.0	35.9	51.2	4.9	.3						11,780	11,780
							C		39.1	55.6	5.3	.3						12,800	12,800
							D		41.2	58.8		.3						13,520	13,520
Do	231	Tipple sample (20 tons)	do	do	D54455	7.4	A	14.7	32.6	48.2	4.5	.2						10,860	10,860
							B	7.9	35.2	52.0	4.9	.2						11,730	11,730
							C		38.2	56.5	5.3	.2						12,730	12,730
							D		40.3	59.7		.3						13,440	13,440
Do	231	Tipple sample (30 tons)	do	do	D54456	7.5	A	14.8	31.9	47.9	5.4	.3						10,740	10,740
							B	7.9	34.6	51.6	5.9	.3						11,620	11,620
							C		37.5	56.1	6.4	.3						12,600	12,600
							D		40.0	60.0		.3						13,460	13,460
Do	231	do	do	do	D54457	7.9	A	14.6	31.3	49.4	4.7	.2						10,800	10,800
							B	7.3	34.0	53.6	5.1	.3						11,730	11,730
							C		36.6	57.9	5.5	.3						12,650	12,650
							D		38.8	61.2		.3						13,390	13,390
Sleepy Cat (lower bed abandoned), NW¼ sec. 16, T. 5 N., R. 88 W.	237	Face of main slope	Bed *L* (?), upper coal group.	do	A23375	3.7	A	14.4	32.6	48.5	4.5	.9	6.0	63.2	1.5	23.9	6,139	11,040	11,040
							C		38.1	56.6	5.3	1.0	5.1	73.8	1.8	13.0	7,172	12,910	12,910
							D		40.3	59.7		1.1	5.4	78.0	1.9	13.6	7,572	13,630	13,630
Cary mine, 10 miles southwest of Hayden, SW¼ sec. 31, T. 6 N., R. 89 W.	335	140 ft in from mine mouth	Bed *I*, upper coal group.	do	22775	4.5	A	16.9	32.2	45.5	5.4	.4					5,755	10,360	10,360
							B	12.9	33.8	47.6	5.7	.4					6,030	10,850	10,850
							C		38.8	54.7	6.5	.5					6,920	12,460	12,460
							D		41.5	58.5		.5					7,405	13,330	13,330
Do	335	Small room, right of main entry.		do	92663	4.7	A	13.4	34.0	47.8	4.8	.6	5.7	62.6	1.6	24.7	6,060	10,910	10,910
							B	9.1	35.7	50.2	5.0	.6	5.5	65.7	1.7	21.5	6,360	11,450	11,450
							C		39.3	55.2	5.5	.7	4.9	72.3	1.8	14.8	7,000	12,600	12,600
							D		41.6	58.4		.7	5.2	76.5	1.9	15.7	7,410	13,340	13,340
Lindholm mine on Sage Creek, 9 miles southeast of Hayden, sec. 30, T. 5 N., R. 87 W.	159	Face of no. 1 left room	Middle coal group.	do	94195	3.4	A	12.3	33.6	43.0	11.1	.4					5,690	10,240	10,240
							B	9.3	34.8	44.4	11.5	.4					5,885	10,590	10,590
							C		38.4	48.9	12.7	.5					6,490	11,680	11,680
							D		44.0	56.0		.5					7,435	13,380	13,380
Mine on Sage Creek, near mouth of canyon, (11-ft seam), sec. 2, T. 5 N., R. 88 W.	246	Main entry, 40 feet from mine mouth.	do	do	2032	2.7	A	11.0	35.8	47.5	5.7	.5					6,315	11,370	11,370
							B	8.6	36.8	48.8	5.8	.5					6,490	11,680	11,680
							C		40.3	53.3	6.4	.6					7,100	12,780	12,780
							D		43.0	57.0		.6					7,580	13,640	13,640
Rose mine, 3 miles southwest of Hayden, NW¼ sec. 18, T. 6 N., R. 88 W.	244	150 ft southwest of mine mouth.	Unnamed	Lance	93317	5.8	A	20.1	31.5	44.2	4.2	.3					5,390	9,700	9,700
							B	15.2	33.4	47.0	4.4	.3					5,715	10,290	10,290
							C		39.4	55.4	5.2	.3					6,745	12,140	12,140
							D		41.5	58.5		.3					7,110	12,800	12,800
Stroud mine, 3 miles southwest of Hayden, NW¼ sec. 18, T. 6 N., R. 88 W.	243	200 ft southeast of mine mouth.	do	do	93318	5.2	A	19.7	31.3	45.1	3.9	.5					5,515	9,930	9,930
							B	15.3	33.0	47.6	4.1	.5					5,820	10,480	10,480
							C		38.9	56.2	4.9	.6					6,870	12,370	12,370
							D		40.9	59.1		.7					7,220	13,000	13,000

TABLE 1.—*Analyses of coal samples from parts of Routt and Moffat Counties, Colo.*—Continued

Mine and location	No. on map	Location in mine	Coal bed and group	Formation	Lab. no	Air-drying loss	Form of analysis	Proximate				Ultimate					Heating value	
								Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu
Hayden district—Continued																		
Lorella mine, 1½ miles northwest of Hayden, SE¼ sec. 32, T. 7 N., R. 88 W.	258	Main heading, 475 ft northeast of mine mouth.	Lorella bed	Lance	94193	5.9	A	19.6	29.3	44.6	6.5	.5	----	----	----	----	5,370	9,670
							B	14.6	31.2	47.3	6.9	.6	----	----	----	----	5,710	10,280
							C	----	36.5	55.4	8.1	.7	----	----	----	----	6,685	12,030
							D	----	39.7	60.3	----	.7	----	----	----	----	7,265	13,080
"Ghosthole" mine (Wm. Kleckner), 8 miles north of Hayden, NW¼ sec. 5, T. 7 N., R. 88 W.	251	Small room, left of heading.	Unnamed	do	94194	4.9	A	16.7	31.3	46.4	5.6	.4	----	----	----	----	5,755	10,360
							B	12.4	32.9	48.8	5.9	.4	----	----	----	----	6,055	10,900
							C	----	37.6	55.7	6.7	.5	----	----	----	----	6,910	12,440
							D	----	40.3	59.7	----	.5	----	----	----	----	7,410	13,340
White mine, 9 miles east of Craig, NE¼ sec. 4, T. 6 N., R. 89 W.	334	170 ft from mine mouth	do	do	92662	8.7	A	20.7	32.4	42.9	4.0	.5	----	----	----	----	5,405	9,730
							B	13.1	35.5	47.0	4.4	.5	----	----	----	----	5,920	10,660
							C	----	40.9	54.1	5.0	.6	----	----	----	----	6,815	12,270
							D	----	43.0	57.0	----	.6	----	----	----	----	7,180	12,920
F. M. Hindman mine, 3 miles east of Craig, SW¼ sec. 33, T. 7 N., R. 90 W.	423	Face of north wall, main entry.	Kimberly bed	do	A3770	3.6	A	20.1	30.4	45.0	4.5	.6	----	----	----	----	5,400	9,720
							B	17.1	31.5	46.7	4.7	.6	----	----	----	----	5,600	10,080
							C	----	38.0	56.4	5.6	.8	----	----	----	----	6,750	12,150
							D	----	40.3	59.7	----	.8	----	----	----	----	7,155	12,880
Haughy mine, 2½ miles east of Craig, SW¼ sec. 33, T. 7 N., R. 90 W.	422	Small room off main heading.	do	do	92665	9.6	A	21.8	31.6	42.5	4.1	.7	6.1	55.8	1.3	32.0	5,365	9,660
							B	13.5	35.0	47.0	4.5	.8	5.6	61.7	1.4	26.0	5,940	10,690
							C	----	40.5	54.3	5.2	.9	4.7	71.4	1.7	16.1	6,865	12,360
							D	----	42.7	57.3	----	1.0	5.0	75.3	1.8	16.9	7,240	13,030
Jim Campbell mine, 6 miles east of Craig, NW¼ sec. 30, T. 7 N., R. 89 W.	341	Small room, right of main entry.	Campbell bed	Fort Union	92669	7.0	A	20.5	32.4	42.5	4.6	.4	----	----	----	----	5,280	9,500
							B	14.5	34.9	45.7	4.9	.5	----	----	----	----	5,680	10,220
							C	----	40.8	53.4	5.8	.5	----	----	----	----	6,635	11,940
							D	----	43.2	56.8	----	.6	----	----	----	----	7,040	12,670
Seymour mine, 12 miles northeast of Craig, SE¼ sec. 18, T. 8 N., R. 89 W.	363	125 ft from mine mouth	Seymour bed	do	93312	3.6	A	17.9	33.4	44.4	4.3	.2	----	----	----	----	5,540	9,970
							B	14.9	34.7	46.0	4.4	.2	----	----	----	----	5,744	10,340
							C	----	40.7	54.1	5.2	.3	----	----	----	----	6,745	12,140
							D	----	43.0	57.0	----	.3	----	----	----	----	7,115	12,810

Do	363		do	do	A2700	8.0	A	18.0	31.8	45.3	4.9	.3					5,600	10,080
							B	10.9	34.5	49.3	5.3	.3					6,085	10,950
							C		38.7	55.4	5.9	.4					6,830	12,290
							D		41.2	58.8		.4					7,260	13,070
Bridges mine, 12 miles northeast of Craig, SW¼ sec. 18, T. 8 N., R. 89 W.	362		do	do	93313	3.5	A	18.4	31.2	46.5	3.9	.2					5,560	10,010
							B	15.4	32.3	48.3	4.0	.3					5,760	10,370
							C		38.2	57.1	4.7	.3					6,810	12,260
							D		40.1	59.9		.3					7,150	12,870
Star mine, 12 miles northeast of Craig, SE¼ sec. 17, T. 8 N., R. 89 W.	361		do	do	93314	2.7	A	17.1	32.2	42.9	7.8	.4					5,360	9,650
							B	14.7	33.1	44.2	8.0	.4					5,510	9,920
							C		38.8	51.8	9.4	.4					6,460	11,630
							D		42.8	57.2		.5					7,135	12,840
Lionel Tuck mine, Elkhead Creek, S½ sec. 26, T. 9 N., R. 88 W.	262	Head of new entry	Unnamed	Lance	A3168	6.2	A	11.0	31.9	53.5	3.6	.7					6,565	11,820
							B	5.1	34.0	57.1	3.8	.7					7,000	12,600
							C		35.8	60.2	4.0	.7					7,380	13,280
							D		37.3	62.7		.8					7,685	13,830
Potholes, Elkhead Creek, upper of two coal beds exposed below large sill, NW¼ sec. 25, T. 9 N., R. 88 W.	261	Upper bed in vertical cliff	do	do	A3166	3.8	A	6.7	6.2	80.7	6.4	.7					7,110	12,800
							B	3.1	6.5	83.8	6.6	.8					7,390	13,300
							C		6.7	86.5	6.8	.8					7,620	13,720
							D		7.2	92.8		.8					8,185	14,730
Potholes, Elkhead Creek, lower of two coal beds exposed below large sill, NW¼ sec. 25, T. 9 N., R. 88 W.	261	Lower bed in vertical cliff	do	do	A3167	4.4	A	7.9	13.6	73.2	5.3	.6					6,990	12,580
							B	3.6	14.2	76.7	5.5	.6					7,310	13,160
							C		14.7	79.6	5.7	.6					7,590	13,660
							D		15.6	84.4		.7					8,050	14,490
Williams Fork Mountains																				
Sun mine (formerly Green), in Hayden Gulch, NE¼ sec. 12, T. 4 N., R. 89 W.	264	10 ft cut at face	Bed *T*, lower coal group.	Iles	2210	3.4	A	11.3	34.5	49.6	4.6	.5						
							B	8.2	35.7	51.3	4.8	.5						
							C		38.9	55.9	5.2	.6						
							D		41.0	59.0		.6						
Do	264	End of 180 ft entry	do	do	9693	4.8	A	12.2	35.8	47.4	4.6	.44	5.51	64.99	1.41	23.03	6,320	11,380
							B	7.8	37.6	49.8	4.8	.46	5.23	68.27	1.48	19.71	6,640	11,950
							C		40.8	54.0	5.2	.50	4.73	74.02	1.61	13.88	7,200	12,960
							D		43.0	57.0		.53	4.99	78.13	1.70	14.65	7,600	13,680
Do	264	Face of main heading, 215 ft from portal.	do	do	C33662	3.5	A	10.8	36.8	46.8	5.6	.5	5.7	66.1	1.4	20.7		11,560
							B	7.6	38.1	48.5	5.8	.6	5.5	68.5	1.5	18.1		11,980
							C		41.3	52.4	6.3	.6	5.0	74.2	1.6	12.3		12,960
							D		44.0	56.0		.6	5.3	79.1	1.7	13.3		13,830

TABLE 1.—*Analyses of coal samples from parts of Routt and Moffat Counties, Colo.*—Continued

Mine and location	No. on map	Location in mine	Coal bed and group	Formation	Lab. no	Air-drying loss	Form of analysis	Proximate				Ultimate					Heating value	
								Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu
Williams Fork Mountains—Continued																		
Rice mine (also known as Webber mine), in Hayden Gulch, NE¼ sec. 12, T 4N., R. 89 W.	263	190 ft in by portal to main heading.	Bed *P*, lower coal group.	Iles	B34465	6.3	A	11.8	34.4	50.2	3.6	.5	5.9	66.6	1.4	22.0	----	11,650
							B	5.9	36.7	53.6	3.8	.6	5.5	71.0	1.5	17.6	----	12,420
							C	----	39.0	56.9	4.1	.6	5.2	75.4	1.6	13.1	----	13,200
							D	----	40.7	59.3	----	.6	5.4	78.6	1.6	13.8	----	13,760
Core hole, NE¼ sec. 34, T. 5 N., R. 89 W.	325a	Depth: 142 ft 9 in. to 148 ft 3 in. (8 in. bone rejected).	Bed *D*(?) lower coal group.	do	D24614	0.9	A	9.9	35.3	47.3	7.5	.6	5.8	64.3	1.4	20.4	----	11,370
							B	9.1	35.6	47.7	7.6	.7	5.7	64.9	1.4	19.7	----	11,480
							C	----	39.2	52.4	8.4	----	5.2	71.4	1.6	12.7	----	12,630
							D	----	42.8	57.2	----	----	5.7	77.9	1.7	13.9	----	13,780
Do	325a	Depth: 196 ft 11 in to 201 ft 8 in. (2 in. coal lost).	Bed *C*(?) lower coal group.	do	D24615	1.0	A	9.8	35.6	50.5	4.1	.5	5.7	68.4	1.3	20.0	----	11,920
							B	8.9	35.9	51.1	4.1	.5	5.6	69.1	1.3	19.4	----	12,030
							C	----	39.4	56.1	4.5	.5	5.1	75.9	1.4	12.6	----	13,210
							D	----	41.3	58.7	----	.6	5.3	79.5	1.5	13.1	----	13,840
Do	325a	Depth: 263 ft 2 in. to 264 ft 6 in. (1½ in. coal lost).	*B* zone, lower coal group.	do	D24616	1.1	A	11.2	35.8	50.3	2.7	.5	5.8	68.2	1.3	21.5	----	11,790
							B	10.2	36.2	50.9	2.7	.5	5.7	68.9	1.4	20.8	----	11,920
							C	----	40.3	56.7	3.0	.6	5.1	76.8	1.5	13.0	----	13,280
							D	----	41.5	58.5	----	.6	5.3	79.1	1.5	13.5	----	13,690
Do	325a	Depth: 284 ft 4½ in. to 287 ft 1 in. (6½ in. coal lost).	----	do	D24617	1.0	A	10.0	35.2	47.0	7.8	.7	5.6	64.1	1.5	20.3	----	11,270
							B	9.1	35.6	47.4	7.9	.7	5.6	64.8	1.5	19.5	----	11,390
							C	----	39.1	52.2	8.7	.7	5.0	71.3	1.6	12.7	----	12,520
							D	----	42.8	57.2	----	.8	5.5	78.0	1.8	13.9	----	13,710
Do	325a	Depth: 315 ft 3½ in. to 316 ft 8¾ in.	----	do	D24618	1.3	A	10.1	35.2	49.4	5.3	.6	5.8	67.1	1.5	19.7	----	11,750
							B	8.9	35.7	50.0	5.4	.6	5.7	68.0	1.5	18.8	----	11,900
							C	----	39.1	55.0	5.9	.7	5.2	74.6	1.6	12.0	----	13,060
							D	----	41.6	58.4	----	.7	5.5	79.3	1.8	12.7	----	13,890
Do	325a	Depth: 329 ft 4 in. to 330 ft 6 in	----	do	D27658	3.8	A	10.7	34.2	51.4	3.7	.5	5.7	67.0	1.5	21.6	----	11,720
							B	7.1	35.6	53.5	3.8	.5	5.5	69.6	1.6	19.0	----	12,190
							C	----	38.3	57.6	4.1	.6	5.1	75.0	1.7	13.5	----	13,120
							D	----	40.0	60.0	----	.6	5.3	78.2	1.8	14.1	----	13,690

Core hole, SW¼ sec. 26, T. 5 N., R. 89 W.	310a	Depth: 423 ft 5 in. to 431 ft (10 in. bone and ironstone and 1 ft 1 in. coal lost).	Upper bed of *H*, zone, middle coal group.	Williams Fork	D27659	1.8	A	11.9	35.5	45.4	7.2	.7	5.8	61.4	1.6	23.3	-----	10,790
							B	10.3	36.1	46.2	7.4	.7	5.7	62.5	1.6	22.1	-----	10,990
							C	----	40.3	51.5	8.2	.8	5.0	69.7	1.8	14.5	-----	12,250
							D	----	43.9	56.1	-----	.9	5.5	75.9	1.9	15.8	-----	13,340
Do	310a	Depth: 451 ft 8 in. to 464 ft 2 in. (½ in shale rejected, 2 ft. 5½ in. coal lost).	Lower bed of *H*, zone, middle coal group.	do	D27660	1.5	A	12.7	35.4	48.2	3.7	.4	5.9	64.4	1.4	24.2	-----	11,170
							B	11.4	35.9	49.0	3.7	.4	5.8	65.3	1.5	23.3	-----	11,340
							C	----	40.5	55.3	4.2	.5	5.1	73.8	1.6	14.8	-----	12,800
							D	----	42.3	57.7	-----	.5	5.3	77.0	1.7	15.5	-----	13,360
Do	310a	Depth: 513 ft 6 in. to 515 ft 10 in. (2½ in. coal lost).	Between zones *G* and *H*, middle coal group.	do	D27661	3.3	A	11.3	36.7	48.4	3.6	.5	5.9	65.4	1.4	23.2	-----	11,460
							B	8.2	37.9	50.2	3.7	.6	5.7	67.6	1.4	21.0	-----	11,850
							C	----	41.3	54.6	4.1	.6	5.2	73.7	1.5	14.9	-----	12,920
							D	----	43.1	56.9	-----	.6	5.4	76.8	1.6	15.6	-----	13,470
Do	310a	Depth: 527 ft 4 in. to 532 ft 6 in. (1 ft 2 in. core lost).	do	do	D28384	2.3	A	12.5	37.6	46.9	3.0	.6	5.7	65.3	1.3	24.1	-----	11,340
							B	10.4	38.5	48.0	3.1	.6	5.6	66.8	1.3	22.6	-----	11,610
							C	----	43.0	53.5	3.5	.7	5.0	74.6	1.5	14.7	-----	12,950
							D	----	44.5	55.5	-----	.7	5.1	77.3	1.5	15.4	-----	13,420
Do	310a	Depth: 582 ft 6 in. to 588 ft 8 in. (3 in. shale rejected).	Top bed *G* zone, middle coal group.	do	D28385	2.0	A	11.1	38.9	42.9	7.1	.5	5.6	63.1	1.2	22.5	-----	11,060
							B	9.3	39.7	43.8	7.2	.5	5.5	64.4	1.2	21.2	-----	11,280
							C	----	43.8	48.2	8.0	.6	4.9	70.9	1.4	14.2	-----	12,440
							D	----	47.6	52.4	-----	.6	5.4	77.1	1.5	15.4	-----	13,520
Do	310a	Depth: 591 ft 4 in. to 592 ft 6 in. (1½ in. bone rejected).	*G* zone, middle coal group.	do	D28386	3.7	A	10.5	31.2	45.0	13.3	.8	5.2	58.3	1.1	21.3	-----	10,140
							B	7.1	32.4	46.6	13.9	.9	5.0	60.5	1.1	18.6	-----	10,530
							C	----	34.9	50.2	14.9	.9	4.5	65.1	1.2	13.4	-----	11,330
							D	----	41.0	59.0	-----	1.1	5.3	76.6	1.4	15.6	-----	13,310
		Depth: 599 ft 10 in. to 605 ft 2 in. (5 in. bone rejected, 3½ in. coal lost).	do	do	D28387	2.3	A	10.7	38.6	43.7	7.0	.6	5.7	63.4	1.2	22.1	-----	11,100
							B	8.6	39.5	44.7	7.2	.6	5.5	64.9	1.2	20.6	-----	11,360
							C	----	43.2	48.9	7.9	.7	5.0	71.0	1.3	14.1	-----	12,420
							D	----	46.9	53.1	-----	.7	5.4	77.0	1.4	15.5	-----	13,480
Do	310a	Depth: 613 ft 4 in. to 617 ft 4 in. (9 in. bone rejected, 3 in. coal lost).	do	do	D28388	2.5	A	10.6	37.0	44.0	8.4	.6	5.5	62.6	1.2	21.7	-----	10,930
							B	8.3	37.9	45.2	8.6	.6	5.4	64.2	1.2	20.0	-----	11,210
							C	----	41.3	49.3	9.4	.6	4.9	70.0	1.3	13.8	-----	12,220
							D	----	45.6	54.4	-----	.7	5.4	77.2	1.4	15.3	-----	13,490
Do	310a	Depth: 631 ft 7 in. to 634 ft 7 in	do	do	D28389	3.9	A	11.6	35.1	45.4	7.9	.5	5.5	62.0	1.2	22.9	-----	10,770
							B	8.1	36.5	47.2	8.2	.6	5.2	64.5	1.3	20.2	-----	11,200
							C	----	39.7	51.4	8.9	.6	4.7	70.2	1.4	14.2	-----	12,190
							D	----	43.6	56.4	-----	.7	5.2	77.0	1.5	15.6	-----	13,380
Do	310a	Depth: 673 ft 2 in. to 674 ft 10 in. (6 in. coal lost).	Between zones *F* and *G*, middle coal group.	do	D28390	3.8	A	10.0	36.1	40.0	13.9	.8	5.3	57.6	1.2	21.2	-----	10,100
							B	6.4	37.6	41.5	14.5	.9	5.1	59.9	1.2	18.4	-----	10,500
							C	----	40.2	44.3	15.5	.9	4.7	64.0	1.3	13.6	-----	11,220
							D	----	47.5	52.5	-----	1.1	5.5	75.7	1.6	16.1	-----	13,280

TABLE 1.—*Analyses of coal samples from parts of Routt and Moffat Counties, Colo.*—Continued

Mine and location	No. on map	Location in mine	Coal bed and group	Formation	Lab. no	Air-drying loss	Form of analysis	Proximate				Ultimate					Heating value	
								Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu
Williams Fork Mountains—Continued																		
Core hole, SW¼ sec. 21, T. 5 N., R. 89 W.	312b	Depth: 81 ft 4 in. to 84 ft 3 in. (2½ in. coal lost).	*H* zone, middle coal group.	Williams Fork	C99751	3.4	A	11.3	37.5	42.3	8.9	.5	5.6	61.0	1.3	22.7	-----	10,590
							B	8.2	38.8	43.8	9.2	.5	5.4	63.2	1.4	20.3	-----	10,960
							C	----	42.3	47.7	10.0	.5	4.9	68.8	1.5	14.3	-----	11,940
							D	----	47.0	53.0	-----	.6	5.4	76.4	1.7	15.9	-----	13,270
Do	312b	Depth: 188 ft to 195 ft 6 in. (1 ft 9 in. coal lost).	*G* zone, middle coal group.	do	C99752	2.6	A	10.2	39.2	42.9	7.7	.4	5.6	63.7	1.2	21.4	-----	11,040
							B	7.7	40.3	44.0	8.0	.4	5.4	65.4	1.2	19.6	-----	11,340
							C	----	43.7	47.7	8.6	.5	5.0	70.9	1.3	13.7	-----	12,290
							D	----	47.8	52.2	-----	.5	5.4	77.6	1.4	15.1	-----	13,450
Do	312b	Depth: 215 ft 4 in. to 223 ft.	do	do	C99753	2.1	A	10.4	36.7	42.8	10.1	.5	5.5	61.6	1.1	21.2	-----	10,730
							B	8.4	37.5	43.8	10.3	.5	5.3	63.0	1.2	19.7	-----	10,960
							C	----	40.9	47.8	11.3	.6	4.8	68.8	1.3	13.2	-----	11,970
							D	----	46.1	53.9	-----	.7	5.4	77.5	1.4	15.0	-----	13,490
Do	312b	Depth: 229 ft 6 in. to 231 ft (4 in. coal lost).	do	do	C99754	4.2	A	11.6	36.8	46.3	5.3	.7	5.6	64.6	1.2	22.6	-----	11,160
							B	7.8	38.4	48.3	5.5	.7	5.4	67.4	1.3	19.7	-----	11,650
							C	----	41.7	52.3	6.0	.8	4.9	73.1	1.4	13.8	-----	12,630
							D	----	44.3	55.7	-----	.8	5.2	77.7	1.5	14.8	-----	13,440
Do	312b	Depth: 231 ft to 233 ft 2 in.	do	do	D2191	2.8	A	8.9	32.7	49.1	9.3	.5	5.4	63.5	1.2	20.1	-----	11,080
							B	6.3	33.7	50.5	9.5	.6	5.2	65.4	1.3	18.0	-----	11,400
							C	----	35.9	53.9	10.2	.6	4.8	69.8	1.3	13.3	-----	12,170
							D	----	40.0	60.0	-----	.7	5.3	77.7	1.5	14.8	-----	13,540
Do	312b	Depth: 242 ft 6 in. to 248 ft (3 in. bone rejected, 2 in. coal lost).	do	do	D2192	2.1	A	9.7	34.7	50.3	5.3	.6	5.6	65.8	1.3	21.4	-----	11,430
							B	7.8	35.5	51.3	5.4	.6	5.5	67.2	1.3	20.0	-----	11,680
							C	----	38.5	55.7	5.8	.6	5.0	72.9	1.4	14.3	-----	12,670
							D	----	40.9	59.1	-----	.7	5.3	77.4	1.5	15.1	-----	13,450
Do	312b	Depth: 267 ft 2 in. to 270 ft 3 in. (9 in. bone and shale rejected).	do	do	D2193	2.4	A	10.7	35.4	49.8	4.1	.9	5.7	65.7	1.3	22.3	-----	11,460
							B	8.5	36.3	51.0	4.2	1.0	5.6	67.3	1.4	20.5	-----	11,740
							C	----	39.7	55.8	4.5	1.0	5.1	73.6	1.5	14.3	-----	12,830
							D	----	41.6	58.4	-----	1.1	5.3	77.1	1.6	14.9	-----	13,440

Do	312b	Depth: 372 ft 1 in. to 377 ft 4 in.	*F* zone, middle coal group.	do	D2194	2.2	A	8.8	28.8	35.5	26.9	.5	4.6	48.4	1.0	18.6		8,390
							B	6.7	29.4	36.4	27.5	.5	4.4	49.5	1.0	17.1		8,580
							C		31.5	39.1	29.4	.5	3.8	53.1	1.1	12.1		9,200
							D		44.7	55.3		.7	5.5	75.2	1.6	17.0		13,040
Core hole, NE¼ sec. 29, T. 5 N., R. 89 W.	313a	Depth: 130 ft 6 in. to 134 ft (1 in. bone rejected, 1 ft 8½ in. coal lost).	Lower coal group.	Iles	D6281	3.3	A	8.5	34.2	50.9	6.4	.9	5.5	66.7	1.4	19.1		11,700
							B	5.4	35.4	52.6	6.6	1.0	5.3	69.0	1.4	16.7		12,100
							C		37.4	55.6	7.0	1.0	5.0	73.0	1.5	12.5		12,790
							D		40.2	59.8		1.1	5.4	78.4	1.6	13.5		13,750
Do	313a	Depth: 164 ft 11 in. to 166 ft 8 in. (8 in. shale and bone rejected).	do	do	D6282	3.1	A	8.9	35.0	47.4	8.7	.7	5.5	64.4	1.4	19.3		11,310
							B	6.0	36.1	48.9	9.0	.7	5.3	66.5	1.4	17.1		11,670
							C		38.4	52.0	9.6	.8	4.9	70.7	1.5	12.5		12,420
							D		42.4	57.6		.9	5.5	78.2	1.7	13.7		13,730
Do	313a	Depth: 226 ft 4 in. to 229 ft 6 in. (1 ft. bone rejected).	do	do	D6283	4.2	A	10.5	33.4	51.1	5.0	.6	5.7	66.6	1.4	20.7		11,650
							B	6.6	34.8	53.4	5.2	.7	5.4	69.5	1.5	17.7		12,160
							C		37.3	57.2	5.5	.7	5.0	74.4	1.6	12.8		13,010
							D		39.4	60.6		.7	5.3	78.8	1.7	13.5		13,770
Do	313a	Depth: 259 ft 4 in. to 261 ft (2 in. bone rejected).	do	do	D6284	3.6	A	9.1	34.9	49.0	7.0	.6	5.5	66.3	1.4	19.2		11,560
							B	5.7	36.3	50.8	7.2	.6	5.3	68.8	1.5	16.6		12,000
							C		38.5	53.8	7.7	.6	5.0	72.9	1.6	12.2		12,720
							D		41.7	58.3		.7	5.4	79.0	1.7	13.2		13,780
Core hole, NW¼ sec. 28, T. 5 N., R. 89 W.	312a	Depth: 140 ft 3½ in. to 145 ft 9½ in. (4½ in. shale and bone rejected, 7½ in. coal lost).	*F* zone, middle coal group.	Williams Fork	D6285	2.4	A	10.3	33.2	49.5	7.0	.7	5.5	65.1	1.3	20.4		11,320
							B	8.1	34.0	50.7	7.2	.7	5.4	66.6	1.3	18.8		11,590
							C		37.0	55.2	7.8	.8	4.9	72.5	1.4	12.6		12,620
							D		40.1	59.9		.8	5.3	78.6	1.6	13.7		13,680
Core hole, SW¼ sec. 7, T. 5 N., R. 89 W.	275a	Depth: 295 ft to 297 ft 3 in. (9 in. coal lost).	Topbed, *H* zone, middle coal group.	do	D24284	1.0	A	10.8	35.7	48.4	5.1	.3	5.7	64.8	1.5	22.6		11,310
							B	9.9	36.0	48.9	5.2	.4	5.7	65.5	1.5	21.7		11,420
							C		40.0	54.3	5.7	.4	5.1	72.7	1.7	14.4		12,670
							D		42.4	57.6		.4	5.4	77.1	1.8	15.3		13,440
Do	275a	Depth: 299 ft 1 in. to 304 ft 1 in. (5 in. coal lost).	*H* zone, middle coal group.	do	D24285	.8	A	10.2	35.5	46.4	7.9	.5	5.8	63.0	1.4	21.4		11,050
							B	9.5	35.8	46.8	7.9	.5	5.7	63.5	1.4	21.0		11,140
							C		39.5	51.7	8.8	.6	5.1	70.2	1.6	13.7		12,300
							D		43.3	56.7		.6	5.6	76.9	1.7	15.2		13,490
Do	275a	Depth: 330 ft to 338 ft 4 in. (4 ft 9 in. coal lost).	Basal bed, *H* zone, middle coal group.	do	D24286	.0	A	10.0	35.8	48.6	5.6	.4	5.7	65.5	1.4	21.4		11,330
							B											
							C		39.7	54.1	6.2	.5	5.1	72.7	1.5	14.0		12,580
							D		42.4	57.6		.5	5.5	77.6	1.6	14.8		13,420
Do	275a	Depth: 427 ft 10 in. to 433 ft 5 in. (3 ft 5 in. coal lost).	*G* zone, middle coal group.	do	D24287	.9	A	9.3	34.5	40.7	15.5	.7	5.3	57.3	1.1	20.1		10,070
							B	8.6	34.8	41.0	15.6	.7	5.2	57.8	1.2	19.5		10,160
							C		38.0	45.0	17.0	.7	4.6	63.2	1.3	13.2		11,110
							D		45.8	54.2		.9	5.6	76.2	1.5	15.8		13,390

TABLE 1.—*Analyses of coal samples from parts of Routt and Moffat Counties, Colo.*—Continued

Mine and location	No. on map	Location in mine	Coal bed and group	Formation	Lab. no	Air-drying loss	Form of analysis	Proximate				Ultimate					Heating value	
								Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu
Williams Fork Mountains—Continued																		
Core hole, SW¼ sec. 7, T. 5 N., R. 89 W.	275a	Depth: 471 ft to 474 ft 3 in. (5 in. bone rejected, 1 ft 9 in. coal lost).	*G* zone, middle coal group.	Williams Fork	D24288	.3	A	8.5	34.2	45.1	12.2	.6	5.3	60.8	1.2	19.9	----	10,700
							B	8.2	34.3	45.2	12.3	.6	5.3	61.0	1.2	19.6	----	10,730
							C	----	37.4	49.2	13.4	.6	4.8	66.4	1.3	13.5	----	11,700
							D	----	43.2	56.8	----	.7	5.5	76.7	1.5	15.6	----	13,500
Do	275a	Depth: 483 ft to 484 ft 2 in. (½ in. coal lost).	do	do	D24289	.0	A	8.43	2.34	6.31	3.0	.5	5.1	61.1	1.2	19.1	----	10,650
							B	----	----	----	----	----	----	----	----	----	----	----
							C	----	35.2	50.6	14.2	.6	4.6	66.7	1.3	12.6	----	11,620
							D	----	41.1	58.9	----	.7	5.3	77.8	1.5	14.7	----	13,550
Do	275a	Depth: 488 ft 7½ in. to 493 ft 7½ in. (7 in. bone rejected).	do	do	D24290	.6	A	8.8	34.1	44.7	12.4	.4	5.3	61.0	1.2	19.7	----	10,680
							B	8.3	34.3	45.0	12.4	.4	5.3	61.4	1.2	19.3	----	10,740
							C	----	37.4	49.0	13.6	.5	4.7	66.9	1.3	13.0	----	11,710
							D	----	43.3	56.7	----	.5	5.5	77.4	1.5	15.1	----	13,540
Do	275a	Depth: 493 ft 7½ in. to 500 ft 2 in. (9 in. bone and shale rejected).	do	do	D24613	.8	A	10.3	36.4	48.1	5.2	.5	5.7	65.4	1.3	21.9	----	11,470
							B	9.6	36.7	48.5	5.2	.5	5.6	66.0	1.3	21.4	----	11,560
							C	----	40.6	53.6	5.8	.6	5.1	73.0	1.4	14.1	----	12,790
							D	----	43.1	56.9	----	.6	5.4	77.4	1.5	15.1	----	13,570
Core hole, SW¼ sec. 10, T. 5 N., R. 90 W.	403a	Depth: 23 ft 10 in. to 25 ft 6 in. (2 in. bone rejected).	Lower coal group.	Iles	D20767	2.2	A	7.6	37.9	38.3	16.2	3.6	5.3	58.0	1.2	15.7	----	10,630
							B	5.4	38.8	39.2	16.6	3.7	5.1	59.3	1.3	14.0	----	10,870
							C	----	41.0	41.4	17.6	3.9	4.8	62.7	1.3	9.7	----	11,490
							D	----	49.8	50.2	----	4.7	5.8	76.1	1.6	11.8	----	13,940
Do	403a	Depth: 35 ft 8 in. to 37 ft 4 in. (10½ in. bone rejected, 3 in. coal lost).	do	do	D20768	3.0	A	9.2	32.3	45.0	13.5	.6	5.1	60.0	1.3	19.5	----	10,510
							B	6.5	33.3	46.3	13.9	.7	5.0	61.9	1.4	17.1	----	10,830
							C	----	35.6	49.5	14.9	.7	4.5	66.1	1.5	12.3	----	11,580
							D	----	41.8	58.2	----	.8	5.3	77.7	1.7	14.5	----	13,600
Do	403a	Depth: 39 ft 2 in. to 43 ft 2 in. (1½ in. coal lost).	do	do	D20769	2.0	A	9.8	36.1	45.1	9.0	.5	5.6	63.2	1.4	20.3	----	11,200
							B	7.9	36.8	46.1	9.2	.5	5.4	64.5	1.5	18.9	----	11,430
							C	----	40.0	50.0	10.0	.6	5.0	70.0	1.6	12.8	----	12,410
							D	----	44.4	55.6	----	.7	5.5	77.8	1.7	14.3	----	13,790

Do	403a	Depth: 52 ft 3 in. to 54 ft (8 in. coal lost).	do	do	D20770	2.5	A	9.6	39.5	46.0	4.9	.7	5.7	66.8	1.5	20.4	-----	11,800
							B	7.3	40.6	47.1	5.0	.7	5.6	68.5	1.6	18.6	-----	12,110
							C	----	43.7	50.9	5.4	.7	5.1	73.9	1.7	13.2	-----	13,060
							D	----	46.2	53.8	-----	.8	5.4	78.1	1.8	13.9	-----	13,800
Do	403a	Depth: 69 ft 6 in. to 73 ft 4½ in. (2 ft 6 in. bone and shale rejected).	do	do	D20771	2.6	A	10.0	36.6	45.2	8.2	.7	5.5	63.2	1.4	21.0	-----	11,240
							B	7.5	37.6	46.5	8.4	.7	5.3	64.9	1.5	19.2	-----	11,550
							C	----	40.6	50.3	9.1	.8	4.8	70.2	1.6	13.5	-----	12,490
							D	----	44.7	55.3	-----	.8	5.3	77.2	1.7	15.0	-----	13,730
Core hole, NW¼ sec. 10, T. 5 N., R. 90 W.	387a	Depth: 88 ft 6 in. to 100 ft (2 ft 2½ in. coal lost).	Top bed, *H* zone, middle coal group.	Williams Fork	D20772	1.2	A	11.6	36.5	48.0	3.9	.5	5.9	64.7	1.4	23.7	-----	11,430
							B	10.5	36.9	48.7	3.9	.4	5.8	65.5	1.4	23.0	-----	11,570
							C	----	41.2	54.4	4.4	.5	5.2	73.2	1.6	15.1	-----	12,920
							D	----	43.1	56.9	-----	.5	5.4	76.5	1.7	15.9	-----	13,510
Do	387a	Depth: 158 ft 7 in. to 169 ft 3 in. (3 ft 7 in. coal lost).	Bottom bed *H* zone, middle coal group.	do	D21616	1.4	A	10.2	37.8	48.5	3.5	.5	5.7	66.5	1.2	22.6	-----	11,710
							B	9.0	38.3	49.2	3.5	.5	5.7	67.4	1.2	21.7	-----	11,870
							C	----	42.1	54.0	3.9	.5	5.1	74.0	1.4	15.1	-----	13,040
							D	----	43.8	56.2	-----	.5	5.3	77.0	1.4	15.8	-----	13,560
Do	387a	Depth: 188 ft to 194 ft (11 in. bone and shale rejected).	Between zones *G* and *H*, middle coal group.	do	D21617	1.5	A	9.6	37.1	46.6	6.7	.8	5.7	63.8	1.2	21.8	-----	11,290
							B	8.2	37.6	47.4	6.8	.8	5.6	64.7	1.2	20.9	-----	11,460
							C	----	41.0	51.6	7.4	.8	5.2	70.5	1.3	14.8	-----	12,490
							D	----	44.3	55.7	-----	.9	5.6	76.2	1.4	15.9	-----	13,490
Do	387a	Depth: 208 ft 6 in. to 210 ft 11 in.	do	do	D21618	1.7	A	9.8	36.5	45.1	8.6	.5	5.6	61.8	1.2	22.3	-----	10,970
							B	8.2	37.1	45.9	8.8	.5	5.5	62.8	1.2	21.2	-----	11,150
							C	----	40.4	50.0	9.6	.5	5.0	68.4	1.3	15.2	-----	12,150
							D	----	44.7	55.3	-----	.6	5.5	75.7	1.4	16.8	-----	13,440
Do	387a	Depth: 409 ft 3 in. to 410 ft 10 in. (6½ in. bone rejected).	*F* zone, middle coal group.	do	D21619	2.1	A	10.2	34.3	48.4	7.1	1.6	5.6	62.8	1.3	21.6	-----	11,100
							B	8.3	35.0	49.4	7.3	1.7	5.5	64.1	1.3	20.1	-----	11,340
							C	----	38.1	54.0	7.9	1.8	5.0	69.9	1.4	14.0	-----	12,360
							D	----	41.4	58.6	-----	2.0	5.4	75.9	1.6	15.1	-----	13,420
Do	387a	Depth: 432 ft 7 in. to 435 ft 6 in. (9 in. siltstone rejected).	do	do	D21620	2.1	A	10.7	35.4	50.9	4.0	.9	5.7	66.1	1.4	21.9	-----	11,670
							B	8.8	36.1	51.0	4.1	.9	5.6	67.5	1.4	20.5	-----	11,920
							C	----	39.6	55.9	4.5	1.0	5.1	74.0	1.6	13.8	-----	13,070
							D	----	41.4	58.6	-----	1.0	5.3	77.5	1.6	14.6	-----	13,680
Do	387a	Depth: 469 ft 2 in. to 470 ft 8 in.	do	do	D21621	2.3	A	9.1	35.0	40.6	15.3	2.7	5.2	57.2	1.2	18.4	-----	10,330
							B	6.9	35.8	41.6	15.7	2.8	5.1	58.6	1.2	16.6	-----	10,580
							C	----	38.5	44.7	16.8	3.0	4.6	63.0	1.3	11.3	-----	11,360
							D	----	46.3	53.7	-----	3.6	5.6	75.7	1.6	13.5	-----	13,660
Core hole, NE¼ sec. 10, T. 5 N., R. 90 W.	387b	Depth: 326 ft to 329 ft 5 in. (1 ft ½ in. bone rejected).	Above *H* zone, middle coal group.	do	D24291	.9	A	9.7	36.3	44.1	9.9	.5	5.7	61.3	1.4	21.2	-----	10,770
							B	8.9	36.6	44.5	10.0	.5	5.6	61.8	1.4	20.7	-----	10,870
							C	----	40.2	48.8	11.0	.5	5.1	67.9	1.5	14.0	-----	11,930
							D	----	45.1	54.9	-----	.6	5.7	76.2	1.7	15.8	-----	13,400

TABLE 2.—*Comparison of averages of analyses of samples of coal from several stratigraphic positions, Routt and Moffat Counties, Colo.*

[Form of analysis: A, as received; B, air dried; C, moisture free; D, moisture and ash free]

Number and/or source of samples	Coal bed and group	Formation	Air-drying loss	Form of analysis	Proximate				Ultimate					Heating value, Btu
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	
5 samples		Fort Union	5.5	A	18.5	32.2	44.5	5.1	0.3					9,842
				B	14.2	33.9	46.7	5.3	.3					10,360
				C		39.4	54.4	6.4	.4					12,052
				D		42.1	57.9		.4					12,852
6 samples		Lance	5.7	A	19.5	31.0	44.7	4.8	.5					9,851
				B	14.6	32.9	47.4	5.1	.5					10,448
				C		38.5	55.5	5.9	.6					12,233
				D		40.9	59.0		.6					13,003
3 samples from Babson mine and 1 sample from Dry Creek mine on Dry Creek.	Dry Creek coal bed, upper coal group.	Williams Fork.	5.4	A	15.7	32.2	48.5	3.6	.35	6.1	62.5	1.7	25.8	10,912
				B	10.5	35.2	53.0	3.9	.4	5.4	67.7	1.7	18.6	11,930
				C		38.5	58.2	4.5	.45	5.2	74.9	2.0	14.3	13,060
				D		39.6	60.4		.4	5.3	77.2	2.0	14.9	13,547
8 samples (lab. nos. 31199–31206) from Harris mine no. 1 at Mount Harris.	Wadge coal bed, middle coal group.	do		A										
				B	5.4	40.0	48.6	6.0	.4	5.4	69.4	1.7	17.0	12,170
				C										
				D										
Composite of 8 samples (lab. nos. 31134 and A13688) from Argo and Pinnacle mines near Oak Creek.	No. 2 coal bed, lower coal group.	Iles	3.3	A	8.8	38.4	48.2	4.6	.6	5.8	68.8	1.5	18.7	12,100
				B	5.3	41.0	51.4	4.9	.7	5.4	73.3	1.6	14.0	12,905
				C		43.3	54.3	4.7	.7	5.4	77.5	1.7	12.3	13,635
				D		44.9	55.1		.5	5.5	79.7	1.7	12.6	14,020

TABLE 3.—*Measured and indicated, undifferentiated, original bituminous coal reserves in parts of Routt and Moffat Counties, Colo., as of October 1949*

[By Frank D. Spencer. In millions of short tons]

Coal group and bed	Less than 1,000 feet overburden				1,000–2,000 feet overburden				2,000–3,000 feet overburden				Total in all overburden categories			Bed total
	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	
T. 3 N., R. 86 W.																
Lower coal group:																
No. 3 bed			2.44	2.44											2.44	2.44
No. 2 bed			50.12	50.12											50.12	50.12
No. 1 bed		5.70	19.93	25.63										5.70	19.93	25.63
Total		5.70	72.49	78.19										5.70	72.49	78.19
T. 4 N., R. 85 W.																
Middle coal group:																
Lennox bed		6.02		6.02										6.02		6.02
Wadge bed			13.55	13.55											13.55	13.55
Wolf Creek bed			18.94	18.94											18.94	18.94
Lower coal group:																
No. 3 bed			29.93	29.93											29.93	29.93
No. 2 bed			34.50	34.50											34.50	34.50
No. 1 bed			24.02	24.02			22.00	22.00							46.02	46.02
Total		6.02	120.94	126.96			22.00	22.00						6.02	142.94	148.96
T. 4 N., R. 86 W.																
Middle coal group:																
Lennox bed		18.49		18.49										18.49		18.49
Wadge bed			45.75	45.75											45.75	45.75
Wolf Creek bed			55.37	55.37											55.37	55.37
Lower coal group:																
No. 3 bed			90.39	90.39			43.88	43.88							134.27	134.27
No. 2 bed		11.90	67.99	79.89		5.09	26.28	31.37						16.99	94.27	111.26
No. 1 bed			62.59	62.59			33.07	33.07							95.66	95.66
Total		30.39	322.09	352.48		5.09	103.23	108.32						35.48	425.32	460.80

TABLE 3.—*Measured and indicated, undifferentiated, original bituminous coal reserves in parts of Routt and Moffat Counties, Colo., as of October 1949*—Continued

[By Frank D. Spencer. In millions of short tons]

Coal group and bed	Less than 1,000 feet overburden				1,000–2,000 feet overburden				2,000–3,000 feet overburden				Total in all overburden categories			Bed total
	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	
T. 4 N., R. 87 W.																
Middle coal group:																
Wadge bed	-------	-------	28.50	28.50	-------	-------	3.82	3.82	-------	-------	-------	-------	-------	-------	32.32	32.32
Lower coal group:																
No. 3 bed	-------	-------	6.42	6.42	-------	-------	17.13	17.13	-------	-------	-------	-------	-------	-------	23.55	23.55
Bed 45 ft below no. 3 bed	-------	-------	1.15	1.15	-------	-------	.66	.66	-------	-------	-------	-------	-------	-------	1.81	1.81
Total	-------	-------	36.07	36.07	-------	-------	21.61	21.61	-------	-------	-------	-------	-------	-------	57.68	57.68
T. 5 N., R. 85 W.																
Middle coal group:																
Lennox bed	-------	2.65	-------	2.65	-------	-------	-------	-------	-------	-------	-------	-------	-------	2.65	-------	2.65
Wadge bed	-------	-------	9.61	9.61	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	9.61	9.61
Wolf Creek bed	-------	-------	25.18	25.18	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	25.18	25.18
Lower coal group:																
Bed of loc. 22	-------	-------	9.40	9.40	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	9.40	9.40
Bed 25 ft below bed of loc. 22	-------	-------	9.88	9.88	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	9.88	9.88
No. 3 bed	-------	-------	29.67	29.67	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	29.67	29.67
No. 2 bed	-------	-------	12.57	12.57	-------	-------	18.05	18.05	-------	-------	-------	-------	-------	-------	30.62	30.62
Bed of loc. 134 (Brooks bed)	-------	-------	14.10	14.10	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	14.10	14.10
No. 1 bed	-------	-------	32.50	32.50	-------	-------	24.17	24.17	-------	-------	-------	-------	-------	-------	56.67	56.67
Total	-------	2.65	142.91	145.56	-------	-------	42.22	42.22	-------	-------	-------	-------	-------	2.65	185.13	187.78

T. 5 N., R. 86 W.

Middle coal group:															
Lennox bed		34.08		34.08		8.92		8.92					43.00		43.00
Wadge bed			186.99	186.99			24.58	24.58						211.57	211.57
Wolf Creek bed			126.80	126.80			58.28	58.28						185.08	185.08
Lower coal group:															
Bed 100 ft above Bear River bed			2.16	2.16			3.90	3.90						6.06	6.06
Bear River bed			1.80	1.80			3.68	3.68						5.48	5.48
Bed of loc. 22			10.61	10.61			15.19	15.19						25.80	25.80
Bed 25 ft below bed of loc. 22			6.38	6.38			9.07	9.07						15.45	15.45
No. 3 bed							80.03	80.03			14.38	14.38		94.41	94.41
No. 2 bed			1.48	1.48		13.64	23.79	37.43		4.57		4.57	18.21	25.27	43.48
Bed of loc. 134 (Brooks bed)			41.29	41.29			45.57	45.57						86.86	86.86
No. 1 bed							27.36	27.36						27.36	27.36
Total		34.08	377.51	411.59		22.56	291.45	314.01		4.57	14.38	18.95	61.21	683.34	744.55

T. 5 N., R. 87 W.

Middle coal group:															
Lennox bed			3.04	3.04										3.04	3.04
Wadge bed			19.23	19.23										19.23	19.23
Wolf Creek bed			12.16	12.16			1.84	1.84						14.00	14.00
Lower coal group:															
Bed 100 ft above bed of loc. 158			2.13	2.13										2.13	2.13
Bed of loc. 158 (near horizon of Bear River bed)			5.39	5.39			1.98	1.98						7.37	7.37
No. 3 bed			.76	.76			.37	.37						1.13	1.13
Total			42.71	42.71			4.19	4.19						46.90	46.90

TABLE 3.—*Measured and indicated, undifferentiated, original bituminous coal reserves in parts of Routt and Moffat Counties, Colo., as of October 1949*—Continued

[By Frank D. Spencer. In millions of short tons]

Coal group and bed	Less than 1,000 feet overburden				1,000–2,000 feet overburden				2,000–3,000 feet overburden				Total in all overburden categories			Bed total
	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	
T. 6 N., R. 86 W.																
Middle coal group:																
Lennox bed			0.81	0.81											0.81	0.81
Wadge bed			14.71	14.71											14.71	14.71
Wolf Creek bed			28.07	28.07											28.07	28.07
Lower coal group:																
Bed of Pruitt mine		0.37	5.93	6.30										0.37	5.93	6.30
Bed 50 ft below bed of Pruitt mine	1.08	1.37		2.45									1.08	1.37		2.45
Bed 90 ft below bed of Pruitt mine		1.39		1.39										1.39		1.39
Bed of loc. 134 (Brooks bed, 600 ft below top of Trout Creek sandstone)		.94		.94										.94		.94
Bed 50 ft below Brooks bed			3.99	3.99											3.99	3.99
Bed 180 ft below Brooks bed		1.07		1.07										1.07		1.07
Bed 213 ft below Brooks bed			1.82	1.82											1.82	1.82
Bed 246 ft below Brooks bed	.50			.50									.50			.50
Bed 354 ft below Brooks bed	.57			.57									.57			.57
Bed 428 ft below Brooks bed	.77			.77									.77			.77
Total	2.92	5.14	55.33	63.39									2.92	5.14	55.33	63.39

T. 6 N., R. 87 W.

Middle coal group:																
Lennox bed		15.59	3.16	18.75		20.53	25.16	45.69						36,12	28.32	64.44
Wadge bed		8.10	70.53	78.63		7.36	92.67	100.03						15.46	163.20	178.66
Lower bench of Wadge bed	3.02			3.02	1.53			1.53					4.55			4.55
Wolf Creek bed			131.74	131.74			186.82	186.82							318.56	318.56
Lower coal group:																
Bed 150 ft above Bear River bed			12.88	12.88			4.81	4.81							17.69	17.69
Bed of Butcher Knife mine			41.20	41.20			18.63	18.63							59.83	59.83
Upper bench of Bear River bed		24.43		24.43		4.12		4.12						28.55		28.55
Bear River bed			69.19	69.19			31.82	31.82							101.01	101.01
Total	3.02	48.12	328.70	379.84	1.53	32.01	359.91	393.45					4.55	80.13	688.61	773.29

T. 7 N., R. 86 W.

Lower coal group:																
Bed of Grey mine (loc. 141)			2.37	2.37											2.37	2.37
Bed of McCroskey mine (loc. 113)			2.10	2.10			9.43	9.43							11.53	11.53
Total			4.47	4.47			9.43	9.43							13.90	13.90

T. 7 N., R. 87 W.

Middle coal group:																
Lennox bed	1.62	6.31		7.93	0.52			0.52					2.14	6.31		8.45
Wadge bed			47.62	47.62			21.84	21.84							69.46	69.46
Wolf Creek bed			49.85	49.85			25.17	25.17							75.02	75.02
Lower bench of Wolf Creek bed			21.07	21.07			9.51	9.51							30.58	30.58
Lower coal group:																
Upper bed of loc. 197			27.68	27.68			15.86	15.86							43.54	43.54
Lower bed of loc. 197			27.47	27.47			14.20	14.20							41.67	41.67
Bed of Block or Franz mine			14.46	14.46			7.28	7.28							21.74	21.74
Bed 32 ft below Block or Franz mine bed			10.56	10.56			4.78	4.78							15.34	15.34
Bed 70 ft below Block or Franz mine bed			12.80	12.80			5.09	5.09							17.89	17.89
Bed 97 ft below Block or Franz mine bed			13.32	13.32			4.60	4.60							17.92	17.92
Total	1.62	6.31	224.83	232.76	0.52		108.33	108.85					2.14	6.31	333.16	341.61

TABLE 3.—*Measured and indicated, undifferentiated, original bituminous coal reserves in parts of Routt and Moffat Counties, Colo., as of October 1949*—Continued

[By Frank D. Spencer. In millions of short tons]

Coal group and bed	Less than 1,000 feet overburden				1,000–2,000 feet overburden				2,000–3,000 feet overburden				Total in all overburden categories			Bed total
	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	
T. 8 N., R. 86 W.																
Middle coal group:																
Bed 350 ft above Trout Creek sandstone member	------	0.71	------	0.71	------	------	------	------	------	------	------	------	------	0.71	------	0.71
Bed 100 ft above Trout Creek sandstone member	------	------	7.71	7.71	------	------	------	------	------	------	------	------	------	------	7.71	7.71
Bed on Trout Creek sandstone member	------	------	4.12	4.12	------	------	------	------	------	------	------	------	------	------	4.12	4.12
Lower coal group:																
Bed 180 ft below top of Trout Creek sandstone member	------	------	5.02	5.02	------	------	------	------	------	------	------	------	------	------	5.02	5.02
Bed 200 ft below top of Trout Creek sandstone member	------	------	6.96	6.96	------	------	------	------	------	------	------	------	------	------	6.96	6.96
Bed 250 ft below top of Trout Creek sandstone member	------	------	6.19	6.19	------	------	------	------	------	------	------	------	------	------	6.19	6.19
Bed 350 ft below top of Trout Creek sandstone member	------	.86	------	.86	------	------	------	------	------	------	------	------	------	.86	------	.86
Bed 400 ft below top of Trout Creek sandstone member	------	.74	------	.74	------	------	------	------	------	------	------	------	------	.74	------	.74
Bed 408 ft below top of Trout Creek sandstone member	0.48	------	------	.48	------	------	------	------	------	------	------	------	0.48	------	------	.48
Bed 500 ft below top of Trout Creek sandstone member	------	------	6.39	6.39	------	------	1.24	1.24	------	------	------	------	------	------	7.63	7.63
Ducey mine bed (500 ft below top of Trout Creek sandstone member)	------	1.17	2.19	3.36	------	------	------	------	------	------	------	------	------	1.17	2.19	3.36
Block mine bed (570 ft below top of Trout Creek sandstone member)	------	------	4.85	4.85	------	------	------	------	------	------	------	------	------	------	4.85	4.85
Bed 700 ft below top of Trout Creek sandstone member	------	------	3.48	3.48	------	------	------	------	------	------	------	------	------	------	3.48	3.48
Bed 800 ft below top of Trout Creek sandstone member	------	1.47	------	1.47	------	0.42	------	.42	------	------	------	------	------	1.89	------	1.89
Bed 1,400 ft below top of Trout Creek sandstone member	------	2.02	------	2.02	------	3.47	------	3.47	------	------	------	------	------	5.49	------	5.49
Total	0.48	6.97	46.91	54.36	------	3.89	1.24	5.13	------	------	------	------	.48	10.86	48.15	59.49

T. 8 N., R. 87 W.

Middle coal group:																
Lennox bed	6.85	1.62		8.47	12.10			12.10	5.64			5.64	24.59	1.62		26.21
Wadge bed			37.24	37.24			38.55	38.55			16.84	16.84			92.63	92.63
Bed 600–700 ft above Trout Creek sandstone member			45.97	45.97			14.43	14.43							60.40	60.40
Bed 300 ft above Trout Creek sandstone member		6.49		6.49		3.85		3.85						10.34		10.34
Bed 50 ft above Trout Creek sandstone member			9.04	9.04			7.25	7.25							16.29	16.29
Bed on Trout Creek sandstone member							2.78	2.78							2.78	2.78
Lower coal group:																
Bed 180 ft below top of Trout Creek sandstone member			1.02	1.02			.24	.24							1.26	1.26
Bed 200 ft below top of Trout Creek sandstone member			1.34	1.34			.34	.34							1.68	1.68
Bed 250 ft below top of Trout Creek sandstone member			7.80	7.80			8.70	8.70							16.50	16.50
Bed 350 ft below top of Trout Creek sandstone member			8.22	8.22			18.19	18.19							26.41	26.41
Bed 400 ft below top of Trout Creek sandstone member			7.17	7.17			1.59	1.59							8.76	8.76
Bed 408 ft below top of Trout Creek sandstone member			4.38	4.38			9.53	9.53							13.91	13.91
Bed 500 ft below top of Trout Creek sandstone member							.16	.16							.16	.16
Ducey mine bed (500 ft below top of Trout Creek sandstone member)		5.92	11.17	17.09			16.30	16.30						5.92	27.47	33.39
Bed 520 ft below top of Trout Creek sandstone member						8.52		8.52						8.52		8.52
Bed 570 ft below top of Trout Creek sandstone member			23.52	23.52			34.30	34.30							57.82	57.82
Bed 700 ft below top of Trout Creek sandstone member		8.06		8.06		14.10		14.10						22.16		22.16
Bed of Block or Franz mine (600 ft below top of Trout Creek sandstone member)			26.84	26.84			16.75	16.75							43.59	43.59
Bed 30 ft below bed of Block or Franz mine			19.56	19.56			11.76	11.76							31.32	31.32
Bed 70 ft below bed of Block or Franz mine			23.04	23.04			13.73	13.73							36.77	36.77
Bed 100 ft below bed of Block or Franz mine			23.51	23.51			13.73	13.73							37.24	37.24
Bed near base of Iles formation			13.41	13.41			7.85	7.85							21.26	21.26
Total	6.85	22.09	263.23	292.17	12.10	26.47	216.18	254.75	5.64		16.84	22.48	24.59	48.56	496.25	569.40

TABLE 3.—*Measured and indicated, undifferentiated, original bituminous coal reserves in parts of Routt and Moffat Counties, Colo., as of October 1949*—Continued

[By Frank D. Spencer. In millions of short tons]

Coal group and bed	Less than 1,000 feet overburden				1,000–2,000 feet overburden				2,000–3,000 feet overburden				Total in all overburden categories			Bed total
	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	
T. 9 N., R. 86 W.																
Middle coal group:																
Bed 350 ft above Trout Creek sandstone member		2.77		2.77										2.77		2.77
Bed 200 ft above Trout Creek sandstone member		3.19		3.19										3.19		3.19
Bed 100 ft above Trout Creek sandstone member			11.64	11.64											11.64	11.64
Bed on Trout Creek sandstone member			8.14	8.14											8.14	8.14
Lower coal group:																
Bed 180 ft below top of Trout Creek sandstone member			7.69	7.69			0.61	0.61							8.30	8.30
Bed 200 ft below top of Trout Creek sandstone member			10.84	10.84			1.06	1.06							11.90	11.90
Bed 250 ft below top of Trout Creek sandstone member			6.60	6.60			1.03	1.03							7.63	7.63
Bed 500 ft below top of Trout Creek sandstone member			10.39	10.39			5.38	5.38							15.77	15.77
Bed 880 ft below top of Trout Creek sandstone member		11.34		11.34		3.86		3.86						15.20		15.20
Bed 1,250 ft below top of Trout Creek sandstone member			27.92	27.92			14.08	14.08							42.00	42.00
Bed 1,400 ft below top of Trout Creek sandstone member		7.16		7.16		6.68		6.68						13.84		13.84
Total		24.46	83.22	107.68		10.54	22.16	32.70						35.00	105.38	140.38

T. 9 N., R. 87 W.

Middle coal group:															
Bed 200 ft above Trout Creek sandstone member		2.35		2.35									2.35		2.35
Bed 350 ft above Trout Creek sandstone member		2.54		2.54		3.98		3.98					6.52		6.52
Bed 250 ft above Trout Creek sandstone member		10.48		10.48		10.69		10.69		6.59		6.59	27.76		27.76
Bed 100 ft above Trout Creek sandstone member							5.61	5.61						5.61	5.61
Bed on Trout Creek sandstone member							3.82	3.82						3.82	3.82
Lower coal group:															
Bed 180 ft below top of Trout Creek sandstone member							1.80	1.80						1.80	1.80
Bed 200 ft below top of Trout Creek sandstone member							1.96	1.96						1.96	1.96
Bed 250 ft below top of Trout Creek sandstone member							4.14	4.14						4.14	4.14
Bed 500 ft below top of Trout Creek sandstone member							2.11	2.11						2.11	2.11
Bed 880 ft below top of Trout Creek sandstone member		.71		.71		3.29		3.29					4.00		4.00
Bed 1,250 ft below top of Trout Creek sandstone member							5.33	5.33						5.33	5.33
Total		16.08		16.08		17.96	24.77	42.73		6.59		6.59	40.63	24.77	65.40

T. 3 N., R. 90 W.

Middle coal group:															
Bed in *H* zone (400 ft above Trout Creek sandstone member)			14.00	14.00										14.00	14.00
Total			14.00	14.00										14.00	14.00

T. 4 N., R. 88 W.

Middle coal group:															
Bed in *H* zone			6.17	6.17										6.17	6.17
Bed in *G* zone			48.34	48.34										48.34	48.34
Bed in *F* zone		0.16		0.16									0.16		0.16
Lower coal group:															
D bed			12.52	12.52			7.88	7.88						20.40	20.40
C bed			14.33	14.33			8.50	8.50						22.83	22.83
B bed			6.72	6.72			3.20	3.20						9.92	9.92
A bed			9.42	9.42			4.48	4.48						13.90	13.90
Total		0.16	97.50	97.66			24.06	24.06					.16	121.56	121.72

TABLE 3.—*Measured and indicated, undifferentiated, original bituminous coal reserves in parts of Routt and Moffat Counties, Colo., as of October 1949*—Continued

[By Frank D. Spencer. In millions of short tons]

Coal group and bed	Less than 1,000 feet overburden				1,000–2,000 feet overburden				2,000–3,000 feet overburden				Total in all overburden categories			Bed total
	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in thick	
T. 4 N., R. 89 W.																
Lower coal group:																
C bed			2.30	2.30											2.30	2.30
A bed			3.53	3.53											3.53	3.53
Total			5.83	5.83											5.83	5.83
T. 4 N., R. 90 W.																
Middle coal group:																
Bed in *H* zone (400 ft above Trout Creek sandstone member			33.38	33.38											33.38	33.38
Total			33.38	33.38											33.38	33.38
T. 5 N., R. 88 W.																
Middle coal group:																
Bed in *H* zone			15.75	15.75											15.75	15.75
Wadge bed			98.64	98.64			22.84	22.84							121.48	121.48
Wolf Creek bed			64.18	64.18			13.50	13.50							77.68	77.68
Bed in *F* zone		1.99		1.99		7.12		7.12						9.11		9.11
Total		1.99	178.57	180.56		7.12	36.34	43.46						9.11	214.91	224.02

T. 5 N., R. 89 W.

Middle coal group:																
J bed			71.05	71.05											71.05	71.05
Bed in *H* zone			143.55	143.55			100.30	100.30							243.85	243.85
Bed in *H* zone	20.05		5.17	25.22									20.05		5.17	25.22
Bed in *H* zone	1.69			1.69									1.69			1.69
Bed in *G* zone	5.80		3.45	9.25	8.14			8.14					13.94		3.45	17.39
Bed in *G* zone	5.07	22.20	154.59	181.86	5.82	30.45	139.39	175.66					10.89	52.65	293.98	357.52
Bed in *G* zone	1.29			1.29									1.29			1.29
Bed in *F* zone	5.00	7.20	57.54	69.74	7.00	5.84	36.74	49.58					12.00	13.04	94.28	119.32
Lower coal group:																
E bed			2.74	2.74											2.74	2.74
D bed		0.83	18.17	19.00			9.14	9.14						.83	27.31	28.14
Local bed between *C* and *D*							2.42	2.42							2.42	2.42
C bed	.75		14.65	15.40		1.38	12.05	13.43					.75	1.38	26.70	28.83
B bed	1.23		1.60	2.83									1.23		1.60	2.83
A bed			4.25	4.25											4.25	4.25
Total	40.88	30.23	476.76	547.87	20.96	37.67	300.04	358.67					61.84	67.90	776.80	906.54

T. 5 N., R. 90 W.

Middle coal group:																
J bed		3.70	6.16	9.86										3.70	6.16	9.86
Bed in *H* zone		3.27		3.27										3.27		3.27
Bed in *H* zone	1.15	3.20		4.35									1.15	3.20		4.35
Bed in *H* zone			75.41	75.41			53.45	53.45							128.86	128.86
Bed in *H* zone	1.87			1.87									1.87			1.87
Bed in *G* zone	0.94	1.34	67.84	70.12			8.78	8.78					.94	1.34	76.62	78.90
Bed in *F* zone	18.05			18.05	12.13			12.13					30.18			30.18
Lower coal group:																
E bed			8.55	8.55											8.55	8.55
D bed	3.57	1.79	13.10	18.46		1.37	17.56	18.93					3.57	3.16	30.66	37.39
B bed			.56	.56											.56	.56
A bed		5.88		5.88										5.88		5.88
Bed 1,275 ft below top of Trout Creek sandstone member		1.84		1.84										1.84		1.84
Total	25.58	21.02	171.62	218.22	12.13	1.37	79.79	93.29					37.71	22.39	251.41	311.51

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TABLE 3.—*Measured and indicated, undifferentiated, original bituminous coal reserves in parts of Routt and Moffat Counties, Colo., as of October 1949*—Continued

[By Frank D. Spencer. In millions of short tons]

Coal group and bed	Less than 1,000 feet overburden				1,000–2,000 feet overburden				2,000–3,000 feet overburden				Total in all overburden categories			Bed total
	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	
T. 6 N., R. 88 W.																
Middle coal group:																
Wadge bed			12.50	12.50			32.50	32.50							45.00	45.00
Wolf Creek bed			18.75	18.75			50.30	50.30							69.05	69.05
Total			31.25	31.25			82.80	82.80							114.05	114.05
T. 6 N., R. 90 W.																
Middle coal group:																
J bed						8.34		8.34						8.34		8.34
Bed in *H* zone						4.76		4.76						4.76		4.76
Bed in *H* zone					1.62	4.64		6.26					1.62	4.64		6.26
Bed in *H* zone							30.32	30.32							30.32	30.32
Bed in *H* zone							7.11	7.11							7.11	7.11
Bed in *G* zone					3.36			3.36					3.36			3.36
Bed in *G* zone							9.12	9.12							9.12	9.12
Bed in *F* zone					7.43			7.43					7.43			7.43
Total					12.41	17.74	46.55	76.70					12.41	17.74	46.55	76.70

TABLE 4.—*Inferred original bituminous coal reserves in parts of Routt and Moffat Counties, Colo., as of October 1949*

[By Frank D. Spencer. In millions of short tons]

Coal group and bed	Less than 1,000 feet overburden				1,000–2,000 feet overburden				2,000–3,000 feet overburden				Total in all overburden categories			Bed total
	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	
T. 4 N., R. 86 W.																
Middle coal group:																
Wadge bed			8.58	8.58											8.58	8.58
Wolf Creek bed			79.10	79.10											79.10	79.10
Total			87.68	87.68											87.68	87.68
T. 4 N., R. 87 W.																
Middle coal group:																
Lennox bed		8.46		8.46										8.46		8.46
Wadge bed			5.68	5.68											5.68	5.68
Total		8.46	5.68	14.14										8.46	5.68	14.14
T. 5 N., R. 85 W.																
Middle coal group:																
Lennox bed		1.10		1.10										1.10		1.10
Total		1.10		1.10										1.10		1.10
T. 5 N., R. 86 W.																
Middle coal group:																
Lennox bed		5.71		5.71		38.28		38.28						43.99		43.99
Wadge bed			46.04	46.04			50.58	50.58							96.62	96.62
Wolf Creek bed			41.80	41.80			227.05	227.05							268.85	268.85
Total		5.71	87.84	93.55		38.28	277.63	315.91						43.99	365.47	409.46

TABLE 4.—*Inferred original bituminous coal reserves in parts of Routt and Moffat Counties, Colo., as of October 1949*—Continued

[By Frank D. Spencer. In millions of short tons]

Coal group and bed	Less than 1,000 feet overburden				1,000–2,000 feet overburden				2,000–3,000 feet overburden				Total in all overburden categories			Bed total
	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	
T. 5 N., R. 87 W.																
Middle coal group:																
Lennox bed		13.44	69.89	83.33			36.79	36.79						13.44	106.68	120.12
Wadge bed			63.58	63.58			8.70	8.70							72.28	72.28
Wolf Creek bed			92.87	92.87			58.71	58.71							151.58	151.58
Total		13.44	226.34	239.78			104.20	104.20						13.44	330.54	343.98
T. 6 N., R. 86 W.																
Middle coal group:																
Lennox bed		7.98		7.98		4.40		4.40						12.38		12.38
Wadge bed			2.19	2.19			1.54	1.54							3.73	3.73
Wolf Creek bed			6.80	6.80			4.39	4.39							11.19	11.19
Total		7.98	8.99	16.97		4.40	5.93	10.33						12.38	14.92	27.30
T. 6 N., R. 87 W.																
Middle coal group:																
Lennox bed						7.94	18.35	26.29						7.94	18.35	26.29
Wadge bed							46.42	46.42							46.42	46.42
Wolf Creek bed							58.98	58.98			19.23	19.23			78.21	78.21
Total						7.94	123.75	131.69			19.23	19.23		7.94	142.98	150.92
T. 4 N., R. 88 W.																
Middle coal group:																
Bed in *H* zone							0.58	0.58							0.58	0.58
Bed in *G* zone			13.45	13.45											13.45	13.45
Bed in *F* zone		4.78		4.78		0.30		.30						5.08		5.08
Total		4.78	13.45	18.23		.30	.58	.88						5.08	14.03	19.11

T. 5 N., R. 88 W.

Middle coal group:																
Wadge bed			40.59	40.59			25.55	25.55							66.14	66.14
Wolf Creek bed			110.43	110.43			63.01	63.01							173.44	173.44
Total			151.02	151.02			88.56	88.56							239.58	239.58

T. 5 N., R. 89 W.

Middle coal group:																
Bed in *G* zone							251.05	251.05							251.05	251.05
Bed in *F* zone		0.74	4.68	5.42		12.13	50.09	62.22						12.87	54.77	67.64
Total		.74	4.68	5.42		12.13	301.14	313.27						12.87	305.82	318.69

T. 6 N., R. 88 W.

Middle coal group:																
Wadge bed							62.40	62.40			32.65	32.65			95.05	95.05
Wolf Creek bed							91.70	91.70			61.20	61.20			152.90	152.90
Total							154.10	154.10			93.85	93.85			247.95	247.95

T. 6 N., R. 89 W.

Middle coal group:																
Wadge bed							21.30	21.30							21.30	21.30
Total							21.30	21.30							21.30	21.30

T. 6 N., R. 90 W.

Middle coal group:																
Wadge bed							77.71	77.71							77.71	77.71
Total							77.71	77.71							77.71	77.71

TABLE 5.—*Measured and indicated, undifferentiated, original subbituminous coal reserves in parts of Routt and Moffat Counties, Colo., as of October 1949*

[By Frank D. Spencer. In millions of short tons]

Formation or group, and coal bed	Less than 1,000 feet overburden				1,000–2,000 feet overburden				2,000–3,000 feet overburden				Total in all overburden categories			Bed total
	In beds 30–60 in. thick	In beds 60–120 in. thick	In beds more than 120 in. thick	Total	In beds 30–60 in. thick	In beds 60–120 in. thick	In beds more than 120 in. thick	Total	In beds 30–60 in. thick	In beds 60–120 in. thick	In beds more than 120 in. thick	Total	In beds 30–60 in. thick	In beds 60–120 in. thick	In beds more than 120 in. thick	
T. 5 N., R. 86 W.																
Upper coal group:																
Fish Creek bed	38.49			38.49									38.49			38.49
Total	38.49			38.49									38.49			38.49
T. 5 N., R. 87 W.																
Upper coal group:																
Bed of bc. 245	8.41		4.01	12.42									8.41		4.01	12.42
Fish Creek bed	21.91			21.91									21.91			21.91
Total	30.32		4.01	34.33									30.32		4.01	34.33
T. 6 N., R. 86 W.																
Upper coal group:																
Fish Creek bed	3.04			3.04									3.04			3.04
Total	3.04			3.04									3.04			3.04
T. 6 N., R. 87 W.																
Upper coal group:																
Dry Creek bed	17.53		19.92	37.45									37.45			37.45
Fish Creek bed	13.20			13.20									13.20			13.20
Total	30.73		19.92	50.65									50.65			50.65

T. 8 N., R. 87 W.

Lance formation:																
Bed of loc. 262	9.92			9.92									9.92			9.92
Total	9.92			9.92									9.92			9.92

T. 7 N., R. 90 W.

Ft. Union formation:																
Seymour bed	1.14			1.14									1.14			1.14
Boone Gulch bed	12.22	16.12		28.34									12.22	16.12		28.34
Campbell bed	14.18			14.18									14.18			14.18
Lance formation:																
Bed of loc. 407a		.66		.66										.66		.66
Kimberly bed			25.94	25.94											25.94	25.94
Total	27.54	16.78	25.94	70.26									27.54	16.78	25.94	70.26

T. 8 N., R. 88 W.

Lance formation:																
Bed of loc. 251	4.01			4.01									4.01			4.01
Bed 100 ft below bed of loc. 251	21.17			21.17									21.17			21.17
Total	25.18			25.18									25.18			25.18

T. 8 N., R. 89 W.

Ft. Union formation:																
Seymour bed	13.63	24.79	67.91	106.33									13.63	24.79	67.91	106.33
Lance formation:																
Bed of loc. 251	.31			.31									.31			.31
Total	13.94	24.79	67.91	106.64									13.94	24.79	67.91	106.64

T. 8 N., R. 90 W.

Ft. Union formation:																
Seymour bed	9.49	6.78	14.50	30.77									9.49	6.78	14.50	30.77
Total	9.49	6.78	14.50	30.77									9.49	6.78	14.50	30.77

TABLE 5.—*Measured and indicated, undifferentiated, original subbituminous coal reserves in parts of Routt and Moffat Counties, Colo., as of October 1949*—Continued

[By Frank D. Spencer. In millions of short tons]

Formation or group, and coal bed	Less than 1,000 feet overburden				1,000–2,000 feet overburden				2,000–3,000 feet overburden				Total in all overburden categories			Bed total
	In beds 30–60 in. thick	In beds 60–120 in. thick	In beds more than 120 in. thick	Total	In beds 30–60 in. thick	In beds 60–120 in. thick	In beds more than 120 in. thick	Total	In beds 30–60 in. thick	In beds 60–120 in. thick	In beds more than 120 in. thick	Total	In beds 30–60 in. thick	In beds 60–120 in. thick	In beds more than 120 in. thick	
T. 9 N., R. 89 W.																
Ft. Union formation:																
Bed 50 ft above Seymour bed	3.62			3.62	.28			.28					3.90			3.90
Total	3.62			3.62	.28			.28					3.90			3.90
T. 9 N., R. 87 W.																
Lance formation:																
Bed of loc. 262	1.59			1.59									1.59			1.59
Bed 50 ft below bed of loc. 262		14.49		14.49										14.49		14.49
Bed of loc. 222	6.74	11.68	29.18	47.60									6.74	11.68	29.18	47.60
Total	8.33	26.17	29.18	63.68									8.33	26.17	29.18	63.68
T. 9 N., R. 88 W.																
Lance formation:																
Bed of loc. 262	18.63			18.63									18.63			18.63
Bed 50 ft below bed of loc. 262	28.65	0.87		29.52									28.65	0.87		29.52
Total	47.28	.87		48.15									47.28	.87		48.15

T. 7 N., R. 88 W.

Lance formation:																
Bed 50 ft above bed of loc. 251	7.59			7.59									7.59			7.59
Bed of loc. 251	8.83			8.83									8.83			8.83
Bed 400 ft above Lorella bed	2.13			2.13									2.13			2.13
Lorella bed	8.30	16.25		24.55									8.30	16.25		24.55
Bed 100 ft below Lorella bed		2.50		2.50										2.50		2.50
Bed 50 ft below Lorella bed		12.06		12.06										12.06		12.06
Total	26.85	30.81		57.66									26.85	30.81		57.66

T. 7 N., R. 89 W.

Ft. Union formation:																
Bed of Boone Gulch mine (loc. 342)	3.62			3.62									3.62			3.62
Campbell bed	3.57			3.57									3.57			3.57
Lance formation:																
Bed of loc. 334, White mine		13.49		13.49										13.49		13.49
Bed of loc. 407a		1.00		1.00										1.00		1.00
Bed of loc. 251	.48			.48									.48			.48
Total	7.67	14.49		22.16									7.67	14.49		22.16

T. 5 N., R. 88 W.

Upper coal group:																
P bed		19.62	19.07	38.69										19.62	19.07	38.69
N bed	0.19			.19									0.19			.19
L bed	22.75	72.62		95.37									22.75	72.62		95.37
K bed	19.92			19.92									19.92			19.92
Bed 12 ft below *K* bed		23.00		23.00										23.00		23.00
Total	42.86	115.24	19.07	177.17									42.86	115.24	19.07	177.17

TABLE 5.—*Measured and indicated, undifferentiated, original subbituminous coal reserves in parts of Routt and Moffat Counties, Colo., as of October 1949*—Continued

[By Frank D. Spencer. In millions of short tons]

Formation or group, and coal bed	Less than 1,000 feet overburden				1,000–2,000 feet overburden				2,000–3,000 feet overburden				Total in all overburden categories			Bed total
	In beds 30–60 in. thick	In beds 60–120 in. thick	In beds more than 120 in. thick	Total	In beds 30–60 in. thick	In beds 60–120 in. thick	In beds more than 120 in. thick	Total	In beds 30–60 in. thick	In beds 60–120 in. thick	In beds more than 120 in. thick	Total	In beds 30–60 in. thick	In beds 60–120 in. thick	In beds more than 120 in. thick	
T. 5 N., R. 89 W.																
Upper coal group:																
S bed		0.26		0.26										0.26		0.26
R bed	1.13			1.13									1.13			1.13
O bed		1.38		1.38										1.38		1.38
P bed		8.28		8.28										8.28		8.28
O bed	13.28	19.51		32.79									13.28	19.51		32.79
N bed	10.93	20.83		31.76									10.93	20.83		31.76
M bed	1.80	48.31		50.11									1.80	48.31		50.11
L bed		44.12		44.12										44.12		44.12
K bed	6.51	27.35		33.86									6.51	27.35		33.86
H bed	13.38			13.38									13.38			13.38
Total	47.03	170.04		217.07									47.03	170.04		217.07
T. 5 N., R. 90 W.																
Upper coal group:																
R bed		1.95		1.95										1.95		1.95
O bed		3.06		3.06										3.06		3.06
N bed		8.67		8.67										8.67		8.67
K bed		33.17		33.17										33.17		33.17
Total		46.85		46.85										46.85		46.85

T. 6 N., R. 88 W.

Lance formation:																
Lorella bed		3.10		3.10										3.10		3.10
Bed of Stroud mine	4.38			4.38									4.38			4.38
Bed of Rose mine	3.03	4.52		7.55									3.03	4.52		7.55
Upper coal group:																
K bed		22.60	106.11	128.71										22.60	106.11	128.71
Total	7.41	30.22	106.11	143.74									7.41	30.22	106.11	143.74

T. 6 N., R. 89 W.

Lance formation:																
Bed of White mine		4.78		4.78										4.78		4.78
Bed of Stroud mine	1.17			1.17									1.17			1.17
Bed of Rose mine		8.27		8.27										8.27		8.27
Beds of loc. 334a:																
Bed 3	13.66			13.66									13.66			13.66
Bed 2		21.57		21.57										21.57		21.57
Bed 1		21.57		21.57										21.57		21.57
Upper coal group:																
S bed	12.92	.24		13.16									12.92	.24		13.16
O bed	18.35			18.35									18.35			18.35
N bed		36.20		36.20										36.20		36.20
M bed		11.25		11.25										11.25		11.25
Bed of loc. 407a		5.17		5.17										5.17		5.17
Total	46.10	109.05		155.15									46.10	109.05		155.15

T. 6 N., R. 90 W.

Uper coal group:																
Bed of loc. 407a		5.72		5.72										5.72		5.72
S bed	14.33			14.33									14.33			14.33
R bed		.77		.77										.77		.77
O bed	35.43	1.79		37.22	9.00			9.00					44.43	1.79		46.22
N bed		30.00		30.00										30.00		30.00
K bed		23.90		23.90										23.90		23.90
Total	49.76	62.18		111.94	9.00			9.00					58.76	62.18		120.94

TABLE 6.—*Inferred original subbituminous coal reserves in parts of Routt and Moffat Counties, Colo., as of October 1949*

[By Frank D. Spencer. In millions of short tons]

Coal group and bed	Less than 1,000 feet overburden				1,000–2,000 feet overburden				2,000–3,000 feet overburden				Total in all overburden categories			Bed total
	In beds 30–60 in. thick	In beds 60–120 in. thick	In beds more than 120 in. thick	Total	In beds 30–60 in. thick	In beds 60–120 in. thick	In beds more than 120 in. thick	Total	In beds 30–60 in. thick	In beds 60–120 in. thick	In beds more than 120 in. thick	Total	In beds 30–60 in. thick	In beds 60–120 in. thick	In beds more than 120 in. thick	
T. 5 N., R. 86 W.																
Upper coal group:																
Fish Creek bed	9.55			9.55									9.55			9.55
Total	9.55			9.55									9.55			9.55
T. 5 N., R. 87 W.																
Upper coal group:																
Bed of loc. 245			13.34	13.34											13.34	13.34
Total			13.34	13.34											13.34	13.34
T. 6 N., R. 87 W.																
Upper coal group:																
Dry Creek bed			99.40	99.40			11.46	11.46							110.86	110.86
Total			99.40	99.40			11.46	11.46							110.86	110.86

T. 5 N., R. 89 W.

Upper coal group:																
K bed		29.42		29.42										29.42		29.42
Total		29.42		29.42										29.42		29.42

T. 6 N., R. 89 W.

Upper coal group:																
N bed						22.22		22.22						22.22		22.22
M bed						76.60		76.60						76.60		76.60
K bed							12.00	12.00							12.00	12.00
Total						98.82	12.00	110.82						98.82	12.00	110.82

TABLE 7.— *Original bituminous coal reserves in parts of Routt and Moffat Counties, Colo., by counties and townships, as of October 1949*

[In millions of short tons]

Township	Less than 1,000 feet overburden				1,000–2,000 feet overburden				2,000–3,000 feet overburden				Total in all overburden categories			Township total
	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	Total	In beds 14–28 in. thick	In beds 28–42 in. thick	In beds more than 42 in. thick	
Measured and indicated, undifferentiated—Moffat County																
T. 3 N., R. 90 W.	------	------	14.00	14.00	------	------	------	------	------	------	------	------	------	------	14.00	14.00
T. 4 N., R. 90 W.	------	------	33.38	33.38	------	------	------	------	------	------	------	------	------	------	33.38	33.38
T. 5 N., R. 90 W.	25.58	21.02	171.62	218.22	12.13	1.37	79.79	93.29	------	------	------	------	37.71	22.39	251.41	311.51
T. 6 N., R. 90 W.	------	------	------	------	12.41	17.74	46.55	76.70	------	------	------	------	12.41	17.74	46.55	76.70
Total	25.58	21.02	219.00	265.60	24.54	19.11	126.34	169.99	------	------	------	------	50.12	40.13	345.34	435.59
Measured aud indicated, undifferentiated—Routt County																
T. 3 N., R. 86 W.	------	5.70	72.49	78.19	------	------	------	------	------	------	------	------	------	5.70	72.49	78.19
T. 4 N., R. 85 W.	------	6.02	120.94	126.96	------	------	22.00	22.00	------	------	------	------	------	6.02	142.94	148.96
T. 4 N., R. 86 W.	------	30.39	322.09	352.48	------	5.09	103.23	108.32	------	------	------	------	------	35.48	425.32	460.80
T. 4 N., R. 87 W.	------	------	36.07	36.07	------	------	21.61	21.61	------	------	------	------	------	------	57.68	57.68
T. 5 N., R. 85 W.	------	2.65	142.91	145.56	------	------	42.22	42.22	------	------	------	------	------	2.65	185.13	187.78
T. 5 N., R. 86 W.	------	34.08	377.51	411.59	------	22.56	291.45	314.01	------	4.57	14.38	18.95	------	61.21	683.34	744.55
T. 5 N., R. 87 W.	------	------	42.71	42.71	------	------	4.19	4.19	------	------	------	------	------	------	46.90	46.90
T. 6 N., R. 86 W.	2.92	5.14	55.33	63.39	------	------	------	------	------	------	------	------	2.92	5.14	55.33	63.39
T. 6 N., R. 87 W.	3.02	48.12	328.70	379.84	1.53	32.01	359.91	393.45	------	------	------	------	4.55	80.13	688.61	773.29
T. 7 N., R. 86 W.	------	------	4.47	4.47	------	------	9.43	9.43	------	------	------	------	------	------	13.90	13.90
T. 7 N., R. 87 W.	1.62	6.31	224.83	232.76	.52	------	108.33	108.85	------	------	------	------	2.14	6.31	333.16	341.61
T. 8 N., R. 86 W.	.48	7.65	46.23	54.36	------	3.89	1.24	5.13	------	------	------	------	.48	11.54	47.47	59.49
T. 8 N., R. 87 W.	6.85	22.09	263.23	292.17	12.10	26.47	216.18	254.75	5.64	------	16.84	22.48	24.59	48.56	496.25	569.40
T. 9 N., R. 86 W.	------	24.46	83.22	107.68	------	10.54	22.16	32.70	------	------	------	------	------	35.00	105.38	140.38
T. 9 N., R. 87 W.	------	16.08	------	16.08	------	17.96	24.77	42.73	------	6.59	------	6.59	------	40.63	24.77	65.40
T. 4 N., R. 88 W.	------	.16	97.50	97.66	------	------	24.06	24.06	------	------	------	------	------	.16	121.56	121.72
T. 4 N., R. 89 W.	------	------	5.83	5.83	------	------	------	------	------	------	------	------	------	------	5.83	5.83
T. 5 N., R. 88 W.	------	1.99	178.57	180.56	------	7.12	36.34	43.46	------	------	------	------	------	9.11	214.91	224.02
T. 5 N., R. 89 W.	40.88	30.23	476.76	547.87	20.96	37.67	300.04	358.67	------	------	------	------	61.84	67.90	776.80	906.54
T. 6 N., R. 88 W.	------	------	31.25	31.25	------	------	82.80	82.80	------	------	------	------	------	------	114.05	114.05
Total	55.77	241.07	2,910.64	3,207.48	35.11	163.31	1,669.96	1,868.38	5.64	11.16	31.22	48.02	96.52	415.54	4,611.82	5,123.88

Inferred—Moffat County

T. 6 N., R. 90 W.			77.71	77.71											77.71	77.71
Total			77.71	77.71											77.71	77.71

Inferred—Routt County

T. 4 N., R. 86 W.			87.68	87.68											87.68	87.68
T. 4 N., R. 87 W.		8.46	5.68	14.14										8.46	5.68	14.14
T. 5 N., R. 85 W.		1.10		1.10										1.10		1.10
T. 5 N., R. 86 W.		5.71	87.84	93.55		38.28	277.63	315.91						43.99	365.47	409.46
T. 5 N., R. 87 W.		13.44	226.34	239.78			104.20	104.20						13.44	330.54	343.98
T. 6 N., R. 86 W.		7.98	8.99	16.97		4.40	5.93	10.33						12.38	14.92	27.30
T. 6 N., R. 87 W.						7.94	123.75	131.69			19.23	19.23		7.94	142.98	150.92
T. 4 N., R. 88 W.		4.78	13.45	18.23		.30	.58	.88						5.08	14.03	19.11
T. 5 N., R. 88 W.			151.02	151.02			88.56	88.56							239.58	239.58
T. 5 N., R. 89 W.		.74	4.68	5.42		12.13	301.14	313.27						12.87	305.82	318.69
T. 6 N., R. 88 W.							154.10	154.10			93.85	93.85			247.95	247.95
T. 6 N., R. 89 W.							21.30	21.30							21.30	21.30
Total		42.21	585.68	627.89		63.05	1,077.19	1,140.24			113.08	113.08		105.26	1,775.95	1,881.21

TABLE 8.—*Original subbituminous coal reserves in parts of Routt and Moffat Counties, Colo., by counties and townships, as of October 1949*

[In millions of short tons]

Township	Less than 1,000 feet overburden				1,000–2,000 feet overburden				2,000–3,000 feet overburden				Total in all overburden categories			Township total
	In beds 30–60 in. thick	In beds 60–120 in. thick	In beds more than 120 in. thick	Total	In beds 30–60 in. thick	In beds 60–120 in. thick	In beds more than 120 in. thick	Total	In beds 30–60 in. thick	In beds 60–120 in. thick	In beds more than 120 in. thick	Total	In beds 30–60 in. thick	In beds 60–120 in. thick	In beds more than 120 in. thick	
Measured and indicated, undifferentiated—Moffat County																
T. 5 N., R. 90 W.	-------	46.85	-------	46.85	-------	-------	-------	-------	-------	-------	-------	-------	-------	46.85	-------	46.85
T. 6 N., R. 90 W.	49.76	62.18	-------	111.94	9.00	-------	-------	9.00	-------	-------	-------	-------	58.76	62.18	-------	120.94
T. 7 N., R. 90 W.	27.54	16.78	25.94	70.26	-------	-------	-------	-------	-------	-------	-------	-------	27.54	16.78	25.94	70.26
T. 8 N., R. 89 W.	13.94	24.79	67.91	106.64	-------	-------	-------	-------	-------	-------	-------	-------	13.94	24.79	67.91	106.64
T. 8 N., R. 90 W.	9.49	6.78	14.50	30.77	-------	-------	-------	-------	-------	-------	-------	-------	9.49	6.78	14.50	30.77
T. 9 N., R. 89 W.	3.62	-------	-------	3.62	.28	-------	-------	.28	-------	-------	-------	-------	3.90	-------	-------	3.90
Total	104.35	157.38	108.35	370.08	9.28	-------	-------	9.28	-------	-------	-------	-------	113.63	157.38	108.35	379.36
Measured and indicated, undifferentiated—Routt County																
T. 5 N., R. 86 W.	38.49	-------	-------	38.49	-------	-------	-------	-------	-------	-------	-------	-------	38.49	-------	-------	38.49
T. 5 N., R. 87 W.	30.32	-------	4.01	34.33	-------	-------	-------	-------	-------	-------	-------	-------	30.32	-------	4.01	34.33
T. 6 N., R. 86 W.	3.04	-------	-------	3.04	-------	-------	-------	-------	-------	-------	-------	-------	3.04	-------	-------	3.04
T. 6 N., R. 87 W.	30.73	-------	19.92	50.65	-------	-------	-------	-------	-------	-------	-------	-------	30.73	-------	19.92	50.65
T. 8 N., R. 87 W.	9.92	-------	-------	9.92	-------	-------	-------	-------	-------	-------	-------	-------	9.92	-------	-------	9.92
T. 9 N., R. 87 W.	8.33	26.17	29.18	63.68	-------	-------	-------	-------	-------	-------	-------	-------	8.33	26.17	29.18	63.68
T. 9 N., R. 88 W.	47.28	.87	-------	48.15	-------	-------	-------	-------	-------	-------	-------	-------	47.28	.87	-------	48.15
T. 7 N., R. 88 W.	26.85	30.81	-------	57.66	-------	-------	-------	-------	-------	-------	-------	-------	26.85	30.81	-------	57.66
T. 7 N., R. 89 W.	7.67	14.49	-------	22.16	-------	-------	-------	-------	-------	-------	-------	-------	7.67	14.49	-------	22.16
T. 8 N., R. 88 W.	25.18	-------	-------	25.18	-------	-------	-------	-------	-------	-------	-------	-------	25.18	-------	-------	25.18
T. 5 N., R. 88 W.	42.86	115.24	19.07	177.17	-------	-------	-------	-------	-------	-------	-------	-------	42.86	115.24	19.07	177.17
T. 5 N., R. 89 W.	47.03	170.04	-------	217.07	-------	-------	-------	-------	-------	-------	-------	-------	47.03	170.04	-------	217.07
T. 6 N., R. 88 W.	7.41	30.22	106.11	143.74	-------	-------	-------	-------	-------	-------	-------	-------	7.41	30.22	106.11	143.74
T. 6 N., R. 89 W.	46.10	109.05	-------	155.15	-------	-------	-------	-------	-------	-------	-------	-------	46.10	109.05	-------	155.15
Total	371.21	496.89	178.29	1,046.39	-------	-------	-------	-------	-------	-------	-------	-------	371.21	496.89	178.29	1,046.39

Inferred—Routt County

T. 5 N., R. 86 W	9.55	-	-	9.55	-	-	-	-	-	-	-	-	9.55	-	-	9.55
T. 5 N., R. 87 W	-	-	13.34	13.34	-	-	-	-	-	-	-	-	-	-	13.34	13.34
T. 6 N., R. 87 W	-	-	99.40	99.40	-	-	11.46	11.46	-	-	-	-	-	-	110.86	110.86
T. 5 N., R. 89 W	-	29.42	-	29.42	-	-	-	-	-	-	-	-	-	29.42	-	29.42
T. 6 N., R. 89 W	-	-	-	-	-	98.82	12.00	110.82	-	-	-	-	-	98.82	12.00	110.82
Total	9.55	29.42	112.74	151.71	-	98.82	23.46	122.28	-	-	-	-	9.55	128.24	136.20	273.99

TABLE 9.—*Measured and indicated, undifferentiated, and inferred original coal reserves in parts of Routt and Moffat Counties, Colo., by counties and townships, as of October 1949*

[In millions of short tons]

Township	Bituminous			Subbituminous			Total in all ranks and categories
	Measured and indicated, undifferentiated	Inferred	Total	Measured and indicated, undifferentiated	Inferred	Total	
Moffat County							
T. 3 N., R. 90 W.	14.00		14.00				14.00
T. 4 N., R. 90 W.	33.38		33.38				33.38
T. 5 N., R. 90 W.	311.51		311.51	46.85		46.85	358.36
T. 6 N., R. 90 W.	76.70	77.71	154.41	120.94		120.94	275.35
T. 7 N., R. 90 W.				70.26		70.26	70.26
T. 8 N., R. 89 W.				106.64		106.64	106.64
T. 8 N., R. 90 W.				30.77		30.77	30.77
T. 9 N., R. 89 W.				3.90		3.90	3.90
County total	435.59	77.71	513.30	379.36		379.36	892.66
Routt County							
T. 3 N., R. 86 W.	78.19		78.19				78.19
T. 4 N., R. 85 W.	148.96		148.96				148.96
T. 4 N., R. 86 W.	460.80	87.68	548.48				548.48
T. 4 N., R. 87 W.	57.68	14.14	71.82				71.82
T. 5 N., R. 85 W.	187.78	1.10	188.88				188.88
T. 5 N., R. 86 W.	744.55	409.46	1,154.01	38.49	9.55	48.04	1,202.05
T. 5 N., R. 87 W.	46.90	343.98	390.88	34.33	13.34	47.67	438.55
T. 6 N., R. 86 W.	63.39	27.30	90.69	3.04		3.04	93.73
T. 6 N., R. 87 W.	773.29	150.92	924.21	50.65	110.86	161.51	1,085.72
T. 7 N., R. 86 W.	13.90		13.90				13.90
T. 7 N., R. 87 W.	341.61		341.61				341.61
T. 7 N., R. 88 W.				57.66		57.66	57.66
T. 7 N., R. 89 W.				22.16		22.16	22.16
T. 8 N., R. 86 W.	59.49		59.49				59.49
T. 8 N., R. 87 W.	569.40		569.40	9.92		9.92	579.32
T. 8 N., R. 88 W.				25.18		25.18	25.18
T. 9 N., R. 86 W.	140.38		140.38				140.38
T. 9 N., R. 87 W.	65.40		65.40	63.68		63.68	129.08
T. 9 N., R. 88 W.				48.15		48.15	48.15

T. 4 N., R. 88 W.	121.72	19.11	140.83				140.83
T. 4 N., R. 89 W.	5.83		5.83				5.83
T. 5 N., R. 88 W.	224.02	239.58	463.60	177.17		177.17	640.77
T. 5 N., R. 89 W.	906.54	318.69	1,225.23	217.07	29.42	246.49	1,471.72
T. 6 N., R. 88 W.	114.05	247.95	362.00	143.74		143.74	505.74
T. 6 N., R. 89 W.		21.30	21.30	155.15	110.82	265.97	287.27
County total	5,123.88	1,881.21	7,005.09	1,046.39	273.99	1,320.38	8,325.47
Grand total	5,559.47	1,958.92	7,518.39	1,425.75	273.99	1,699.74	9,218.13

TABLE 10.—*Analyses of gas samples, in percent, from the Tow Creek and Williams Park fields, Routt County, Colo.*

[After Anderson and Hinson (1951, p. 54–55)]

Field	Company	Farm and well	Location			Depth to gas zone (feet)	Formation	Carbon dioxide	Oxygen	Methane	Ethane	Nitrogen and helium	Helium	Total heating value (B.t.u.)[1]
			Sec.	T.	R.									
Tow Creek	Texas Co	Adair, no. 1	7	6N	86W	1,980	Niobrara	3.1	0.4	79.2	16.3	1.0	0.10	1,094
Do	do	Carstarphen-Irwin, no. 3.	5	6N	86W	3,580	do	3.5	.1	79.1	13.7	3.6	.08	1,047
Do	do	H. Dennis, no. 3	18	6N	86W	2,680	do	14.1	.2	33.3	51.7	.7	.07	1,264
Williams Park	Twenty Mile Oil & Gas Co.	no. 2	36	4N	88W	453	Dakota sandstone.	.1	.5	78.4	.0	21.0	1.04	794

[1] Per cubic foot for dry gas at 60°F and 30 in. Hg.

TABLE 11.—*Analyses of crude oil from the Tow Creek and Oak Creek fields, Routt County, Colo.*

SAMPLE 40278

[Tow Creek field (south pool); Niobrara equivalent; 2,733 feet; sec. 18, T. 6 N., R. 86 W. Analysis by U. S. Bureau of Mines, Bartlesville, Okla.]

Sp gr, 0.839
Sulfur, percent, 0.17
Saybolt Universal viscosity at 100°F, 41 sec.
API gravity, 37.2°
Color, brownish-green

Distillation, Bureau of Mines Hempel method

Fraction no.	Cut at—		Percent	Sum, percent	Sp gr, 60/60°F	API, 60°F	Correlation index	Viscosity,[1] 100°F	Cloud test, °F
	°C	°F							
At atmospheric pressure, 740 mm									
[First drop, 34°C (93°F)]									
1	50	122	1.7	1.7	0.655	84.5			
2	75	167	2.2	3.9	.686	74.8	15		
3	100	212	5.0	8.9	.716	66.1	19		
4	125	257	6.5	15.4	.742	59.2	23		
5	150	302	6.0	21.4	.763	54.0	25		
6	175	347	5.1	26.5	.783	49.2	28		
7	200	392	5.2	31.7	.799	45.6	29		
8	225	437	4.5	36.2	.814	42.3	31		
9	250	482	5.3	41.5	.828	39.4	32		
10	275	527	6.5	48.0	.836	37.8	31		
Continued at 40 mm									
11	200	392	4.7	52.7	0.847	35.6	32	41	15
12	225	437	7.2	59.9	.855	34.0	32	47	35
13	250	482	6.1	66.0	.869	31.3	36	61	55
14	275	527	6.6	72.6	.882	28.9	39	97	75
15	300	572	5.9	78.5	.895	26.6	42	180	90
Residuum[2]			21.1	99.6	.949	17.6			

[1] Saybolt Universal.
[2] Carbon residue of residuum, 4.8 percent; carbon residue of crude, 1.0 percent.

Approximate summary

	Percent	Sp gr	° API	Viscosity
Light gasoline	8.9	0.697	71.5	
Total gasoline and naphtha	31.7	0.749	57.4	
Kerosene distillate	4.5	0.814	42.3	
Gas oil	21.6	0.841	36.8	
Nonviscous lubricating distillate	14.0	0.858–0.887	33.4–28.0	50–100.
Medium lubricating distillate	5.3	0.887–0.898	28.0–26.1	100–200.
Viscous lubricating distillate	1.4	0.898–0.901	26.1–25.6	Above 200.
Residuum	21.1	0.949	17.6	
Distillation loss	0.4			

TABLE 11.—*Analyses of crude oil from the Tow Creek and Oak Creek fields, Routt County, Colo.*—Continued

SAMPLE 40279

[Tow Creek field (south pool); Niobrara equivalent; 2,586 feet; sec. 18, T. 6 N., R. 86 W. Analysis by U. S. Bureau of Mines, Bartlesville, Okla.]

Sp gr, 0.838
Sulfur, percent, 0.16
Saybolt Universal viscosity at 100°F, 42 sec.
API gravity, 37.4°
Color, brownish-green

Distillation, Bureau of Mines Hempel method

Fraction no.	Cut at—		Percent	Sum, percent	Sp gr, 60/60°F	API, 60°F	Correlation index	Viscosity,[1] 100°F	Cloud test, °F
	°C	°F							
At atmospheric pressure, 746 mm									
[First drop, 32°C (90°F)]									
1	50	122	1.7	1.7	0.648	86.9			
2	75	167	2.3	4.0	.671	79.4	8.0		
3	100	212	5.1	9.1	.719	65.3	21		
4	125	257	7.0	16.1	.744	58.7	24		
5	150	302	5.5	21.6	.765	53.5	26		
6	175	347	5.0	26.6	.781	49.7	27		
7	200	392	4.3	30.9	.799	45.6	29		
8	225	437	4.8	35.7	.815	42.1	31		
9	250	482	5.3	41.0	.826	39.8	31		
10	275	527	6.8	47.8	.836	37.8	31		
Continued at 40 mm									
11	200	392	4.7	52.5	0.846	35.8	32	41	15
12	225	437	6.3	58.8	.855	34.0	32	46	30
13	250	482	6.4	65.2	.866	31.9	34	58	50
14	275	527	5.8	71.0	.876	30.0	36	89	70
15	300	572	6.4	77.4	.889	27.7	39	150	85
Residuum[2]			22.0	99.4	.946	18.1			

[1] Saybolt Universal.
[2] Carbon residue of residuum, 4.6 percent; carbon residue of crude, 1.0 percent.

Approximate summary

	Percent	Sp gr	° API	Viscosity
Light gasoline	9.1	0.694	72.4	
Total gasoline and naphtha	30.9	0.747	57.9	
Kerosene distillate	4.8	0.815	42.1	
Gas oil	22.1	0.840	37.0	
Nonviscous lubricating distillate	11.2	0.859–0.878	33.2–29.7	50–100.
Medium lubricating distillate	8.4	0.878–0.896	29.7–26.4	100–200.
Viscous lubricating distillate				Above 200.
Residuum	22.0	0.946	18.1	
Distillation loss	.6			

TABLE 11.—*Analyses of crude oil from the Tow Creek and Oak Creek fields, Routt County, Colo.*—Continued

SAMPLE 41446

[Tow Creek field; Mancos shale; oil seep; sec. 32, T. 7 N., R. 86 W. Analysis by U. S. Bureau of Mines, Bartlesville, Okla.]

Sp gr, 0.960
Sulfur, percent, 0.40
Saybolt Universal viscosity at 100°F, 3100 sec.
API gravity, 15.9°
Color, greenish-black

Distillation, Fureau of Mines Hempel method

Fraction no.	Cut at—		Percent	Sum, percent	Sp gr, 60/60°F	API, 60°F	Correlation index	Viscosity,[1] 100°F	Cloud test, °F.
	°C	°F							
At atmospheric pressure, 745 mm									
[First drop, 59°C (138°F)]									
1	50	122							
2	75	167							
3	100	212							
4	125	257							
5	150	302							
6	175	347							
7	200	392	0.2	0.2	0.829	39.2			
8	225	437	.3	.5	.833	38.4	40		
9	250	482	1.4	1.9	.861	32.8	48		
10	275	527	5.9	7.8	.880	29.3	52		
Continued at 40 mm									
11	200	392	3.2	11.0	0.898	26.1	56	48	Below 5.
12	225	437	7.2	18.2	.907	24.3	57	62	Do.
13	250	482	8.8	27.0	.924	21.6	62	105	Do.
14	275	527	10.9	37.9	.941	18.9	67	280	Do.
15	300	572	14.8	52.7	.954	16.8	70	Over 400	Do.
Residuum [2]			45.6	98.3	1.003	9.6			

[1] Saybolt Universal.
[2] Carbon residue of residuum, 11.4 percent; carbon residue of crude, 5.2 percent.

Approximate summary

	Percent	Sp gr	°API	Viscosity
Light gasoline				
Total gasoline and naphtha				
Kerosene distillate				
Gas oil	10.1	0.879	29.5	
Nonviscous lubricating distillate	11.6	0.899–0.922	25.9–22.0	50–100.
Medium lubricating distillate	6.3	0.922–0.933	22.0–20.2	100–200.
Viscous lubricating distillate	24.7	0.933–0.962	20.2–15.6	Above 200.
Residuum	45.6	1.003	9.6	
Distillation loss	1.7			

TABLE 11.—*Analyses of crude oil from the Tow Creek and Oak Creek fields, Routt County, Colo.*—Continued

LAB. NO. 50–0 11

[Oak Creek field; Morrison(?), Shinarump(?); 6,314 feet; sec. 2, T. 3 N., R. 86 W. Analysis by U. S. Geological Survey, Casper, Wyo.]

Sp gr, 0.835
Sulfur, percent, 0.19
Saybolt Universal viscosity at 70°F, 57.8 sec.; at 100° F, 44.4 sec.
API gravity, 37.9°
Color, brownish-green

Distillation, Bureau of Mines Hempel method

Fraction no.	Cut at—		Percent	Sum, percent	Sp gr, 60/60°F	API, 60°F	Correlation index	Viscosity,[1] 100°F	Cloud test, °F
	°C	°F							
At atmospheric pressure, 637 mm Hg.									
[First drop, 40°C (104°F)]									
1	50	122	0.7	0.7	0.660	82.9			
2	75	167	2.5	3.2	.663	81.9	[2] 4.2		
3	100	212	2.0	5.2	.691	73.3	[2] 7.5		
4	125	257	3.8	9.0	.713	67.0	[2] 8.9		
5	150	302	4.7	13.7	.739	60.0	[2] 14		
6	175	347	5.2	18.9	.761	54.5	[2] 17		
7	200	392	6.1	25.0	.783	49.2	[2] 22		
8	225	437	5.7	30.7	.799	45.6	[2] 24		
9	250	482	6.5	37.2	.814	42.3	[2] 25		
10	275	527	8.2	45.4	.828	39.4	[2] 27		
Continued at 40 mm									
11	200	392	4.4	49.8	0.841	36.8	29	43	10
12	225	437	7.3	57.1	.846	35.8	28	48	26
13	250	482	7.4	64.5	.854	34.2	28	60	46
14	275	527	8.2	70.7	.863	32.5	30	64	66
15	300	572	8.3	79.0	.875	30.2	32	138	84
Residuum [3]			21.0	100.0	.943	18.6			

[1] Saybolt Universal.
[2] Calculated on basis of Bureau of Mines T. P. no. 610.
[3] Carbon residue of residuum, 11.7 percent; carbon residue of crude, 2.8 percent.

Approximate summary

	Percent	Sp gr	° API	Viscosity
Light gasoline	5.2	0.662	82.2	
Total gasoline and naphtha	25.0	0.734	61.3	
Kerosene distillate	12.2	0.807	43.8	
Gas oil	17.8	0.837	37.6	Below 50.
Nonviscous lubricating distillate	15.3	0.848–0.868	35.4–31.5	50–100.
Medium lubricating distillate	8.7	0.868–0.882	31.5–28.9	100–200.
Viscous lubricating distillate				Above 200.
Residuum	21.0	0.943	18.6	
Distillation loss	0			

TABLE 11.—*Analyses of crude oil from the Tow Creek and Oak Creek fields, Routt County, Colo.*—Continued

SAMPLE 40280

[Tow Creek field (south pool); Niobrara shale; 3,066 feet; sec. 18, T. 6 N., R. 86 W. Analysis by U. S. Bureau of Mines, Bartlesville, Okla.[

Sp gr, 0.847
Sulfur, percent, 0.18
Saybolt Universal viscosity at 100°F, 43 sec.
API gravity, 35.6°
Color, brownish-green

Distillation, Bureau of Mines Hempel method

Fraction no.	Cut at—		Percent	Sum, percent	Sp gr, 60/60°F	API, 60°F	Correlation index	Viscosity,[1] 100°F	Cloud test, °F
	°C	°F							
At atmospheric pressure, 742 mm									
[First drop, 33°C (91°F)									
1	50	122	1.0	1.0	0.655	84.5			
2	75	167	1.5	2.5	.678	77.2	11		
3	100	212	4.1	6.6	.723	64.2	23		
4	125	257	6.3	12.9	.747	57.9	25		
5	150	302	5.7	18.6	.766	53.2	27		
6	175	347	5.5	24.1	.785	48.8	29		
7	200	392	4.1	28.2	.803	44.7	31		
8	225	437	4.7	32.9	.819	41.3	33		
9	250	482	4.6	37.5	.831	38.8	33		
10	275	527	6.9	44.4	.839	37.2	32		
Continued at 40 mm									
11	200	392	3.8	48.2	0.850	35.0	34	40	10
12	225	437	7.7	55.9	.856	33.8	33	46	30
13	250	482	5.5	61.4	.868	31.5	35	58	50
14	275	527	5.9	67.3	.878	29.7	37	85	70
15	300	572	6.5	73.8	.889	27.7	39	150	85
Residuum[2]			24.6	98.4	.946	18.1			

[1] Saybolt Universal.
[2] Carbon residue of residuum, 4.5 percent; carbon residue of crude, 1.1 percent.

Approximate summary

	Percent	Sp gr	°API	Viscosity
Light gasoline	6.6	0.702	70.1	
Total gasoline and naphtha	28.2	0.756	55.7	
Kerosene distillate	4.7	0.819	41.3	
Gas oil	21.6	0.845	36.0	
Nonviscous lubricating distillate	11.3	0.860–0.880	23.0–29.3	50–100.
Medium lubricating distillate	8.0	0.880–0.895	29.3–26.6	100–200.
Viscous lubricating distillate				Above 200.
Residuum	24.6	0.946	18.1	
Distillation loss	1.6			

TABLE 11.—*Analyses of crude oil from the Tow Creek and Oak Creek fields, Routt County, Colo.*—Continued

SAMPLE 40287

[Tow Creek field (south pool); Niobrara shale; 3,105 feet; sec. 17, T. 6 N., R. 86 W. Analysis by U. S. Bureau of Mines, Bartlesville, Okla.]

Sp gr, 0.851
Sulfur, percent, 0.20
Saybolt Universal viscosity at 100°F, 45 sec.
API gravity, 34.8°
Color, brownish-green

Distillation, Bureau of Mines Hempel method

Fraction no.	Cut at—		Percent	Sum, percent	Sp gr, 60/60°F	API, 60°F	Correlation index	Viscosity,[1] 100°F	Cloud test, °F
	°C	°F							
At atmospheric pressure, 743 mm									
[First drop, 33°C (91°F)]									
1	50	122	0.8	0.8	0.651	85.9			
2	75	167	1.9	2.7	.678	77.2	11		
3	100	212	4.5	7.2	.724	63.9	23		
4	125	257	6.1	13.3	.748	57.7	26		
5	150	302	5.1	18.4	.768	52.7	27		
6	175	347	5.1	23.5	.788	48.1	30		
7	200	392	4.2	27.7	.807	43.8	33		
8	225	437	4.5	32.2	.821	40.9	34		
9	250	482	4.6	36.8	.834	38.2	35		
10	275	527	6.7	43.5	.842	36.6	34		
Continued at 40 mm									
11	200	392	4.2	47.7	0.850	35.0	34	41	10
12	225	437	7.1	54.8	.856	33.8	33	46	30
13	250	482	6.5	61.3	.869	31.3	36	59	50
14	275	527	5.5	66.8	.880	29.3	38	87	70
15	300	572	7.4	74.2	.891	27.3	40	155	85
Residuum [2]			25.5	99.7	.949	17.6			

[1] Saybolt Universal.
[2] Carbon residue of residuum, 4.9 percent; carbon residue of crude, 1.2 percent.

Approximate summary

	Percent	Sp gr	°API	Viscosity
Light gasoline	7.2	0.704	69.5	
Total gasoline and naphtha	27.7	0.756	55.7	
Kerosene distillate	4.5	0.821	40.9	
Gas oil	21.2	0.846	35.8	
Nonviscous lubricating distillate	11.9	0.860–0.882	33.0–28.9	50–100.
Medium lubricating distillate	8.9	0.882–0.897	28.9–26.3	100–200.
Viscous lubricating distillate				Above 200.
Residuum	25.5	0.949	17.6	
Distillation loss	0.3			

TABLE 11.—*Analyses of crude oil from the Tow Creek and Oak Creek fields, Routt County, Colo.*—Continued

SAMPLE 40281

[Tow Creek field (north pool, abandoned); Niobrara shale; 3,485 feet; sec. 5, T. 6 N., R. 86 W. Analysis by U. S. Bureau of Mines, Bartlesville, Okla.]

Sp gr, 0.889
Sulfur, percent, 0.32
Saybolt Universal viscosity at 77°F, 170 sec.; at 100°F, 97 sec.
API gravity, 27.7°
Color, greenish-black

Distillation, Bureau of Mines Hempel method

Fraction no.	Cut at—		Percent	Sum, percent	Sp gr, 60/60°F	API, 60°F	Correlation index	Viscosity,[1] 100°F	Cloud test, °F
	°C	°F							
At atmospheric pressure, 746 mm									
[First drop, 59°C (138°F)]									
1	50	122							
2	75	167	1.1	1.1	0.697	71.5			
3	100	212	2.6	3.7	.741	59.5	31		
4	125	257	1.6	5.3	.761	54.4	32		
5	150	302	2.2	7.5	.777	50.6	32		
6	175	347	3.8	11.3	.797	46.0	34		
7	200	392	3.1	14.4	.815	42.1	37		
8	225	437	4.1	18.5	.832	38.6	39		
9	250	482	4.3	22.8	.846	35.8	41		
10	275	527	6.0	28.8	.857	33.6	41		
Continued at 40 mm									
11	200	392	2.7	31.5	0.867	31.7	42	43	Below 5.
12	225	437	7.2	38.7	.874	30.4	41	49	5.
13	250	482	6.9	45.6	.887	28.0	44	68	30.
14	275	527	6.0	51.6	.894	26.8	44	115	50.
15	300	572	8.3	59.9	.904	25.0	46	200	70.
Residuum[2]			39.2	99.1	.953	17.0			

[1] Saybolt Universal.
[2] Carbon residue of residuum, 5.8 percent; carbon residue of crude, 2.3 percent.

Approximate summary

	Percent	Sp Gr	°API	Viscosity
Light gasoline	3.7	0.728	62.9	
Total gasoline and naphtha	14.4	0.776	50.9	
Kerosene distillate				
Gas oil	21.1	0.854	34.2	
Nonviscous lubricating distillate	11.1	0.875–0.892	30.2–27.1	50–100.
Medium lubricating distillate	9.1	0.892–0.904	27.1–25.0	100–200.
Viscous lubricating distillate	4.2	0.904–0.910	25.0–24.0	Above 200.
Residuum	39.2	0.953	17.0	
Distillation loss	.9			

TABLE 11.—*Analyses of crude oil from the Tow Creek and Oak Creek fields, Routt County, Colo.*—Continued

SAMPLE 40288

[Tow Creek field (north pool, abandoned); Niobrara shale; 3,435 feet; sec. 5, T. 6 N., R. 86 W. Analysis by U. S. Bureau of Mines, Bartlesville, Okla.]

Sp gr, 0,896
Sulfur, percent, 0.34
Saybolt Universal viscosity at 100°F, 105 sec.; at 130°F, 69 sec.

API gravity, 26.4°
Color, greenish-black

Distillation, Bureau of Mines Hempel method

Fraction no.	Cut at—		Percent	Sum, percent	Sp gr, 60/60°F	API, 60°F	Correlation index	Viscosity,[1] 100°F	Cloud test, °F
	°C	°F							
At atmospheric pressure, 745 mm									
[First drop, 52°C (126°F)]									
1	50	122							
2	75	167	0.8	0.8	0.701	70.4			
3	100	212	2.3	3.1	.735	61.0	28		
4	125	257	3.0	6.1	.761	54.4	32		
5	150	302	3.1	9.2	.783	49.2	35		
6	175	347	3.0	12.2	.804	44.5	38		
7	200	392	3.1	15.3	.822	40.6	40		
8	225	437	3.7	19.0	.841	36.8	43		
9	250	482	4.1	23.1	.856	33.8	45		
10	275	527	5.9	29.0	.866	31.9	45		
Continued at 40 mm									
11	200	392	1.3	30.3	0.875	30.2	46	43	Below 5.
12	225	437	6.2	36.5	.882	28.9	45	49	Do.
13	250	482	6.4	42.9	.891	27.3	46	67	15.
14	275	527	6.7	49.6	.898	26.1	46	110	30.
15	300	572	8.9	58.5	.908	24.3	48	220	55.
Residuum [2]			41.0	99.5	.954	16.8			

[1] Saybolt Universal.
[2] Carbon residue of residuum, 5.9 percent; carbon residue of crude, 2.4 percent.

Approximate summary

	Percent	Sp Gr	°API	Viscosity
Light gasoline	3.1	0.726	63.4	
Total gasoline and naphtha	15.3	0.779	50.1	
Kerosene distillate				
Gas oil	18.5	0.862	32.7	
Nonviscous lubricating distillate	11.0	0.882–0.896	28.9–26.4	50–100.
Medium lubricating distillate	7.9	0.896–0.906	26.4–24.7	100–200.
Viscous lubricating distillate	5.8	0.906–0.914	24.7–23.3	Above 200.
Residuum	41.0	0.954	16.8	
Distillation loss	.5			

TABLE 11.—*Analyses of crude oil from the Tow Creek and Oak Creek fields, Routt County, Colo.*—Continued

SAMPLE 40289

[Tow Creek field (north pool, abandoned); Niobrara shale; 3,635 feet; sec. 5, T. 6 N., R. 86 W. Analysis by U. S. Bureau of Mines, Bartlesville, Okla.]

Sp gr, 0.890
Sulfur, percent, 0.31
Saybolt Universal viscosity at 77°F, 165 sec.; at 100° F, 93 sec.
API gravity, 27.5°
Color, greenish-black

Distillation, Bureau of Mines Hempel method

Fraction no.	Cut at—		Percent	Sum, percent	Sp gr, 60/60°F	API, 60°F	Correlation index	Viscosity,[1] 100°F	Cloud test, °F
	°C	°F							
At atmospheric pressure, 745 mm									
[First drop, 53°C (127°F)]									
1	50	122							
2	75	167	0.5	0.5	0.696	71.8			
3	100	212	1.9	2.4	.723	64.2	23		
4	125	257	3.0	5.4	.752	56.7	27		
5	150	302	3.1	8.5	.776	50.9	31		
6	175	347	3.5	12.0	.797	46.0	34		
7	200	392	3.4	15.4	.816	41.9	37		
8	225	437	4.1	19.5	.834	38.2	40		
9	250	482	4.3	23.8	.848	35.4	41		
10	275	527	5.8	29.6	.858	33.4	41		
Continued at 40 mm									
11	200	392	2.8	32.4	0.867	31.7	42	43	Below 5.
12	225	437	6.4	38.8	.874	30.4	41	49	5.
13	250	482	6.4	45.2	.885	28.4	43	65	25.
14	275	527	7.5	52.7	.894	26.8	44	110	45.
15	300	572	8.8	61.5	.905	24.9	46	220	70.
Residuum[2]			38.3	99.8	.955	16.7			

[1] Saybolt Universal.
[2] Carbon residue of residuum, 6.2 percent; carbon residue of crude, 2.4 percent.

Approximate summary

	Percent	Sp gr	°API	Viscosity
Light gasoline	2.4	0.717	65.9	
Total gasoline and naphtha	15.4	0.776	50.9	
Kerosene distillate				
Gas oil	20.6	0.855	34.0	
Nonviscous lubricating distillate	11.4	0.875–0.892	30.2–27.1	50–100.
Medium lubricating distillate	8.3	0.892–0.903	27.1–25.2	100–200.
Viscous lubricating distillate	5.8	0.903–0.911	25.2–23.8	Above 200.
Residuum	38.3	0.955	16.7	
Distillation loss	0.2			

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