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Harold L. Ickes, Secretary  
GEOLOGICAL SURVEY  
W. C. Mendenhall, Director

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Bulletin 906-C

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THE MIZPAH COAL FIELD  
CUSTER COUNTY  
MONTANA

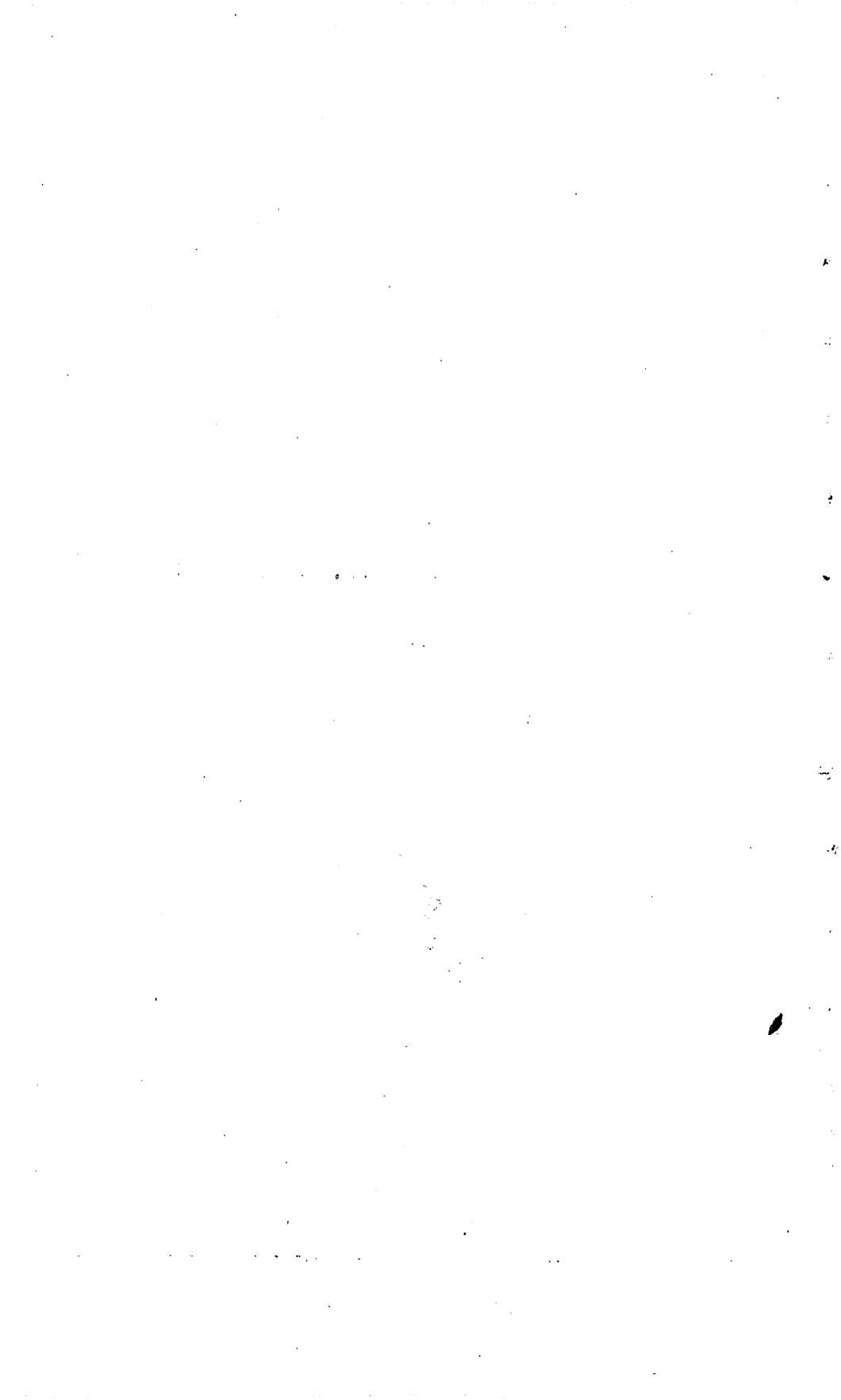
BY  
FRANK S. PARKER AND DAVID A. ANDREWS

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Contributions to economic geology, 1938-39  
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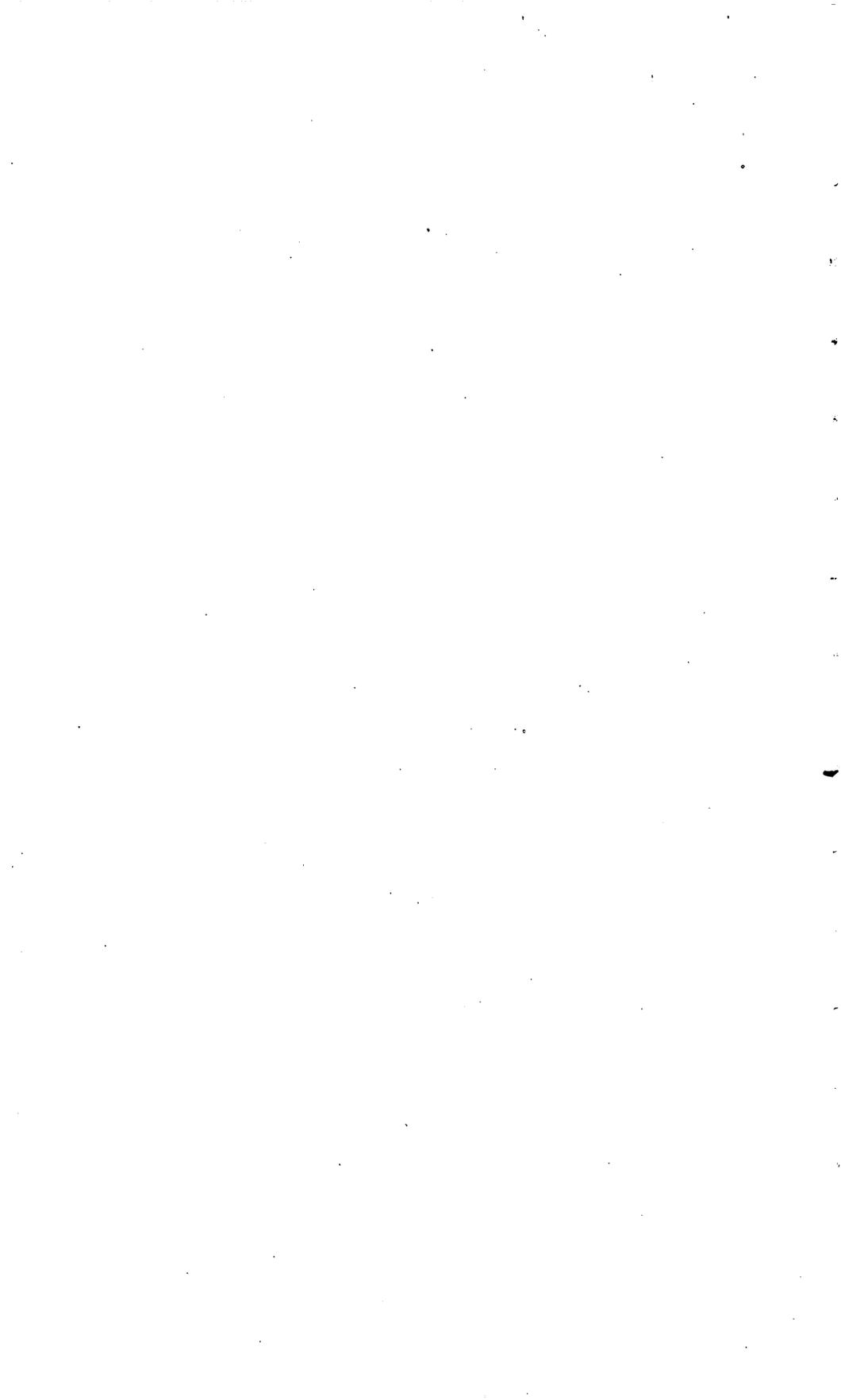
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# THE MIZPAH COAL FIELD, CUSTER COUNTY, MONTANA

By FRANK S. PARKER and DAVID A. ANDREWS

## ABSTRACT

The Mizpah coal field, an area of about 850 square miles in southeastern Montana, is named from Mizpah Creek, which flows northward through its central part. The field is irregular in outline, bounded on the east by the Powder River, on the west roughly by Pumpkin Creek, on the north by the Miles City coal field, and on the south by the primary base line of Montana, which is also the southern boundary of Custer County.

The field includes a portion of the Great Plains province. The topography has moderate relief, generally less than 400 feet in any one township, and is dominated by the valleys of the three northward-flowing streams, with high interstream divides. In general the divides are more dissected in the northern part of the field than in the southern part. In the north the divides are irregular in profile, sharp and serrate, with only local areas of rolling land. In the south the divides are rolling gentle slopes and low hills, though locally surmounted by buttes capped with resistant clinker.

The rocks exposed in the Mizpah field are nonmarine sedimentary deposits that range in age from Eocene (?) to Recent. The oldest rock is a sandstone, which is assigned to the Lance formation and correlated with the lower part of the Hell Creek member of the Lance of neighboring areas. Only the upper 250 feet of this sandstone is exposed in the Mizpah field. It consists of thick massive and cross-bedded buff friable sandstone, locally cemented with limy material, and lesser amounts of buff to gray shale and carbonaceous shale. It contains no coal in this field. It grades upward, by increase of shale, through a zone 50 to 150 feet thick, into the overlying somber-colored beds.

The somber-colored beds measure 450 to 650 feet in thickness and consist of siltstone, shale, and clay, with lesser amounts of buff sandstone and shale and thin lenticular beds of carbonaceous shale and coal. In general the beds are more sandy in the southern part of the field. They include beds that have been traced into adjoining areas, where different names have been applied to them. Some beds in their lower portion are probably equivalent to the top of the Hell Creek member of the Lance formation. The main portion of the somber-colored beds is equivalent to the Tullock member of the Lance and to the overlying Lebo shale member of the Fort Union formation. In their upper part the somber-colored beds probably include about 100 feet of strata that are equivalent to the basal portion of the Tongue River member of the Fort Union as described by N. W. Bass in the Ashland field, which adjoins the west side of the Mizpah area. The somber-colored beds thicken eastward across this area by transgressing across the strata both above and below them.

In the Mizpah field the somber-colored beds are overlain by the Tongue River member of the Fort Union formation. This member occupies the same stratigraphic position as in other areas except that the base is higher. Only the lower

350 feet of the member is present in this field. It consists of light-yellow to light-gray massive sandstone, light-buff to light-gray shale, and persistent carbonaceous shale and coal beds.

Terrace gravel of Miocene (?) to Pleistocene age occurs along the principal streams and consists of rounded pebbles of a variety of igneous and metamorphic rocks and subangular pebbles of local rocks, sand lenses, and some silt.

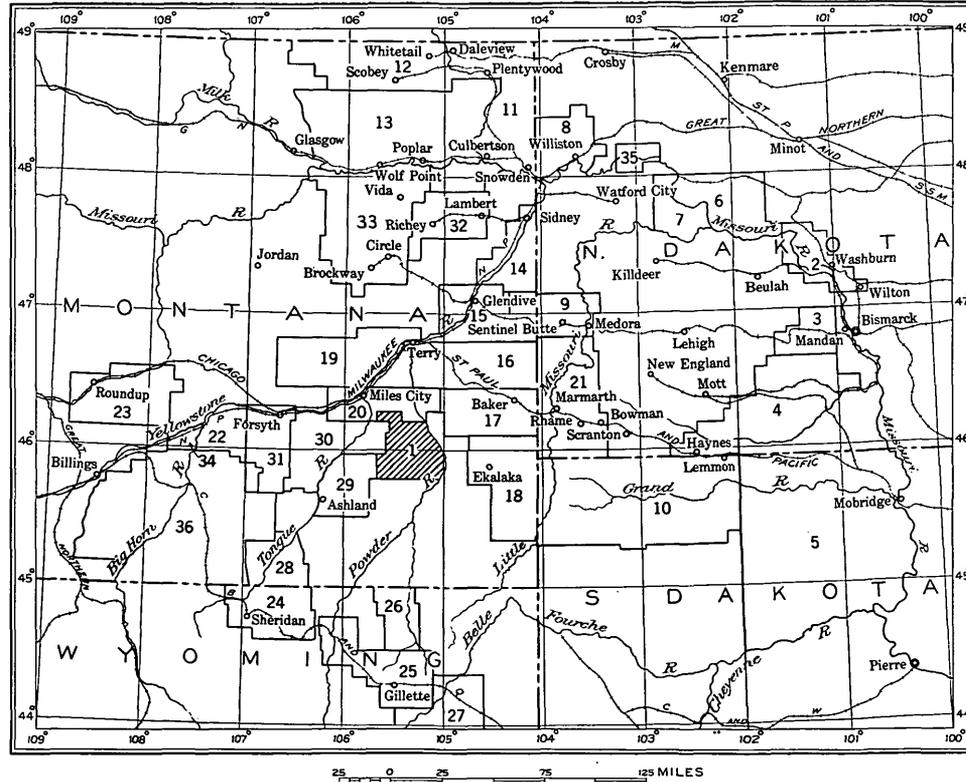
Alluvium, composed mostly of silt but including some sand and gravel, occurs in most of the stream valleys.

The coal of the Mizpah field is lignite. It has a woody texture and is tough when fresh but slacks rapidly when exposed to the air. The sandstone member of the Lance is barren of coal beds; the overlying somber-colored beds have numerous lenticular beds of coal, none of which exceeds 6 feet in thickness. The Tongue River member of the Fort Union formation contains thick beds of coal, and they are more persistent than those of the somber-colored beds but are limited to the small area of the member that remains uneroded in this field. The estimated reserves of coal for the field amount to 1,366,900,000 tons.

## INTRODUCTION

*Purpose and scope of report.*—The information contained in this report was gathered during an investigation forming a part of the systematic survey of western coal lands conducted by the United States Geological Survey for the purpose of classifying public lands and determining their mineral resources and geologic features. Although attention was directed principally toward the location of coal outcrops and measurement of the thickness of coal beds, in order to determine coal reserves and localities favorable for coal mining, the area was examined carefully for other possible mineral resources and for geologic features, and in addition a base map was made showing streams, land lines, roads, and houses.

*Location and relations of the field.*—The Mizpah coal field is an area of about 850 square miles lying principally between Pumpkin Creek and the Powder River in the southern part of Custer County, Mont. It includes a considerable part of the drainage basin of Mizpah Creek, from which it takes its name. The western limit of the area adjoins the Ashland and Rosebud coal fields, and the northern limit adjoins the Miles City coal field. The location of the Mizpah field and other coal fields of eastern Montana and adjacent parts of Wyoming, South Dakota, and North Dakota that are described in bulletins of the Geological Survey is shown on plate 17, and the names of the fields, indicated by numbers on the map, and the numbers of the bulletins in which they are described are given in the following table:



INDEX MAP SHOWING THE LOCATION OF THE MIZPAH COAL FIELD, MONTANA (SHADED PATTERN), AND THE LOCATION OF AREAS DESCRIBED IN OTHER BULLETINS OF THE GEOLOGICAL SURVEY.

Numbers refer to bulletins listed on p. 87.

*Coal fields whose location is shown on plate 17*

No.	Field	Bulletin
1	Mizpah.....	906-C.
2	Washburn.....	381-A.
3	New Salom.....	726-A.
4	Cannonball River.....	541-G.
5	Standing Rock and Cheyenne River.....	575.
6	Fort Berthold.....	381-A and 471-C.
7	do.....	726-D.
8	Williston.....	531-E.
9	Sentinel Butte.....	341-A.
10	Northwestern South Dakota.....	627.
11	Culbertson.....	471-D.
12	Scobey.....	751-E.
13	Fort Peck.....	381-A.
14	Sidney.....	471-D.
15	Glendive.....	471-D.
16	Terry.....	471-D.
17	Baker.....	471-D.
18	Ekalaka.....	751-F.
19	Little Sheep Mountain.....	531-F.
20	Miles City.....	341-A.
21	Marmarth.....	775.
22	Tullock Creek.....	749.
23	Bull Mountain.....	647.
24	Sheridan.....	341-B.
25	Powder River.....	381-B.
26	Little Powder River.....	471-F.
27	Gillette.....	790-A.
28	Northern extension of Sheridan.....	806-B.
29	Ashland.....	831-B.
30	Rosebud.....	847-B.
31	Forsyth.....	812-A.
32	Richey-Lambert.....	847-C.
33	McCone County.....	905.
34	Area southwest of Custer.....	541-H.
35	Nesson anticline.....	691-G.
36	Crow Indian Reservation and Big Horn County.....	856.

*Field work and acknowledgments.*—The field work forming the basis of this report was done during the summers of 1931 and 1932. F. S. Parker was assisted in the field in 1931 by C. W. Wilson, M. M. Knechtel, W. S. Pike, Jr., G. C. Sleight, and A. K. Dashti, and in 1932 by D. A. Andrews, M. M. Knechtel, and T. A. Hendricks. W. G. Pierce aided in organizing the party in 1931 and gave much valuable instruction in field methods. The writing of the present report and the preparation of the illustrations have been done jointly by Messrs. Parker and Andrews, who wish to express their appreciation of the efficient services and cooperation of their associates named above. G. J. Newlin served as cook both seasons and performed emergency repairs to motor cars, as well as occasionally aiding with the field work.

The field work was further aided by the kindness and hospitality of ranchers of the district, who furnished water and camp sites and helped in other ways.

The field mapping was done by plane-table methods on a scale of 2 inches to the mile. Individual beds of rock, generally coal beds, were traced laterally. Thicknesses of the coal beds were measured about every half mile along their outcrops. Altitudes on the different beds were taken from stations in the adjoining Rosebud coal field, where altitudes had been determined by W. G. Pierce from bench

marks at Colstrip and along the Yellowstone River. The triangulation system was tied to the land surveys where corners could be found, and the triangulation system and the land-survey plats were used in conjunction in making the base map.

*Land surveys.*—The Mizpah field has been subdivided by the United States General Land Office. The surveys for 12 townships were made by engineers of that office in the period from 1883 to 1899, and few of the stones set at that time to mark the corners in these townships could be found. The surveys for 11 townships were made in 1904 or 1905, and the corners in these townships are well preserved. T. 4 N., R. 52 E., and the eastern part of Tps. 4 and 5 N., R. 51 E., were surveyed in 1909 and 1910, and many of the corner stones in this portion of the area are preserved. The western part of Tps. 4 and 5 N., R. 51 E., was subdivided in 1914, and iron pipes with bronze markers were set. Parts of Tps. 1 and 2 N., Rs. 49 and 50 E., have been resurveyed by the county surveyor of Custer County to relocate the land lines, and some of the monuments set by him were found during the field work for the present report. The corners found during the field examination are shown on plate 16.

*Previous work.*—The presence of coal beds in this region has been known for many years, but no previous detailed examination within the Mizpah field has been made. In October 1920 C. E. Dobbin and W. T. Thom, Jr., made a reconnaissance through this region and noted a few of its structural features.<sup>1</sup>

The Ashland and Rosebud coal fields, west of the Mizpah field, and the Miles City coal field, to the north, have been examined in detail for coal. In connection with the field work in the Ekalaka lignite field, an area adjacent to the southeastern part of the Mizpah field was examined. The ground water of eastern and central Montana, including parts of the Mizpah coal field, has been discussed by Perry,<sup>2</sup> who has shown the general position of some of the geologic boundaries. The location of the coal fields mentioned above, as well as other coal fields of eastern Montana and adjacent States, is shown on plate 17.

## GEOGRAPHY

### LAND FEATURES

The Mizpah field is a portion of the Great Plains province. The area has moderate relief with a fairly uniform summit level and may be characterized as a dissected plateau. The topography is dominated by broad valleys and high interstream divides. Pumpkin Creek, Mizpah Creek, and the Powder River flow from south to north across

<sup>1</sup> Oil possibilities in southeastern Montana: U. S. Geol. Survey press notice, January 1921.

<sup>2</sup> Perry, E. S., Ground water in eastern and central Montana: Montana Bur. Mines and Geology Mem. 2, 1931.

the field, and the divides between these streams show a variety of land forms.

In the southeastern part of the field the divide between the Powder River and Mizpah Creek is marked on the east side by an escarpment 100 to 400 feet high and on the west side by gentle grassy slopes. North of T. 2 N., R. 52 E., the divide is mostly a sharp serrate ridge bordered on both sides by intricately carved badlands. The divide between Mizpah and Pumpkin Creeks is in part sharp and rugged but has local areas of rolling surface at the foot of prominent clinker-capped hills and mesas (pl. 18.)

In general the plateau is more dissected in the northern part of the area than in the southern part. In the north the ridges between the tributary creeks are long, high, irregular in profile, and, except where small areas of rolling land or gravel-covered stream terraces are preserved, sharp and serrate. In the south many of the divides between the tributary streams are relatively undissected and are marked by rolling land, gentle slopes, and low hills.

The highest point in the area—Maxwell Butte, in sec. 20, T. 2 N., R. 52 E., on the divide between Elmhurst and Spring Creeks—is a conspicuous landmark that can be seen from a distance of 40 to 50 miles in any direction. (See pl. 19, A.) The butte, capped with clinker, is 3,704 feet above sea level and rises more than 400 feet above the surrounding country, 900 feet above the valley of Mizpah Creek, and over 200 feet above the general summit level of the Mizpah field. The relief between Maxwell Butte and the lowest point, the Powder River at the north border of the field, whose altitude is about 2,500 feet above sea level, is slightly over 1,200 feet. The relief within single townships ranges from about 200 feet in T. 1 N., R. 54 E., to 800 feet in T. 2 N., R. 52 E. The relief in most of the townships is about 400 feet. The general summit altitude ranges from 3,000 to 3,200 feet above sea level in the northern part of the field and from 3,300 to 3,500 feet in the southern part of the field, with the notable exception of Maxwell Butte.

Gravel deposits, ranging from small isolated patches to extensive steplike successions of terraces on long sloping benches, occur on the ridges between the tributaries of the larger streams. These terraces are particularly abundant along the west side of Pumpkin Creek but are also found on the east side. Several terraces were mapped along the west side of Sand and Mizpah Creeks and are indicated on plate 16 as uncorrelated terrace gravel. These gravel terraces are from 50 to 260 feet above the stream levels. Only a few isolated patches of gravel were found along the Powder River.

In addition to the terraces along the stream valleys, there is an extensive terrace near the divide between Sand and Pumpkin Creeks in T. 1 N., R. 49 E., which stands 3,300 to 3,430 feet above sea level

and 200 to 300 feet above Sand Creek. An isolated deposit of gravel caps the high peak on the divide between the Powder River and Mizpah Creek, in the southeastern part of sec. 24, T. 2 N., R. 52 E., at 3,484 feet above sea level and nearly 700 feet above the Powder River.

The valleys of the rivers and many of the creeks have wide, gently sloping floors and are adjoined by slopes that rise abruptly to badland spurs or high, rugged interstream ridges. The valley floors are not all smooth but may have from one to five steps away from the actual stream trench. The height of these steps does not exceed 5 feet at places, but the largest steps are 20 feet high in some valleys.

#### DRAINAGE AND WATER SUPPLY

The Powder River, which forms the eastern boundary of the field, rises southeast of the Big Horn Mountains in Wyoming, flows in a general northerly direction, and joins the Yellowstone River about 30 miles north of this area. It is one of the two large tributaries of the Yellowstone in southeastern Montana. During 1929 a Government gaging station near Mizpah, about 2 miles north of this area, showed a maximum discharge of 14,700 second-feet on March 12, a minimum discharge of 12 second-feet on September 5, and a discharge of 600 to 800 second-feet for most of the year. Ice prevents complete measurements during midwinter. At Moorhead, Mont., 50 miles southwest of this area, the records for 1929-30 show a maximum discharge of 8,610 second-feet on June 3, 1929, a minimum discharge of 1.0 second-feet on July 9 and 10, 1930, and a mean discharge of 494.5 second-feet for the period February 25 to November 30. In times of large discharge the Powder River overflows its banks and spreads over the flood plain. During such periods it is a raging stream that causes much damage to farms and buildings and is likely to shift its course. Mizpah and Ash Creeks are major tributaries of the Powder in the Mizpah field.

Over half of the Mizpah field lies within the drainage basin of Mizpah Creek, which enters the Powder River 3 miles north of the area. In years of normal rainfall this creek flows at all times except during the late summer. The channel is narrow, trenched 10 to 25 feet deep, and the stream does not overflow the flood plain except during spring thaws or heavy rains. Sand and Spring Creeks, the two largest tributaries of Mizpah Creek, are intermittent streams but in their lower reaches contain pools of water throughout the year. All the remaining tributaries of Mizpah Creek are dry except during heavy rains or spring thaws.

Pumpkin Creek flows north across the west end of the Mizpah area and joins the Tongue River about 5 miles beyond the northwest corner. Although Pumpkin Creek does not flow throughout the year,

it contains permanent pools of water in the deeper portions of its channel. It has a narrow channel and in times of spring thaws or heavy rains commonly overflows its banks. None of the tributaries in the western part of the area are permanent except for short distances below points where they are fed by springs.

Water for domestic supply is obtained from wells and springs. Along the Powder River flowing wells 100 to 300 feet in depth penetrate sandy layers of the sandstone member of the Lance formation and furnish plentiful supplies of potable water. Along Mizpah Creek wells of equal depth do not flow, but the water rises within a short distance of the surface. Perry<sup>3</sup> believes that the intake area for this region is along the heads of the streams flowing westward into the Powder River from the higher region about 20 miles east of the area. Analysis of the water from the well at Mizpah shows 685 parts per million of dissolved matter, consisting largely of sodium bicarbonate and sulphate with small amounts of calcium and magnesium chlorides. The water obtained from the shallow wells varies in quality from place to place but is usually potable and often is less mineralized than the water from the deep wells. Springs occur most commonly at the outcrops of coal beds, and although the water is usually colored brown, it is of good quality if the flow is sufficiently great.

Water for stock is obtained from the larger streams, from wells and springs, and from small artificial reservoirs. Reservoirs on small tributaries, with well-constructed earth dams and ample spillways for excess water, will retain water throughout the dry season in years of normal rainfall. Attempts to dam streams with drainage areas in excess of about 1 square mile are not usually successful, because of the destruction of the reservoir through cutting down of the spillway or dam by the excess water.

Should an attempt be made to exploit the coal beds of the Mizpah field on a commercial scale, difficulty would be found in obtaining sufficient water of good quality for steam boilers. Water of the type most plentiful in this field causes foaming or scale when used for steam boilers.

#### CLIMATE

The climate of the Mizpah field is semiarid, with an average annual precipitation of about 13½ inches. About three-fourths of the rainfall occurs in the period from April through September. Most of this rain comes in the form of local storms rather than in general rains; thus the streams of one part of the area may be flooded while those of another part remain dry. The prevailing winds of this region are from the west and northwest.

<sup>3</sup> Perry, E. S., Ground water in eastern and central Montana: Montana Bur. Mines and Geology Mem. 2, p. 30, 1931.

A compilation of the climatologic data from the yearly reports of neighboring stations of the United States Weather Bureau is shown in the table below. Ashland is 30 miles southwest of this area, Ekalaka 20 miles east, and Miles City 10 miles northwest. The Ashland record includes data only for the years 1928-31. The temperatures for Miles City, which is in the Yellowstone River Valley, are higher in the summer than they are in most of the Mizpah field.

*Temperature (° F.) at stations in the vicinity of the Mizpah field*

Station	Length of record (years)	Highest	Lowest	Mean yearly	Mean monthly											
					Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
					Ashland.....	4	108	-38	45.0	16.4	26.4	33.5	44.9	53.8	61.6	71.7
Ekalaka.....	34	104	-36	43.6	16.8	18.5	29.0	42.1	52.8	63.7	70.6	68.7	58.9	46.6	33.5	21.9
Miles City.....	40	107	-38	42.2	14.5	16.8	28.6	44.7	56.7	65.3	72.9	71.5	61.2	46.5	30.9	21.0

*Precipitation (inches) at stations in the vicinity of the Mizpah field*

Station	Length of record (years)	Mean yearly	Mean monthly											
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			Ashland.....	4	14.87	0.70	0.85	1.34	1.06	1.94	2.44	2.08	0.59	1.10
Ekalaka.....	34	13.66	.50	.41	.64	1.04	2.23	2.82	1.71	1.56	1.34	.82	.29	.29
Miles City.....	40	13.77	.66	.49	.86	1.02	2.24	2.66	1.54	1.03	1.04	.88	.57	.63

#### VEGETATION<sup>4</sup>

Within the Mizpah field there are four different habitats or environments of vegetation—bottom lands, dissected badlands and gumbo valley slopes, loamy valley slopes and rolling uplands, and clinker and sandstone ledges. The bottom lands support a growth of grama (buffalo) and western wheat grasses and valley sage. Such trees as cottonwood, scrub boxelder, and, more rarely, scrub ash grow close to the stream channels, or on the flats where the water table is near the surface. In the dissected badlands or on the gumbo valley slopes, where the soil is derived from clays and shales, the vegetation is confined to a sparse growth of grasses such as grama, little bluestem, and western wheat, and shrubs such as black sage, matchweed, and prickly pear. On the valley slopes where the soil is derived from sandstone and siltstone and on the rolling uplands, grama, needle, sand, wire, little bluestem, and June grasses are abundant. In the shallow draws and coulees of the rolling upland there are shrubs such as wild rose, buckbrush, wild plum, chokecherry, and valley sage.

<sup>4</sup> Most of the information concerning vegetation and utility is furnished by L. R. Brooks and R. E. Morgan, of the conservation branch, U. S. Geol. Survey.

On the clinker and sandstone ledges and on most of the gravel terraces grama, nigger wool, and little bluestem are the common grasses, and black sage and creeping juniper the common shrubs. The clinker ridges and light-colored sandstone outcrops are favorable for the growth of western yellow pine and cedar. These forested areas stand in marked contrast to the other habitats, where evergreen trees are absent. There is little merchantable timber in the Mizpah field, but some logging has been done along the divide between Sand Creek and Pumpkin Creek in the southwestern part of the field to supply a portable sawmill operated at times, in the western part of T. 2 N., R. 50 E.

#### UTILITY

The greater portion of the land surface in the Mizpah field is suitable only for grazing. The area as a whole will support 20 to 30 head of cattle to a section, but the feeding conditions vary with the locality, the badlands and gumbo valley flats having very sparse vegetation and the rolling upland areas affording an abundance of feed. By act of Congress, March 29, 1928, the public land in an area of about 180 square miles in the northwestern portion of the field was set aside as the Mizpah-Pumpkin Creek grazing district, to be leased for range development and grazing. This tract and the conditions of its utilization are described in United States General Land Office Circular 1263.

In the bottom lands of the larger streams the conditions are favorable for the growth of hay to supplement the natural feed of the range during the winter. In T. 1 N., Rs. 49, 50, and 52 E., and T. 6 N., R. 50 E., farming of small grains has met with some success. Melons can be grown in favorable years in the bottom lands.

The coal has been mined only for local use, and presumably it will not be mined commercially in competition with the coals of higher grade and thicker beds that are more accessible to railroad facilities. Gravel deposits on Pumpkin Creek have been utilized for surfacing the State highway running across the area from Miles City to Broadus. Great quantities of gravel and clinker are available as road metal throughout the field.

#### SETTLEMENT

There are no villages in the Mizpah area. At Volborg post office, which was moved into the southwestern part of the area in 1932, there is a general store. Beebe, near the western margin; Mizpah, 5 miles from the northeast corner; and Coalwood, 4 miles south of the field, have post offices and general store buildings. Powderville, 3 miles south of the southeast corner, is a village of about 30 inhabitants. Miles City, about 10 miles northwest of the Mizpah field, is the trading and shipping center of the entire area. It is the largest town in eastern Montana, having a population of 7,175 in 1930.

At the time of the examination in 1931 and 1932 there were 98 occupied ranches in the Mizpah field, of which 63 were in the southern 2 tiers of townships. The northern townships have much larger unproductive badland areas.

#### TRANSPORTATION FACILITIES

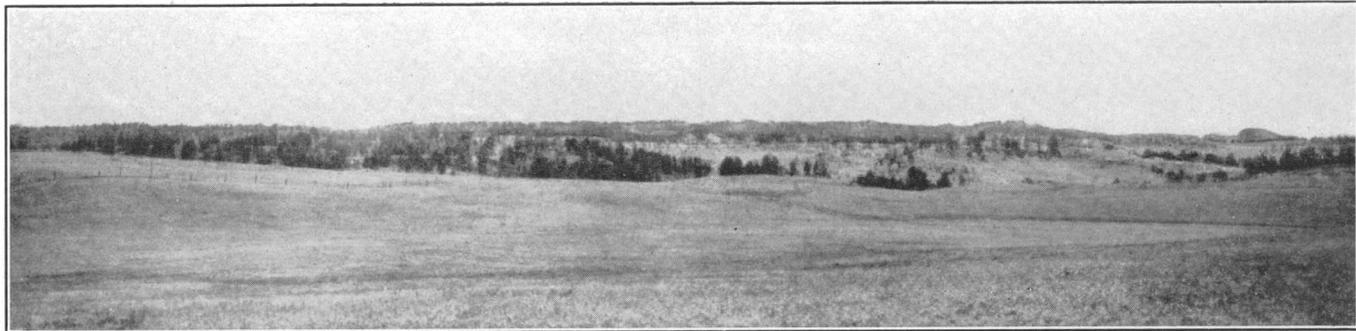
The nearest railroads to the Mizpah coal field are the Northern Pacific Railway and the Chicago, Milwaukee, St. Paul & Pacific Railway, which follow the valley of the Yellowstone River and have stations at Miles City. At Fallon the Chicago, Milwaukee, St. Paul & Pacific Railway leaves the Yellowstone Valley to follow the valley of O'Fallon Creek. It has a station at Ismay, 25 miles northeast of this area, but, because of the poorer roads leading to that town, most of the inhabitants use Miles City as a shipping point.

A graded and graveled State road from Miles City to Broadus follows the valleys of the Tongue River and Pumpkin Creek and crosses the western part of this area. Graded roads follow the valleys of Mizpah Creek and the Powder River and connect with the Ekalaka-Miles City road, 5 miles to the north. Another graded road crosses the area from Beebe to Powderville. From these graded roads secondary ungraded roads, which lead to ranches, timbered areas, and mines, give access to other parts of the area. The old Miles City-Deadwood stage road can still be traced through parts of T. 3 N., R. 50 E., and T. 2 N., Rs. 50 and 51 E. Parts of the area may be reached by driving an automobile across the open prairie, but other parts are accessible only on horse or afoot.

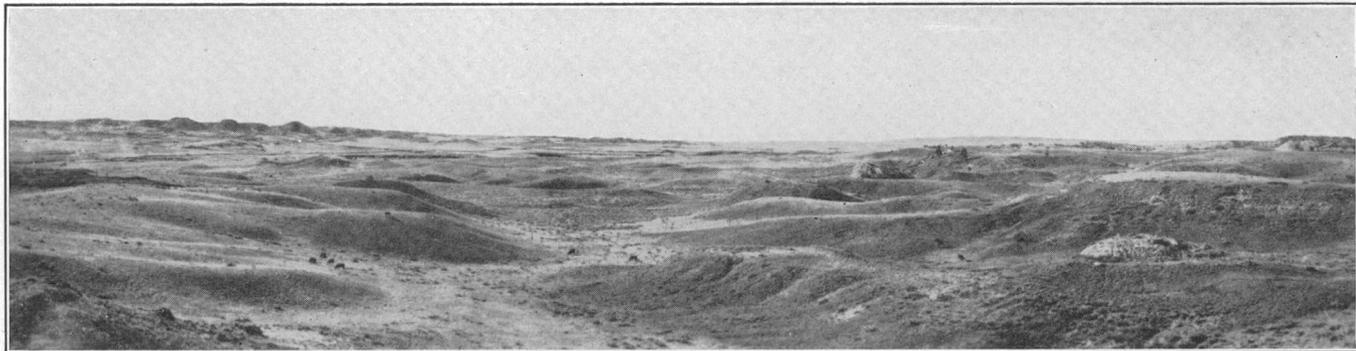
#### STRATIGRAPHY

##### GENERAL SECTION

The rocks exposed in the Mizpah field are nonmarine sedimentary deposits. The older beds were laid down in marshy areas or on low plains near sea level, and the younger beds as patchy gravel terrace deposits or belts of alluvium in stream valleys cut into the older rocks. The older rocks lie in a conformable succession of three lithologic units with a total exposed thickness of about 1,130 feet. The lower unit, a sandstone, is referred to the Lance formation, of Eocene (?) age. The middle unit, or somber-colored beds, includes strata equivalent to the upper part of the Hell Creek member of the Lance formation, the Tullock member of the Lance formation, and the Lebo shale member of the Fort Union formation, and the boundary between the two formations (Lance and Fort Union) has not been drawn in this area. The upper unit is considered essentially the equivalent of the Tongue River member of the Fort Union formation, of Eocene age, found in adjacent areas, and is here designated by that name. The thickness and character of the rocks of the Mizpah field are summarized in the

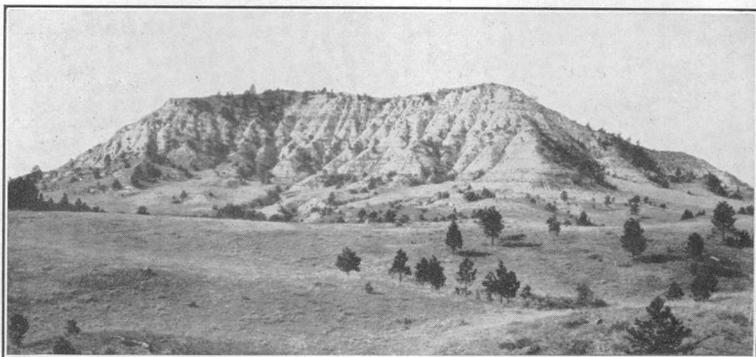


A. ROLLING UPLAND SURFACE WITH HIGHER CLINKER-CAPPED BUTTES ON THE SKY LINE.

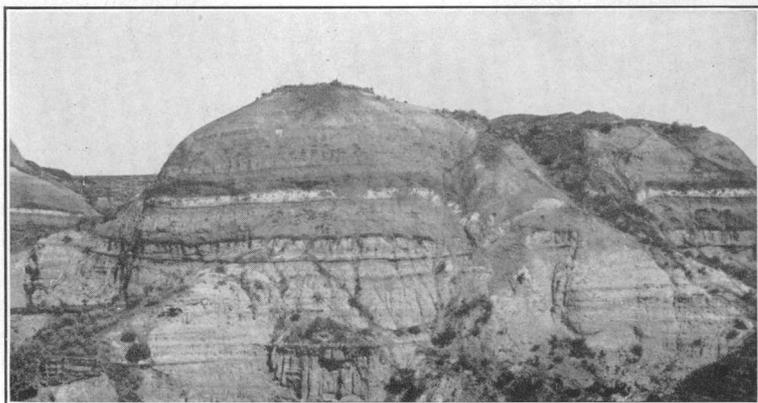


B. VIEW SOUTHEAST ACROSS PUMPKIN CREEK VALLEY, SHOWING IN THE FOREGROUND A ROLLING SURFACE DEVELOPED ON TERRACE GRAVEL.

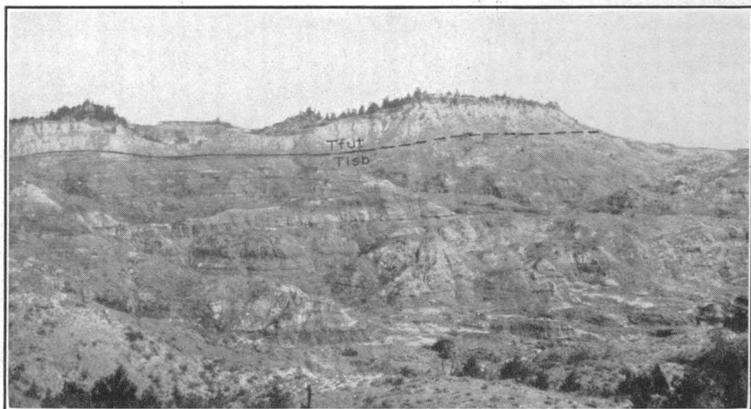
In T. 2 N., R. 49 E., sec. 31.



A. MAXWELL BUTTE, VIEWED FROM THE EAST, SHOWING TYPICAL LIGHT-COLORED BEDS OF THE TONGUE RIVER MEMBER OF THE FORT UNION FORMATION.



B. TYPICAL EXPOSURE OF THE SOMBER-COLORED BEDS, SHOWING LEDGES OF LIMY AND FERRUGINOUS CONCRETIONS AND BADLAND TOPOGRAPHY.  
In T. 4 N., R. 50 E., near locality 97.



C. TYPICAL VIEW OF BADLAND AREAS DEVELOPED IN THE SOMBER-COLORED BEDS (Tlsb) IN THE NORTHERN PART OF THE AREA.  
The light-colored beds overlying the somber beds belong to the Tongue River member of the Fort Union formation (Tfut).

table below, and their correlations and descriptions are given in detail in the following pages.

*Rocks exposed in the Mizpah coal field, Montana*

System	Series	Formation and member	Character	Thickness (feet)
Quaternary.	Recent and Pleistocene.	Alluvium.	Flood-plain deposits of silt and some sand and gravel, occurring in valleys up to 30 feet above present streams.	0-35
Quaternary and Tertiary.	Pleistocene and Pliocene or Miocene.	Terrace gravel.	Gravel deposits of rounded pebbles of a variety of igneous and metamorphic rocks and subangular pebbles of local rocks; sand lenses and some silt.	0-12+
-Unconformity-				
Tertiary.	Eocene.	Fort Union formation.	Tongue River member. Light-yellow to light-gray massive sandstone and silty sandstone, light-buff to light-gray shales, and persistent coal beds which reach a maximum thickness of 25 feet.	350+
Tertiary (?).	Eocene (?).	Lance formation.	Somber-colored beds. Somber-colored siltstones, shales, and clays and lesser amounts of buff sandstones, buff shales, and thin lenticular coal beds and beds of carbonaceous shale. The siltstones bear numerous layers of brown ferruginous concretions. These beds are more sandy in the southern part of the field. They are equivalent to the Lebo shale member of the Fort Union formation, the Tullock member of the Lance formation of neighboring regions, and the upper part of the Hell Creek member of the Lance formation as mapped in the Rosebud field. The basal 100 feet of the Tongue River member of the Fort Union formation, which in this area is somber-colored and shaly, instead of yellow and sandy, is also included in this unit.	450-650
		Sandstone member.	Thick massive and cross-bedded buff friable sandstones, locally cemented with limy material, and lesser amounts of buff to gray shale and carbonaceous shale. The member grades upward by increase of gray shale and gray clay through a zone of 50 to 150 feet in thickness into the overlying somber-colored beds. Equivalent to the lower part of the Hell Creek member of the Lance formation of neighboring areas.	250+

**LANCE FORMATION (TERTIARY?) AND FORT UNION FORMATION (EOCENE)**

**SANDSTONE MEMBER OF LANCE FORMATION**

The lower part of the Lance formation, here designated the "sandstone member," crops out in the Powder River Valley in the eastern part of the field. It is composed of thick beds of massive friable buff silty sandstone, with smaller amounts of gray and brown shale and gray siltstone, and contains no valuable coal beds. The sandstones are commonly cross-bedded and in many places are cemented with limy material. The rocks weather to a rolling topography varied by

mesas and benches formed by the resistant limy ledges. The soil derived from this member is generally poor and supports only a sparse growth of vegetation, and locally it is so sandy that dunes are formed.

The sandstone member becomes increasingly shaly upward and grades into the overlying somber-colored beds. The upper contact is poorly defined, and an arbitrary horizon was chosen for mapping. In the southern part of the field the contact was drawn at the base of the Nicholls coal bed or at the top of the highest thick buff sandstone. In the northern part of the field the contact was drawn at the base of the Kitty Springs coal bed, or at approximately that horizon where the coal bed was absent. The contact is possibly 50 feet lower stratigraphically in the northeastern part of the field than in the southeastern part. In the following section, which shows the sandstone member below the Kitty Springs coal bed in T. 3 N., R. 53 E., the change in lithology between the sandstone member and the somber-colored beds occur near the base of the section, at the top of the lowest sandstone. A few miles both to the north and the south the change of lithology occurs practically at the horizon of the Kitty Springs bed.

*Section of transition zone of Sandstone member of the Lance formation in sec. 13,  
T. 3 N., R. 53 E.*

Top.	Ft.	in.
Ash and clinker of coal bed-----	4	
Clay, gray, with siltstone lenses-----	26	
Shale, finely laminated, brown-----		3
Coal-----		3
Shale, finely laminated, gray-----	} Kitty Springs coal bed----	1
Coal-----		9
Top of sandstone member.		
Shale, finely laminated, brown-----	1	2
Siltstone, gray to light brown; contains fossil bones-----	28	2
Sandstone, gray to light brown, argillaceous-----	20	7
Clay, gray-----	6	11
Sandstone, argillaceous, friable, light brown-----	5	8
Sand, unconsolidated, bright yellow-----		6
Clay, brown to gray, with layers of brown and gray shale-----	16	
Clay, gray and olive-drab, with sandy lenses-----	12	10
Shale, brown, and clay, gray, interlaminated-----		10
Clay, gray; contains large fossil bones-----	3	
Coal-----		5
Shale, brown-----		5
Clay, dark to light gray; contains bones of <i>Triceratops</i> -----	13	8
Shale, finely laminated, brown to light brown-----	4	11
Shale, irregularly fissile, gray-----	3	5
Shale, brown-----	2	8
Sandstone, argillaceous, buff to light gray-----	14	
Base of section.	168	1

Bones collected from the clay bed about 40 feet above the base of the above section were identified by C. W. Gilmore, of the United

States National Museum, as *Triceratops* sp., a fossil characteristic of the Hell Creek member or †*Ceratops* beds,<sup>5</sup> which are found in the lower part of the Lance formation throughout Montana.

A maximum of about 250 feet of the sandstone member is exposed near the southern boundary of the field. According to information given to the writers by Levi Mack, of Loesch, Mont., who drilled wells along the Powder River in and near the Mizpah field, the exposed portion of the member is underlain by 300 to 350 feet of sandstone and shale similar in character to those exposed, indicating a possible total thickness of the member of over 500 feet.

**SOMBER-COLORED BEDS (UNDIFFERENTIATED LANCE AND FORT UNION DEPOSITS)**

The somber-colored beds crop out over most of the Mizpah field. The character of the rocks varies considerably, both along the bedding and in vertical sections. Siltstone, shale, sandstone, carbonaceous shale, and coal beds with colors ranging from ash-gray and pale tan to dark brown and black, with the somber tones prevailing, occur in rapidly changing succession in the section. (See pl. 19.) Sandstone may be replaced laterally by siltstone or shale within a few hundred feet, and locally irregular masses of sandstone, probably representing former stream channels, are embedded in rocks of entirely different character. The somber-colored beds are somewhat sandier in the southern part of the field than in the northern part. The following two stratigraphic sections show the character of these beds in the two regions:

*Stratigraphic section of somber-colored beds measured on Fivemile Creek in secs. 16-18, T. 5 N., R. 51 E.*

	<i>Ft.</i>	<i>in.</i>
Base of Tongue River member of Fort Union formation.		
Shale, chippy, gray to brown.....	8	6
Clay, gray.....	11	8
Siltstone, pale yellow; limy concretions.....	2	7
Clay, with streaks of carbonaceous shale.....		8
Clay, dark to light gray, weathers with mottled orange-colored streaks.....	9	3
Shale, gray, with streaks of coal.....	1	3
Coal; contains numerous shale partings.....	1	10
Clay, light to dark gray, with limy and sideritic concretions.....	7	10
Shale, thin laminations, brown to black.....	1	6
Clay, gray, with sideritic and limy layers.....	10	8
Shale, thin laminations, brown.....		8
Siltstone, light gray; sideritic concretions.....	7	3
Siltstone, olive-drab; sideritic and limy concretions.....	9	3

<sup>5</sup> A dagger (†) preceding a geologic name indicates that the name has been abandoned or rejected for use in classification in publications of the U. S. Geological Survey. Quotation marks, formerly used to indicate abandoned or rejected names, are now used only in the ordinary sense.

*Stratigraphic section of somber-colored beds measured on Fivemile Creek in secs. 16-18, T. 5 N., R. 51 E.—Continued*

	Ft.	in.
Coal, dirty.....		7
Shale and clay, carbonaceous, gray to brown.....	1	4
Coal, dirty.....	1	6
Shale, brown.....		5
Siltstone, light gray; large sideritic concretions.....	8	8
Clay, light gray, sandy toward top.....	5	1
Coal and carbonaceous shale.....		10
Clay, and siltstone, gray; sideritic concretions.....	15	4
Sandstone, clayey, light gray to light brown; limy concretions.....	5	3
Clay, gray.....		4
Shale, fine laminations, gray, brown, and black.....	2	1
Sandstone, clayey, friable, light gray to brown.....	21	0
Carbonaceous shale, black.....		4
Coal (Hercules bed).....	2	3
Shale, thin laminations, gray, yellow, and brown.....	2	8
Coal.....		4
Siltstone, gray, lighter toward top; limy and sideritic concretions.....	50	3
Coal.....	2	8
Shale, chippy, gray to brown.....	2	8
Shale, brown.....	3	10
Sandstone, olive-drab.....	5	8
Sandstone, limy, hard, tan.....	1	6
Siltstone, gray to olive-drab; sideritic concretions.....	20	10
Clay, brown.....		3
Coal, dirty.....	1	2
Clay and carbonaceous shale, brown to black.....	2	6
Sandstone, fine-grained, light gray.....	1	10
Clay, gray.....	5	5
Shale, carbonaceous, brown.....		7
Coal, dirty.....	3	9
Siltstone, olive-drab.....	3	3
Shale, carbonaceous, and coal.....		9
Siltstone, gray to olive-drab.....	3	6
Coal, dirty.....	1	1
Clay, gray.....	1	8
Coal and carbonaceous clay.....	1	6
Shale, brown.....		10
Clay, gray, with orange streaks.....	1	7
Shale, carbonaceous, black.....		5
Sandstone, fine-grained, light gray to light tan.....	4	1
Clay, gray, orange streaks; limy and sideritic concretions.....	2	11
Coal and carbonaceous clay.....		10
Clay, light gray.....	3	9
Siltstone, light gray.....		11
Clay, gray.....	8	7
Sandstone, light brown, and shale, dark brown, in alternate layers.....	1	6
Sandstone, limy, hard, tan.....	1	0
Sandstone, light gray.....	1	7

*Stratigraphic section of somber-colored beds measured on Fivemile Creek in secs.  
16-18, T. 5 N., R. 51 E.—Continued*

	Fl.	in.
Clay, light gray to dark gray, with orange streaks.....	3	
Sandstone, clayey, light yellow to tan.....	12	4
Clay, gray.....	2	2
Sandstone, cross-bedded; a channel filling in gray clay and siltstone which is present at this horizon elsewhere near this locality.....	29	2
Creek bottom.....	330	3

*Section of a part of the somber-colored beds in sec. 36, T. 1 N., R. 52 E.*

	Fl.	in.
Concealed to top of hill.....		
Siltstone, light yellow.....	6	
Coal.....		10
Shale, fissile.....	3	
Sandstone, clayey, pale gray.....	6	6
Coal.....		8
Siltstone, gray to light gray.....	10	9
Sandstone, fine, limy; contains plant remains.....	1	1
Sandstone, white, locally massive; channel.....	26	
Coal.....		4
Siltstone, gray.....	14	6
Sandstone, white; grades downward to siltstone.....	12	5
Sandstone, fine, limy, hard.....	1	5
Siltstone, pale olive-drab.....	15	3
Coal, Carter bed.....	3	3
Shale, fine laminations.....		10
Sandstone, clayey, light yellow.....	5	8
Shale, fissile, gray to brown.....	2	2
Sandstone, white to light gray, friable.....	3	6
Shale, fissile, brown to gray.....	2	10
Shale, carbonaceous.....	0	8
Siltstone, gray to brown.....	22	
Shale, fissile, carbonaceous, gray to dark brown.....	4	0
Clay, light gray to brown, sandy.....	2	6
Siltstone, orange-gray; sideritic concretions.....	3	1
Coal.....		6
Siltstone, olive-drab to gray.....	7	4
Coal, dirty, Snedeker bed.....	3	2
Clay, sandy, gray.....	5	4
Coal, dirty.....	1	3
Shale, chippy, light gray to brown.....	7	6
Coal.....		10
Siltstone, light yellow to gray; shaly layers.....	8	
Sandstone, fine-grained, limy, hard.....	1	
Sandstone, clayey, light yellow to olive-drab; sideritic con- cretions and some shaly layers.....	11	
Clay, gray.....	3	
Shale, carbonaceous, black.....	1	8
Clay, olive-drab; weathers pale gray.....	2	6
Coal, dirty.....	1	6
Clay, yellow, drab, sandy toward top.....	10	

Section of a part of the somber-colored beds in sec. 36, T. 1 N., R. 52 E.—Contd.

	Ft.	in.
Shale, carbonaceous, black.....	1	8
Siltstone, gray.....	5	
Coal, with thin beds of shale and clay.....	2	6
Clay, pale yellow.....	5	11
Shale, brown.....	3	
Clay, with thin beds of coal.....	5	6
Shale, chippy, gray.....	17	

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The somber-colored beds are of continental origin, probably deposited along stream courses and in temporary ponds and marshes on an area of low relief. Deposition was irregular, and probably none of the area received sediments continuously for more than short intervals. The intervals of nondeposition probably allowed erosion of part of the sediments previously deposited and transportation elsewhere for redeposition. Such conditions are inferred because of the extreme lenticularity of the individual beds, the abrupt truncation of cross-bedding, the channel-like depressions filled with sandstone that cut across coal and shale beds, and the abundant carbon particles that give the beds their somber color.

The somber-colored beds here described are equivalent to the Lebo shale member of the Fort Union formation and the Tullock member of the Lance formation of neighboring areas, also to the upper part of the Hell Creek member of the Lance as mapped in the Rosebud field.<sup>6</sup> They also include the equivalent of the basal 100 feet of the Tongue River member of the Fort Union formation, because in this area these equivalent beds are somber-colored and shaly instead of yellow and sandy like the customary beds of the Tongue River member.

The problem of correlation of the continental beds above the Hell Creek member or †*Ceratops* bed has long been troublesome, partly because of the rarity or absence of diagnostic fossils characteristic of the various members and partly because of the inconsistency of lithologic contacts with respect to determinable time horizons. The only fossil remains found above the sandstone member of the Lance formation in the Mizpah field were plants and fresh-water mollusks. The fresh-water mollusks are of a type that changed little during the deposition of continental beds and are of little value in distinguishing between the members or correlating them precisely with beds elsewhere. R. W. Brown has collected a number of fossil plants from the Mizpah field and found no species that would aid in correlating any group of strata in this field with any single member of the Lance or the Fort Union formation elsewhere. The fallibility of lithologic

<sup>6</sup> Pierce, W. G.. The Rosebud coal field, Rosebud and Custer Counties, Mont.: U. S. Geol. Survey Bull. 847-B, p. 54, 1936.

contacts for correlating these strata can be seen within the Mizpah field itself, for the interval between the Moths coal bed and the base of the yellow beds of the Tongue River member varies from 200 feet in the southwestern part of the field to over 300 feet in the eastern part, increasing by lateral gradation of somber-colored beds westward into yellow beds. (See profile sections, pl. 16.) In the Rosebud coal field Pierce<sup>7</sup> found that the yellow beds of the Tullock member of the Lance formation, which are well marked in the western part of the field, were replaced to the east by somber-colored beds similar to the overlying Lebo shale member of the Fort Union formation. Also he was unable to distinguish the part of the section equivalent to the Tullock member from the part equivalent to the Lebo member at the eastern border of the Rosebud field, adjacent to the Mizpah field. The relation of the somber-colored beds of the Mizpah field to the strata of neighboring fields is shown diagrammatically on plate 20.

In the Miles City field Collier<sup>8</sup> made essentially the same division of strata as the writers have in the Mizpah field, his lower member of the Fort Union formation being the equivalent of the somber-colored beds of the Mizpah field. The field notes and maps of Collier for the Miles City field and of Bowen<sup>9</sup> for the Baker field show that the contact between the somber-colored beds and overlying yellow beds can be traced from the Miles City field into the Ekalaka field,<sup>10</sup> where the somber-colored beds are considered the upper part of the Hell Creek member of the Lance formation and the lower 250 to 300 feet of the yellow beds are considered the Ludlow member of the Lance formation. (See pl. 20.)

The thickness of the somber-colored beds ranges from about 450 feet in the northwestern part of the field to at least 600 feet in the southeastern part. The figures are somewhat uncertain because of the considerable distances between exposures of the upper and lower contacts and the difficulty of detecting small structural features that might give erroneous impressions of thickness.

#### TONGUE RIVER MEMBER OF FORT UNION FORMATION

The Tongue River member of the Fort Union formation crops out over a large area in the southwestern part of the field and over small areas around Maxwell Butte and on the high divide between Mizpah and Pumpkin Creeks in the northwestern part.

The member consists of prevailingly light-yellow, light-gray, or pale-buff sandstone and argillaceous sandstone containing round

<sup>7</sup> Idem, p. 55-56.

<sup>8</sup> Collier, A. J., and Smith, C. D., The Miles City coal field, Mont.: U. S. Geol. Survey Bull. 341, pl. 3, 1909.

<sup>9</sup> Bowen, C. F., manuscript notes in Geological Survey files.

<sup>10</sup> Bauer, C. M., The Ekalaka lignite field, southeastern Montana: U. S. Geol. Survey Bull. 751, pp. 236, 239-244. 1925.

concretions of pyrite and light-yellow to light-gray shale, with lesser amounts of brown to black carbonaceous shale; persistent beds of coal, gray siltstone, and layers of bench-forming limy concretions. The lighter color of this member is a sharp contrast to the somber hues of the beds that underlie it. The following section, which is typical of the Tongue River member, is shown in plate 19, A:

*Stratigraphic section of Tongue River member at Maxwell Butte, sec. 20, T. 2 N.,  
R. 5 E.*

	<i>Ft.</i>	<i>in.</i>
Clinker.....	31	
Ash of coal bed.....	3	
Sandstone, silty, with shale streaks, pale tan.....	17	2
Siltstone, pale yellow.....	2	8
Shale, gray, alternating with white silty sandstone.....	16	7
Clay, sandy, white.....	2	8
Sandstone, limy, fine-grained.....	1	3
Sandstone, white, shaly.....	10	
Shale, pale gray.....	2	
Sandstone, pale orange.....	3	
Sandstone, limy, with pyrite concretions.....	1	
Clay, sandy, white.....	4	10
Siltstone, with many limonitic concretions, pale gray.....	1	2
Sandstone, massive, friable, white.....	6	2
Clay, sandy, white; limonitic concretions.....	10	3
Sandstone, limy and hard, cross-bedded, yellow.....	2	10
Clay, sandy, white.....	21	2
Sandstone, white; limy concretions.....	17	
Clay, sandy, white.....	12	
Sandstone, pale yellow.....	14	5
Siltstone, white, with thin beds of shale; limonitic concretions.....	19	6
Shale, carbonaceous, brown.....	8	
Siltstone, white, with thin beds of shale.....	12	9
Sandstone, silty, pale buff.....	5	
Shale, gray to brown, some carbonaceous.....	6	
Shale, olive-drab, poorly exposed.....	28	
Sandstone, silty, tan, poorly exposed.....	22	
Sandstone, massive, light tan.....	33	

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The Tongue River rocks weather into rolling hills with loamy soil that supports a heavy growth of grasses and, in marked contrast to soils underlain by the somber-colored beds, fair stands of western yellow pine. In many places through the field the Tongue River rocks have been baked to scoriae, or clinker, by the burning of coal beds. The clinker is more resistant to erosion than the other strata and generally caps steep-sided buttes and hills. In the southern part of the field the Tongue River member grades downward into the somber-colored beds through a transition zone of shale and gray

EKALAKA LIGNITE FIELD  
Compiled from Bull. 751 and  
field notes of C. M. Bauer

MILES CITY COAL FIELD  
Bull. 341, pl. 3

BAKER LIGNITE FIELD  
Compiled from Bull. 471 and  
field notes of C. F. Bowen

SOUTHWESTERN PART OF  
MIZPAH COAL FIELD

EASTERN PART OF  
ROSEBUD COAL FIELD  
Bull. 847

EASTERN PART OF  
ASHLAND COAL FIELD  
Compiled from Bull. 831

CENTRAL PART OF  
ROSEBUD COAL FIELD  
Bull. 831, pl. 2 (upper portion omitted)

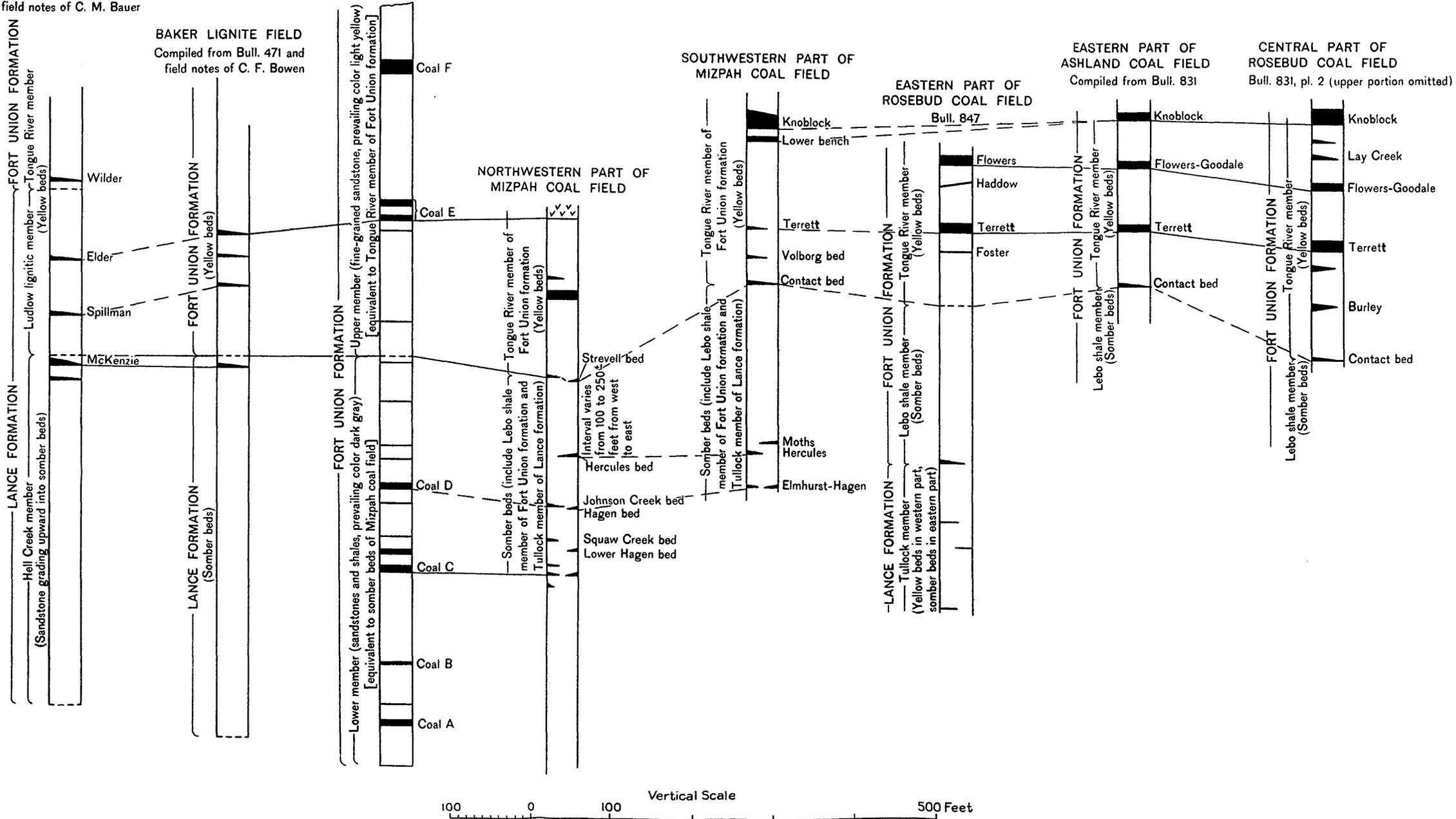


DIAGRAM SHOWING CORRELATION BETWEEN COAL BEDS AND OTHER ROCKS IN PARTS OF THE MIZPAH AND ADJACENT FIELDS.

sandstone from 10 to 50 feet thick. Throughout this part of the area a persistent coal bed lies in or near the transition zone and is mapped as the base of the Tongue River member. In the northern part of the field the contact between the Tongue River member and the underlying somber-colored beds is more distinct and could be shown on the map. Locally, however, coal beds occur at or near the contact and were mapped as the contact. The correlation of the Tongue River member between this and adjacent fields is shown diagrammatically in plate 20.

In the Mizpah field about 380 feet of the Tongue River member is exposed, probably less than a third of the total thickness of Tongue River strata that formerly extended over this region. Bass <sup>11</sup> believes that about 1,150 feet of Tongue River strata extended over the eastern portion of the adjoining Ashland field.

#### TERTIARY AND QUATERNARY TERRACE GRAVEL

Terrace gravel occurs in small areas at various altitudes in the Mizpah field (pl. 18, *B*). The deposits consist of unsorted silt, sand, and pebbles. Most of the pebbles are of clinker or other local rocks, but in addition there are pebbles of quartzite, schist, silicified wood, and various igneous rocks. The deposits found on the high divides contain a larger percentage of the igneous and other foreign pebbles than the terrace deposits adjacent to the streams. In addition, the terrace deposits along the major streams, such as Pumpkin and Mizpah Creeks, contain a larger percentage of foreign materials than the deposits along their tributaries, which contain a large percentage of clinker and sandstone pebbles. Sand Creek, however, has a large amount of foreign pebbles, which were probably derived from the extensive terrace at its head.

The highest extensive terrace in the field is in the southwestern part, on the divide between Sand and Pumpkin Creeks. It is from 3,300 to 3,430 feet above sea level, or 200 to 300 feet above Sand Creek and 430 feet above Pumpkin Creek. It may be equivalent to the gravel at about 3,300 feet in secs. 5 and 8, T. 2 N., R. 48 E., in the Ashland field, tentatively correlated by Bass <sup>12</sup> with the Flaxville bench, of Miocene or Pliocene age. In sec. 24, T. 2 N., R. 52 E., a small remnant of gravel, about 3,480 feet above sea level and about 700 feet above the Powder River, is also tentatively correlated with the Flaxville. The other gravel deposits of the Mizpah field are lower and occur along the sides of the valleys above the level of the alluvium which borders the streams. Near Ashland the oldest alluvium contains bones of *Elephas columbi*, a form of Pleistocene age. Pre-

<sup>11</sup> Bass, N. W., The Ashland coal field, Rosebud, Powder River, and Custer Counties, Mont.: U. S. Geol. Survey Bull. 831, p. 35, 1932.

<sup>12</sup> Bass, N. W., op. cit., p. 43.

sumably the gravel terraces range in age from Miocene or Pliocene to Pleistocene, although they may be entirely Pleistocene.

No fossils have been found in the gravel deposits, and the remnants are so small and so poorly preserved that only the few benches that occur along Pumpkin Creek could be correlated definitely with deposits outside the Mizpah field. By tracing these terraces, using their altitudes and the intervals between them, a satisfactory correlation could be made along some of the streams. The altitude of the terraces decreases slightly downstream, but although the interval between terraces remains fairly constant, the interval between any terrace and the stream increases downstream; also younger terraces at a lower level are found downstream.

Along the west side of Pumpkin Creek four terraces are found at altitudes of 3,172 to 3,186, 3,082 to 3,098, 3,023 to 3,044, and 2,922 to 2,951 feet above sea level. The lowest one of these terraces does not extend to the southwestern corner of the area; the higher three are correlated with the lowest three terraces found by Bass<sup>13</sup> in sec. 24, T. 1 N., R. 48 E. At this locality Bass found four terraces standing 90 feet, 155 feet, 210 feet, and 310 feet above Pumpkin Creek, whereas the highest three terraces found in the Mizpah field along Pumpkin Creek stand 100 feet, 150 feet, and 210 feet above the stream. Bass also found two higher terraces which were not found in the Mizpah field. Pierce<sup>14</sup> mapped five terraces along Pumpkin Creek northward from the Mizpah field. He called these A, B, C, D, E, from lowest to highest. Terraces A and B mapped by Pierce do not extend as far south as the north border of the Mizpah field, but his terraces C, D, and E are tentatively correlated with the lowest three terraces along Pumpkin Creek in this field.

#### QUATERNARY ALLUVIUM

Alluvial material, composed of clay, silt, and fine sand, is present to depths of as much as 30 feet in the valleys of the rivers and larger creeks. It has a characteristic property of standing in steep bluffs along the stream channels. (See pl. 21, A.) The alluvium occurs in a succession of benches from the present stream channels to 35 feet above them. The wide highest alluvial bench, about 20 to 35 feet above the streams, probably corresponds to the bench containing the Pleistocene fossil *Elephas columbi* at about the same height above the Tongue River at Ashland.<sup>15</sup> The material of the lower benches and the alluvial flat bordering the stream channel may be of very late Pleistocene or Recent age.

<sup>13</sup> Bass, N. W., The Ashland coal field, Rosebud, Powder River, and Custer Counties, Mont.: U. S. Geol. Survey Bull. 831, p. 45, 1932.

<sup>14</sup> Pierce, W. G., The Rosebud coal field, Rosebud and Custer Counties, Mont.: U. S. Geol. Survey Bull. 847.

<sup>15</sup> Bass, N. W., op. cit., p. 46.

## STRUCTURE

The strata of the Mizpah field have a very low regional dip of about 10 feet to the mile to the northwest, varied in many places by small folds of low relief, but, because of the variation in stratigraphic intervals and uncertain correlation between beds, the size, closure, and configuration of the folds cannot be determined satisfactorily. Thom and Dobbin,<sup>16</sup> in a reconnaissance through this field, noted a monocline or anticline south of Johnson Creek, a syncline at Maxwell Butte, and slight variations in dip in the Mizpah Creek Valley. In addition to these, the present writers have noticed other minor folds, faults of small displacement, and landslide masses in various parts of the field. All the folds in the Mizpah field have a closure on the surface rocks of less than 100 feet and, even if they persist in depth, are probably too small to be valuable reservoirs for oil or gas.

## COAL

### PHYSICAL AND CHEMICAL CHARACTER

The coal of the Mizpah field belongs to the rank of coal termed "lignite"—that is, it has a brown streak or powder, is very tough when fresh, slacks rapidly when exposed to air, shows a woody texture, and has a moisture content of about 34 percent. At nearly half of the coal outcrops in the Mizpah field, particularly at those in the somber-colored beds, the coal is either dirty or contains a number of clay or shale partings, and at all the natural exposures where the bed is not kept moist by springs the coal is slacked to small grains or powder for 2 feet or more into the face. The freshly mined coal from some localities is massive and hard, but with exposure to dry air for an hour or two it cracks into small pieces and eventually into fine grains. Where the coal is stored in closed bins or away from the circulation of air it can be preserved for several months.

The table below presents analyses of coal from the Moths bed in the Mizpah field and, for comparison, coals from various other fields in Montana and adjacent States. The single analysis obtained from the Mizpah field represents only in a general way the quality of the coal in the field, as doubtless the coal varies in composition from place to place. Three forms of analysis are given in the table. Form A represents the coal as received in the laboratory of the United States Bureau of Mines and shows approximately the composition of the coal as it is mined. Form B represents the composition of the coal with moisture excluded, and form C with both moisture and ash excluded. Coal does not exist in nature with the composition shown by forms B and C, but these forms are valuable for the purpose of comparison.

<sup>16</sup> Thom, W. T., Jr., and Dobbin, C. E., Oil possibilities in southeastern Montana: U. S. Geol. Survey Press Bull., January 1921.

## Analyses of coal from the Mizpah field and from some other fields of Montana and adjacent States

Laboratory No.	Kind of coal and locality	Form of analysis	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	Heating value	
								Calories	British thermal units
A84104	Lignite from Krutzfeldt mine, <sup>1</sup> T. 1 N., R. 53 E., Mizpah field.	A	34.3	25.3	31.9	8.5	0.5	3,878	6,980
		B	-----	38.6	48.4	13.0	.8	5,911	10,640
		C	-----	44.3	55.7	-----	1.0	6,784	12,220
	Lignite from Miles City, Mont.; average of 5 analyses from Kircher bed.	A	30.1	27.5	33.4	9.05	.68	4,195	7,551
		B	-----	39.3	47.7	12.95	.98	5,994	10,789
		C	-----	45.1	54.8	-----	1.12	6,917	12,452
A3229	Lignite from Curran & Marengo mine, Broadus, Mont.	A	30.8	26.8	34.6	7.8	.3	4,200	7,560
		B	-----	38.8	50.0	11.2	.4	6,067	10,920
		C	-----	43.7	56.3	-----	.5	6,839	12,310
A45204	Lignite from Reclamation mine of Montana & Dakota Power Co., Williston, N. Dak.	A	37.9	26.7	30.4	5.0	.5	3,880	7,000
		B	-----	43.0	49.0	8.0	.9	6,256	11,260
		C	-----	46.7	53.3	-----	1.0	6,806	12,250
A45881	Lignite from mine of Lucky Strike Coal Corporation, Zap, N. Dak.	A	33.6	27.1	33.2	6.1	.8	4,272	7,690
		B	-----	40.9	49.9	9.2	1.3	6,439	11,590
		C	-----	45.0	55.0	-----	1.4	7,989	12,760
A45885	Lignite from Minot White River Coal Co., Beulah, N. Dak.	A	34.4	26.7	33.3	5.6	.8	4,139	7,450
		B	-----	40.7	50.8	8.5	1.2	6,311	11,360
		C	-----	44.5	55.5	-----	1.3	6,900	12,420
A35365	Subbituminous coal from strip mine of Northwestern Montana Improvement Co., Colstrip, Mont.	A	24.4	28.3	39.9	7.4	.6	5,028	9,050
		B	-----	37.4	52.8	9.8	.8	6,650	11,970
		C	-----	41.4	58.6	-----	.9	7,367	12,260
00543	Bituminous coal from No. 4, Rock Springs mine of Union Pacific Coal Co., Rock Springs, Wyo.	A	11.2	36.5	46.3	6.0	.8	6,244	11,240
		B	-----	41.1	52.2	6.7	.9	7,028	12,650
		C	-----	44.1	55.9	-----	.9	7,535	13,560

<sup>1</sup> Coal was wet and somewhat weathered

## BURNING OF THE COAL

Thick coal beds containing coal of good quality have burned at many places along their outcrops and under narrow ridges and shallow cover. The extent of the burning is a rough measure of the quality and thickness of the coal, but it depends also on the thickness of cover, porosity of the cover, and the presence or absence of water in the coal bed. During the burning of the coal the overlying rocks are baked into bricklike material or even fused to form what is variously termed "clinker," "slag," "scoria," or "porcelanite." Rogers<sup>17</sup> has described these processes and the mineralogical and physical changes that occur.

The origin of the fires in the coal beds has been variously ascribed to lightning, prairie fires, and the agency of man, but probably most

<sup>17</sup> Rogers, G. S., Baked shale and slag formed by the burning of coal beds: U. S. Geol. Survey Prof. Paper 108, pp. 1-10, 1917.

such fires start through spontaneous combustion caused by slow oxidation of the coal or the pyrite in the coal. The presence of clinker fragments in the highest terrace gravel indicates that fires must have been burning as long ago as late Tertiary time.

The clinker beds and places where coal has been burned at the outcrop are shown by symbols on plate 16, and where it was possible to judge, the limit of unburned coal is also indicated.

#### THE COAL BEDS

In the Mizpah field coal beds occur in the somber-colored beds and in the overlying Tongue River member of the Fort Union. The strata are nearly horizontal, and the coal outcrops accordingly follow approximately the contour of the land surface. The outcrop lines and the localities where the beds were measured are shown on plate 16. With the exception of the Knoblock bed, the coals of the Mizpah field are lenticular and discontinuous, and an outcrop line on the map represents outcrops of a series of lenses at about the same horizon rather than a single continuous coal bed. For this reason the variation in interval between beds may be due as much to cumulative errors in correlation of the numerous lenses as to the thickening or thinning of the barren strata between them. The character and occurrence of the more extensive beds are discussed in a general way below, but a more detailed description of these beds and a discussion of the local beds are given in the description of coal in the individual townships. Because no beds of rock except the coals can be followed throughout the Mizpah field the position of each coal bed is given with reference to some higher or lower bed.

*Kitty Springs bed.*—The Kitty Springs bed, named from the Kitty Springs mine, occurs at the base of the somber-colored beds in the northeastern part of the field. This bed reaches a maximum thickness of 3 feet 5 inches at locality 20, in T. 4 N., R. 53 E., but through most of its extent is thin and contains impure coal. This bed is only 2 feet 11 inches thick, with a 1-inch shale parting, at the Kitty Springs mine (locality 9), in T. 4 N., R. 53 E., and the coal there is fresh, owing to the constant moisture from Kitty Springs.

*Nicholls bed.*—The Nicholls coal bed, named from Nicholls Creek, where it crops out, is exposed for a few miles in the southeastern part of the field. It also is mapped as the base of the somber-colored beds, but, owing to the southeastward rise of the top of the underlying sandstone member of the Lance, the Nicholls bed is 30 to 50 feet higher than the Kitty Springs bed. It contains 3 feet 7 inches of coal with a 3-inch parting at locality 1, in T. 1 N., R. 53 E., and over 2 feet of coal in several other localities. There is a small mine on this bed at locality 11.

*Mizpah bed.*—The Mizpah bed crops out locally along Mizpah Creek through the central portion of the field about 30 to 70 feet above the horizon of the Kitty Springs bed. The outcrops of this bed are covered in many places by alluvium or thick outwash, and the correlation of the bed from place to place is uncertain. Some coal has been taken from the Mizpah bed in T. 3 N., R. 51 E., at localities 27, 37, and 62, but the exposures are so near the water level of Mizpah Creek that mining is difficult.

*Lower Hagen bed.*—The Lower Hagen bed crops out in the valleys of Johnson, Lovetts, and Third Creeks, in the northwestern part of the field. It lies about 30 feet below the Hagen bed. It is thickest to the north and contains 6 feet 3 inches of dirty coal at locality 71, T. 5 N., R. 50 E., and 4 feet 3 inches of clean coal at locality 75, T. 6 N., R. 49 E.

*Monarch bed.*—The Monarch bed occurs at about the same horizon as the Lower Hagen bed but in the eastern part of the field, in the hills west of Ash Creek and in the valley of Monarch Creek. The bed in the southeastern part of T. 3 N., R. 53 E., at localities 35 and 36, may be a continuation of this bed. Where thick and nearly pure the Monarch bed is not readily accessible except for a short distance near locality 29, T. 3 N., R. 53 E., where the bed contains 3 feet 7 inches of clean coal.

*Hagen bed.*—The Hagen bed, named from the Hagen ranch, where it is well exposed, occurs through several townships in the western part of the field, in the drainage basin of Pumpkin Creek. It is about 90 feet above the Mizpah bed. The maximum thickness of 4 feet 8 inches is found at locality 60, T. 4 N., R. 50 E., although there the coal is rather dirty. It is variable in thickness and generally dirty.

*Elmhurst bed.*—The Elmhurst bed crops out in the valleys of Mizpah and Elmhurst Creeks, in the southern part of the field. It is at about the same horizon as the Hagen bed but probably is not continuous with that bed. The Elmhurst bed contains 6 feet of clean coal at locality 21, T. 2 N., R. 52 E., but thins rapidly to the north and was not traced continuously in T. 3 N., R. 52 E.

*Elmhurst-Hagen bed.*—The bed or series of beds designated the "Elmhurst-Hagen bed" occurs on the west side of Mizpah Creek as far north as the northern part of T. 5 N., R. 51 E. This series of beds may be in part continuous with the Hagen bed and in part continuous with the Elmhurst bed, to the south, but no definite connection was traced. The lenses making up this bed are commonly covered. One outcrop contains 4 feet 11 inches of clean coal with two thin shale partings at locality 107, T. 5 N., R. 51 E., but nearly half the outcrops show dirty coal.

*Squaw Creek bed.*—The Squaw Creek bed crops out in the northwestern part of the field in the valleys of Squaw and Johnson Creeks, about 50 feet above the Lower Hagen bed. Locally in the Squaw Creek Valley it consists of two benches, and at locality 25, T. 6 N., R. 49 E., the lower bench contains 4 feet 8 inches of clean coal and the upper bench, 3 feet higher, 1 foot 8 inches of clean coal. Where the bed is thicker than this the coal is dirty.

*Johnson Creek bed.*—The Johnson Creek bed crops out in the Johnson Creek Valley in the northwestern part of the field, about 50 to 80 feet above the Lower Hagen bed. It is a local lens containing 5 feet 7 inches of clean coal at locality 48, T. 6 N., R. 49 E. It is burned at the outcrop through considerable distances.

*Fivemile bed.*—The Fivemile bed, 50 to 70 feet above the Elmhurst-Hagen, crops out in the valleys of Fivemile and Second Creeks, in the north-central part of the Mizpah field. This bed is persistent in that vicinity and contains 5 feet of dirty coal at locality 17, T. 5 N., R. 51 E. Where the bed contains clean coal it does not exceed 3 feet 5 inches in thickness.

*Hercules bed.*—The Hercules bed, named from Hercules Creek, where it is well exposed, crops out over a large part of the northern two-thirds of the Mizpah field 50 to 100 feet above the Elmhurst-Hagen horizon and 200 to 270 feet above the Kitty Springs horizon. Although the map and coal sections, for simplicity, show it as a continuous bed, it probably represents a series of lenses occurring in a stratigraphic interval of about 80 feet. In T. 3 N., R. 52 E., the distinction between lenses is shown on the map, a higher lens being mapped in the eastern part of the township and a lower lens in the western part. Such changes probably occur at many other places in the field but were not detected because of poor exposures. Much of the coal in the Hercules bed is dirty, but at locality 164, in T. 4 N., R. 50 E., there is 6 feet 3 inches of clean coal with a 5-inch shale parting near the center of the bed.

*Shook bed.*—The Shook bed occurs near the horizon of the Hercules bed in the northern part of T. 5 N., R. 52 E. At the Shook mine the bed contains 4 feet 7 inches of coal, with a thinner bench containing 3 feet 2 inches of coal, 2½ feet above it. Although the coal is clean and the exposure accessible, very little coal has been taken from the bed, and the mine appears to be abandoned.

*Moths bed.*—The Moths bed crops out in the drainage area of Mizpah Creek in the southern part of the field. It lies about 25 to 60 feet above the Hercules horizon and 60 to 100 feet above the Elmhurst bed. It has been mined at the Moths mine, at the Krutzfeldt mine, and at numerous other prospects in T. 1 N., R. 52 E. It contains 6 feet of clean coal at locality 12, T. 2 N., R. 51 E., but is less accessible here than in the Spring Creek Valley.

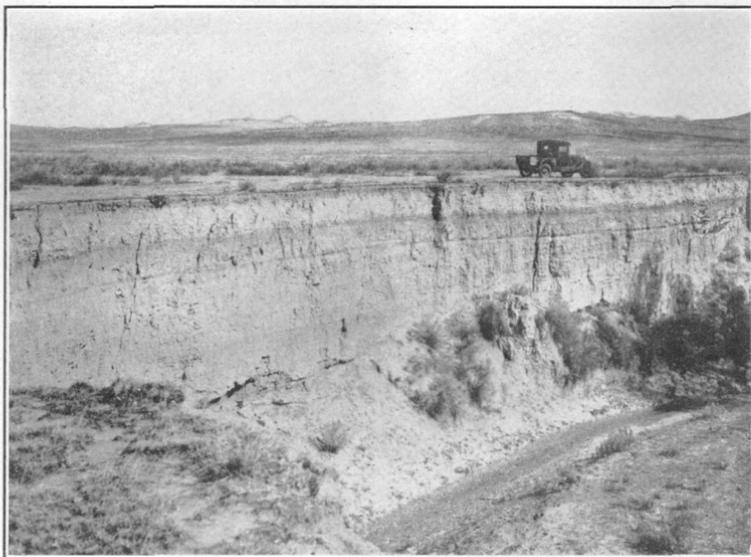
*Snedecker bed.*—The Snedecker bed, in the southeastern part of the field, crops out near the base of the escarpment east of the Powder River-Mizpah Creek divide, at about the horizon of the Moths bed, 200 feet or so above the Nicholls horizon. It is of little value, having a maximum thickness of only 2 feet 10 inches with a 4-inch shale parting at locality 39, T. 1 N., R. 53 E. It has been prospected at the Snedecker ranch (locality 31), but there contains only 2 feet 6 inches of clean coal with a 4-inch shale parting.

*Dead Horse bed.*—The Dead Horse bed, which lies at about the same horizon as the Moths and Snedecker beds, crops out along the west side of Ash Creek and is well exposed at the head of Dead Horse Creek, in the east-central part of the field. This bed is thickest in T. 2 N., R. 53 E., but extends into the townships to the north and northwest. The bed usually contains a thick parting of shale or impure coal, but at localities 17 and 24, T. 2 N., R. 53 E., it contains 2 feet 9 inches of clean coal.

*Divide bed.*—The Divide bed, 60 to 130 feet above the Hercules bed, crops out along the divide between Mizpah and Pumpkin Creeks, in the central western part of the field. In the southwestern part of T. 4 N., R. 51 E., the Divide bed is well exposed on the west slope of the divide but is entirely replaced by shale on the east slope. In T. 3 N., Rs. 50 and 51 E., and T. 5 N., R. 50 E., local beds at the horizon of the Divide bed are possibly correlative with it. The Divide bed contains 3 feet 11 inches of clean coal at locality 109, T. 4 N., R. 50 E., and over 3 feet of clean coal at several other localities.

*Carter bed.*—The Carter bed, about 60 feet above the Snedecker bed, crops out in the escarpment east of the divide between Mizpah Creek and the Powder River in the southeastern part of the Mizpah field and locally on the grassy slopes at the head of Spring Creek on the west side of the divide. Through part of its extent it has two benches. For a considerable distance this bed exceeds 3 feet in thickness, but where it is thick it is inaccessible in the steep escarpment. At the Carter mine (locality 3), in T. 1 N., R. 53 E., the bed contains only 2 feet of dirty coal but is readily accessible. Some of the isolated outcrops of coal in T. 1 N., R. 52 E., may belong to this bed, but the outcrops cannot be traced continuously because of the thick soil cover.

*Bear Jaw bed.*—The Bear Jaw bed crops out along the divide between the Powder River and Mizpah Creek through the central eastern part of the field and is well exposed at the head of Bear Jaw Creek. It lies at about the same horizon as the Carter bed and about 80 to 130 feet above the Hercules bed. Through part of the northern portion of the field it has two benches of about equal thickness. The Bear Jaw bed commonly contains impure coal, but at locality 28, T. 5 N., R. 52 E., the lower bench contains 4 feet 1 inch of clean coal.



**A. BLUFF OF ALLUVIUM DEVELOPED BY THE TRENCHING OF ELMHURST CREEK IN ITS BROAD ALLUVIAL FLAT.**

In sec. 36, T. 3 N., R. 51 E.



**B. KRUTZFELDT MINE.**

In sec. 3, T. 2 N., R. 52 E. Practically all of the coal now used in the field is obtained from open-pit mines of this sort.

*Strevell bed.*—The Strevell coal bed occurs at the base of the Tongue River member near the head of Strevell and Johnson Creeks, in the northwestern part of the field, and crops out at the spring half a mile east of the Damm ranch. Although it is generally thin and was mapped principally to show the basal contact of the Tongue River member, it thickens to 3 feet 8 inches at locality 2, T. 5 N., R. 50 E. A local bed at the base of the Tongue River member in the northern part of T. 6 N., R. 50 E., occurs at a higher horizon than the Strevell bed but also marks the lithologic change from yellow Tongue River beds to the somber-colored beds.

*Contact bed.*—The Contact bed, which occurs at the base of the Tongue River member in the southwestern part of the field, was named by Bass<sup>18</sup> in the Ashland field and traced to the borders of the Mizpah field. The Contact bed is well exposed in Tps. 1 and 2 N., R. 49 E., but to the east it is concealed for long distances, and the bed designated the "Contact bed" in the central part of T. 1 N., R. 50 E., may possibly be at a slightly higher horizon. The Contact bed is 3 feet 7 inches thick at locality 35, T. 1 N., R. 49 E., and there are several other exposures in the same township that might afford a supply of coal for local use.

*Volborg bed.*—The Volborg bed is well exposed in the hills east of Volborg post office, in T. 1 N., R. 49 E., 25 to 40 feet above the Contact bed, and outcrops possibly belonging to this bed are found at the same horizon in adjacent townships. The Volborg bed contains 3 feet 1 inch of clean coal and 6 inches of dirty coal at locality 30, T. 1 N., R. 49 E., and at many other outcrops it is more than 2 feet thick.

*Terrett bed.*—The Terrett bed was traced to the west border of the Mizpah field by Bass,<sup>18</sup> who noted that it thins to the east and that the interval between it and the base of the Tongue River member also decreases eastward until at the eastern border of the Ashland field (the western border of the Mizpah field) the Terrett bed is about 70 feet above the Contact bed. (See pl. 20.) In the Mizpah field the Terrett bed contains a maximum of 3 feet 8 inches of coal at locality 86, T. 1 N., R. 49 E., but thins to the north and east and does not occur in adjacent townships.

*Knoblock bed.*—The Knoblock bed occurs 100 to 200 feet above the Contact bed, on the high ridges in the southwestern part of the Mizpah field and at the base of the yellow Tongue River member in the region of Maxwell Butte, where the underlying part of the Tongue River has become somber-colored. It is burned at nearly every outcrop. In the southwestern part of the field it has two benches. The upper

<sup>18</sup> Bass, N. W., The Ashland coal field, Mont.: U. S. Geol. Survey Bull. 831, p. 53, 1932.

bench was encountered when the wells at the Percy Bird and Ray Bird ranches were dug, and thicknesses of 25 and 28 feet were reported; the upper portion of the bed showed some weathering. The lower bench is exposed at three localities and ranges in thickness from 4 feet to 6 feet 3 inches. In the region around Maxwell Butte the Knoblock bed marks the base of the yellow Tongue River beds but is burned out along the outcrop and under the ridges except at four localities. At locality 53, T. 2 N., R. 52 E., it contains 12 feet of coal with a 4-inch shale parting, but elsewhere in that vicinity it is thinner.

#### ESTIMATES OF COAL RESERVES

Most of the coal in the Mizpah field occurs as thin lenticular beds of varying purity. For the purpose of estimating the coal reserves, coal beds were considered to be of possible value only where they exceed 1 foot 6 inches in thickness and the coal is sufficiently clean to be usable. For computing the tonnage, the area underlain by each bed was measured with a planimeter, and the average thickness of the bed under that area was estimated from the measured sections of the bed. Where beds extend under cover they were assumed, if other data were not available, to have the form of a semicircular lens of regularly varying thickness, with the diameter coinciding roughly with the outcrop. No allowance was made for beds not exposed in the township or within a short distance of it. It is apparent from the foregoing explanation that there is a possibility of large errors in the estimate, the probability being that there are beds of coal in the unexposed portions of the somber-colored beds.

*Estimated reserves of coal in the Mizpah coal field, by townships*

Township and coal bed	Thickness (feet)	Area (acres)	Tons
T. 1 N., R. 49 E.:			
Upper Knoblock.....	20	2,000	72,000,000
Lower Knoblock.....	5	2,000	18,000,000
Terrett.....	2.5	6,360	28,600,000
Volborg.....	2	7,500	27,000,000
Contact.....	2	9,330	33,600,000
			179,200,000
T. 1 N., R. 50 E.:			
Contact.....	2	8,920	32,100,000
			32,100,000
T. 1 N., R. 51 E.:			
Local.....	2	344	1,200,000
Moths.....	2	6,508	23,400,000
			24,600,000
T. 1 N., R. 52 E.:			
Carter.....	2	1,120	4,000,000
Moths.....	3	16,260	87,800,000
			91,800,000

## Estimated reserves of coal in the Mizpah coal field, by townships—Continued

Township and coal bed	Thickness (feet)	Area (acres)	Tons
T. 1 N., R. 53 E.:			
Local above Carter.....	3	112	600,000
Carter.....	3	2,620	14,100,000
Snedecker.....	2	84	300,000
Nicholls.....	2	2,300	8,300,000
			23,300,000
T. 2 N., R. 49 E.:			
Contact.....	2	3,320	12,000,000
			12,000,000
T. 2 N., R. 50 E.:			
Contact.....	2	1,940	7,000,000
Moths.....	2	8,692	31,300,000
			38,300,000
T. 2 N., R. 51 E.:			
Moths.....	3	2,682	14,500,000
Elmhurst.....	3	6,088	32,900,000
			47,400,000
T. 2 N., R. 52 E.:			
Local.....	4	56	400,000
Knoblock.....	7	120	1,500,000
Local, 20 feet above Moths.....	1.5	424	1,100,000
Moths.....	3	7,720	41,700,000
Elmhurst.....	3.5	14,152	89,200,000
			133,900,000
T. 2 N., R. 53 E.:			
Dead Horse.....	2	1,240	4,500,000
Nicholls.....	3	672	3,600,000
			8,100,000
T. 2 N., R. 54 E.:			
Nicholls.....	2.5	20	100,000
			100,000
T. 3 N., R. 50 E.:			
Divide.....	2	1,920	6,900,000
Local beds in secs. 25 and 36.....	2	450	1,700,000
Hercules.....	3	6,000	32,400,000
			41,000,000
T. 3 N., R. 51 E.:			
Divide.....	2	170	600,000
Hercules.....	2	1,720	6,200,000
Elmhurst-Hagen.....	2.5	1,160	5,200,000
			12,000,000
T. 3 N., R. 52 E.:			
Moths.....	3	400	2,200,000
Hercules.....	4	6,200	44,600,000
Lower bench of Hercules.....	5	680	8,100,000
Monarch.....	2	2,400	8,600,000
			61,500,000
T. 3 N., R. 53 E.:			
Monarch.....	2.5	3,120	14,000,000
Local bed 90 to 130 feet above Kitty Springs bed.....	3	160	900,000
Kitty Springs.....	2	700	2,500,000
			17,400,000
T. 4 N., R. 50 E.:			
Divide.....	3	740	4,000,000
Hercules.....	2.5	5,700	16,700,000
Hagen.....	2	300	1,100,000
			21,800,000

## Estimated reserves of coal in the Mizpah coal field, by townships—Continued

Township and coal bed	Thickness (feet)	Area (acres)	Tons
<b>T. 4 N., R. 51 E.:</b>			
Divide.....	2.75	2,560	12,700,000
Hercules.....	2.5	2,340	10,500,000
Elmhurst-Hagen.....	2	12,320	44,400,000
			67,600,000
<b>T. 4 N., R. 52 E.:</b>			
Bear Jaw.....	1.83	660	2,200,000
Local outcrops below Bear Jaw.....	1.66	760	2,300,000
Hercules.....	2	3,488	12,600,000
Local outcrops 20 to 60 feet below Hercules.....	2	1,080	3,900,000
Monarch.....	1.5	1,280	3,500,000
Local beds 100 feet above Kitty Springs bed.....	2	2,640	9,500,000
Local bed 50 feet above Kitty Springs.....	2	3,040	10,900,000
Kitty Springs.....	1.66	2,180	6,500,000
			51,400,000
<b>T. 4 N., R. 53 E.:</b>			
Local bed 100 feet above Kitty Springs.....	2	572	2,100,000
Local bed 50 feet above Kitty Springs.....	2	864	3,100,000
Kitty Springs.....	3	4,292	23,200,000
			28,400,000
<b>T. 5 N., R. 50 E.:</b>			
Strevell.....	2.5	1,020	4,600,000
Local bed 40 to 60 feet above Hercules.....	2	600	2,200,000
Hercules.....	2.5	9,000	40,600,000
Johnson Creek.....	3	4,480	24,200,000
Hagen.....	2.66	1,380	6,600,000
Lower Hagen.....	3	10,580	57,100,000
Local bed below Lower Hagen.....	4	7,720	55,600,000
			190,800,000
<b>T. 5 N., R. 51 E.:</b>			
Hercules.....	2	2,200	7,900,000
Fivenille.....	2.75	2,720	13,500,000
Upper bench of Elmhurst-Hagen.....	1.75	80	300,000
Elmhurst-Hagen.....	3	8,640	46,700,000
Local beds 20 to 30 feet below Elmhurst-Hagen.....	2.5	1,440	6,500,000
Local beds 20 feet above Mizpah.....	1.75	64	200,000
Mizpah.....	3.5	7,480	47,100,000
			122,200,000
<b>T. 5 N., R. 52 E.:</b>			
Bear Jaw.....	2.5	204	900,000
Lower bench of Bear Jaw.....	3.75	204	1,400,000
Hercules.....	1.5	520	1,400,000
Shook.....	2.75	520	2,600,000
Local bed 40 feet below Shook.....	2	300	1,100,000
Local bed 60 feet below Shook.....	2	200	700,000
Local bed 100 feet below Shook.....	2	700	2,500,000
Local bed 100 feet above Kitty Springs.....	2.75	768	3,800,000
			14,400,000
<b>T. 6 N., R. 49 E.:</b>			
Johnson Creek.....	4.5	2,092	16,900,000
Local bed equivalent to bed D of Miles City field.....	1.5	1,740	4,700,000
Squaw Creek (upper bench included).....	2.75	15,290	75,700,000
Lower Hagen.....	2.33	3,158	13,300,000
			110,600,000
<b>T. 6 N., R. 50 E.:</b>			
Strevell.....	2	700	2,500,000
Johnson Creek.....	3	1,140	6,200,000
Local bed equivalent to bed D of Miles City field.....	4	1,086	7,800,000
Lower Hagen.....	3	3,800	20,500,000
			37,000,000
Grand total.....			1,366,900,000

## TOWNSHIP DESCRIPTIONS

## T. 1 N., R. 49 E.

The western part of T. 1 N., R. 49 E. is drained by Pumpkin Creek and its tributaries, Deer, Shelter, and Essell Creeks. The eastern part is drained by Sand Creek. The terrane at the heads of the tributaries of Pumpkin Creek is dissected into narrow steep valleys and clinker-capped benches. Badlands are present locally in the western portion. The part draining into Sand Creek is gently rolling sod-covered country. Gravel-covered terraces occupy much of this portion of the township.

The coals in this township are found only in the Tongue River member of the Fort Union formation, which crops out over most of the township. (See pl. 22.) The Contact bed, at the base of the Tongue River member, was found in the valleys of Pumpkin Creek and its tributaries. This bed varies considerably in purity and thickness. It thins out and was not mapped in the southwestern part of the township, and locally elsewhere it is entirely replaced by carbonaceous shale. A maximum thickness of 3 feet 7 inches was measured at locality 35. A local outcrop with 2 feet 3 inches of coal about 170 feet below the Contact bed was observed at locality 18 in sec. 4. The Volborg bed, 25 to 40 feet above the base of the Tongue River member, crops out in the valleys of Deer, Shelter, and Essell Creeks. The coal of this bed is replaced by carbonaceous shale in the northern part of Deer Creek Valley and between Deer and Shelter Creeks. A maximum thickness of 3 feet 1 inch was measured at locality 30. The Terrett coal bed, about 70 feet above the base of the Tongue River member, crops out in the western and central parts of the township. It is replaced by shale and was not mapped in sec. 28 or the northern part of the township. The Terrett bed is a thick coal bed west of this area but is thin here, having a maximum measured thickness of 3 feet 6 inches of clean coal at locality 86. The Knoblock coal bed in two benches, about 150 to 200 feet above the base of the Contact bed, has burned to form the massive clinker capping the hills of the northern and western parts of the township and the benches on the rolling divide between Sand and Pumpkin Creeks. Burning is extensive and the main Knoblock bed, the higher bench, is not exposed at the surface in the township, and the lower bench is exposed only at localities 73, 75, and 88. The line shown on the map represents the outcrop of both benches except where it is especially distinguished as the lower bench. The main Knoblock bed was encountered in the wells of Ray Bird and Percy Bird, at localities 74 and 92, respectively, where thicknesses of 25 and 28 feet were reported to the writers, and the lower bench was measured at localities 73, 75, and 88 with thicknesses of 6 feet 3 inches, 5 feet, and 4 feet, respectively. The main bed underlies nearly 2 square miles, and the lower bench a somewhat larger area in the southeastern part of the township, covered by an average of 70 feet of overburden. This constitutes the most valuable reserve of coal in this field.

## T. 1 N., R. 50 E.

The northern and western part of T. 1 N., R. 50 E., is drained by Sand Creek, a tributary of Mizpah Creek. The eastern part is drained by Road Creek and other shorter tributaries of Mizpah Creek. The western part is occupied by pine-covered masses of clinkered rocks, but most of the valleys are shallow and more open than is common in clinkered areas. The eastern part of the township is made up of gently rolling grass-covered hills with local small badland areas.

The Moths coal bed crops out 200 feet below the base of the Tongue River member of the Fort Union formation in the northeast corner of the township. It was not measured in this township but is 2 to 3 feet thick in the adjacent parts

of T. 2 N., R. 51 E. The Contact coal bed, at the base of the Tongue River member, is persistent, and though it is concealed by surface wash in most of the northwestern part, it could be traced throughout the township. It was measured at localities 1 to 24 and 26 to 36. Its thickness ranges from 1 foot 6 inches to more than 3 feet, and its purity ranges from clean to very dirty. (See fig. 18.) The Knoblock coal bed, 150 feet above the base of the Tongue River member, is almost completely burned out in this township. At locality 25, where an area of a few acres is underlain by unburned coal, there is a thickness of 12 feet of clean coal. The small amount of coal remaining unburned in the Knoblock bed may

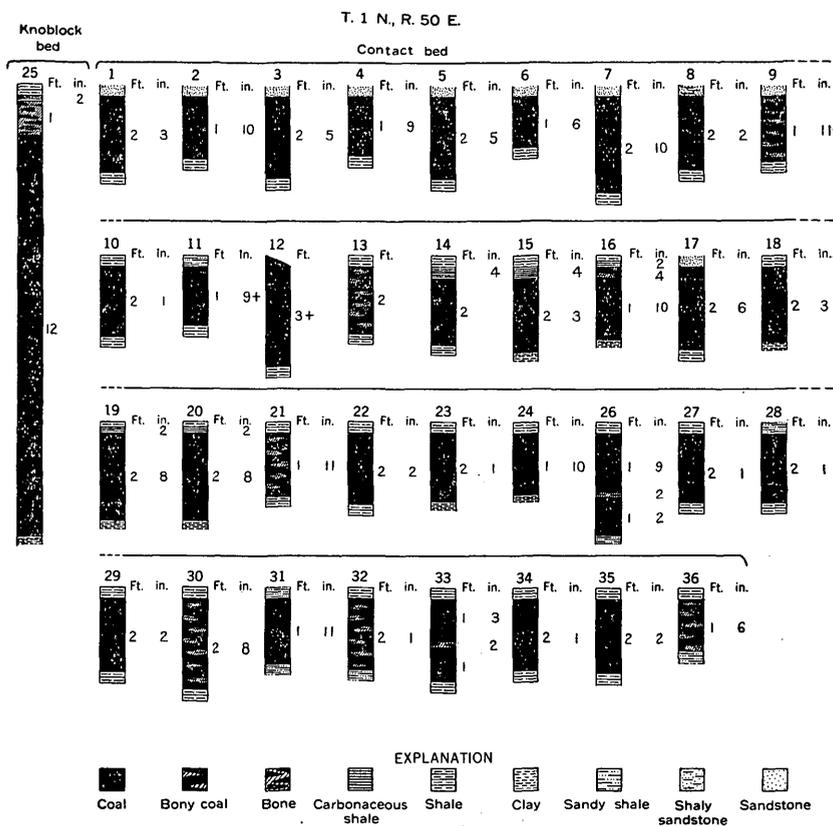


FIGURE 18.—Sections of coal beds in T. 1 N., R. 50 E.

be of value for domestic supply in this locality, but the area is too small to afford a large reserve.

#### T. 1 N., R. 51 E.

Mizpah Creek flows northward through the western part of T. 1 N., R. 51 E. The larger tributaries draining parts of the township are Corral, Horse, and Road Creeks. Areas of flat land adjoin Mizpah Creek, but the remainder of the township is hilly or badland.

Local coal crops out about 40 feet below the Moths bed at localities 8, 13, 19, and 20. At locality 20 there is 3 feet of clean coal, which has been mined for local use, but elsewhere these outcrops are too thin to be of value. The Moths coal bed, about 200 feet below the base of the Tongue River member, is valuable

only in the northern and south-central parts of the township. (See fig. 19.) At locality 9 it contains 2 feet 9 inches of clean coal, with a lower bench of dirty coal over 2 feet thick. The correlation of the Moths bed across Mizpah Creek is somewhat uncertain. Two local outcrops were noted at localities 12 and 22, 70 and 90 feet, respectively, above the Moths bed. The Contact bed, at the base of the Tongue River member, was measured at locality 3, where it contains 1 foot 10 inches of dirty coal. A local bed at approximately the same horizon and probably equivalent to the Contact bed crops out on the hills of the southeastern part of the township. This correlation is suggested in spite of the fact

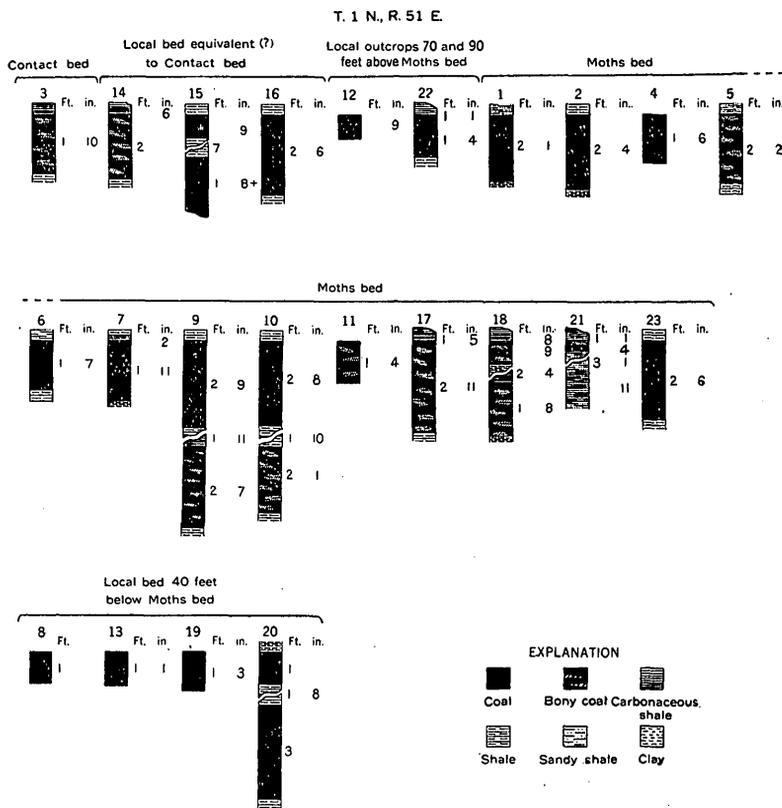


FIGURE 19.—Sections of coal beds in T. 1 N., R. 51 E.

that the strata overlying this bed have the type of lithology common in the somber-colored beds rather than the type characteristic of the Tongue River member. But the change from somber-colored beds to the yellow beds of the Tongue River does not occur at a constant horizon (p. 101), and the absence of the strata of the Tongue River type overlying the coal bed in the eastern part of the township does not necessarily invalidate the correlation. At locality 16 this bed contains 2 feet 6 inches of clean coal, but the bed becomes thinner eastward.

T. 1 N., R. 52 E.

Most of T. 1 N., R. 52 E., is drained by Spring and Corral Creeks, tributaries of Mizpah Creek, and is gently rolling ground with small areas of badlands. Two small areas in the extreme eastern part are drained by tributaries of the

Powder River, and here the surface breaks sharply away on the east side of the divide in a steep erosional escarpment.

The Moths coal bed, in this township about 380 feet below the base of the Tongue River member, which is exposed in T. 2 N., R. 52 E., can be traced with some uncertainty through the northwestern part of the township. Although it contains 4 feet 7 inches of clean coal at locality 20, it varies considerably in purity and in some places is almost entirely replaced by carbonaceous shale. (See pl. 23.) The Snedeker coal bed, exposed in the escarpment in the southeastern part of the township, lies at about the same horizon as the Moths bed, but the two cannot be definitely correlated. It ranges in thickness from 1 foot 3 inches at locality 27 to 3 feet 7½ inches at locality 28. The Carter coal bed occurs about 260 feet below the base of the Tongue River member and about 120 feet above the horizon of the Moths and Snedeker beds in the southeastern part of the township. The isolated outcrops at localities 1, 4, 5, 16, and 24 may belong to this bed. In the southeastern part of the township the thickness ranges from 1 foot 7 inches to 2 feet 8 inches. A local coal bed about 240 feet above the Moths bed, possibly equivalent to the Contact bed west of Mizpah Creek, was measured at locality 29, where it contains 1 foot 5 inches of clean coal. The outcrop at locality 17 occurs near this same horizon.

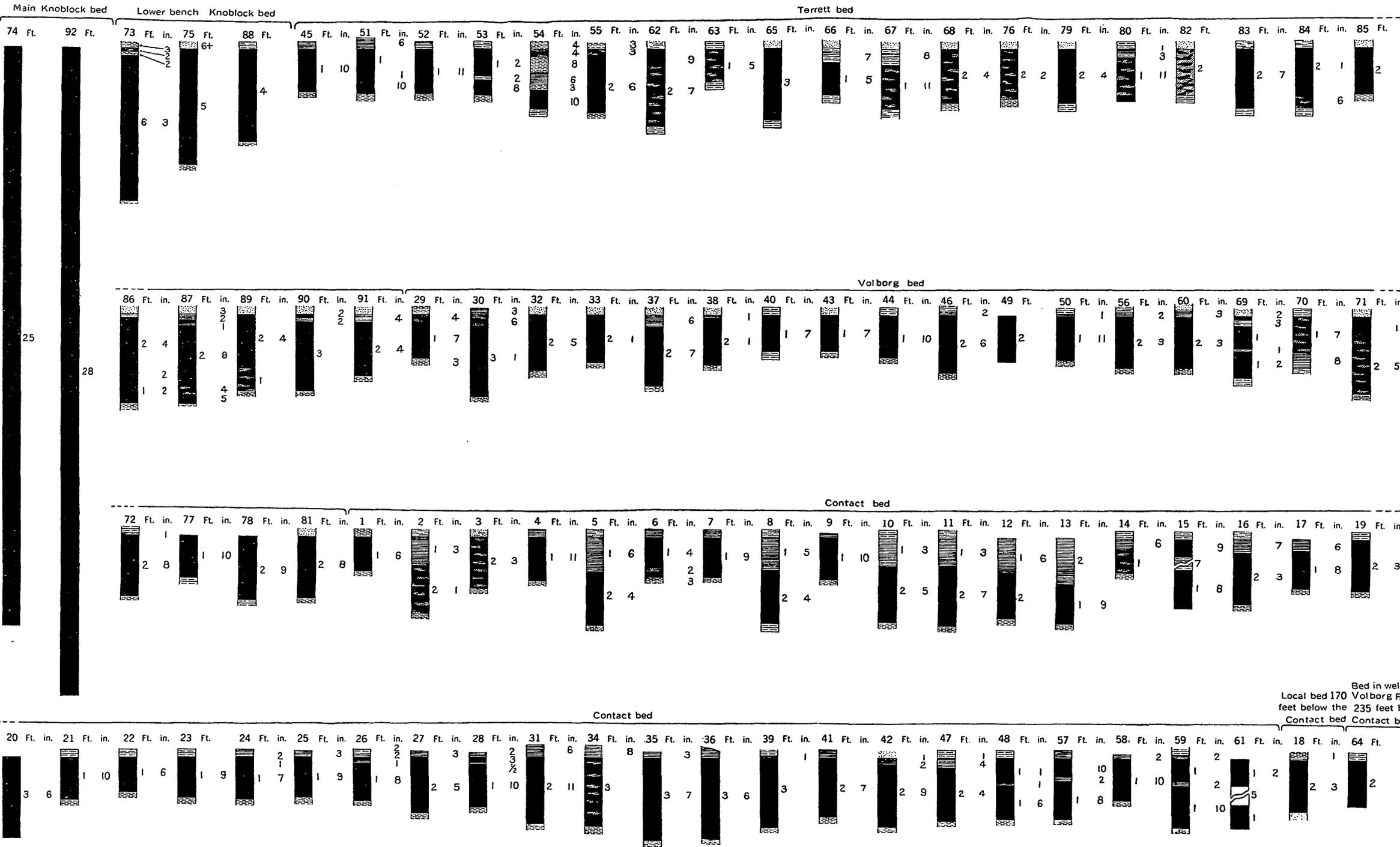
The Moths bed has been mined for local coal supplies at the Moths mine (locality 20) and the Krutzfeldt mine (locality 2; see pl. 21, B) and has been prospected at localities 3, 6, and 7. An analysis of the lower 1 foot 9 inches of this bed at the Krutzfeldt mine shows a heating value of 6,980 British thermal units as mined.

#### T. 1 N., R. 53 E.

The divide between Mizpah Creek and the Powder River trends northward through the western part of T. 1 N., R. 53 E. The west side of this divide is grass-covered and slopes gently westward. On the east this divide breaks sharply away along an erosional escarpment about 300 feet high, at the foot of which the somber-colored beds form badlands over an area from 1 to 2 miles wide. The eastern part of the township is underlain by the sandstone member of the Lance formation, and the surface is rolling and grass-covered, with streams entrenched 20 to 30 feet into the alluvial flat.

The lowest coal found in this township is the Nicholls coal bed, at the base of the somber-colored beds. This coal crops out in the northeastern part of the township but thins out southward and is not recognizable in the southern part of the township. A maximum thickness of 3 feet 7 inches, exclusive of partings, was measured at locality 1. Elsewhere in the northern part of the township it is between 11 inches and 3 feet 1 inch thick. (See pl. 24.) This coal has been strip-mined on a small scale at locality 7, where the coal is of poor quality but easily accessible. Sections of two isolated outcrops of coal low in the somber-colored beds were measured at localities 26 and 40, with 2 feet and 1 foot 8 inches of coal, respectively. No correlation could be made between these coals. A local bed that may be equivalent to the Snedeker bed, about 125 feet above the Nicholls bed, crops out at locality 2, where it has a measured thickness of 2 feet of coal with 8 inches of shale partings. The Snedeker bed, 200 feet above the base of the somber-colored beds and 55 to 60 feet below the Carter bed, crops out in secs. 30 and 31. This bed is thin and has a shale parting near the middle, which further reduces its value. The Carter bed, about 260 feet below the base of the Tongue River member, which crops out in T. 2 N., R. 52 E., is exposed along the east side of the escarpment from sec. 10 southward to sec. 31 and also on the west side of the divide in sec. 18. This bed has a maximum thickness of 4 feet 8 inches of coal at locality 14, but elsewhere in this part of the township its average thickness is about 3 feet. At locality 15 there is a lower bench of 2 feet 8 inches of dirty coal 9 feet

T. 1 N., R. 49 E.



EXPLANATION

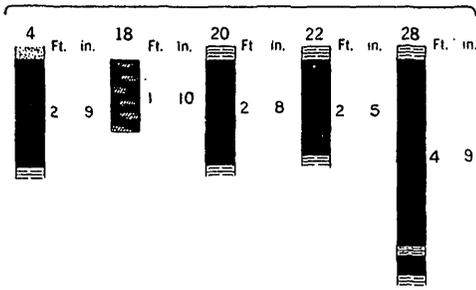
Coal
 Bony coal
 Bone
 Carbonaceous shale
 Shale
 Sandy shale
 Silty sandstone
 Clay
 Sandstone
 Alluvium

SECTIONS OF COAL BEDS IN T. 1 N., R. 49 E.

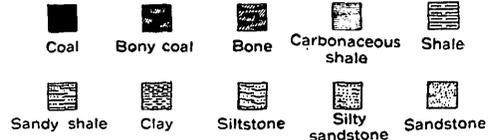


T. 1 N., R. 53 E.

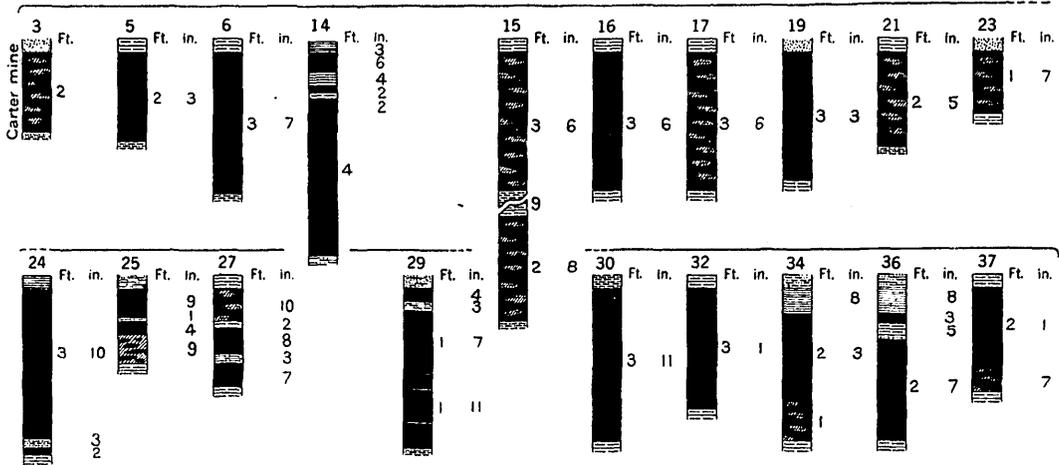
Local bed 22 feet above Carter bed



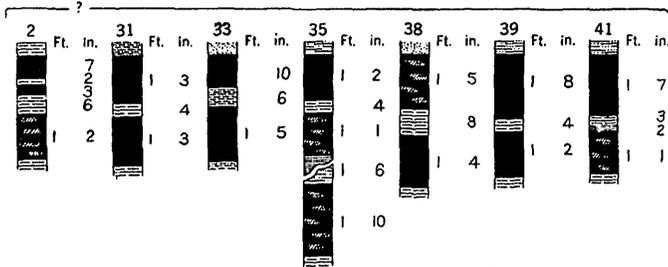
EXPLANATION



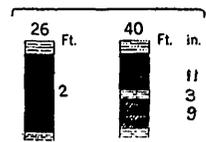
Carter bed



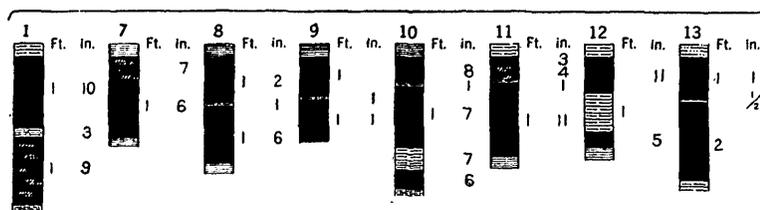
Snedecker bed



Uncorrelated local outcrops above Nicholls bed



Nicholls bed



SECTIONS OF COAL BEDS IN T. 1 N., R. 53 E.

below the main bed. A bed about 22 feet above the Carter bed crops out locally on the east side of the high divide in secs. 9, 17, 20, and 29. This coal was not found on the west side of the divide in the grass-covered slopes. Measured sections show a maximum thickness of 5 feet 3 inches of coal at locality 28.

The Carter coal bed has been mined at locality 3 (the Carter mine) and locality 25. At both of these places the coal is obtained for local use by small-scale strip mining along the cut banks of the stream, only 9 inches of the bed being mined at locality 25. Where it crops out on the east side of the escarpment this coal, though thicker, is difficultly accessible. The local coal 22 feet above the Carter bed has been prospected at locality 28 but is difficultly accessible by a very poor wagon road from the east. A better road from the west leads to the crest of the escarpment above the mine proper, but the coal would have to be raised about 50 feet up a steep hill to the head of the road.

T. 1 N., R. 54 E.

Only the part of T. 1 N., R. 54 E., that lies west of the Powder River is included in the Mizpah field. Alluvium, which fills much of the valley of the Powder River to a depth of 30 feet and extends for a short distance up some of the larger tributaries, forms the surface of much of the township. In the northwestern part of the township the upper 200 feet of the sandstone member of the Lance formation crops out on the gently rolling interstream areas.

The Nicholls bed, at the base of the somber-colored beds, is the only coal exposed in this township, and its outcrop barely enters the west side of secs. 6 and 7 for a few hundred feet. No coals

are known in the exposed portions of the sandstone member, and wells drilled in the Powder River Valley did not penetrate a thick bed.

T. 2 N., R. 49 E.

Pumpkin Creek and its tributaries—Cottonwood, Betts, and Nine Sixty-nine Creeks on the west and Broughton, Road, and Harris Creeks on the east—drain most of T. 2 N., R. 49 E. A small area near the southeast corner is drained by Sand Creek. The southeastern part of the township is rugged, consisting of clinker-capped mesas, steep-walled valleys, and areas of badlands. In the northeastern part of the township sharp clinker-capped peaks rise about 200 feet above the rolling uplands. Small areas of flat agricultural land border Pumpkin Creek.

The Contact bed, at the base of the Tongue River member of the Fort Union formation, crops out in the hills on both sides of Pumpkin Creek and is traceable for

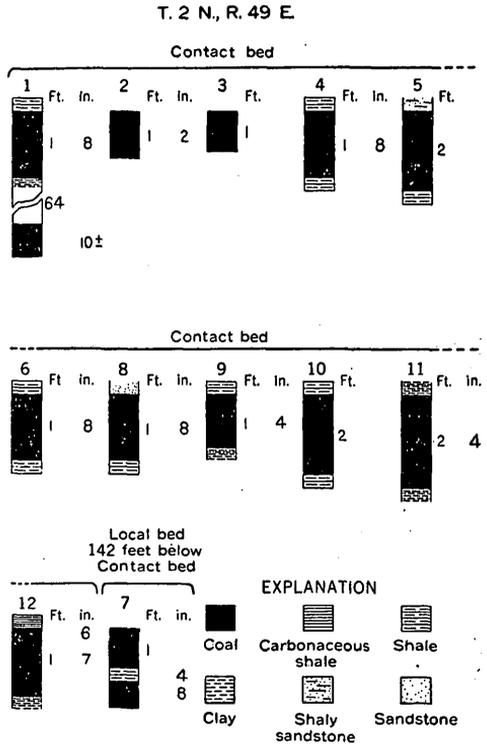


FIGURE 20.—Sections of coal beds in T. 2 N., R. 49 E.

considerable distances, although it is not persistent throughout the township. (See fig. 20.) It reaches a maximum thickness of 2 feet 4 inches at locality 11. The Knoblock bed, 120 to 160 feet above the base of the Tongue River member, is burned out in this township and is represented by thick masses of clinker capping the highest hills in the southeastern and western parts of the township.

#### T. 2 N., R. 50 E.

Most of T. 2 N., R. 50 E., is drained by Sand Creek, which flows northeastward into Mizpah Creek. The northwestern part of the township is drained by Anderson Creek, which flows northwestward into Pumpkin Creek. Parts of secs. 25, 26, 35, and 36 are drained by a short tributary of Mizpah Creek. Most of the surface of the township consists of gently rolling grass-covered slopes broken in places by gullies and small badland areas, but in the western part there is a high pine-covered ridge with mesalike hills capped by the clinker of the Knoblock coal bed.

A local bed about 40 feet below the Moths bed in sec. 13 is 1 foot 5 inches thick at locality 8 and 1 foot 4 inches thick at locality 9. (See pl. 25.) A bed on Anderson Creek, which may be equivalent to the Hercules bed in T. 3 N., R. 50 E., contains 1 foot 10 inches of coal at locality 2 but is thin and impure at most other exposures. The Moths bed, about 200 to 250 feet below the base of the Tongue River member of the Fort Union formation, crops out along Sand Creek in the eastern part of the township. The maximum thickness was measured at localities 19 and 20, where the bed consists of two and three benches, respectively. The combined total thickness of coal at locality 19 is 4 feet 5 inches, and at locality 20 an upper bench 1 foot 11 inches thick is separated from a lower bench 2 feet 3 inches thick by 7 feet 6 inches of sand and shale. This bed elsewhere in the eastern part of the township is usually about 2 feet thick, with a minimum thickness of 1 foot of dirty coal at locality 4. The Contact coal bed, at the base of the Tongue River member of the Fort Union formation, crops out in the western part of the township and in isolated outliers in secs. 10, 35, and 36. The maximum thickness measured was 3 feet 2 inches at localities 13 and 18. In this township this coal has an average thickness of about 2 feet, except in the extreme western and southwestern parts, where it thins out. The Volborg coal bed, about 40 feet above the base of the Tongue River member, crops out in the southwestern part of the township with a maximum thickness of 2 feet 3 inches at locality 27. The Knoblock coal bed, 120 to 160 feet above the base of the Tongue River member, has been burned out and forms massive clinkers in the western portion of the township.

At localities 19 and 20 the Moths coal bed has been mined by Willys Jones and other inhabitants of the surrounding region by stripping the overburden along the stream bed. The Contact coal is in most places of fair quality and could be easily mined.

#### T. 2 N., R. 51 E.

T. 2 N., R. 51 E., is drained by Mizpah Creek and its tributaries, Sand, Lindsay, and Spring Creeks. Adjacent to these larger creeks the surface is flat or gently rolling, but farther from them the surface is more hilly and in the northeastern part of the township is intricately dissected into badlands.

The Mizpah coal bed, about 120 feet below the Elmhurst bed, does not crop out in this township but probably lies a few feet beneath the level of the bed of Mizpah Creek in the northern part of the township and, to judge from a measurement in sec. 33, T. 3 N., R. 51 E., may exceed 2 feet in thickness. The Elmhurst bed crops out in the valleys of Mizpah Creek and its tributaries. At locality 23 this bed contains 6 feet of clean coal exclusive of partings, and through the northeastern part of the township the average thickness is between 4 and 5 feet. (See pl. 26.)

The Moths coal bed, 70 feet above the Elmhurst bed and cropping out in about the same parts of the township, reaches a maximum thickness of 6 feet at locality 12 and is between 3 and 4 feet thick through most of the northeastern part of the township. In the southwest corner of the township the Moths bed lies about 200 feet below the base of the yellow Tongue River strata, but at the east boundary, owing to the rise of somber-colored beds, the Moths bed lies more than 300 feet below the base of the yellow Tongue River beds. At localities 62 and 63, in the southern part of the township, this bed has a lower bench 5 feet and 9 feet respectively below the upper member of the bed. A local bed at locality 19 contains 3 feet 5 inches of coal, exclusive of shale, but thins rapidly in all directions from this place. It is about 130 feet above the Moths bed.

Roads up Lindsay Creek or Elmhurst Creek would reach both the Elmhurst and the Moths beds in the region of their greatest thickness, in the northeastern part of this township. As there are no very thick beds at accessible places in the surrounding region, these two beds might constitute a convenient source of coal for local use.

T. 2 N., R. 52 E.

Although a considerable area in the southeastern part of T. 2 N., R. 52 E., is gently rolling and is suitable for farming, this township has a greater relief than any other in the Mizpah field. Maxwell Butte, in sec. 20, rises to an altitude of 3,704 feet above sea level and is bordered on the north, west, and south by steep slopes and intricate badland areas. The northern part and most of the eastern part of the township are drained by Elmhurst Creek, and the southern part by Spring Creek. Small areas along the eastern margin are drained by tributaries of Ash Creek.

The Elmhurst coal bed, 60 to 100 feet below the Moths bed, crops out along Elmhurst Creek in the northern part of the township. At locality 21 it contains 6 feet of clean coal, but elsewhere it is thinner and in most localities contains impurities. (See pl. 27.) The Moths coal bed, 290 to 380 feet below the base of the Tongue River member, crops out in the valleys of Elmhurst and Spring Creeks. At locality 34 it contains 4 feet 8 inches of clean coal split by several partings. The bed contains between 2 and 3 feet of coal in the western part of the township, but eastward it is impure and thin. The Dead Horse coal bed, possibly equivalent to the Moths bed, crops out on the east side of the Powder River-Mizpah Creek divide in secs. 1 and 12. Its average thickness is about 1 foot 6 inches, but it contains 2 feet 4 inches of clean coal at locality 1. A local bed crops out about 50 feet above the Moths bed north of Elmhurst Creek, and for a distance of about 1 mile along the outcrop it contains about 2 feet of coal, reaching a maximum thickness of 2 feet 3 inches at locality 45. The local bed measured at locality 50 may be equivalent to the two isolated outcrops measured at localities 2 and 48. Except for a short distance near locality 50, it does not exceed 1 foot 5 inches in thickness. The Knoblock bed, which in this township is at the base of the Tongue River member, crops out in the vicinity of Maxwell Butte and along the ridge in the central part of the township. The coal is almost entirely burned out and is represented by massive clinker capping the hills. Measurements of thickness at localities 53, 54, and 55 show variations from 2 feet 7 inches to 12 feet. A local coal bed about 60 feet above the base of the Tongue River member was measured at localities 52 and 56 but is commonly burned at the outcrop, perhaps because of its proximity to the burned-out Knoblock bed. A bed about 310 feet above the base of the Tongue River member has burned out to form the massive clinker capping Maxwell Butte.

T. 2 N., R. 53 E.

Most of T. 2 N., R. 53 E., is drained by Ash Creek and its tributaries, Jim Mays, Dead Horse, and Mills Creeks. A small strip along the eastern border

is drained by tributaries of the Powder River, and small areas along the western border are drained by Elmhurst and Spring Creeks. An eastward-facing escarpment 100 to 250 feet high is a prominent feature of the western part of the town-

T. 2 N., R. 53 E.

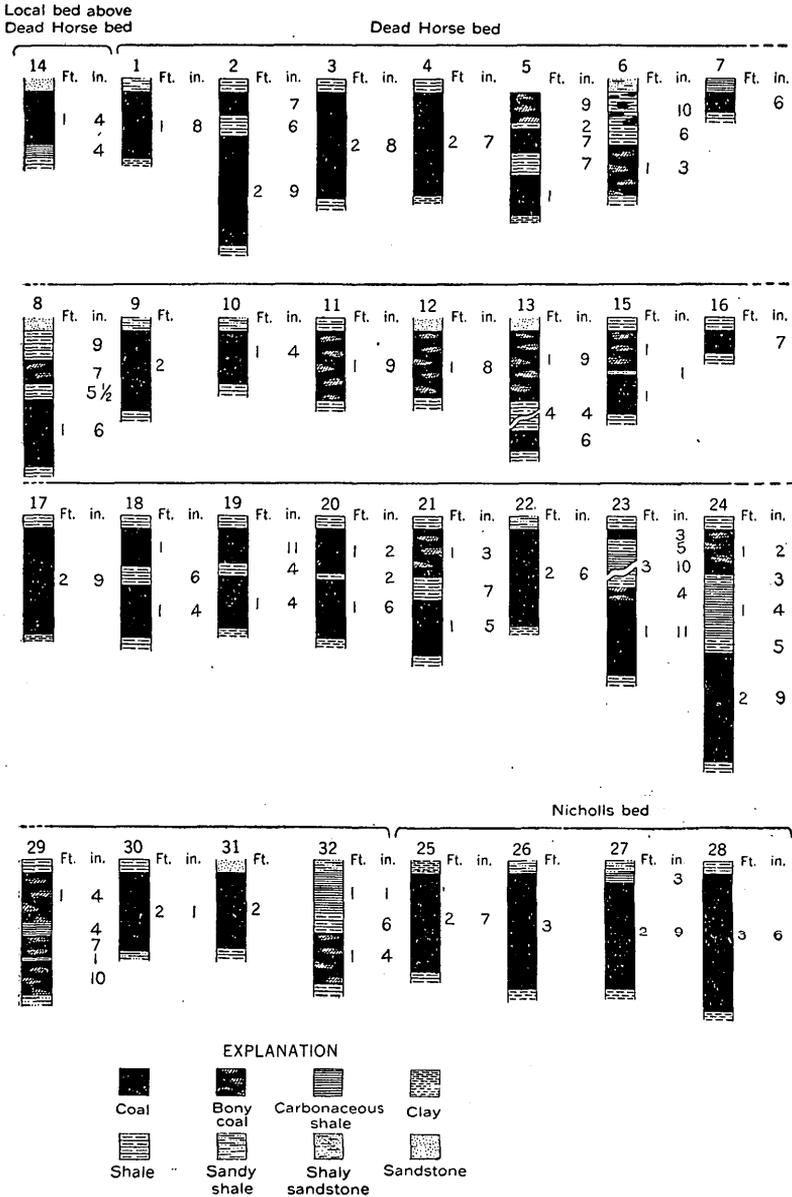
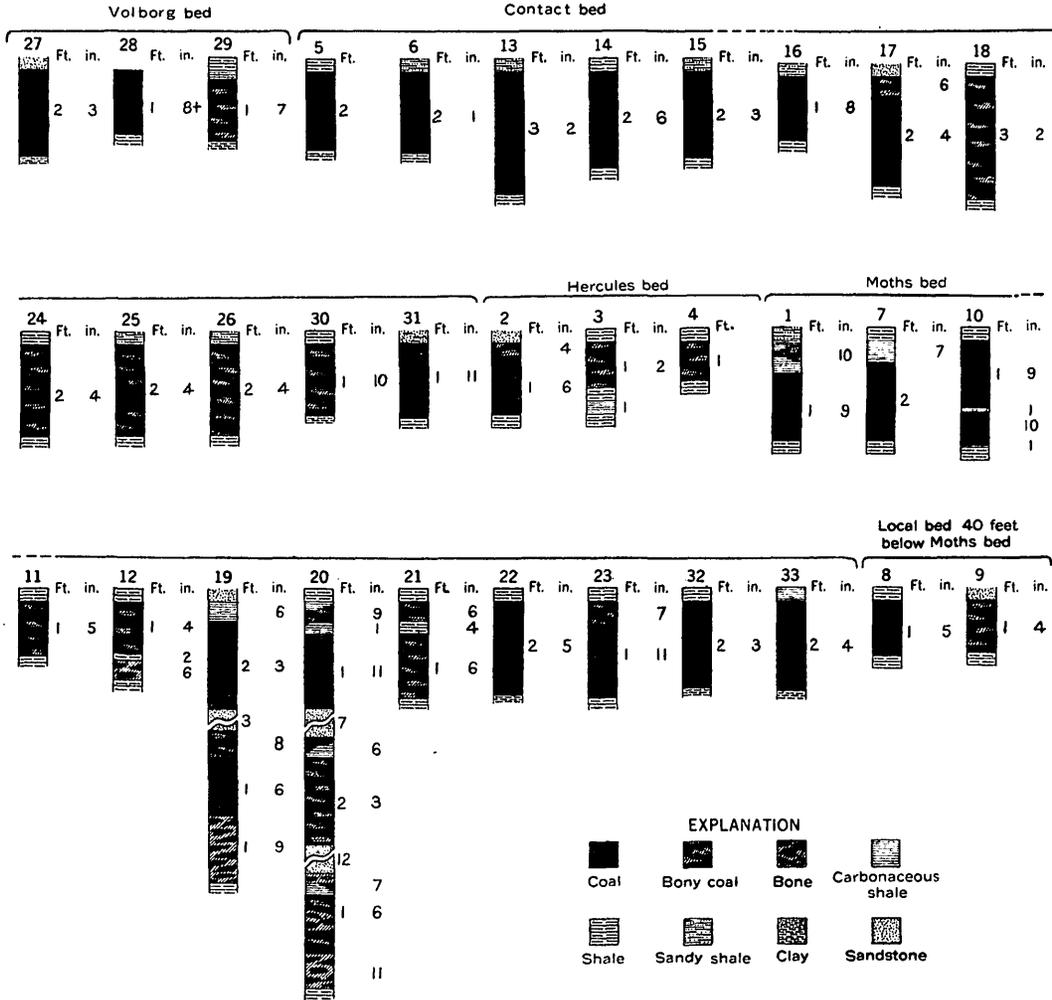


FIGURE 21.—Sections of coal beds in T. 2 N., R. 53 E.

ship. The remainder of the township consists principally of rolling land locally interrupted by small badland areas.

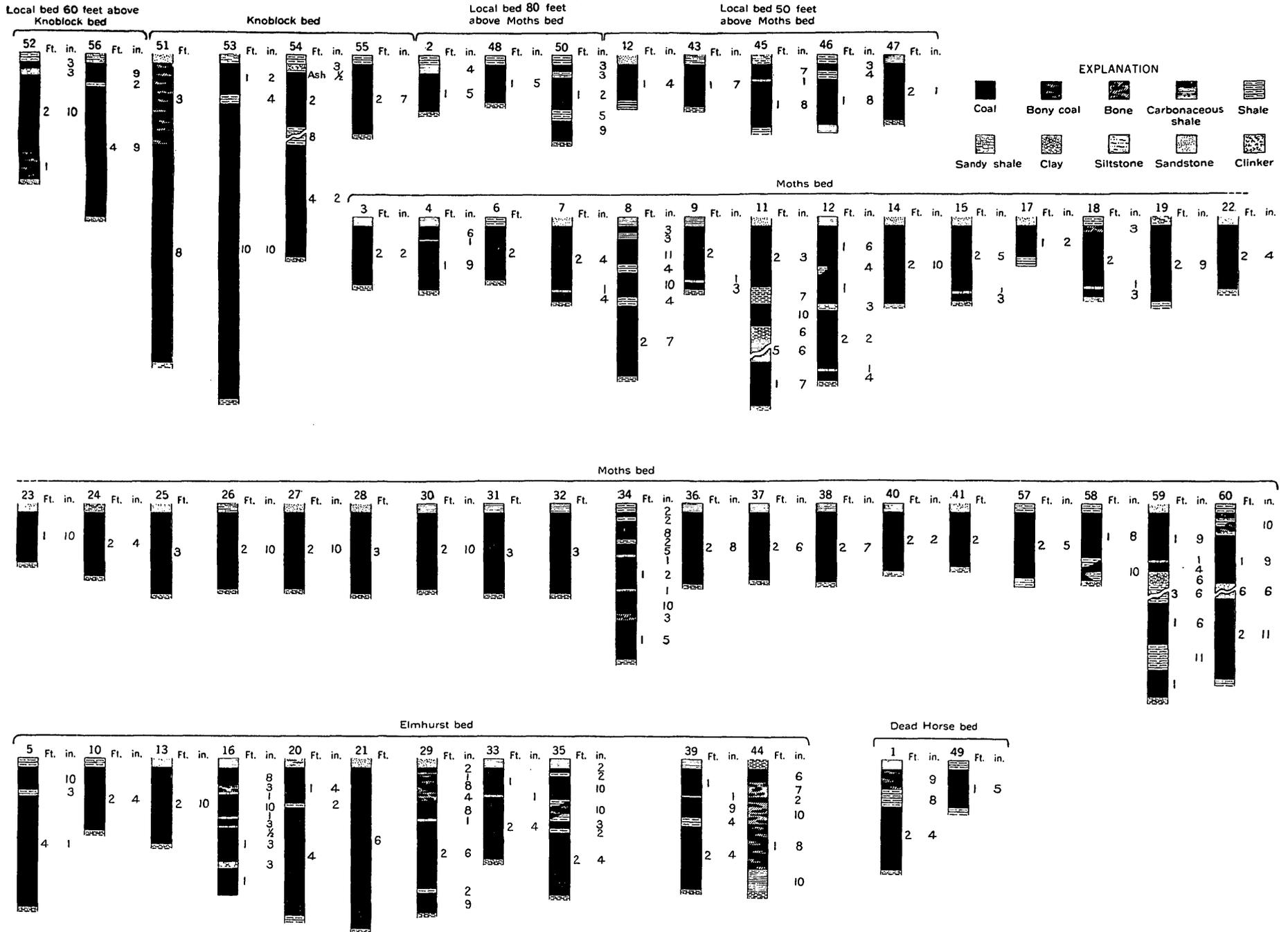
The Nicholls coal bed, at the base of the somber-colored beds, crops out in the southeastern part of the township in the valley of the Powder River. It is 2 feet

T. 2 N., R. 50 E.



SECTIONS OF COAL BEDS IN T. 2 N., R. 50 E.





SECTIONS OF COAL BEDS IN T. 2 N., R. 52 E.

7 inches to 3 feet 6 inches thick at localities 25 to 28 (see fig. 21), but both northward and southward from these localities the bed thins, and in the northeastern part of the township it is absent. The Dead Horse coal bed, about 200 feet above the base of the somber-colored beds, crops out in the escarpment in the western part of the township and on some of the highest hills in the central part. At locality 2 this bed contains 3 feet 4 inches of clean coal with a 6-inch parting, but the bed is variable and in many places is entirely worthless. A thin local bed 40 feet above the Dead Horse bed crops out in secs. 18 and 19 and was measured at locality 14.

T. 2 N., R. 54 E.

T. 2 N., R. 54 E., includes gently rolling hills and broad stream valleys in its western part and extends eastward onto the Powder River alluvial plain. Only the portion of the township west of the Powder River is included in the Mizpah field. The township is drained by the Powder River, and most of the smaller tributaries flow out onto the alluvial terrace and have no well-defined channels connecting across the alluvium with the river proper.

The sandstone member of the Lance formation is barren of valuable coals in this region. The Nicholls coal bed, at the base of the somber-colored beds, crops out on the hills of the southwestern part of the township. At localities 1 and 2 it contains 2 feet 7 inches and 2 feet 6 inches of coal, respectively. (See fig. 22.) Farther north, where beds at the same horizon are exposed, the coal is absent.

T. 3 N., R. 50 E.

Deer and Anderson Creeks, tributaries to Pumpkin Creek, drain most of the surface of T. 3 N., R. 50 E. A small area in the northern part of the township is drained by Fourth Creek, and some of the eastern part is drained by tributaries of Mizpah Creek. The part of the township near the divide between Mizpah and Pumpkin Creeks and the part north of Deer Creek are rugged and broken by badlands, but much of the remainder of the township is smooth rolling land.

The Hercules coal bed, 250 to 300 feet below the base of the Tongue River member, crops out in the Deer Creek Valley and has a maximum thickness of 4 feet 9 inches at locality 18 with a bench 2 feet 11 inches thick 19 feet below it. (See pl. 28.) This bed where exposed elsewhere exceeds 18 inches in thickness only in secs. 10, 11, 15, 22, and 23 and is generally very impure. In the central part of the township there is a bench 14 to 27 feet below the main Hercules bed. The thin bed that crops out at localities 34 and 35, in the Anderson Creek Valley, lies at the same horizon as the Hercules bed. The Divide bed, 150 to 200 feet below the base of the Tongue River member, can be readily traced in the northern part of the township but thins out in the central and eastern parts. It has a maximum thickness, exclusive of partings, of 3 feet 3 inches at locality 6. A bed near this horizon is exposed at locality 46. A local bed about 40 feet below the horizon of the Divide bed is exposed at localities 31, 32, and 47. It is as much as 2 feet 10 inches thick but contains only impure coal. A local bed above the horizon of the Divide bed and about 140 feet below the base of the Tongue River member is exposed at localities 37 and 42. It contains clean coal but is not over 1 foot 3 inches in thickness. The Contact bed, at the base of the Tongue River member, crops out near the base of the prominent buttes in the southeastern part of the township. Although this bed contains 1 foot 11 inches of clean coal at locality 36, it is thin or contains only impure coal elsewhere and was mapped principally to show the base of the Tongue River member. A bed 30 feet above the Contact bed contains a maximum of 2 feet 2 inches of coal at locality 33, but the coal in this bed is dirty at all exposures in this township. The clinkers and ash of a bed

about 130 feet above the Contact bed cap the highest hills of the southeastern portion of the township. This may be the equivalent of the Knoblock bed, but the coal is entirely burned out in this township.

T. 3 N., R. 51 E.

Mizpah Creek flows northward through a wide valley in the central part of T. 3 N., R. 51 E. Adjacent to the creek the land is flat and open, but on valley slopes there are many coulees and small areas of badland. Several gravel terraces occur at various levels on the ridges west of Mizpah Creek.

The Mizpah coal bed crops out locally along Mizpah and Elmhurst Creeks, but through most of the township the bed, if continuous, is covered by alluvium. At locality 27 it contains over 4 feet 3 inches of coal, but elsewhere it is probably much thinner. (See pl. 29.) The Elmhurst-Hagen bed, 120 feet above the Mizpah bed, is discontinuous, and the correlation from point to point is uncertain. Coal outcrops were found at many localities near that horizon, but the bed is continuous and of valuable thickness only in the northwestern part of the township. The Hercules bed, about 50 to 70 feet above the Elmhurst-Hagen bed, crops out on both sides of Mizpah Creek, but the correlation between the various

outcrops is uncertain. The bed contains a maximum of 3 feet 7 inches of clean coal at locality 20 and contains over 2 feet of coal at several other localities. A local bed 15 to 20 feet below the Hercules bed occurs in the southeastern part of the township. The Moths bed, 40 to 60 feet above the Hercules bed, crops out in the highest hills of the southeastern part of the township. It contains only 2 feet 9 inches of clean coal at the most favorable locality. The

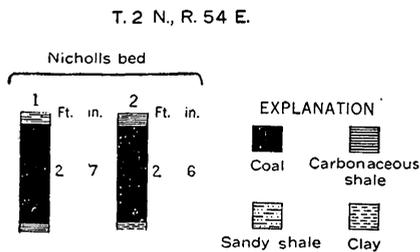


FIGURE 22.—Sections of coal beds in T. 2 N., R. 54 E.

Divide coal bed, about 100 feet above the Hercules, crops out in the northwestern part of the township. A bed cropping out in the southwestern part of the township at localities 57, 59, and 60 may be equivalent to the Divide bed. The coal in the Divide bed is impure in most localities, and the bed is nowhere more than 3 feet thick. There are numerous local coal outcrops in the southwestern part of the township between the Hercules and Divide beds. These outcrops are grouped into beds as follows: A bed 35 to 45 feet above the Hercules bed occurs at localities 15, 34, 36, 53, and 61; a bed 50 feet above the Hercules bed occurs at localities 52 and 55; a bed 70 feet above the Hercules occurs at localities 51, 54, 56, and 58

T. 3 N., R. 52 E.

The high serrate ridge that forms the divide between Mizpah Creek and the Powder River lies in the eastern part of T. 3 N., R. 52 E. East of the divide the surface is dissected into impassable badlands, but west of the divide the badland areas are less rugged, and there are small areas of flat land near the creeks.

The Monarch coal bed, 100 to 150 feet above the base of the somber-colored beds, crops out in the lowest valleys along the eastern border of the township. This bed and, in fact, all the other beds of this township contain pure coal only in a very few localities. (See pl. 30.) The Monarch bed probably underlies the northeastern part of the township with an average thickness of about 2 feet. The Elmhurst bed may be represented by the outcrops at localities 9, 62, and 65, but there is no evidence that these outcrops are connected. The Hercules bed, about 120 feet above the Monarch bed in this township, consists of one to three benches. The middle and upper benches are nowhere more than 5 feet

apart and are shown together on the map in the eastern part of the township. The lower bench, being locally thicker, is mapped in the western part. The Moths coal bed, 25 to 60 feet above the Hercules bed, crops out on the ridge in the southern part of the township but thins out to the north and east. The Bear Jaw bed, in the northeastern part of the township, is probably a little above the horizon of the Moths coal bed. A local bed that may correspond to the Dead Horse bed, which was mapped in the townships to the south and southeast, crops out locally in the southeastern part of this township, at about the same horizon as the Moths bed in the central southern part. The local outcrops at localities 53 and 71 may correspond to the Bear Jaw bed.

**T. 3 N., R. 53 E.**

The wide valley of Ash Creek trends northward through the central part of T. 3 N., R. 53 E., and the Powder River crosses the northeast corner of the township. Areas of flat land lie adjacent to Ash Creek, but much of the remainder of the township is deeply dissected, and along the western border there are many badland areas.

The Kitty Springs bed occurs at the base of the somber-colored beds in the northern and northeastern portions of the township but thins out and disappears south of sec. 23. The Kitty Springs bed usually contains impure coal (see pl. 31) and was mapped principally to mark the contact between the sandstone member of the Lance and the somber-colored beds. In the eastern part of the township a bed 90 to 130 feet above the Kitty Springs bed is thick enough locally to have burned out, forming clinker layers. At locality 25 this bed contains 4 feet of clean coal. The Monarch bed, 100 to 150 feet above the Kitty Springs bed, crops out in the northwestern part of the township but thins southward and eastward. It contains 3 feet 7 inches of clean coal at locality 29. The coal outcrops at localities 30, 35, and 36 may belong to this bed. The Hercules bed, 200 to 250 feet above the Kitty Springs bed, is 3 feet 7 inches thick at locality 10, but to the south and east it is thin or impure. The bed that occurs on the hills in the southwestern part of the township at localities 32, 33, and 34 may be the equivalent of the Hercules bed or of the Dead Horse bed, which crops out in T. 2 N., R. 53 E.

**T. 3 N., R. 54 E.**

The Powder River forms the eastern boundary of the part of T. 3 N., R. 54 E., that is included in the Mizpah field. The alluvial plain and terraces of the Powder River occupy most of this part of the township. No coal beds of value crop out in this township, but a local bed about 120 feet above the base of the somber-colored beds has burned out, leaving a clinker capping the hills in the western part of sec. 30.

**T. 4 N., R. 50 E.**

T. 4 N., R. 50 E., is drained by Pumpkin Creek, which flows north through the western part of the township, and its tributaries, Third, Fourth, and Deer Creeks. The portion of the township lying east of the Pumpkin Creek flats is a part of the Mizpah-Pumpkin Creek grazing district. The western half of this township, bordering Pumpkin Creek, is nearly flat lowland, but the eastern half is a region of intricate badland topography.

A local coal bed about 500 feet below the base of the yellow Tongue River member of the Fort Union formation crops out in the banks of Pumpkin and Third Creeks in sec. 6. However, at localities 54 and 55 is it of poor quality. (See pl. 32.) The Lower Hagen coal bed, about 280 feet below the base of the Tongue River member, crops out in secs. 3 and 4. It contains 2 feet 5 inches of clean coal at locality 37 but is thin or impure elsewhere. The Hagen coal bed, about

30 feet above the Lower Hagen bed, is so variable in thickness and quality that it was not mapped continuously in this township. This bed contains 3 feet 2 inches of clean coal with a 1-inch shale parting at locality 57, but other measurements show variations from 1 foot 6 inches of carbonaceous shale with streaks of coal to 4 feet 8 inches of dirty coal. The Hercules bed, about 70 feet above the Hagen bed, though variable in thickness and quality, can be found wherever its horizon is exposed in this township. At locality 164 the bed contains 6 feet 3 inches of clean coal with a 5-inch shale parting near the middle and a local bed, 3 feet 2 inches thick, 10 feet below. In the northern part of the township this bed at many places contains 3 to 4 feet of clean coal. The Divide coal bed, about 110 to 200 feet below the base of the Tongue River member and 60 to 130 feet above the Hercules bed, crops out on the hills and ridges of the eastern part of the township. A maximum observed thickness of 3 feet 11 inches of clean coal was noted at locality 109, and many outcrops were found where the bed contains more than 2 feet 6 inches of clean coal. In other places the bed is thin or replaced by carbonaceous shale, or it may be entirely cut out by channel sandstone. A local bed 40 feet above the Hercules, with three benches, the uppermost containing 3 feet 8 inches of clean coal, was observed at locality 168, but no valuable coal bed could be found at this horizon elsewhere in the township.

The strata in secs. 1, 2, 11, and 12 are slightly warped to form a dome with a closure of 50 feet. This warping may be superficial, not persisting to great depths.

#### T. 4 N., R. 51 E.

Mizpah Creek flows northward through a wide valley in the eastern part of T. 4 N., R. 51 E. The surface rises westward through an area of sharp ridges and trenched creek valleys, to the divide between Mizpah Creek and Pumpkin Creek, which lies near the west side of the township. An area of badland hills in the southeastern part of the township is marked by thin red clinker beds. Gravel deposits cap a few of the ridges between the tributary streams adjacent to the valley of Mizpah Creek.

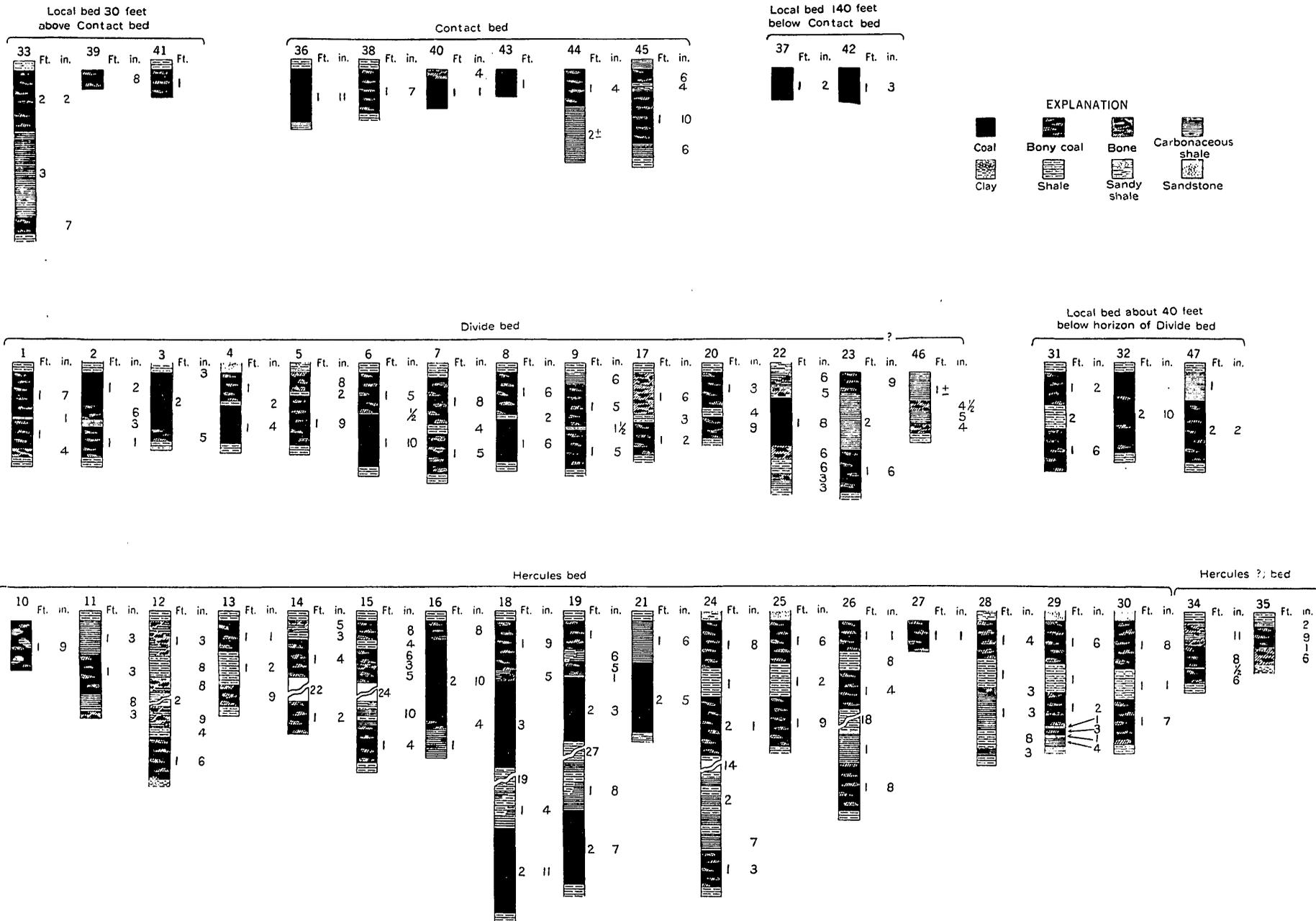
The Mizpah bed occurs near the level of the alluvial flat of Mizpah Creek and is covered by alluvium through most of its extent. The four measurements made on this bed show an average thickness of less than 3 feet of impure coal. (See pl. 33.) The Elmhurst-Hagen bed, 90 to 120 feet above the Mizpah bed, crops out in the creek valleys west of Mizpah Creek and in a small area in the southeastern part of the township. It reaches a thickness of 4 feet 2 inches at locality 27, but here and at most other outcrops the coal is impure. A bench 8 to 15 feet below the Elmhurst-Hagen bed occurs in the northern part of the township. The Hercules bed, 50 to 70 feet above the Elmhurst-Hagen bed, is exposed at widely scattered localities but appears to be discontinuous. This bed is most prominent in the northern part of the township, where it has a maximum thickness of 3 feet 4 inches of clean coal at locality 7 and thins southward, but it thickens again in secs. 21, 22, 28, and 30. The horizon of this bed is exposed in secs. 20, 29, and 32, but the coal is replaced by carbonaceous shale. The Divide bed, 60 to 80 feet above the Hercules bed, crops out along the divide between Mizpah Creek and Pumpkin Creek. This bed is impure and thin through most of its extent in this township, but for short distances it thickens, as at localities 33, 35, and 40.

The strata in the northwestern part of this township are slightly bowed up to form a low anticline or dome with a closure of 20 to 50 feet. This feature may not persist with depth so is unlikely to be a source of petroleum or natural gas.

#### T. 4 N., R. 52 E.

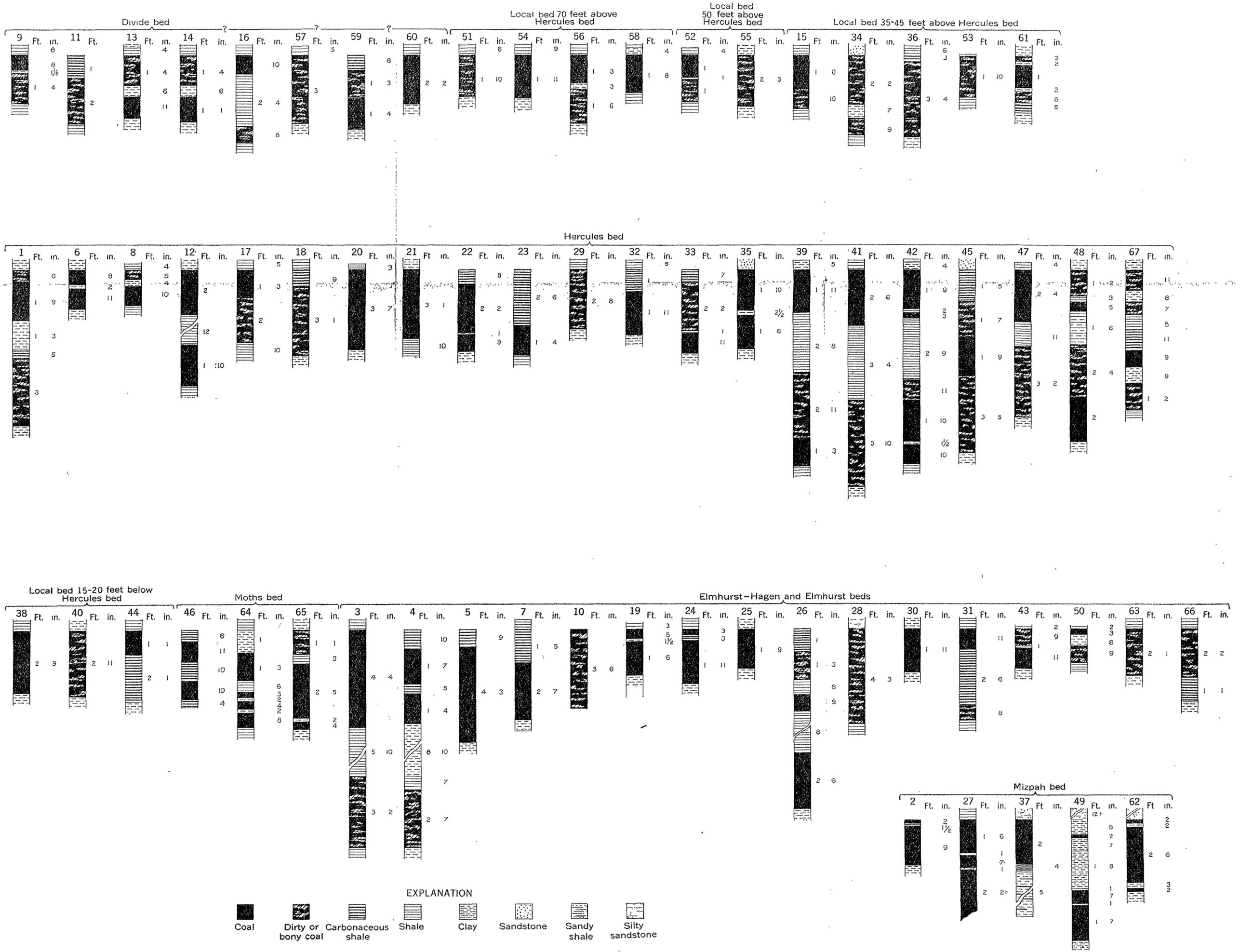
A high serrate ridge that forms the divide between Mizpah Creek and the Powder River trends northward through the east-central part of T. 4 N., R. 52 E.

T. 3 N., R. 50 E.



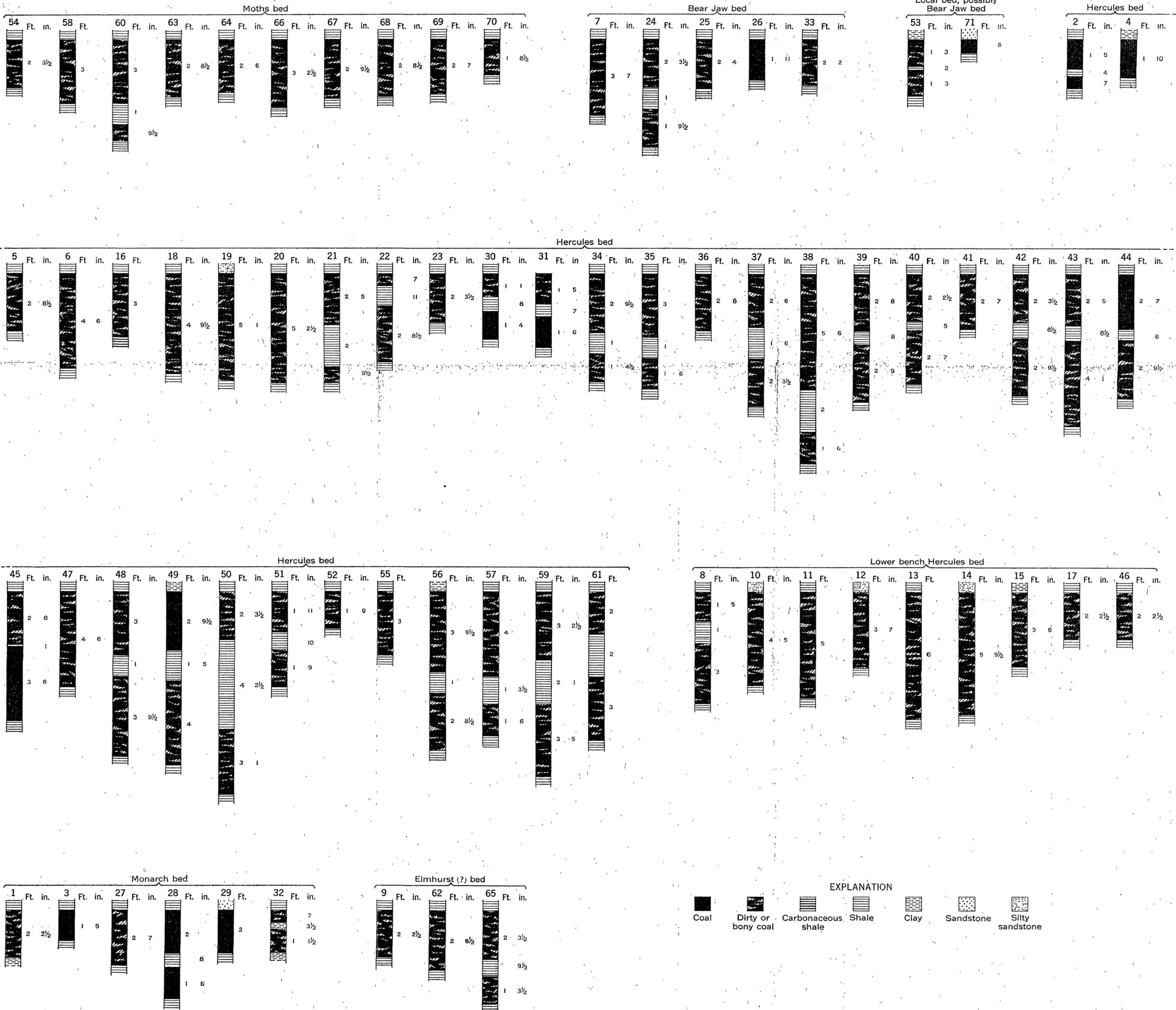
SECTIONS OF COAL BEDS IN T. 3 N., R. 50 E.

T. 3 N., R. 51 E



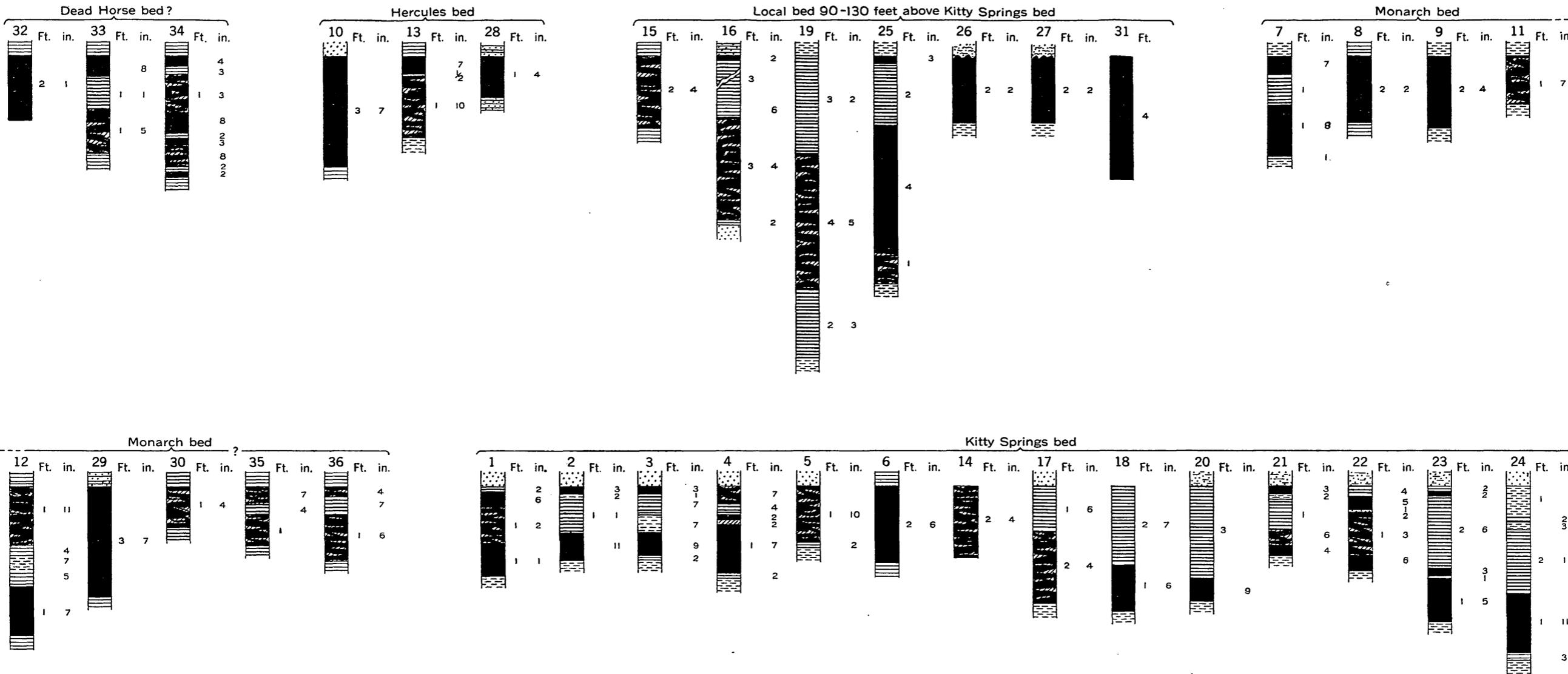
SECTIONS OF COAL BEDS IN T. 3 N., R. 51 E.

T. 3 N., R. 52 E.



SECTIONS OF COAL BEDS IN T. 3 N., R. 52 E.

T. 3 N., R. 53 E.

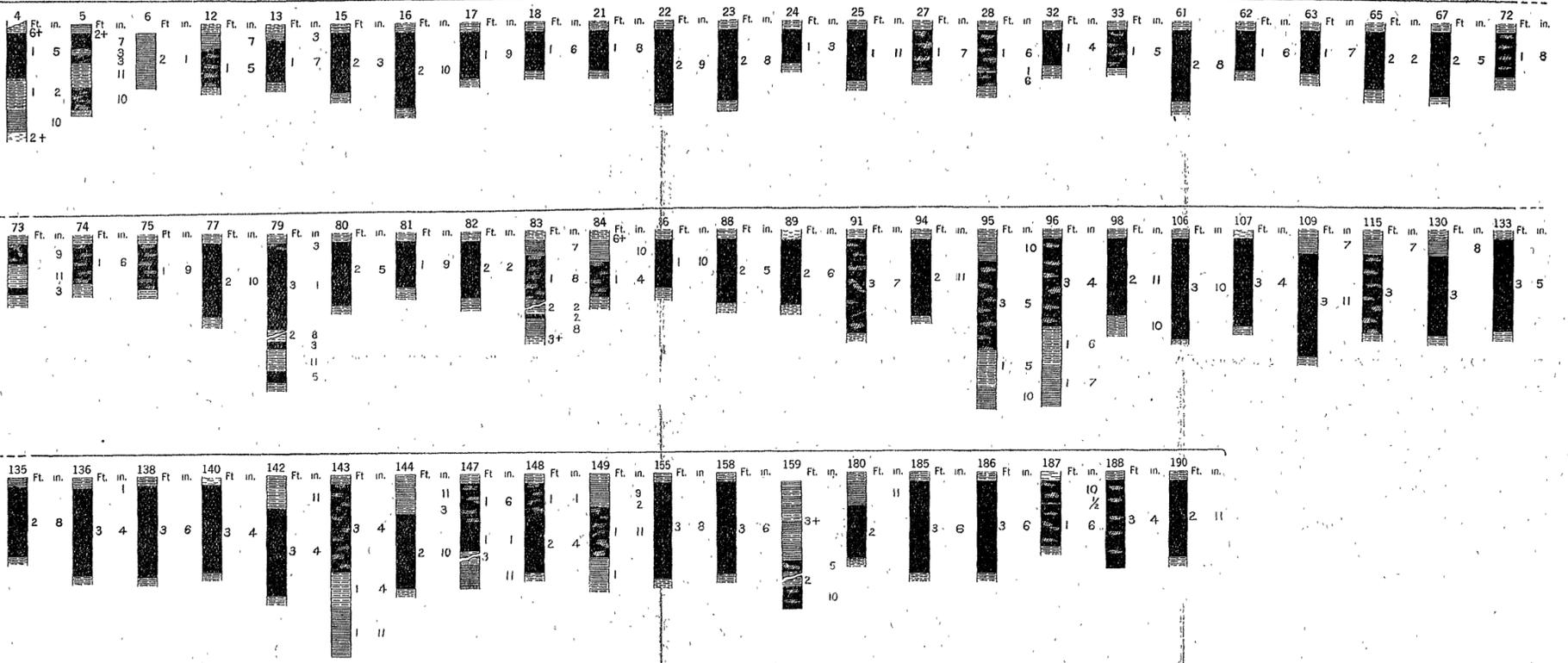


EXPLANATION

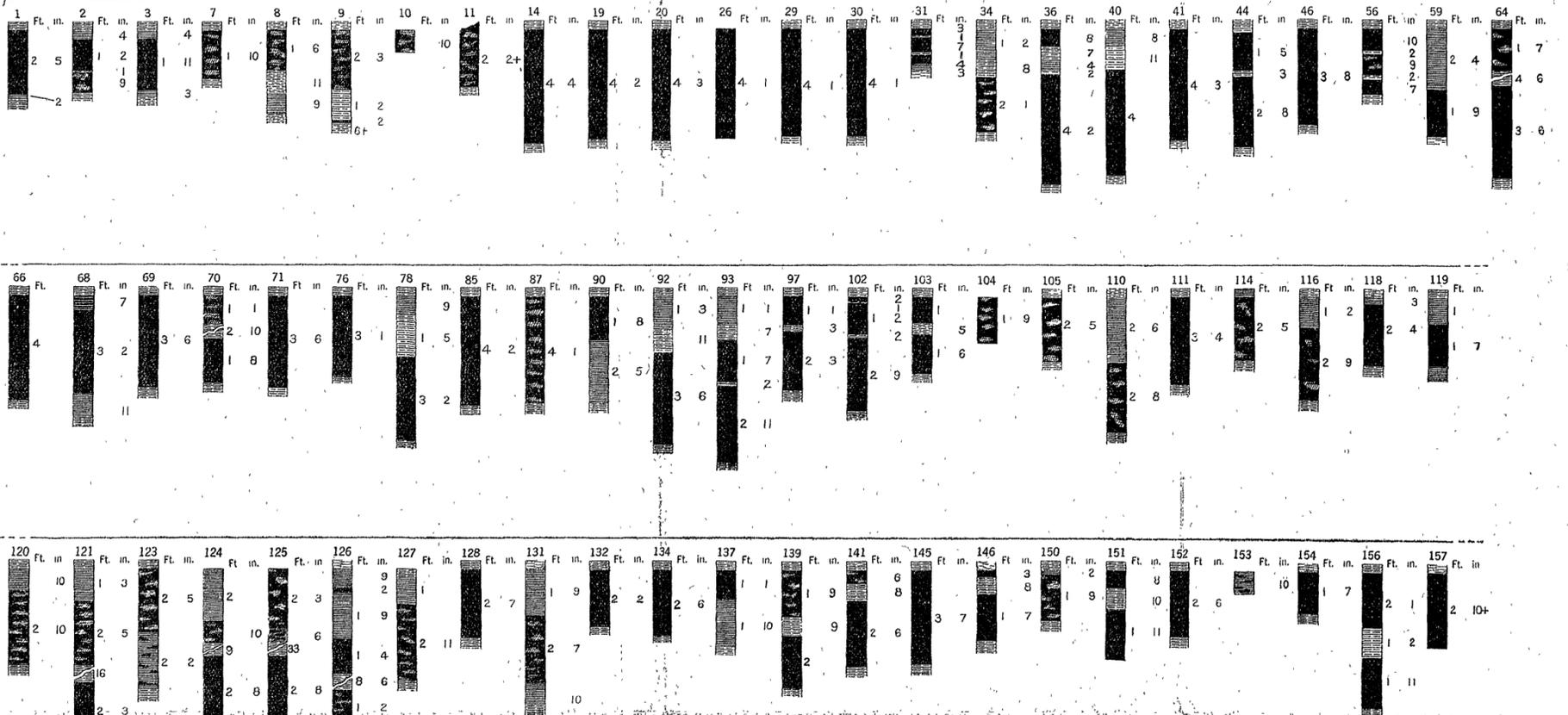
-   
 Coal
-   
 Dirty or bony coal
-   
 Carbonaceous shale
-   
 Shale
-   
 Clay
-   
 Sandstone
-   
 Silty sandstone
-   
 Sandy shale
-   
 Soil or alluvium

SECTIONS OF COAL BEDS IN T. 3 N., R. 53 E.

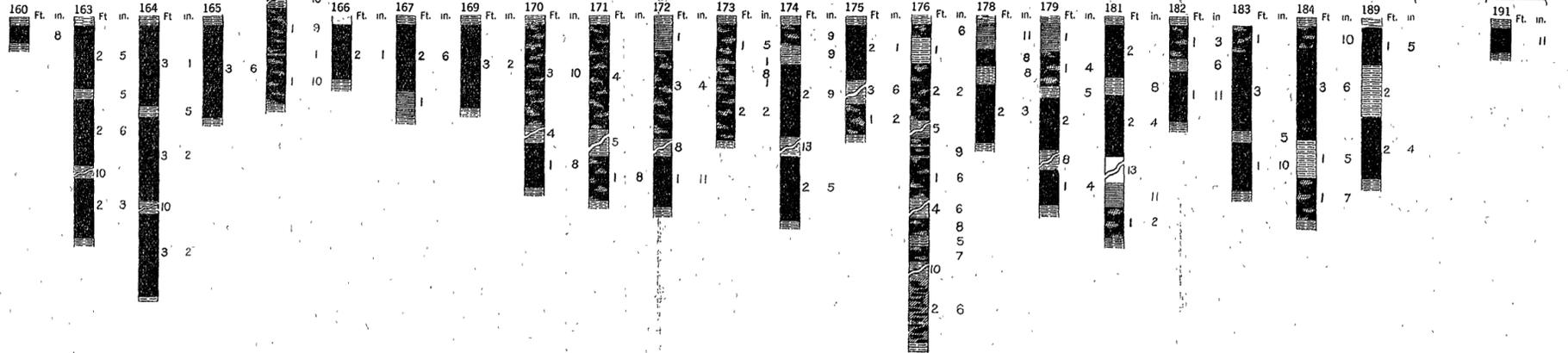
Divide bed



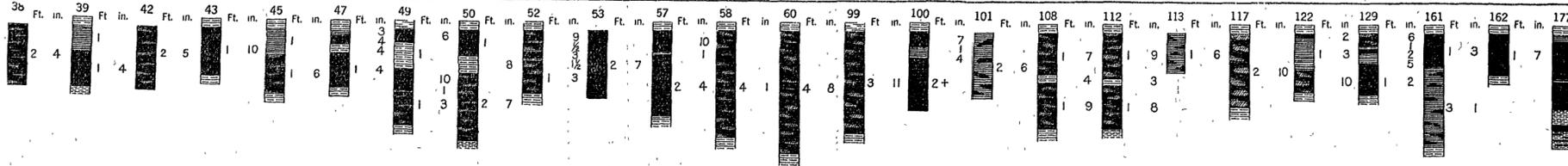
Hercules' bed



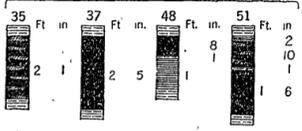
Local bed 35 feet above Hercules bed



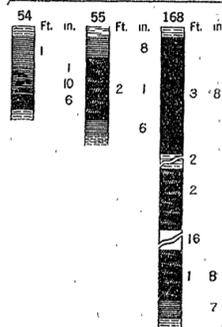
Hagen bed



Lower Hagen bed



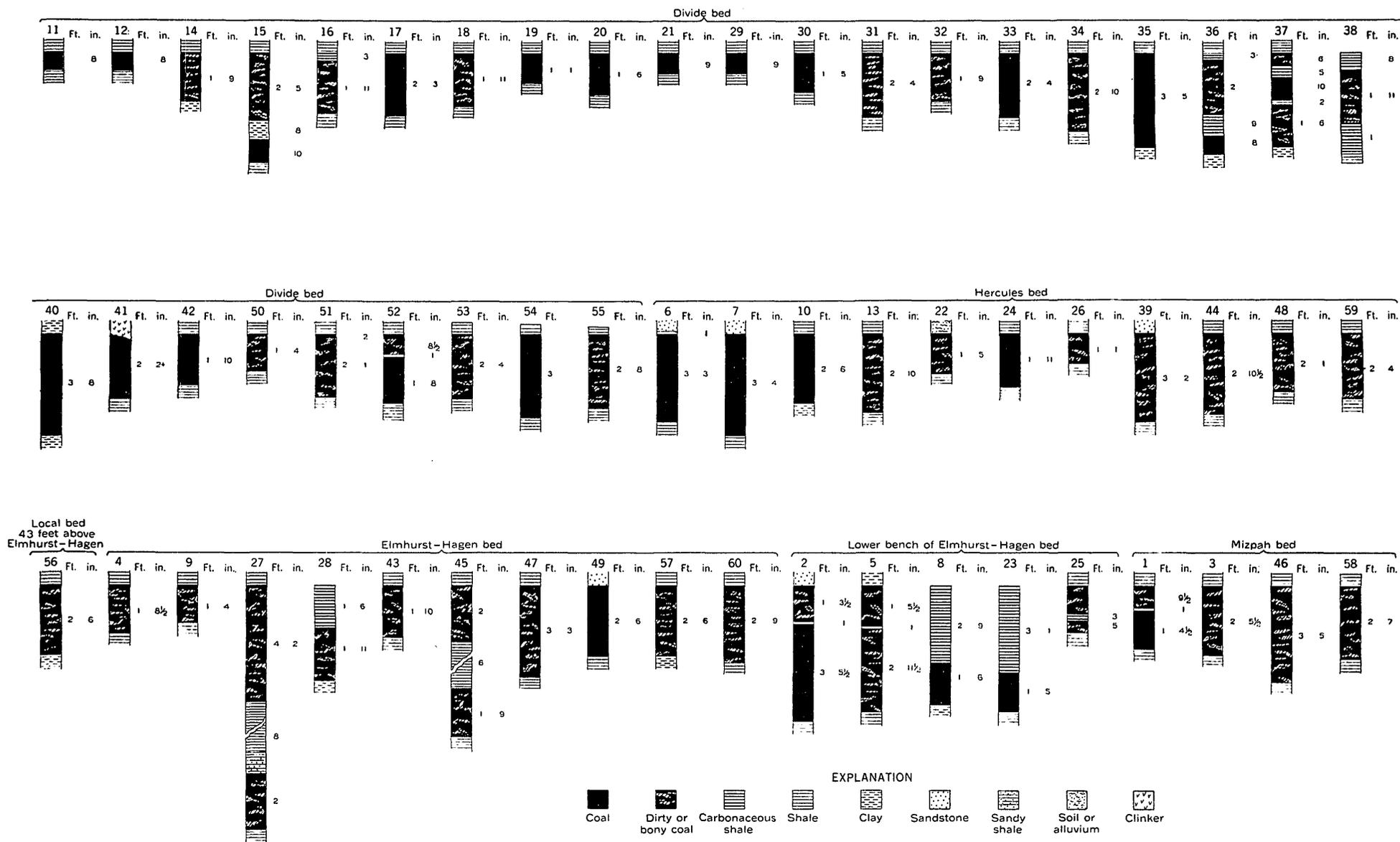
Uncorrelated local beds



- EXPLANATION
- Coal
  - Bony coal
  - Bope
  - Carbonaceous shale
  - Shale
  - Clay
  - Sandy shale
  - Sandstone
  - Gypsum

SECTIONS OF COAL BEDS IN T. 4 N., R. 50 E.

T. 4 N., R. 51 E.



SECTIONS OF COAL BEDS IN T. 4 N., R. 51 E.

From this ridge two high, sharp spurs extend northwestward to form the divides between Forty Creek, Double Corral Creek, and a shorter creek lying north of Double Corral Creek and tributary to Mizpah Creek. The eastern part of the township is extremely rough in many places. The western part is more open, but the small tributaries have cut deep trenches in the valley floors of the larger creeks.

The Kitty Springs coal bed, at the base of the somber-colored beds, crops out in sec. 1 and was measured at locality 2, where it contains 1 foot 8 inches of coal. (See pl. 34.) Measurements in adjoining townships (see pl. 38) indicate that this bed thins northward and perhaps westward, so it presumably underlies only a small part of this township. Two local coal beds about 50 and 100 feet above the Kitty Springs bed crop out in the eastern part of the township. These beds vary in thickness and purity but locally may exceed 2 feet and contain clean coal. They thin both southward and northward and presumably underlie only the northeastern part of the township. The Monarch bed, 140 to 160 feet above the Kitty Springs bed, crops out in the southeastern part of the township but is thin or impure in that neighborhood. The Mizpah bed, which lies at a slightly higher horizon at the western border of the township, is covered by surface wash and alluvium. A local bed which lies near the same horizon and which may be the equivalent of the Mizpah bed is 2 feet 5 inches thick at locality 18, but the coal is too dirty to be usable. There are several local outcrops of coal 20 to 60 feet below the Hercules bed in the township.

The Hercules bed, 230 to 270 feet above the Kitty Springs bed, crops out on the ridges of the higher parts of the township. It thins out and disappears locally but at several places contains over 3 feet of coal and at locality 108 contains 4 feet 4 inches of clean coal. The Elmhurst-Hagen bed, about 70 feet below the Hercules bed, crops out for a short distance in sec. 31 and perhaps also in secs. 32 and 33, but the bed is very shaly, and no measurement of its thickness was made. Local coal outcrops were found 20 to 60 feet below the Hercules bed, one at locality 57 containing a total of 3 feet 6 inches of coal in two benches. The Bear Jaw bed, at a varying interval of 80 to 130 feet above the Hercules bed, crops out on the ridges in the northern and eastern parts of the township and in several localities on the ridge between Forty and Double Corral Creeks. This bed exceeds 3 feet in thickness, exclusive of partings, at only three localities. At most localities it is less than 2 feet thick. Local outcrops of coal at intervals of 10 to 50 feet below the Bear Jaw bed were found in the north-central part of the township. These are not extensive enough to warrant mapping, and all are less than 2 feet in thickness. Local outcrops at localities 52 and 66, 50 feet and 65 feet respectively above the Bear Jaw bed, are thin and of short extent.

#### T. 4 N., R. 53 E.

The Powder River forms the eastern boundary of the part of T. 4 N., R. 53 E., that is included in the Mizpah coal field. The large part of the township adjacent to the river and its tributary Ash Creek is flat land, but along the western border the higher land is deeply dissected and badlands are common.

The Kitty Springs coal bed, at the base of the somber-colored beds, crops out in the southern and western parts of the township. The bed is thin at the northern border and at localities 17 and 26, but elsewhere in the township it exceeds 2 feet in thickness. (See pl. 35.) The Kitty Springs mine, from which this bed derives its name, is a small prospect in this bed that supplies coal to nearby ranches. A bed about 50 feet above the Kitty Springs bed crops out along the northern part of the western border of the township. From sec. 18 northward it ranges in thickness from 1 foot 9 inches to 2 feet 5 inches. At 50 feet above

this bed is another local bed of about the same extent and thickness. The Monarch bed, 140 to 160 feet above the Kitty Springs bed, crops out in some small buttes in secs. 30 and 31. This bed contains a little over 2 feet of coal in this township.

**T. 5 N., R. 50 E.**

The divide between Mizpah and Pumpkin Creeks trends northward through the eastern part of T. 5 N., R. 50 E., and the high sinuous ridge that forms the divide between Johnson and Lovetts Creeks extends westward through the northern part of the township. Except for small areas near the creeks and along the divide the surface is dissected into rugged badlands.

Local coal outcrops, 20 to 40 feet below the Lower Hagen bed, that may be exposures of continuous beds, were found in the creek banks at localities 29, 69, and 72, in the western part of the township. (See pl. 36.) The Lower Hagen bed crops out low in the valleys of the western part of the township. This bed is variable in thickness but contains as much as 4 feet 3 inches of clean coal near locality 68 and 6 feet 3 inches of somewhat bony coal at locality 71. The Hagen bed crops out in the valley of Lovetts Creek but thins out to the north and west. It contains a maximum of 3 feet 8 inches of clean coal at locality 98. The Johnson Creek bed, 50 to 80 feet above the Lower Hagen bed, crops out in the valley of Johnson Creek but thins out southward and disappears abruptly in sec. 7. The Fivemile bed, which is near the same horizon as the Johnson Creek bed, crops out near the head of Second Creek, in sec. 1. The Hercules bed, 140 to 170 feet above the Lower Hagen bed, crops out on the ridges through most of the township but thins and disappears locally along the eastern border. This bed contains 4 feet 4 inches of coal at locality 15, but the average thickness is between 2 and 3 feet. A local bed was found 30 feet below the Hercules bed at locality 61, but it is not present elsewhere in the township. A bed 40 to 60 feet above the Hercules bed crops out in the central eastern part of the township. This may correspond to the Divide coal bed in the township to the south. The local outcrop at locality 66 is also near this horizon. The Strevell bed is present at the base of the Tongue River member in the northern part of the township. This bed varies in thickness but contains over 2 feet of coal in parts of secs. 11 and 12.

The ridge between Johnson and Lovetts Creeks roughly coincides with a low anticlinal warp, which may have a closure of 30 to 50 feet. Like the other folds of the Mizpah field it may be superficial, not persisting with depth.

**T. 5 N., R. 51 E.**

Mizpah Creek flows northward through the eastern part of T. 5 N., R. 51 E. The land surface near the creek is flat and open, but in the remainder of the township the surface is rugged and broken by badlands and sharp ridges.

The coal beds crop out in the ridges between tributary streams, and the pattern of their outcrop lines reveals the intricate dissection of the land surface. The Mizpah bed, which crops out in the eastern part of the township, contains, on an average, over 3 feet of clean coal (see pl. 37), but the bed thins out and disappears in the northern part of sec. 14. A local bed about 40 feet below the Mizpah bed contains 2 feet 4 inches of dirty coal at locality 35 but is not present elsewhere in the township. The Elmhurst-Hagen bed, about 90 feet above the Mizpah bed, is the next continuous bed. Its thickness and quality vary within short distances, and its value where covered cannot be predicted. Between the Elmhurst-Hagen and Mizpah beds there are a number of local coal outcrops which for convenience have been considered two local beds. The local bed that crops out in the valley of Second Creek about 20 feet above the Mizpah bed contains a maximum of 3 feet 3 inches of coal, and the local bed 20 to 30 feet

below the Elmhurst-Hagen bed contains a maximum of 1 foot 9 inches of coal in the valley of Fivemile Creek and as much as 3 feet 3 inches of clean coal with a 3-inch shale parting in the valley of Second Creek. A local bench of the Elmhurst-Hagen bed occurs 10 feet above the main bed at localities 20, 22, 28, 109, and 111. The Fivemile coal bed, 50 to 70 feet above the Elmhurst-Hagen bed, crops out on the divide between Second and Fivemile Creeks but pinches out about a mile south of Fivemile Creek. It has a maximum measured thickness of 5 feet of dirty coal at locality 17, but through most of its extent it contains between 2 and 3 feet of clean coal. The Hercules bed crops out on the ridges of the western part of the township about 60 feet above the Fivemile bed. It pinches out in some places and contains more than 2 feet of good coal in others. A local bed of impure coal crops out 30 feet below the Hercules bed in sec. 18. The Strevell bed, at the base of the Tongue River member, crops out in secs. 7 and 18 but was not measured in this township. In the eastern part of T. 5 N., R. 50 E., it has an average thickness of about 2 feet. A coal bed about 100 feet above the Strevell bed in the Tongue River member has been completely burned out, leaving a massive clinker-capped mesa in sec. 7.

T. 5 N., R. 52 E.

The Powder River forms the eastern boundary of the part of T. 5 N., R. 52 E., that is included in the Mizpah coal field. The divide between the Powder River and Mizpah Creek trends northward through the western part of the township. Through most of its extent the divide follows a high ridge, but there are two low passes across it in the central part of the township. Adjacent to the Powder River and Mizpah Creek the land is flat, but near the divide it is much dissected. Considerable areas of gravel occur in the southeastern part of the township about 180 feet above the level of the Powder River.

The Kitty Springs coal bed, at the base of the somber-colored beds, crops out in the southern part of secs. 35 and 36 but thins out northward. A local bed 50 feet above the base of the somber-colored beds is prominent in the township to the south and crops out for a few miles in the southeastern part of this township. It contains 1 foot 8½ inches of coal at locality 35 (see pl. 38) but thins rapidly to the north. A local bed 100 to 120 feet above the base of the somber-colored beds has an average thickness of 2½ feet in the southeastern part of the township but thins northward and at locality 22 contains only 1 foot 9 inches of coal with two shale partings. Near this horizon in the northwestern part of the township a local bed 100 feet below the Shook bed contains 3 feet 11 inches of coal at locality 9. The Shook bed crops out extensively in the northwestern part of the township but could not be traced south of sec. 17. At locality 10 this bed contains 4 feet 7 inches of clean coal and has been mined to a small extent, but elsewhere it is much thinner. A local bed about 40 feet below the Shook bed is exposed at localities 4, 8, 12, 15, and 16, and another local bed 60 feet below the Shook bed is exposed at localities 11 and 18, but these beds are of value only over very small areas. The Hercules bed, which occurs in the southwestern part of the township near the horizon of the Shook bed, thins out to the north and is not continuous with the Shook bed. The Hercules bed does not exceed 1 foot 6 inches in thickness in this township. A bed about 40 feet above the Shook bed in the northwestern part of the township has burned out and formed layers of clinker. The Bear Jaw bed, about 100 feet above the Hercules bed, consists of two benches which crop out on the high divide in the southern part of the township. In secs. 33 and 34 the lower bench has an average thickness of nearly 4 feet, but it thins northward. The upper bench contains 3 feet 3 inches of coal at locality 21 but is thinner to the south. The upper bench may be equivalent to the bed forming the clinker in the northern part of the township.

## T. 6 N., R. 49 E.

Johnson Creek, a tributary of Pumpkin Creek, drains the southern part of T. 6 N., R. 49 E., and Squaw Creek, a tributary of the Tongue River, drains the remainder. The surface is deeply dissected and intricately carved except for small areas in the creek valleys and on the ridges of the eastern part of the township.

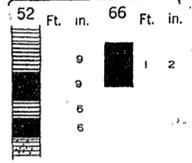
The Lower Hagen coal bed crops out for short stretches in the valley of Johnson Creek but is concealed through most of its extent by surface wash and alluvium. This bed has a maximum thickness of 4 feet 3 inches, with thin beds above and below, at locality 75. (See pl. 39.) A local bed 30 feet below the Lower Hagen bed crops out in a cut bank of Johnson Creek in sec. 31, T. 6 N., R. 50 E., and may underlie the alluvium of the Johnson Creek Valley. The Squaw Creek bed, which is possibly the equivalent of bed C of the Miles City field, crops out in the western and southern parts of the township. It ranges in thickness from 1 foot 1 inch to 4 feet 8 inches. In the central part of the township a bench is present 6 to 10 feet above the Squaw Creek bed. The bench about 3 feet above the main bed at localities 24 and 25 may be a continuation of this upper bench. The Johnson Creek bed, about 30 feet above the Squaw Creek bed, is more than 4 feet thick in the southeastern part of the township but thins westward and is absent north and west of sec. 28. It has burned in places along the outcrop to form conspicuous layers of red clinker. A local bed at about the same horizon, probably equivalent to coal bed D of the Miles City field, crops out in the northern part of the township. It is burned locally, but where exposed it does not exceed 2 feet in thickness. Two local coal outcrops were found at localities 58 and 69, in the southern part of the township, 50 and 66 feet respectively above the Johnson Creek bed.

## T. 6 N., R. 50 E.

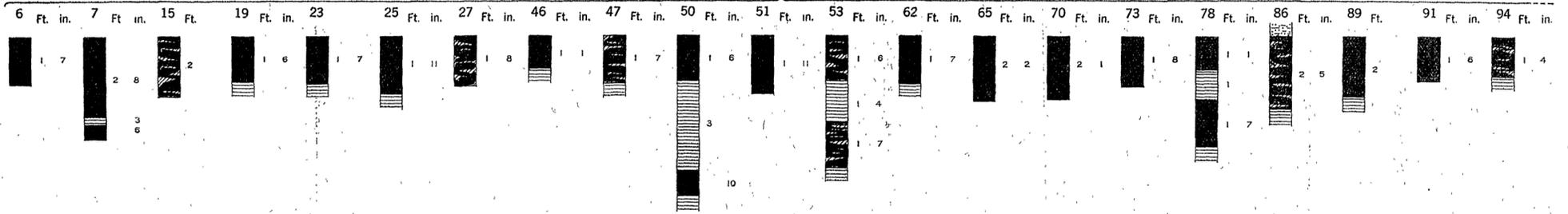
Johnson Creek, a tributary of Pumpkin Creek, drains the southwestern part of T. 6 N., R. 50 E., and Strevell Creek, a tributary of Mizpah Creek, the northeastern part. The remainder of the township is drained by Squaw Creek, a tributary of the Tongue River, and by small tributaries of Mizpah Creek. The surface of the township is much dissected, particularly in the northeastern part (see pl. 18, A), but a few square miles of rolling upland, conforming in extent in a general way with the outcrop of Tongue River rocks, is preserved in the northwestern part of the township.

The coal beds occur in the somber-colored beds and in the Tongue River member of the Fort Union formation. A bed that crops out in the banks of Johnson Creek in sec. 31, about 30 feet below the Lower Hagen bed, contains 5 feet 10 inches of coal in sec. 6, T. 5 N., R. 50 E. Although to the west this bed is not prominent and probably thins out, it may underlie 2 or 3 square miles of the southwestern part of T. 6 N., R. 50 E. The lower Hagen bed crops out in secs. 31 and 32 and is very irregular in its content of good-quality coal, ranging from 2½ inches of clean coal at locality 22 to 3 feet 4 inches of clean coal at locality 23. (See pl. 40.) The Squaw Creek bed, 50 feet above the Lower Hagen bed, crops out in secs. 29, 31, and 32. At locality 20 this bed contains 2 feet 1 inch of dirty coal and appears to thin rapidly eastward. The Johnson Creek bed crops out about 30 feet above the Squaw Creek bed. This bed varies in thickness and quality, but at several places along the outcrop it contains as much as 3 feet of clean coal. A bed at about the same horizon crops out in the valley of Strevell Creek and attains a maximum thickness of 4 feet 2 inches of clean coal at locality 7. This bed is the equivalent of coal bed D in the adjacent parts of the Miles City coal field. Local outcrops and discontinuous beds were found 20 to 50 feet above this horizon in the eastern part of the township, but they are too lenticular to be of value as sources of coal. The Hercules coal bed, which crops out in secs. 27,

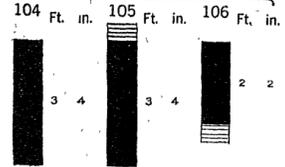
Local outcrops 50-65 feet above Bear Jaw bed



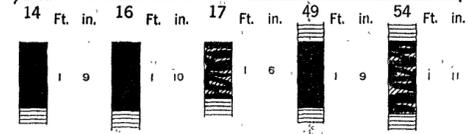
Bear Jaw bed



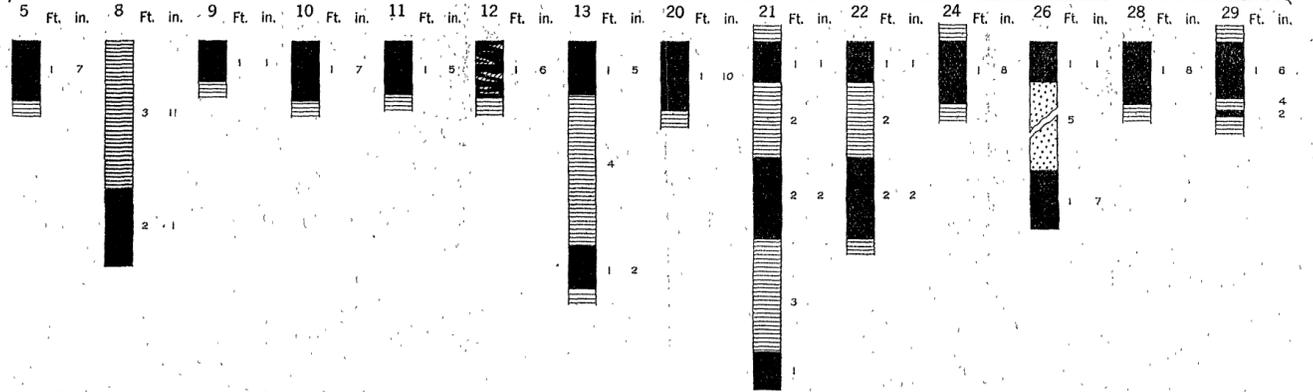
Bear Jaw bed



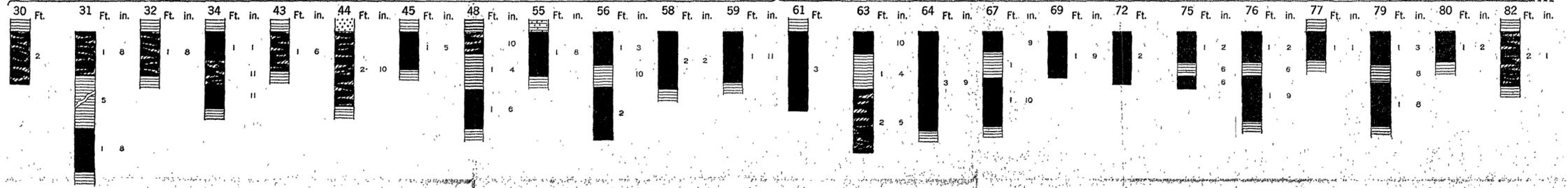
Local outcrops 10-50 feet below Bear Jaw bed



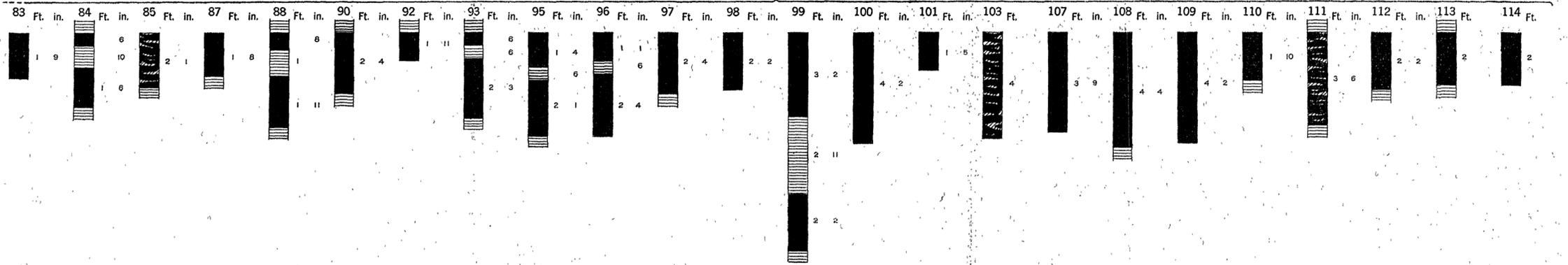
Hercules bed



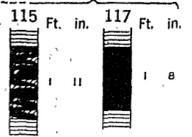
Hercules bed



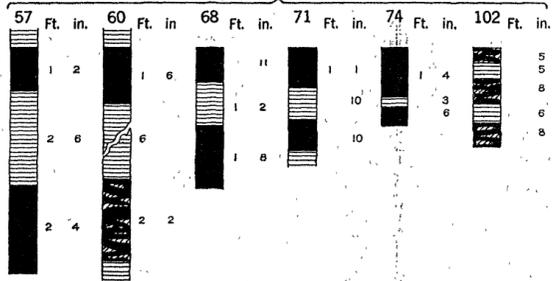
Hercules bed



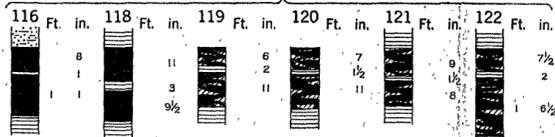
Hercules bed



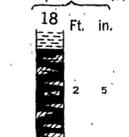
Local coal croppings 20-60 feet below Hercules bed



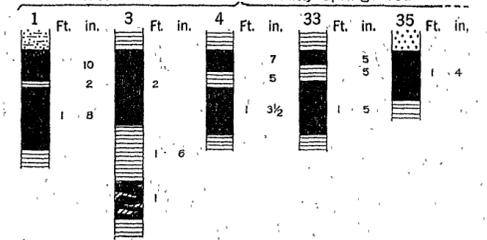
Monarch bed



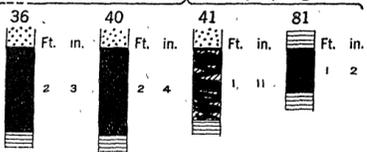
Mizpah bed (?)



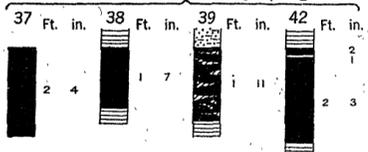
Local bed 100± feet above Kitty Springs bed



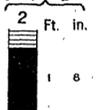
Local bed 100± feet above Kitty Springs bed



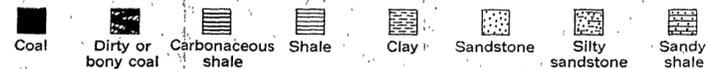
Local bed 50± feet above Kitty Springs bed



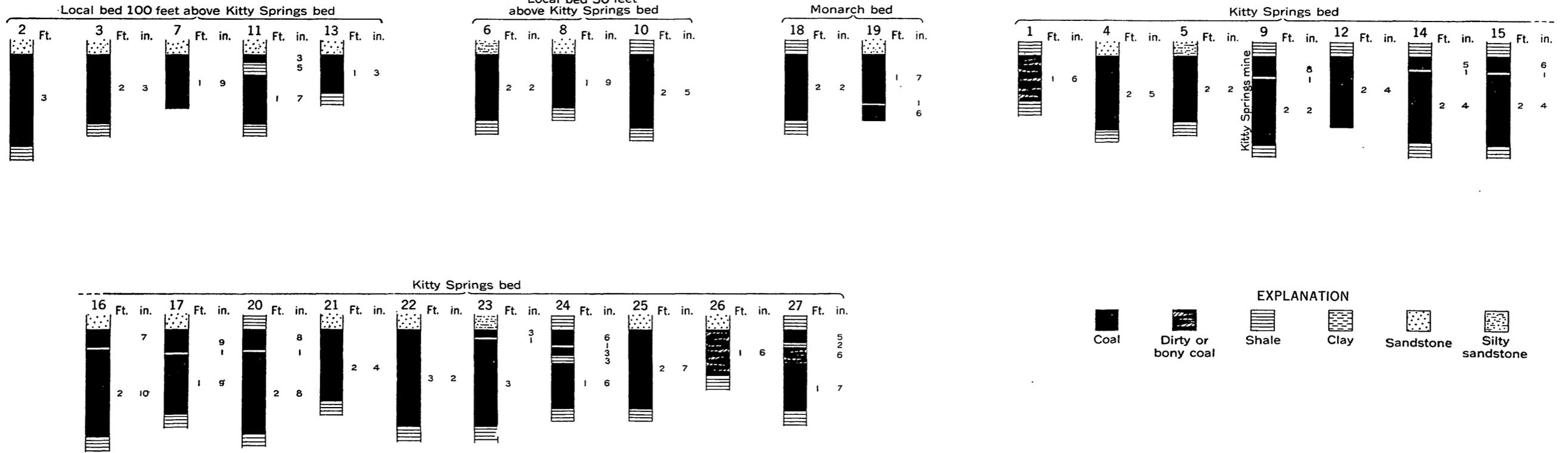
Kitty Springs bed



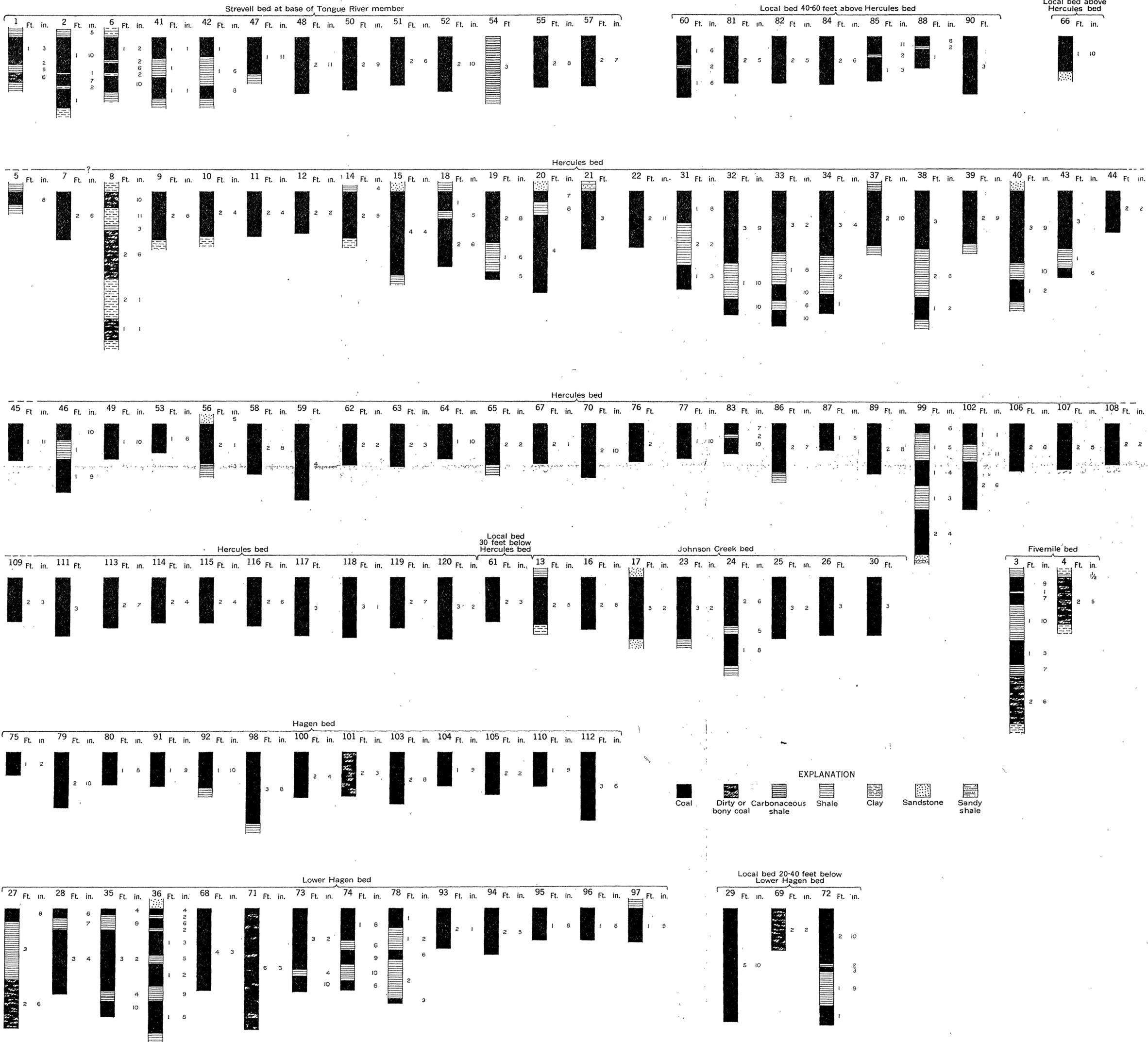
EXPLANATION



T. 4 N., R. 53 E.

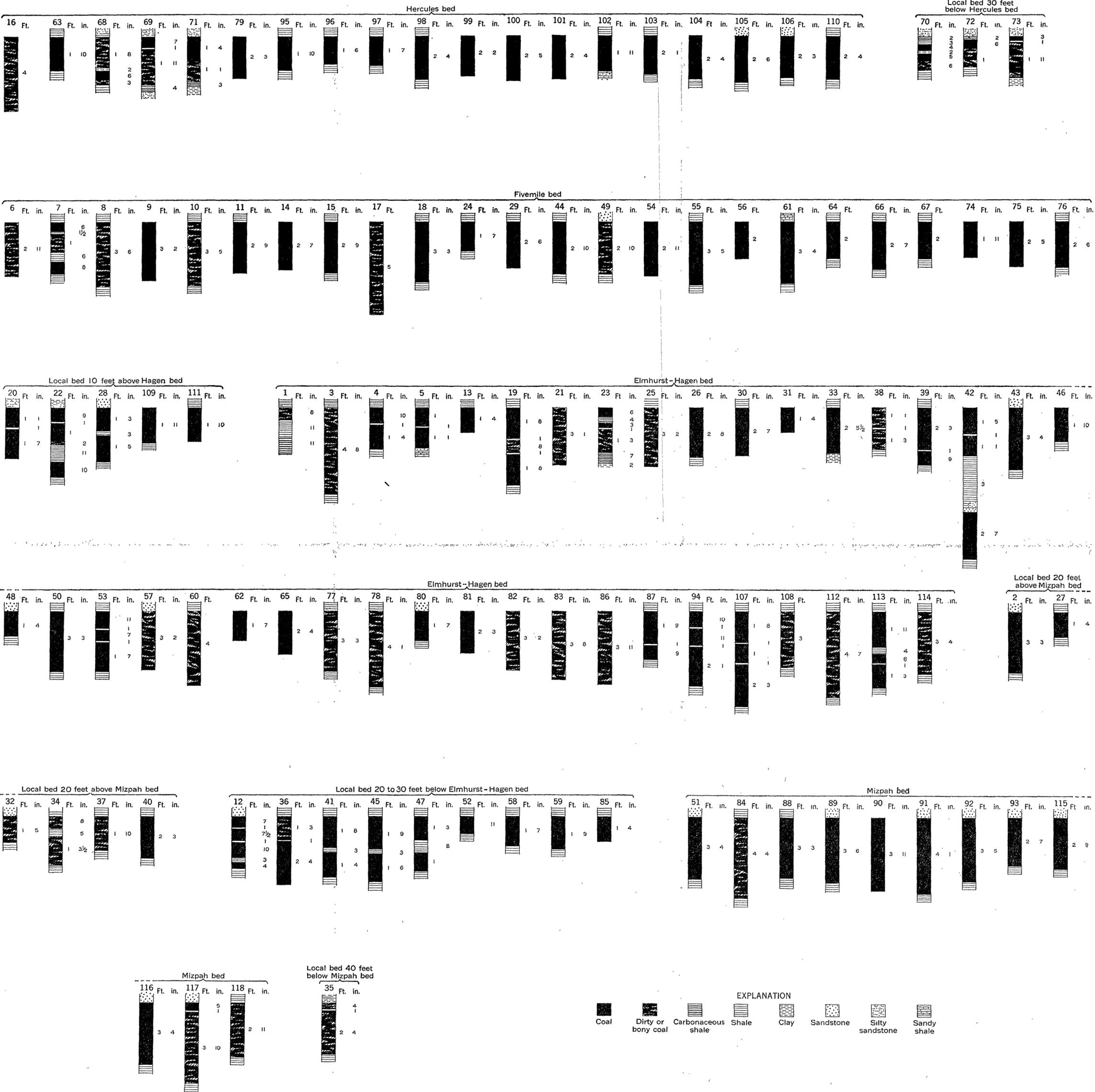


SECTIONS OF COAL BEDS IN T. 4 N., R. 53 E.



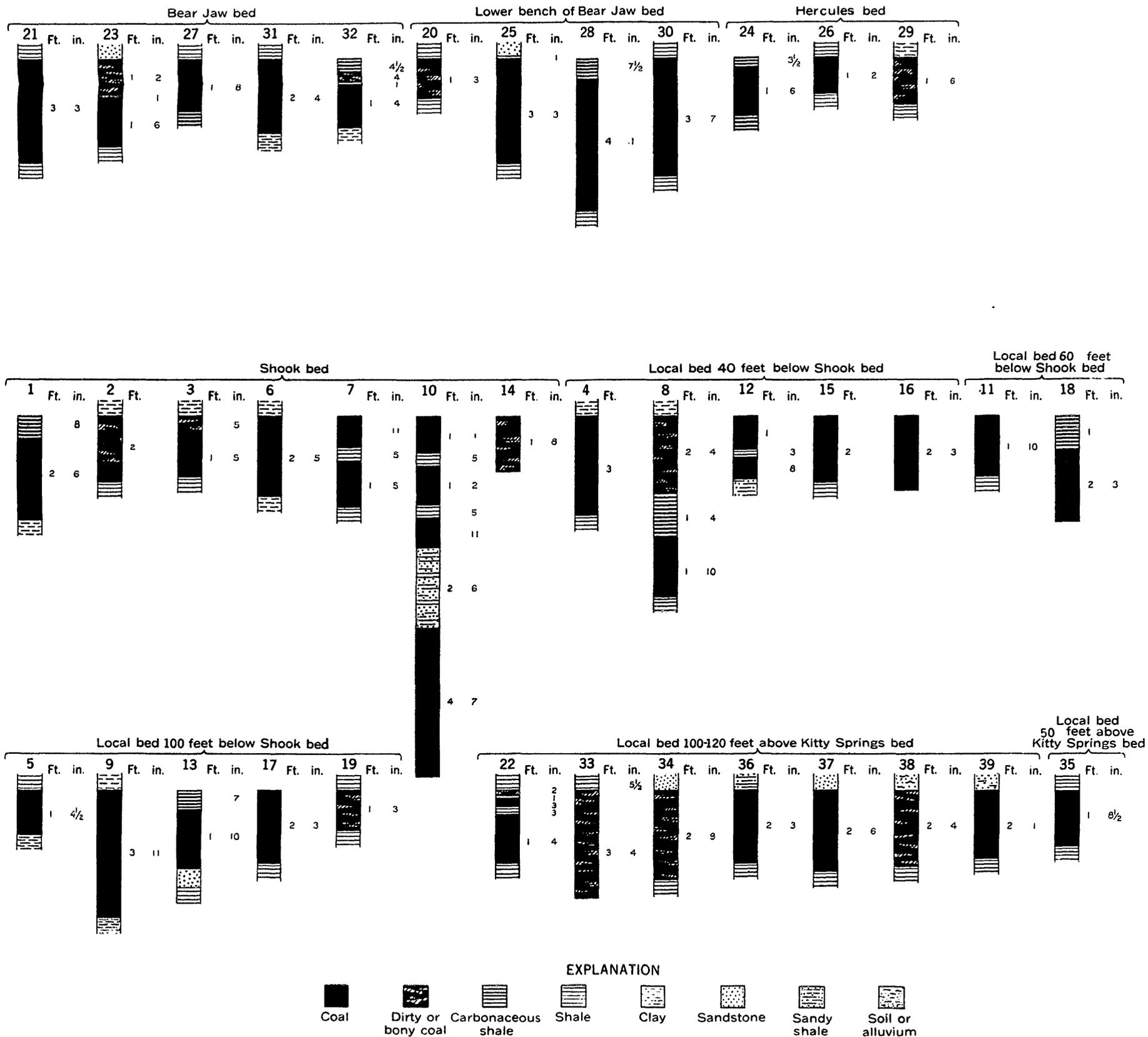
SECTIONS OF COAL BEDS IN T. 5 N., R. 50 E.

T. 5 N., R. 51 E.

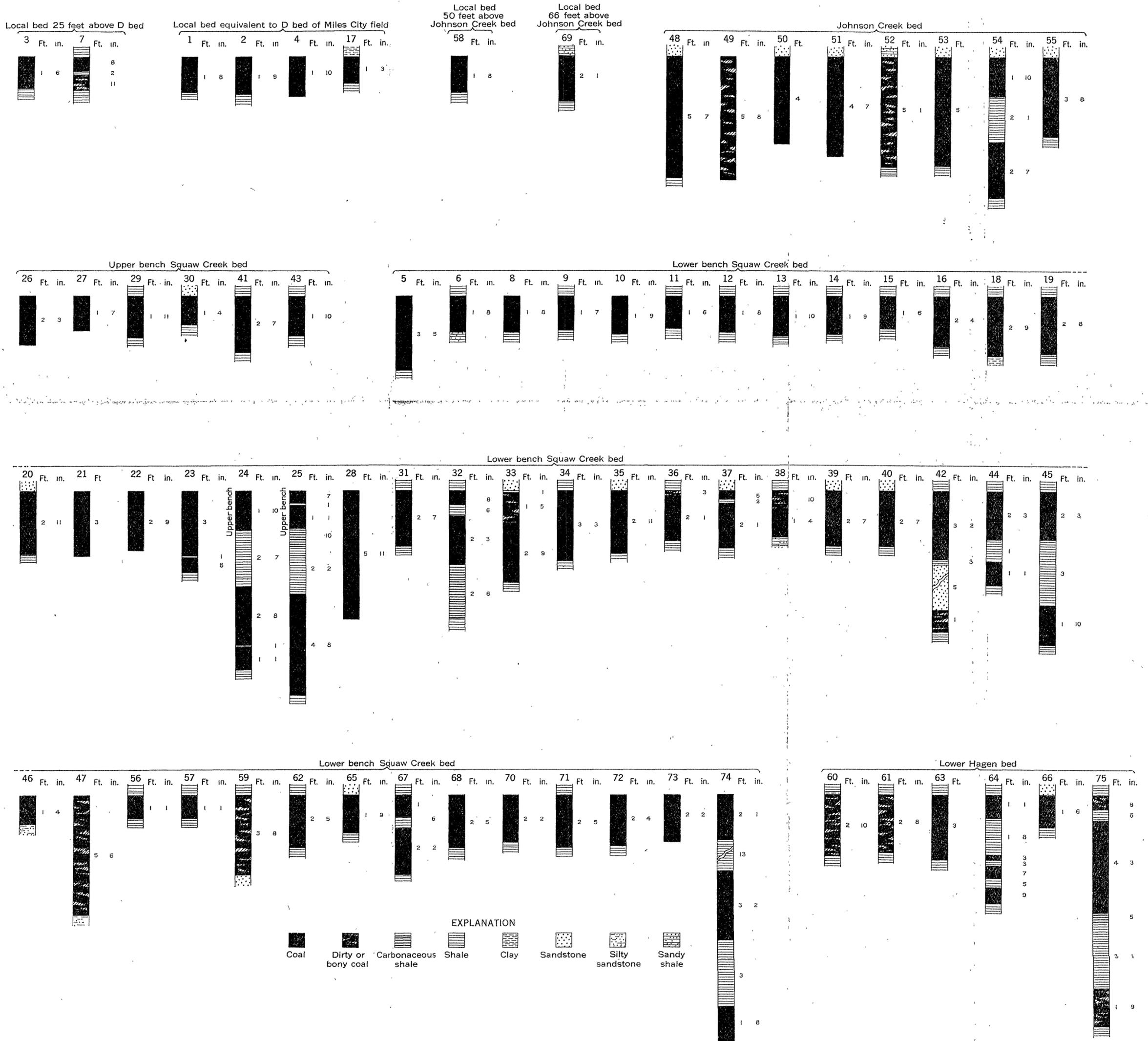


SECTIONS OF COAL BEDS IN T. 5 N., R. 51 E.

T. 5 N., R. 52 E.

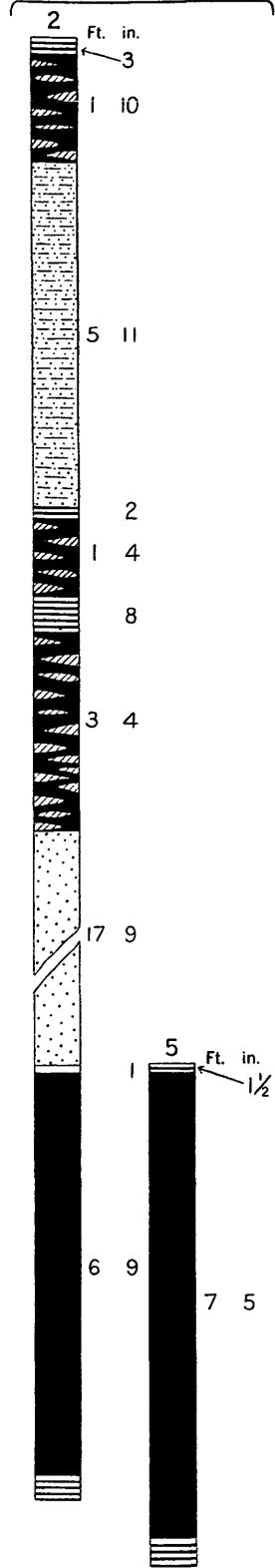


SECTIONS OF COAL BEDS IN T. 5 N., R. 52 E.

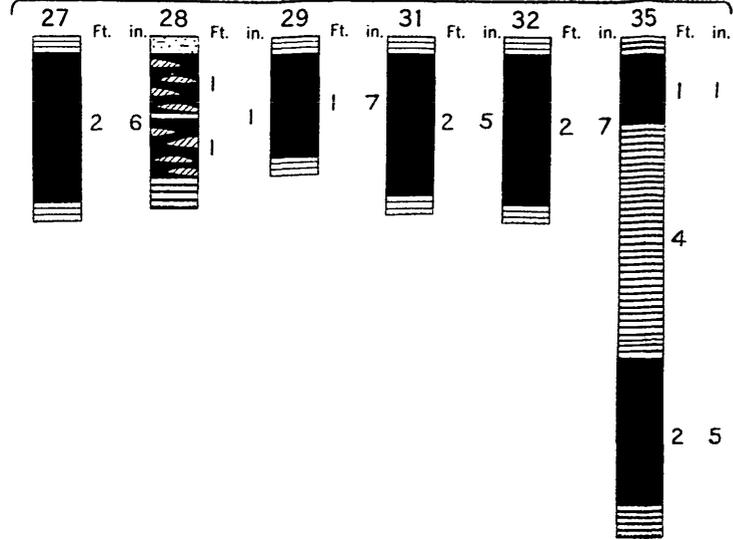


SECTIONS OF COAL BEDS IN T. 6 N., R. 49 E.

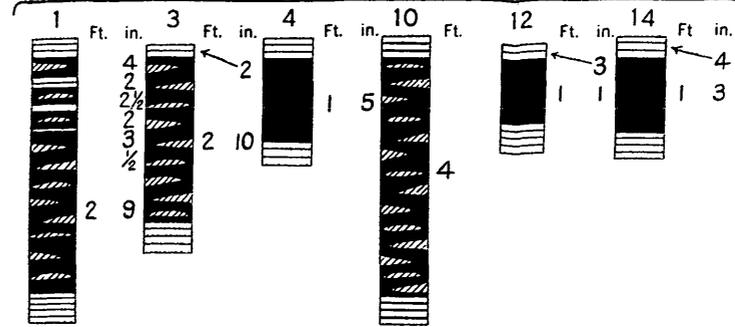
Coal in Tongue River



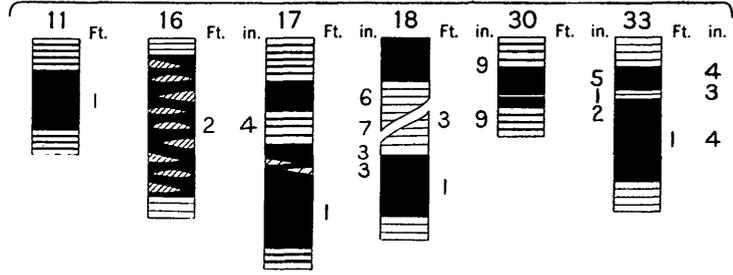
Strevell bed locally at base of Tongue River



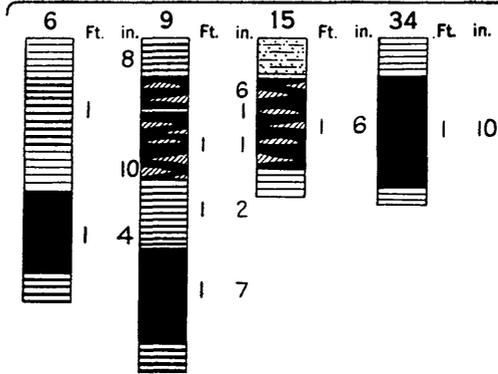
Local bed at base of Tongue River



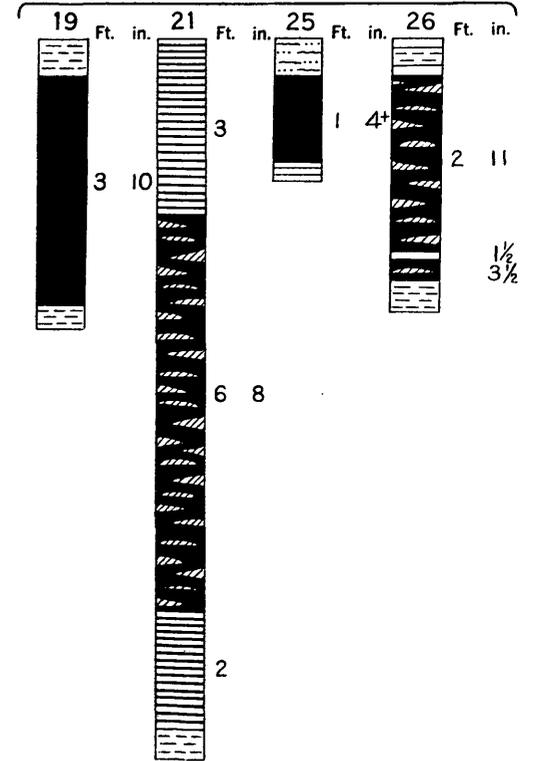
Hercules bed



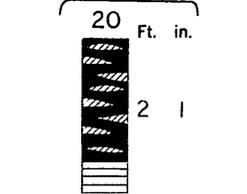
Local outcrops 20-50 feet above Johnson Creek bed



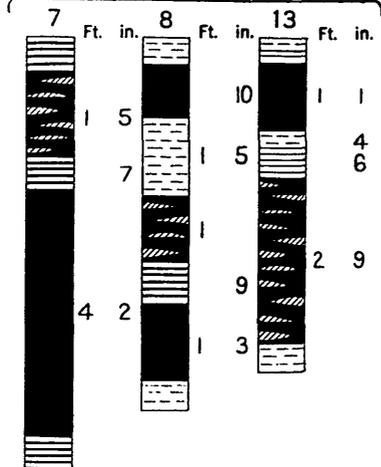
Johnson Creek bed



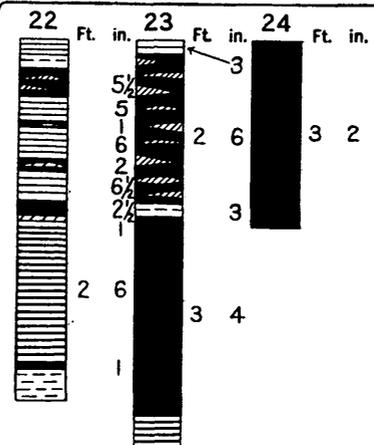
Squaw Creek bed



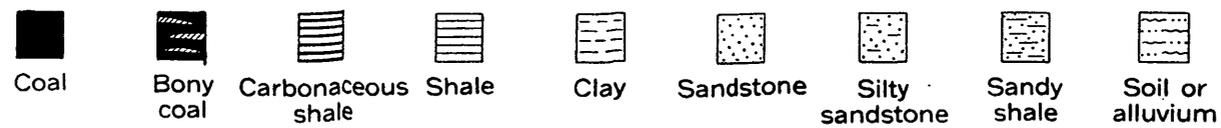
Local bed equal to bed D of Miles City Field



Lower Hagen bed



EXPLANATION



SECTIONS OF COAL BEDS IN T. 6 N., R. 50 E.

28, 34, and 36, is thin and commonly contains only dirty coal. The Strevell coal bed occurs at the base of the Tongue River member in the southeastern part of the township. In that vicinity it contains 1 foot 7 inches to 2 feet 7 inches of coal, but to the north it thins out and disappears, and another bed higher in the section was mapped as the base of the Tongue River member. Where this higher bed is thick it contains only impure coal. It thins westward and does not occur in the western part of the township. A coal bed about 80 feet above the base of the Tongue River member forms massive clinkers on many of the high hills of the township. Small portions of the outcrop remain unburned, and measurements were obtained at localities 2 and 5, where the bed contained 6 feet 9 inches and 7 feet 5 inches of clean coal, respectively. This coal bed probably remains unburned beneath a small area in secs 8 and 17 and might constitute a source of coal for local supply. A bed about 200 feet above the base of the Tongue River member and equivalent to coal bed E in adjacent parts of the Miles City field is represented by layers of clinker in the highest hills along the northern border of the township.



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