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HENRY LANDES, State Geologist

BULLETIN No. 9

# The Coal Fields of Kittitas County

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## LETTER OF TRANSMITTAL.

*Governor Ernest Lister, Chairman, and Members of the Board of Geological Survey.*

GENTLEMEN: I have the honor to submit herewith a report entitled "The Coal Fields of Kittitas County," by E. J. Saunders, with the recommendation that it be printed as Bulletin No. 9 of the Survey reports.

Very respectfully,
HENRY LANDES,
*State Geologist.*

University Station, Seattle, November 23, 1914.

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# INTRODUCTION.

## LOCATION AND EXTENT OF THE COAL FIELDS.

Kittitas County is located on the eastern slope of the Cascade Mountains in central Washington, extending in a northwesterly direction from the Columbia River to the summit of the Cascade range. Its northern boundary follows the Wenatchee Mountains, a spur of the Cascades, southeast toward


FIG. 1. Index Map Showing Location of Kittitas County Coal Fields and Area Covered in the Report.

the Columbia River. Its southern boundary follows the Naches River, Cleman Mountain and the Umptanum Ridge to the Columbia River, and is roughly parallel to the northern boundary.

The areas containing the coal are located in the Yakima River basin in the northwestern part of the county, including the upper part of the Yakima River valley together with the valleys of several of its larger tributaries, from which the different fields are named. They occupy only a small portion of the total area of the county. (Index Map, Fig. 1; Plate 1.) Practically all the coal shipped up to date is mined from the Roslyn-Clealum field, covering an area of about 10,000 acres, along Yakima and Clealum valleys from Clealum to Lake Clealum. This is one of the highest grade coals in the state and the production of this field has kept Kittitas County in the lead since 1901, except the year 1911, when King County production was slightly greater. (Appendix A.)

The Northern Pacific, and the Chicago, Milwaukee and St. Paul railways follow the Yakima River valley, and pass through the lower end of the Roslyn-Clealum field. The other fields, located on the valleys tributary to the Yakima valley are not yet connected with the main lines by rail but could readily be connected in case the developments guaranteed the building of spurs, as the Roslyn-Clealum field has already done.

## PREVIOUS WORK IN THIS FIELD.

With the exception of a narrow strip on the eastern edge of the field north of Ellensburg, the general geology of the area was worked out by Geo. Otis Smith and party in 1904 to 1906, and is mapped and described in the Mount Stuart and Snoqualmie folios, Numbers 106 and 139 of the United States Geological Survey.

Israel C. Russell, in Bulletin 108 of the United States Geological Survey, published in 1893, describes in general the geology of central Washington, mentioning the Roslyn coal as belonging to the Kittitas system of sedimentary rocks. In the Twentieth Annual Report of the United States Geological Survey, published in 1900, he describes the geology of the Cascade Mountains, including this section.

In 1901 and 1902 Professor Henry Landes, State Geologist, made reports on the coal mines of the state, including the mines in Kittitas County that were open at that time. These reports are contained in Volumes I and II of the Washington Geological Survey.

Under the direction of the United States Geological Survey, in co-operation with the State Geological Survey, the coals of the state were sampled during the field season of 1909 by E. E. Smith. This included the Roslyn-Clealum field and a full report of the analyses of these coals is contained in Bulletin 474 of the United States Geological Survey.

### METHOD OF PRESENT INVESTIGATION.

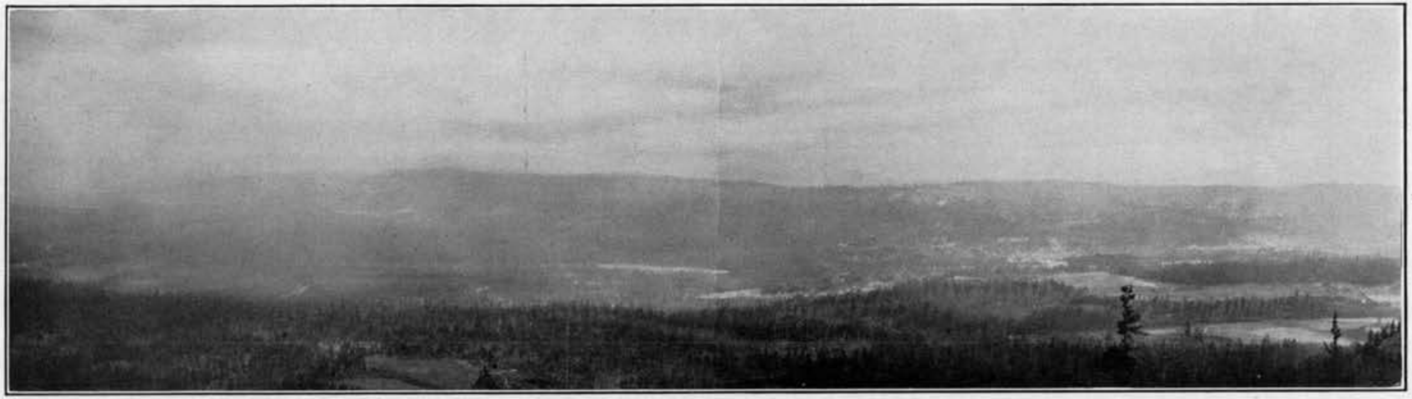
The field work on which the report is based was begun in the summer of 1911. At this time all the areas outside of the Roslyn-Clealum field, known or reported to contain coal, were examined and mapped. Later during the same year and the following summer a study of the Roslyn-Clealum field was carried on, and the field work was completed during the summer of 1913.

The writer was assisted in the field by F. B. Lassoie, as surveyor and draftsman. The underground geology and mine workings of the Roslyn-Clealum field were worked out, and are described by Joseph Daniels, Assistant Professor of Mining Engineering and Metallurgy, University of Washington (Chapters III and VII).

Using the earlier maps and reports as a basis for the field work, a detailed examination of all the areas in which coal was reported or had since been discovered, was made. The boundaries of the areas were carefully worked out, resulting in slight changes in the extent and location of the different areas as formerly mapped. These changes are largely due to further developments in the different fields and more recent land surveys. Drill hole records have been used where available in making up the sections. Many traverses were run along the stream channels cutting the coal bearing formation outside of the known coal areas, for the purpose of determining the geological structure, and the exact limits and relations between the two coal-bearing formations of the county.

### ACKNOWLEDGMENTS.

The compilation of a report of this kind would be impossible without the assistance and suggestions of the different owners, superintendents, engineers, and foremen of the properties visited. To all of these we wish to express our appreciation of the courtesy shown us, and help rendered in every way.



General View of Yakima-Clealum Valley From Point Clealum on the South Side of the Valley.

HISTORY OF DEVELOPMENT.

No authentic report of the earliest discovery of coal in Kittitas County has been found, although inquiry has been made of many of the oldest settlers.

Mr. Isaiah Buchanan was in the Roslyn district and knew of the coal there in 1871 or 1872 and at that time he took up land on Manastash Creek in Township 18 North, Range 15 East. He has opened a number of prospect cuts and tunnels on different beds of coal located in sections 21, 22, 15 and 16. Coal was hauled to Ellensburg about 1890 and used by the blacksmiths there. He is still working on this land and holding it for a company in the east, prospecting in different parts with open cuts and wells, and has found a number of coal beds, some good and some poor. This area is described later in the report as the Manastash field.

Messrs. Wm. McKay and Archie Anderson were among the first in the Roslyn field, and to the first named of these gentlemen we owe most of the history of the development of this field.

In May, 1886, the Northern Pacific Railway sent a party into the Clealum valley to prospect the field. Some prospecting had been done earlier by the Union Pacific, and coal was mined from the 12-foot bed, overlying the Roslyn bed, and hauled to Ellensburg as early as 1882. After carefully prospecting the field, coal was found in August at the present No. 2 mine on the east side of the draw north of Roslyn (Plate XXVII). Soon after this, Roslyn mine No. 1 (Plate II) was opened on the west side of the same draw, and the workings extended up the dip. (Plate XXIX.) In the meantime the main line of the Northern Pacific Railroad had been extended to Clealum, and the Roslyn branch, begun in the fall, was completed so that the first coal was shipped in December, 1886.

The Roslyn shaft, begun in 1893, was sunk 650 feet to coal in 1894. The shaft at Clealum was also opened in this year and the property was acquired by the Northern Pacific two years later. They opened No. 2 and No. 3 at Clealum about 1903. At that time the Clealum and Roslyn beds were thought to be different, but later developments have proven them to be the same. Roslyn Nos. 3, 5, 6, and 7 were opened respectively in 1887, 1903, 1905, and 1907.

At the western end of the field the Roslyn Fuel Company opened its Beekman mine on the Roslyn bed in 1907, although work had been done on the property as early as 1895, and the upper bed, the "Big Dirty," had been opened up in 1882. Work was resumed on this bed in 1911 and coal is now being shipped from it. The Roslyn-Cascade Coal Company began to acquire rights in 1902 in sections 6 and 12, but did not ship much coal until 1907. A number of smaller companies have worked at various times along the upper outcrop of the Roslyn bed and have taken out considerable coal; among them, the Busy Bee Mining Company, Yakima-Roslyn Coal Company, Summit Coal Company, and Inland Improvement & Mining Company. (See Table of Production, Appendix B.)

The Lakedale mine, on a bed lying below the Roslyn, was opened in 1908-1909 and shipped coal for two years but has been idle since that time. Plant's mine on the same bed has been in operation for about a year, although opened as a prospect in 1910. This lower bed is also opened up in several prospects in the Teanaway basin, but no mining has been done on that side of the ridge. For location of these different properties see large mine map, Plate II.

In 1889, W. A. Jordan and Charles Helm found coal along lower First Creek, about 20 miles north of Ellensburg. They sunk a shaft and drove a tunnel on the bed for some distance. (Fig. XXV.) From these prospects a considerable quantity of coal was hauled to Ellensburg, but they were abandoned on account of the low grade of coal in the bed. About 1902 or 1903 coal, which proved of little value, was discovered farther up First Creek opposite Green Canyon.

In 1890 the same men, prospecting up Wilson Creek northeast of Ellensburg, came over the divide to the head of Williams' Creek, and found a thick bed of dirty coal on the west face of Table Mountain, several thousand feet above the Williams'

Creek valley (Plate I). A slope was driven on the coal for some distance, but on account of its inaccessibility, little coal was ever shipped from this locality. (Plate XXVI.)

In 1899 John H. Carothers, in company with his brothers, Wm. H., Andrew H., and several other men, prospecting along the south fork of the Taneum Creek in Township 19 North, Range 15 East, sections 27 and 28, 33 and 34, found coal along the south wall of the valley and opened several prospects on the outcrops. (Plate VI.) They also drove short tunnels on the beds, but never shipped any coal. A number of prospect wells and short tunnels were also made on the north side of the valley, but very little coal was found in these. This area is described later in the report as the Upper Taneum field.

Within the last ten years a few prospects have been opened on the north fork of the Taneum Creek in Section 20, Township 19 North, Range 15 East, by Mr. Hooper, who has a homestead in this valley. These are on the continuation of the same formation as those just described, but little coal of any value has yet been discovered.

In the fall of 1905 Joseph Wilson found coal on his homestead, on Taneum Creek, in Township 19 North, Range 16 East, Section 33, and, tunneling in on a 14-foot seam, has sold coal locally ever since. During the winter of 1908, about 300 tons of this coal were taken out for use by the ranchers of Kittitas valley. In 1909 the Chicago, Milwaukee & St. Paul Railroad put down several bore holes in this part of the canyon, but did not take up the land. In 1910 the property was leased by the Northwest Coal Company of North Yakima and the work of gouging out the coal was continued. In 1912 the property was subleased by Hawkins, Williams & Murray Company and regular mining operations begun. Coal was shipped by carload lots from Thorp, with the disadvantage of a 10-mile haul to the railroad. This area is described later in the report of the Lower Taneum field.

In 1908 or 1909 Mr. Pearson discovered a thin bed of coal on the upper Naneum Creek, about 25 miles north of Ellensburg. (Plate I.) A prospect slope was driven for 30 or 40 feet but was abandoned on account of the poor quality of the coal.

## CHAPTER I.

## GEOGRAPHY AND GEOLOGY OF KITTITAS COUNTY FIELDS.

### GEOGRAPHIC POSITION.

The coal areas lie on the east slope of the Cascade Mountains, under the western edge of the Columbia Lava Plateau, at elevations ranging from 2,000 to 4,500 feet. Immediately north of the field the Wenatchee Mountains, a secondary ridge transverse to the general direction of the Cascade Mountains, reaches its highest elevation, 9,470 feet, in Mount Stuart. (Plate IV A). The elevation of the Cascade summit west of the field is between 4,000 and 6,000 feet.

Three large lakes, Keechelus, Kachess, and Clealum, held behind glacial barriers in long, almost parallel glacial troughs. extending southward from the Wenatchee ridge, serve as reservoirs for the Yakima River, which, with its numerous tributaries, drains the area toward the southeast. Aided by the glaciers, and on account of the heavy precipitation in the mountains, the rivers have been able to reduce this part of the county to a mature stage of dissection with deep valleys and sharp, narrow divides. The master stream and its larger tributaries have been able to erode rather low grade valleys far back toward their sources in the mountain mass, thereby furnishing the railroads with a good grade directly into the heart of the Roslyn-Clealum field. Thus Lake Keechelus, near the head of the valley, is only 2,456 feet above sea level, while the highlands about it are 5,000 feet. Thirty miles from the main stream, on the Clealum River at Hyas Lake, a few miles from its source, the valley is 2,500 feet below the surrounding summits.

### TOPOGRAPHIC RELATIONS OF THE VARIOUS FIELDS.

As the rivers leave the mountain valleys and cut into the Columbia Lava Plateau, with rapidly decreasing precipitation, the topography assumes an entirely different aspect. The

A. Teanaway Basin, Showing Deeply Eroded Valley in Roslyn Sandstone and Mt. Stuart.

B. Teanaway Basin, Showing North Side Slope of Roslyn Ridge and Outcrop of Roslyn Sandstone.

streams still cut deep valleys, but the divides are broad and comparatively flat. Where the rivers are working in less resistent rock the valleys are broad, but in the intervening ridges of more resistent rock the valleys are steep-walled canyons, and the rivers have a strong gradient. Thus in the softer Roslyn sandstone the Yakima and Clealum rivers have developed a broad flat valley with steep rugged slopes on the south and west, but gentle rounded slopes to the northeast. (Plates III, V and XXVIII.) The Teanaway River, also working in the Roslyn sandstone, has eroded a broad valley east of the Clealum valley with steep slopes on the Teanaway side of the divide. (Plate IV.) The coal measures are present in this divide, and outcrop along the Teanaway side of the ridge, dipping gently toward and under the Clealum valley. (Plate I, Structure Section.)

A broad ridge south of the Yakima-Clealum valley separates it from the Taneum valley. Here the Taneum Creek, an eastward flowing tributary of the Yakima River, has cut a deep valley through the overlying igneous rocks and exposed the Manastash formation in two localities, one at an elevation of 2,200 feet, and the other at an elevation of 3,200 feet, described as the lower and upper Taneum fields. (Plate VI.) The Taneum valley below the lower coal area furnishes a fairly good grade to Thorp, a town on the Northern Pacific and Chicago, Milwaukee & St. Paul railways, ten miles distant.

A second east and west flat-top divide separates the Taneum valley from the Manastash valley, where the same formation is exposed at an elevation of about 4,500 feet in a basin surrounded by steep rugged hills of igneous rock. Through this rim the Manastash Creek cuts a deep canyon in its course eastward to join the Yakima River at Ellensburg, twenty-four miles distant. (Plate VIII.) The road from this basin passes over the high lava plateau lying between it and Kittitas valley along the Yakima River.

A. Looking South Toward Point Clealum, Showing River Terrace on South Side of Yakima Valley and Igneous Rock Rim of the Valley.

B. Looking North Over Roslyn Sandstone Hills, Showing Tramway to Summit Mine.

## GEOLOGICAL RELATIONS OF THE COAL BEARING FORMATIONS.

### GENERAL STATEMENT.

The geological relations of the coal bearing formations may be best explained by a brief description of the various formations, and the prinicpal events in the history of this section during later geological periods. The stratigraphic relations of these periods is shown in the following table:

| | | |
|---|---|---|
| Cenozoic Era | Quaternary | Recent |
| | | Pleistocene |
| | Tertiary | Pliocene |
| | | Miocene |
| | | Eocene |
| Mesozoic Era | | |
| Paleozoic Era | | |
| Algonkian Era | | |
| Archean Era | | |

### PRE-TERTIARY FORMATIONS.

The oldest rock exposed in the area is the Easton schist, found underlying the Manastash formation west of Clealum, along Taneum Creek, and along the south fork of Manastash Creek. (See Plate I.) It varies considerably in composition and appearance, but is commonly a hornblende or a mica schist, dark gray, almost black, green or silver gray in color. It is badly crumpled and seamed with numerous quartz veins and stringers, and is probably of sedimentary origin.

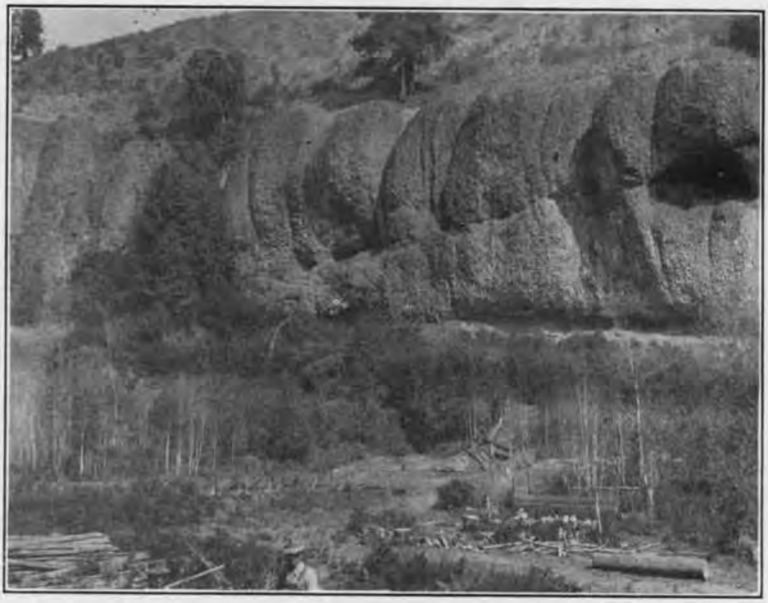
Associated with this formation north of the area studied are the Peshastin and Hawkins formations, and later intrusions of granodiorite and peridotite, now largely altered to serpentine, all furnishing a complicated record of sedimentation and vulcanism in pre-tertiary time.

### TERTIARY SYSTEM.

#### Eocene Series.

*Swauk Formation*—Early in the Eocene time a long period of erosion allowed the older rocks to be deeply dissected and worn down. The waste thus furnished was deposited as thick

A. Tunnel on Contact Between Easton Schist and Manastash Formation; also Tunnel at Station 16, Carother's Field, Upper Taneum Creek.



B. Yakima Basalt on Lower Taneum Creek, Showing Location of Drill Hole at Base of Cliffs.

beds of gravel, coarse sand, and mud about the eroded highlands, giving rise to what is now called the Swauk formation of coarse conglomerate, sandstone, and shale, measuring in places 5,000 feet in thickness. (Plate VII B.) Since this formation contains no marine fossils it is believed that these deposits were formed in a large lake, and the present irregular distribution of the formation indicates a lake of very irregular outline. The Swauk formation contains a few carbonaceous shale beds, and these are quite rich in fossil leaves, from which Dr. F. H. Knowlton has placed it in the lower Eocene.

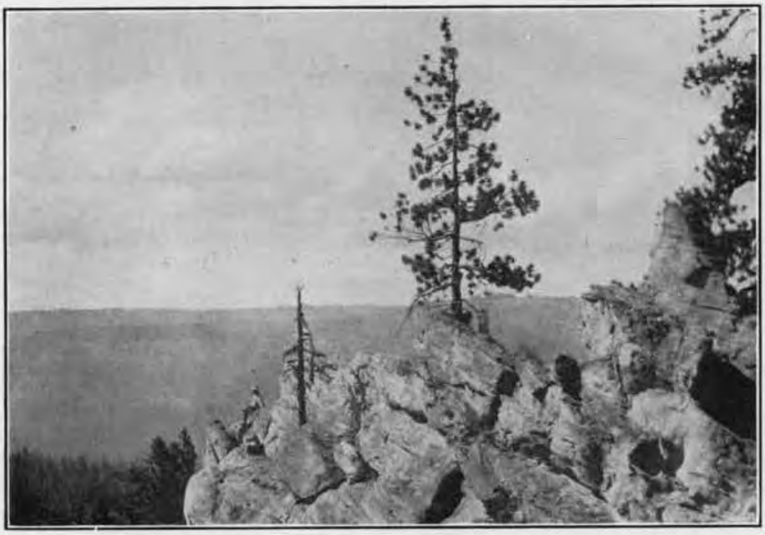
*Teanaway Basalt*—Uplift with folding caused considerable erosion of this formation before volcanic activity began, which covered the eroded surface with a series of lava flows, in places attaining a thickness of over 5,000 feet. The lava reached the surface through numerous fissures in the sandstone and other underlying rocks, and spreading out over the surface formed great sheets of basalt, known as the Teanaway basalt, from the fine exposure of the sheets and the feeding diabase dikes in the upper valley of the Teanaway River. (Plate I.) In many localities the presence of steam in the lava seems to have caused a breaking up of the molten mass, forming thick layers of tuff interbedded with the lava flows and with the lower beds of the overlying Roslyn formation.

Where the diabase dikes cut the Swauk formation, many veins of quartz, calcite, and talcose materials branch out into the sandstone. They carry gold with silver in considerable quantities and have been worked for a number of years along Williams Creek, a tributary of the Swauk Creek, where it has cut a deep valley into the sandstone.

This period of volcanic activity was followed by a period of erosion on the highlands and deposition in several distinct basins, two of which are included in the area covered by this report.

*Roslyn Formation*—In the Roslyn-Clealum basin beds of coarse sand and clay aggregating 3,500 feet in thickness were laid down over an area of at least 140 square miles. At the base

A. Yakima Lava at Summit of Mt. Baldy Above Swauk Formation at Head of Naneum Creek.



B. Swauk Sandstone Near Head of Naneum Creek. Table Mountain Showing in the Background.

of the formation these beds are interbedded with lava sheets and tuff beds, indicating that vulcanism continued after sedimentation had begun. In the upper part of this series, known as the Roslyn formation, is found the most important supply of coal in Kittitas County. There are at least ten beds of coal, only four of which have been worked at all, and of these only two are real producers. They lie in a synclinal trough extending from Clealum on the Yakima River to Lakedale, near Lake Clealum. (Plates I and II.) This formation overlies the Teanaway basalt conformably and passes beneath the Yakima basalt on the southeastern side of the basin, although for the most part it is covered only by Quaternary deposits. From a collection of fossil leaves Dr. F. H. Knowlton has determined the age of this formation as Eocene, later than the Swauk formation, and with entirely different flora. The full description of the Roslyn-Clealum field will be found in Chapter III of this report.

*Manastash Formation*—In the Manastash basin farther south a series of conglomeratic sandstones and shales were laid down directly on the eroded surface of the Easton schist. In some cases a distinct basal conglomerate is found, containing pebbles of earlier rocks, and numerous coarse pebble and boulder bands are found throughout the formation, containing white quartz pebbles. The fossil leaves found in the fine shales of the formation have been examined by Dr. F. H. Knowlton and not a single species found in the Roslyn or Swauk sandstones has been found in the Manastash formation, but they correspond to the flora of the Clarno beds of Oregon. He therefore classes this formation as upper Eocene, later than the Roslyn.* With the exception of the small area west of Clealum, it is overlain by the Taneum andesite or by the Yakima basalt. (Plate I.) Numerous thin and more or less impure coal beds are found in different sections where these measures are exposed. These are described more fully in Chapter IV.

* Mount Stuart folio No. 106, U. S. Geol. Survey, 1904.

A. Narrows Below Coal Felds in Manastash Canyon.

B. Basalt and Tuff Cliffs in Narrows Below Manastash Coal Fields.

### Miocene Series.

The decided unconformity between the coal bearing formations and the overlying igneous rocks indicates a long period of erosion between the uplift and folding of the Eocene rocks and the extrusion of immense flows of Miocene lavas.

*Taneum Andesite*—The earliest of these flows is the Taneum andesite which is found overlying the Manastash formation, on the south fork of Taneum Creek, on Frost Creek, and on the northern border of the Manastash field farther south. (Section, Plate I.) This formation varies in thickness from less than 300 feet in the Manastash basin to 1,500 feet in the Taneum basin. It is made up of tuffs, tuff breccias, and loose textured lavas occurring in high cliffs underneath the Yakima basalt in the canyon of Frost Creek. Closely associated with this extrusive mass is the intruded andesite or diorite porphyry of Clealum point across the Yakima River from Clealum. (Plate VIII A.)

*Yakima Basalt*—Following the extrusion of Taneum andesite and lying on the eroded surface of it and older formations is the Yakima basalt. (Plates I and VII A.) This mass of lava was extruded quietly through numerous fissures and flooded not only this section of Kittitas County but covered an area of 200,000 square miles, including southeastern Washington, eastern Oregon, and southwestern Idaho to a depth in some places of 5,000 feet, filling deep depressions and obliterating previous surface irregularities. The lava mass is not one continuous flow, but is made up of a series of interlocking or overlapping flows interbedded with deposits of surface debris. Where the older underlying rocks have since been exposed by erosion the conduits may be seen as diabase dikes or stocks. None of these dikes so far as known interrupt or cut the coal measures of the Roslyn-Clealum field, but they are an important disturbing factor in the Manastash coal field.

*Ellensburg Formation*—Even before the last flows of andesite and basalt were extruded sedimentation began again. Over the low basalt plains was spread a thick series of volcanic sediments of foreign origin, containing fragments of pumice, volcanic ash, sand, and gravel, known as the Ellensburg formation. The coarse texture of much of the material, the presence of stream bedding, and the andesitic nature of the fragments, indicate the action of powerful streams flowing from the andesitic upland mass west of the area, carrying heavy loads of sand and gravel out over the lower lava plains. These streams were so overloaded with sediment that they built up great alluvial fans, spreading the materials for miles over the gently sloping surface. Some of the beds of finer material are no doubt of eolian origin, or showers of volcanic ash derived from volcanic eruptions in the neighboring highlands. Regular stratification in some sections of this formation indicates deposition in water, due possibly to local ponding at different times.

#### Pliocene Movements.

During the earlier part of the Pliocene, or later part of the Miocene, there occurred a gentle folding or warping of the earlier formations with a decided uplift that caused increased erosion. This was continued until the whole region was reduced to a lowland surface, slightly rolling and since called the Pliocene peneplain. The Yakima River and its tributaries, after planing off the surface, flowed over it with little regard to rock structure and a well-developed meandering course. This plain is well preserved in the region about the Kittitas coal fields and is fully described in the Ellensburg Folio No. 81, and the Mount Stuart Folio No. 96 of the U. S. Geological Survey.

The closing event in the Tertiary period was the uplift of the whole Cascade Mountain mass to form what has been called the "Cascade Plateau," the remnants of which are still plainly seen in the more resistant rocks. (Plate IX.) The uplift was accompanied by a gentle folding or warping, following in general the lines of previous warping, which caused a number of ridges in the lava plains to be raised transverse to the general trend of the Cascade Mountains and the course of the Yakima River. Across these ridges the river and its stronger tributaries were able to maintain their courses and began to

A. View From Head of Manastash Creek, North Fork, Showing Old Cascade Peneplain Level and Deep Dissection by Streams.

B. View Down Frost Creek Valley, Showing Deeply Dissected Nature of Country.

intrench themselves in deep canyons. On account of this relation the rivers have been called "antecedent" streams, and the principal topographic features of the field are the result of the work of the rivers in cutting deep canyons in the uplifted resistant rocks or opening out wide valleys in the less resistant rocks exposed to river erosion.

Thus the Yakima, the Clealum and the Teanaway Rivers, working in the soft Roslyn sandstone, have eroded broad valleys (Plates III to V) and removed a considerable part of the coal-bearing formation. The coal measures in Taneum and Manastash valleys are exposed where the rivers, having cut through the overlying andesite or basalt, are eroding their valleys in the less resistant formations, due to local upwarp in these sections. (Plate I.)

## QUATERNARY SYSTEM.

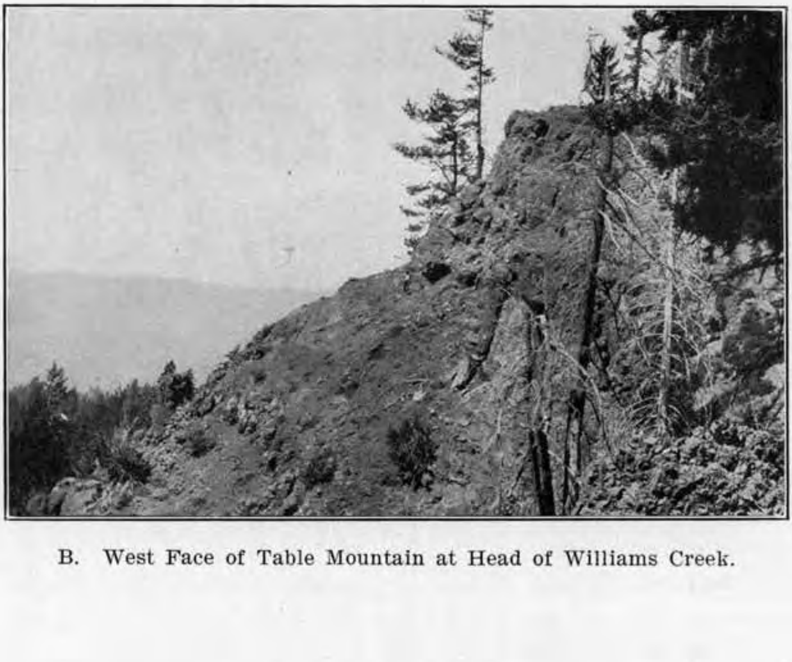
### Glaciation.

The Quaternary period has been one of active erosion of the "Cascade Plateau" into its present form. Early in the period the climate changed, gradually becoming colder. Deep snows collected on the mountains north and west of Kittitas County, and, filling the higher valleys in some cases, crept down them as glaciers to the main valleys of the Yakima River. The largest glaciers extended southward from the mass of ice collected on the Wenatchee Mountains, in the three valleys now occupied by lakes Keechelus, Kachess, and Clealum. The lower limit of these glaciers was for some time about the position of the lower ends of the present lakes. Here they built up heavy terminal moraine barriers across the valleys behind which the lakes were formed when the ice receded. The Clealum valley probably contained the longest glacier, about twenty to twenty-five miles in length.

### Pleistocene Gravels.

In the valleys below the limits of glaciation the streams were so loaded with detritus from the melting ice front that they were not able to carry it when they reached the lower grade valleys,

A. Yakima Basalt at South End of Table Mountain.



B. West Face of Table Mountain at Head of Williams Creek.

and deposited it as a deep gravel filling in the valley bottom. After the glaciers receded the load of the rivers diminished and they began to re-excavate their valleys in the glacial gravels. This work is still going on, and the result is a series of gravel terraces along the Yakima River and its larger tributaries at different heights above the river. (Plate V.) In the Roslyn-Clealum field the gravel covering over the Roslyn formation in the Clealum and Yakima valley reaches a depth of over 300 feet and has entirely covered the southeastern part of the formation. Scattered over the hills of the Roslyn formation at considerable elevations above the town are numerous glacial boulders.

In the Manastash and Taneum fields no evidence of glaciation extending as far down the valleys as the coal fields was observed. These valleys were probably occupied by very short glaciers, even at the time of maximum glaciation.

#### Landslide Topography.

A striking feature in the topography of the basalt rim, bordering in part the coal areas, is the occurrence of numerous landslides. Heavy masses of the basalt tablelands, undermined by the erosion of the underlying sandstones, have become detached from the steep cliffs, and pushing downward have come to rest in the form of a series of steps below the upper escarpment. These forms are common on Lookout Mountain southeast of Clealum, and on Table Mountain at the head of Williams Creek. (Plate X.)

#### Changes in Drainage.

Many readjustments of drainage have occurred along the Yakima River, and since one of these has been effective in exposing the coal beds on First Creek, which are mentioned later, the conditions leading up to it will be described in detail. By referring to the general map (Plate I), the changes may be readily followed.

Where the Yakima River leaves the Roslyn-Clealum valley its antecedent character is well shown. Here it has cut a narrow canyon, 1,200 to 1,500 feet deep across the uplifted northwestern edge of the great basalt plateau. For a distance of over ten miles it has intrenched its valley, with well developed meanders, below the surface of the old plateau on which the meanders were developed. The glacial gravel filling, already described, extends through this gap and forms finely developed gravel terraces above the present river level. Two large tributary streams, the Teanaway and the Swauk Creeks, join the river near the gap. They both appear formerly to have had their course across the basalt rim, but on account of differences in the power of the streams, and in the resistance of rocks across which they had to erode their valleys, rather interesting readjustments have taken place since the last uplift.

The Teanaway Creek, one of the largest tributaries of the Yakima River, now flowing into it on the Roslyn sandstone northeast of Lookout Mountain, formerly flowed by way of what is now called Swauk Prairie through the valley occupied by Swauk Creek into the Yakima River. The Swauk Creek flowed through Horse Canyon as a tributary of the lower Teanaway. But a tributary of the Teanaway, a stronger stream working in the softer Roslyn sandstone, captured the headwaters of the Swauk Creek and later, since the Yakima was able to lower its gap in the basalt rim more quickly than the Teanaway, it captured the headwaters of the Teanaway, by means of a tributary from the east, and took them out along the softer formation, leaving the smaller Swauk Creek in its old channel.

The most recent adjustment here, and the one referred to above, is in First Creek that formerly flowed through and cut Green Canyon. It now flows into Swauk Creek through a deep canyon, along a narrow belt of soft Roslyn sandstone, north of and below the ridge of hard Yakima basalt in which Green Canyon is cut. The coal beds described later are exposed in the young valley freshly cut in the Roslyn sandstone. (Plate XXV.) So recent is the capture that the new valley is not eroded very far back from Green Canyon, and by going up stream about one mile the head waters of First Creek are still taken out through Green Canyon, their old channel, for irrigation purposes. Below Green Canyon the old valley, a large flat-floored dry creek bed, is now called Dry Creek.

## CHAPTER II.

## GEOLOGY AND CLASSIFICATION OF COAL.

### HISTORY OF FORMATION.

From a geological standpoint coal must be considered as a sedimentary rock, interstratified with other common sediments, such as sandstones, shales, and conglomerates. Thus in the Roslyn formation, consisting of approximately 3,000 or 4,000 feet of sediments, there are 10 or more coal beds, varying in thickness from 20 inches to 15 feet, but aggregating about 47 feet of more or less pure coal. (Figs. 3 and 4.) No way is known by which such large beds of carbon could be formed, except by the accumulation of vegetable matter, and proof of the vegetable origin of these beds is seen in the presence of plant remains in the beds of shale and sandstone associated with the coal, and in the remains of trees and other forms of vegetation in the coal itself. From the fossil leaves contained, and the nature of the sediments and their distribution, it is thought these beds were laid down in a lake basin of irregular outline.

There is, however, some difference of opinion concerning the way in which these immense beds of vegetable matter accumulated, and the conditions under which they were converted into the various classes of coal. Much of the coal in different beds is practically pure, containing little matter that was not present in the plants from which it was formed. In the Roslyn bed, which is 4 feet 6 inches in width, there are in general only two very thin clay partings; it is also quite uniform throughout the entire field of 10,000 acres. The purity and uniformity of such a bed points to the conclusion that it must have been built up of vegetation growing where the coal is found at present. If it were made up of vegetation carried from the surrounding slopes into the basin, it would certainly have been mixed with clay and sand which would have caused more numerous partings, and it would not show the uniformity in character and thickness that it does throughout the field.

The fact that the most delicate portions of plants are frequently preserved intact in the coal, along with tree trunks and larger branches, could hardly be explained by transportation of material for any great distance, or by any method of accumulation other than the growth in place of the bulk of the vegetation forming the coal. But while this explains the formation of large masses of uniform, pure coal, it is not to be understood that some coal beds, or portions of some of the beds more or less pure, may not have been formed by vegetable matter carried into swamps, along with other sediments, by rivers or other transporting agencies. The absence of partings indicates also that very little silt was washed into the basin during the collection of the vegetable matter.

### CONDITIONS FAVORABLE TO COAL FORMATION.

The conditions under which such collection in place might occur are exemplified at present in various marshes and peat bogs. They are the only places where such collection of vegetation is going on without the addition of large quantities of sediment, and those that are most free from sediment are surrounded by low lying land from which little sediment is derived. The condition for the collection, preservation, and change of vegetation into the different varieties of coal are well described in a report on the Peat Deposits of Ohio by Alfred Dachnowski.*

The most favorable conditions for development of peat bogs are the accumulation of plant debris in relatively permanent bodies of water or in moist shallow swamps. In either case chemical disintegration is brought about partly by weathering and partly by bacteria and fungi, but with restricted access of air. By the aid of the bacteria and fungi the plant tissues, largely covered by water, at first undergo a very slow chemical decay. Later as they become buried under deeper layers of vegetation, and are protected from atmospheric oxidization, they

* Bulletin 16, 4th Series, Geological Survey of Ohio, 1912. Peat deposits. By Alfred Dachnowski, pp. 21-23.

are subject to fermentation and reduction processes, and to gradually increasing pressure. By such changes certain gases and moisture are set free and the plant tissue becomes carbonized to peat, lignite coal, bituminous coal, and finally to anthracite coal.

### TIME NECESSARY FOR COAL FORMATION.

The period of time necessary for the collections of the vegetation and for the formation of coal is always an interesting matter, even though the estimates are based on insufficient data, and lead only to approximate figures. It has been estimated that if the products of a vigorous annual growth of vegetation were all preserved for 1,000 years and compressed to the same density as coal, without any loss, it would give rise to a layer about 6 inches thick. But this would include much vegetable matter that escapes during the process of coal formation and if we take an average of about 40 per cent of the vegetable matter remaining to form coal it would yield about 2 inches per 1,000 years, or a foot of coal in 6,000 years. For the Roslyn bed, which is 4 feet, 6 inches thick, it would require about 25,000 to 30,000 years for the collection of the vegetation alone under conditions as we know them at present. Adding to this the indefinite time necessary for the collection of the thousands of feet of sand and shale, and other coal beds, and the time necessary for the conversion of the vegetation into coal, we have a very rough approximation of the long period of time required for the development of the coal bearing formation of the Roslyn basin.

### OCCURRENCE OF COAL.

From a study of the formation of coal we are led to think of the coal beds as being built up in almost horizontal layers in the various coal basins in the county. But we must also consider the fact that these swamp basins were limited in extent, and that if we could trace the coal beds to the border of the old swamp they would gradually thin out and disappear. The complete section of a coal bed would therefore be in the form of a very much flattened lens, and not a bed of uniform thickness throughout unlimited areas. The uneroded portions of the different beds examined do not show this peculiarity, because apparently only the central thicker part of the coal bed is left and we see the exposed edges of these thicker portions.

### IRREGULARITIES DUE TO MOVEMENTS OF THE EARTH'S CRUST.

None of the Kittitas County coal beds studied are at present in their original horizontal position. They are all tilted more or less in different directions, even in the same bed, and this is largely a result of the compression to which this portion of the earth's crust has been subjected during the development of the Cascade Mountains. After the formation of the coal an uplift or series of uplifts, accompanied by folding and faulting of the coal-bearing formations, changed the attitude of the coal beds and caused them to dip at various angles in different directions. (Plates I and II.)

Thus the Roslyn bed is in the form of a large but simple synclinal fold with axis running irregularly in a northwest northeast direction. The fold is not symmetrical, as we find the beds on the north side of the fold dipping at a low angle, (Plate XXII.) while the beds on the south side dip at a higher angle toward the axis. The axis of the fold is not horizontal, but pitches to the southeast, going deeper under cover at the eastern end of the field, and causing the coal to outcrop in curved form at the western end of the field. Several faults and variations in thickness of the Roslyn bed occur where the dip changes. For description of these see Chapter III, "Folds and Rolls in the Roslyn Bed," and Figures 6 to 29.

In the upper Taneum field the coal stands at higher angles and is badly crushed, indicating more intensive folding and slipping due to stronger pressure. The same is true of the lower Taneum field, where although the coal bed dips at a low angle it is badly faulted and shattered. In the Manastash field the beds are strongly tilted and have been subject to slight faulting, no doubt due to the intrusion of the large diabase dike through this formation. (Plate I.)

IRREGULARITIES DUE TO EROSION.

Irregularities in coal beds caused by erosion may be of two general types, first, irregularities in the bed itself caused by erosion when the coal was being formed and described in this chapter under irregularities in deposition, and second, irregularities produced by erosion after the coal beds were formed and subjected to movements just described. Thus after folding and tilting occurred in the Kittitas coal fields, active river, and in some cases glacial erosion, removed a large part of the deformed strata containing the coal and left the edges of the coal beds exposed in very irregular form. (Plate I.)

The effects of erosion depend on the general style of fold, whether syncline or anticline, the direction of the drainage lines in relation to the folds, and the extent to which erosion has cut into or removed the coal-bearing formation.

In the Roslyn-Clealum field the structure is a large unsymmetrical syncline pitching to the southeast, with steep dips on the south side, and gentle dips on the north side of the axis. Two river systems, the Teanaway and the Clealum-Yakima have eroded valleys almost parallel to the axis of the fold, leaving a ridge along which the northern outcrops of the Roslyn and lower beds occur in regular outline. The southern limb of the fold has been eroded to some depth, and is hidden by the gravel filling along the Yakima and Clealum valleys, which in places is 300 feet deep. The curved form of the outcrop, at the western end of the field, is the result of the eastward pitching syncline as it brings the coal to the irregularly eroded surface. The coal beds lie in the upper part of the formation, and have thus escaped erosion only in this belt of varying width on either side of the axis of the syncline. The dip of the beds on the slope back of Roslyn and Clealum is so near that of the erosion slope, and the coal so near the surface, that the small tributary streams cutting ravines on this slope have removed irregular areas of the coal, thus adding to the irregularity of the outcrop line. (Plate II.) A comparison of the area underlaid by the Roslyn coal with the total area of the Roslyn formation, indicates the possible extent to which erosion has been effective in removing the upper coal-bearing part of the formation.

In the Manastash field the south fork of Manastash Creek has eroded its valley almost parallel to the axis of an anticlinal fold, thus causing the coal to occur on either side of the valley in irregular outcrops dipping away from the valley. Tributary valleys from either side cut the limbs of the folds, thus increasing the irregularities of the coal outcrops. The top of the fold, and the gaps in the sides have been removed by erosion, along with a considerable amount of the coal-bearing formation, leaving on either side only the remnants of once continuous beds.

In the lower Taneum field the whole exposure of the coal-bearing formation has resulted from the Taneum Creek eroding the basalt cover from a small anticline of sedimentary rocks. The erosion of the valley, at an angle across the fold with low dips on either side, has removed a larger portion of the coal, and it is found outcropping on the south side of the valley dipping westward, but it also crosses the valley or runs along through it as indicated by the presence of coal in the drill hole west of the mine. (Fig. 38.)

In the upper Taneum field the two forks of Taneum Creek cut across the uptilted edge of a series of strata containing coal at an angle of 45 degrees to the strike of the beds. In both cases the river eroding against the south side of valleys causes the exposure of the coal on the south bank, while it is hidden in the broad valley by alluvial deposits. No outcrops corresponding to those on the south valley walls were found on the north side because of the loose mantle rock cover. (Plate XXIII.)

Thus it is seen in the different fields that the relation of the present outcropping beds of boal and the amount of coal still remaining depends on the relations of the valleys to structure of the coal bearing series.

Another type of irregularity due to erosion is seen in the "Busy Bee" mine. (Plate II.) Here there seems to have been an early period of erosion which cut ravines into the slopes of Roslyn sandstone. This was followed by deposition of sands and gravels filling some of the old drainage lines. The former drainage eroded portions of the coal bed, and the bed is now found, under a regular surface, interrupted by areas of coarse sand and gravel. (Fig. 2.) This same thing occurring, when the coal beds were being formed would allow the Roslyn sandstone to occur as masses interrupting the continuity of the Roslyn bed.

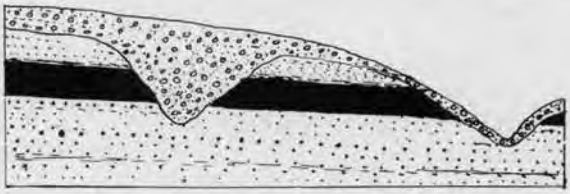


Fig. 2. Section Showing Conditions at "Busy Bee" Property.

IRREGULARITIES IN DEPOSITION OF THE COAL BEDS.

No marked irregularities in the Roslyn bed due to erosion at the time of formation, or irregular deposition of material in the swamp have been discovered. The coal varies only slightly in character and in thickness from one end of the field to the other (Figs. 26 to 29), and the conditions during formation must have been remarkably uniform, with low lying lands around the swamp, and any streams flowing into it almost free from silt. During the formation of the "Big Dirty" bed which lies above the Roslyn bed, the conditions must have changed from time to time, as the benches of clean coal in this bed are separated by layers of bony coal, carbonaceous shale, and shale. (Fig. 31.)

In the lower Taneum field there seems to have been irregular deposition of silt in the swamp from the fact that a thick band of slate appears in certain parts of the seam but is not continuous. (Fig. 40.) Many of the beds containing coal in the different parts of Kittitas County cannot be profitably worked because of the amount of sand and silt mixed with the coal at the time of formation. This is the case in the First Creek, Williams Creek and Naneum Creek beds and also in some of the

A. No. 5 Mine, N. W. I. Co. Normal Appearance of Roslyn Bed.

B. Beekman No. 2 Mine, Roslyn Fuel Co. Erosion of Coal and Gravel Filling Near Outcrop in Big Dirty Bed.

beds in the Manastash, Taneum and Roslyn field. (Figs. 42, 45 and 46.)

ROCKS ACCOMPANYING COAL.

Commonly underlying the coal will be found a layer of shale, or sandy shale, representing the soil on which the coal-forming vegetation grew. In some cases, however, a pure sandstone may underlie the coal bed. The conditions following the collection of vegetation seem to have been favorable for the collection of fine silt immediately above the coal, and carbonaceous shale, shale, and sandy shale are common roof materials.

Carbonaceous shale and bone commonly occur associated with the coal beds, and some so-called coal beds are composed largely of these materials. In any case a change laterally may take place in the bed, so that a bed of good coal in one part of the field may become bony or change to carbonaceous shale, or vice versa, due to local variations in the conditions of deposition. The bone represents a condition in which the vegetation is thoroughly mixed with silt during deposition, and the carbonaceous shale represents a close interbedding of vegetable matter with these beds of clay.

The shales found in the coal measures vary in color from light gray almost white, to dark gray, or almost black filled with carbonaceous matter. They also vary from a pure shale, with scarcely any grit, to shale with abundant sand, known as a sandy shale. The mud forming the pure shale beds was carried into the coal basins from the low surrounding country, and deposited in layers between the masses of vegetation forming the coal. No use is made of these shales at the present time in Kittitas County, but in other localities they are used for the manufacture of various clay products, as porcelain, pottery, brick and tile.

The sandstones and conglomerate, interbedded with the coal, represents stronger erosive agencies carrying coarser and heavier materials from the surrounding country in the intervals between the periods of vegetable growth and collection. Very thick layers of heavy sandstone occur in the Roslyn formation and extensive layers of coarse conglomerate are found in the Manastash formation. The nature of these beds points to a limited transportation of the materials forming them. Cross-bedding due to current action and sudden changes in thickness and texture are quite common. The sandstones are so friable that little use is being made of them for building purposes.

No limestone beds have been found in the coal-bearing formations of Kittitas County, nor any beds containing marine fossil shells. This would indicate absence of shell-forming animals in any abundance, due probably to the fact that these beds were laid down in temporary fresh water lakes. Interbedded with the regular sedimentary rocks of the series, are thin beds of volcanic ash mixed with clay, collected from volcanic eruptions during the periods when the basins were occupied by lakes.

The coal beds are also closely associated with igneous rocks of the basaltic type. The Roslyn formation was underlaid and capped by basalt, but no dikes have been found cutting it. (Plate I.) The Manastash formation was capped by basalt and is only exposed at present where the basalt has been eroded. (Plate I.) Cutting through it in various localities are numerous diabase dikes which no doubt represent the filled conduits or feeders of the surface flows. These dikes offer serious obstacles to the continuity of the coal beds in the Manastash field. (Cross sections and map, Plates I and XVIII.) The Taneum field and the Manastash field are separated only by an area of the basalt cap that has not been eroded. The Taneum coal beds are also greatly disturbed, probably by the proximity of intrusive masses of lava.

## CLASSIFICATION AND ANALYSES OF COAL.

A general, simple, and satisfactory classification for all grades of coal has not been finally decided upon by coal operators, or even by the United States Geological Survey. But a classification based upon analyses of a large number of samples, and used in the trade and in the eastern coal field includes the following divisions: (1) anthracite, (2) semi-anthracite, (3) semi-bituminous, (4) bituminous, (5) sub-bituminous, (6) lignite, and a still lower grade, (7) peat. The general criterion for distinguishing these groups is that of the "fuel ratio," or the quotient of the fixed carbon divided by the volatile matter. This classification also follows closely the relative amounts of fixed carbon.*

The following table shows proximate analyses of coals of the more important divisions compared with coal from the Roslyn-Clealum field.

PROXIMATE ANALYSES OF COALS.*

| | Peat | Lignite | Bituminous | Anthracite | Bituminous |
|---|---|---|---|---|---|
| | Dismal Swamp | California | Illinois | Pennsylvania | Roslyn No. 2 |
| Moisture | 20.22 | 10.80 | 5.50 | 3.16 | 3.10 |
| Volatile matter | 52.31 | 43.10 | 39.50 | 3.72 | 35.6 |
| Fixed carbon | 24.52 | 38.57 | 54.60 | 81.14 | 48.8 |
| Ash | ........ | 7.53 | 5.40 | 11.08 | 12.47 |
| Sulphur | ........ | ........ | ........ | 8.99 | 0.35 |
| Fuel ratio | .47 | .87 | 1.38 | 21.83 | ........ |

* Taken from table pp. 6-8, Ries' Economic Geology of United States.

In connection with the classification based on fuel ratio, E. E. Smith in his report on the Coals of Washington describes the physical characteristics of the different classes of coal as follows:†

"1. Anthracite may be defined as a very hard, jet-black coal having a dense homogeneous texture, a bright luster, irregular conchoidal fracture, burning with a short blue flame, and having a fuel ratio of 10 or more. The coal from the Scranton-Wilkesbarre district in Pennsylvania is typical anthracite.

"2. Semi-anthracite is below the grade of anthracite, but its limits are not well defined. In general, it is fairly hard and

* For a detailed description of the classification of coals, see (1) Professional Paper No. 48, U. S. Geological Survey, pp. 156-173, Classification of Coals, by M. R. Campbell. (2) Bulletin No. 1035, Canadian Geological Survey, p. 44, Scheme of Classification, by D. P. Dowling.

† Bulletin 474, U. S. Geological Survey, Coals of Washington, by E. E. Smith, pp. 8 to 10.

bright, but it resembles bituminous coal in that it is more or less affected by minute jointing. It contains a considerably lower percentage of volatile matter than bituminous coal and has a fuel ratio of about 6 to 10.

"3. Semi-bituminous coal is the next group below the semi-anthracite and above the bituminous. This group includes some of the best known coal of the country, such as Pocahontas coals of Virginia and West Virginia, and most of the coal of Arkansas. The fuel ratio of coal of this group ranges approximately from 3 to 6.

"4. Bituminous coal includes all so-called 'soft coal' which is lower in fuel ratio than semi-bituminous coal and which does not contain sufficient moisture to cause it to crumble (mechanical breaking down not being considered). In the State of Washington coal from the mines operating at present in Pierce and Kittitas Counties and from the Black Diamond and many other mines in King County is typical bituminous coal.

"5. Sub-bituminous coal has generally heretofore been called 'black lignite.' The criteria for the distinction of coal of the sub-bituminous group are in general (1) grayish black or black color; (2) almost universal absence of a distinct system of joints; (3) high percentage of moisture, which is given off readily on exposure to the sun or air, thus producing the peculiar irregular weathering spoken of as "slacking," and (4) the tendency of many of these coals to separate on weathering into thin plates parallel to the bedding. Of these features the color and the manner of weathering are the most characteristic. The color distinguishes the group from lignite; the manner of weathering separates it from bituminous coal. Fresh blocks of sub-bituminous coal, when exposed to the air or to the direct rays of the sun, tend to break up independently of the joint planes into smaller and smaller fragments having irregular faces. The fresh coal has a bright luster and an irregular conchoidal fracture; the resultant fragments are lusterless and their surfaces do not show an even fracture of any kind. Certain sub-bituminous coals have high heating value and will stand transportation in closed cars without 'slacking,' but will check slightly when exposed to the direct rays of the sun in open cars. Such coal is evidently near the border line between the bituminous and sub-bituminous groups.

"6. Lignite is distinguished from sub-bituminous coal by its color, texture, and amount of moisture. It is brown in color or has a distinctly brownish cast. The texture is usually more or less distinctly woody, although some lignite, notably that of Texas, is amorphous. The amount of moisture is greater than that of sub-bituminous coal, and ranges from 25 to nearly 45 per cent. The lignite of North Dakota is typical of this group. The name lignite is perhaps more loosely used at the present time than any other in the list. On the Pacific coast, especially in the State of Washington, this term is applied to all the coals commonly classed as 'lignite,' 'brown lignite,' 'brown coal,' 'black lignite,' 'lignitic coal,' and very frequently to a good grade of bituminous coal."

The coals from Black Diamond, Carbonado and Roslyn are often referred to as lignite, though they are the best bituminous coals of the state.

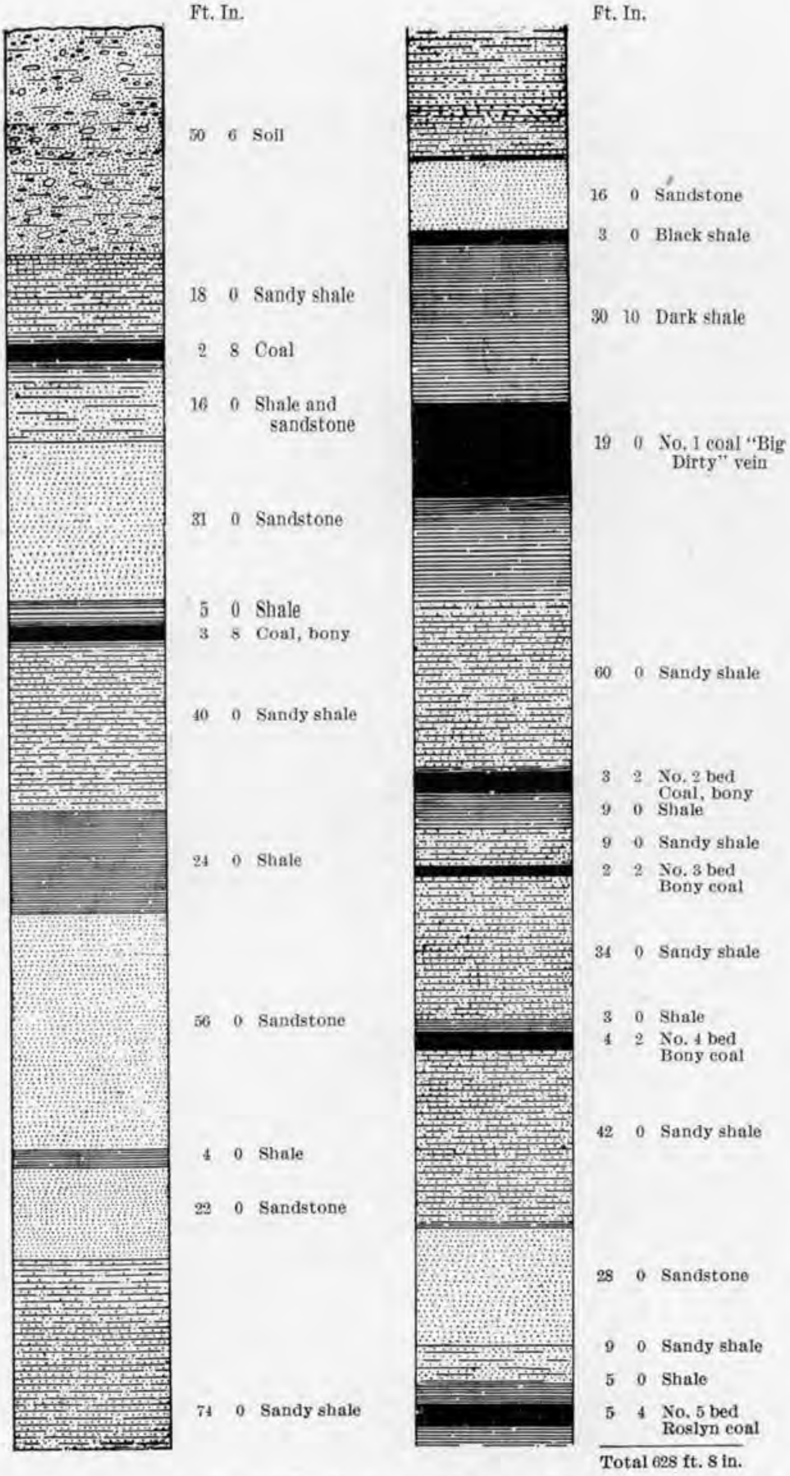



**Fig. 3. CROSS-SECTION OF COAL MEASURES AS SHOWN IN ROSLYN SHAFT.**
**Section 17, T. 20 N., R. 15 E.**

# CHAPTER III.

## DETAILS OF THE ROSLYN-CLEALUM FIELD.

### GENERAL DESCRIPTION.

#### LOCATION AND EXTENT.

The Roslyn-Clealum coal field, one of the most productive on the Pacific coast, is located along the Yakima and Clealum River valleys. It extends diagonally across T. 20 N., R. 15 E. from the town of Clealum, on the Northern Pacific, and Chicago, Milwaukee & St. Paul railroads, about six miles northwest to Lakedale near the lower end of Lake Clealum. It includes at the western end of the field part of sections 1, 2, 11, 12 and 13 of T. 20 N., R. 14 E. and sections 35 and 36 of T. 21 N., R. 14 E., and at the eastern end of the field a few sections in the west central portion of T. 20 N., R. 16 E. (Plate I, shaded area.)

From the outcrops along the northern edge of the field, and the drill hole records and mine workings in other parts, it is estimated that the total area of the section underlaid by more or less productive coal measures is about 26,000 acres. Most of the coal mined at present, however, is taken from the Roslyn bed, and the area over which this extends is only about 10,000 or 11,000 acres, or less than half the total area. In Plates I and II the larger area is shown by a dotted line indicating the estimated extent of the lower beds and the smaller area is shaded showing probable extent of the Roslyn bed. The northern border is both cases is definitely marked by the outcropping seams, but the southern border is more or less indefinite because it is deeply covered by valley gravels, and drill hole records are not complete over the entire section.

The coal occurs in the upper part of a series of sandstones and shales known as the Roslyn formation. This formation occupies a basin surrounded by Teanaway basalt except on the southeast side, where it disappears under a high rim of Yakima basalt, the most prominent part of which is called Lookout Mountain. The total area underlaid by the coal bearing measures is about 140 square miles or 90,000 acres. This basin has been strongly eroded by, and is now drained by the Yakima and its two tributaries, the Clealum and Teanaway Rivers, the latter furnishing a well exposed section of the lower part of the formation. (Plate I.)

Along the southwest side of the basin the formation is exposed in a few small areas ranging in elevation from 2,300 feet to 3,000 feet immediately in contact with the rim of Teanaway basalt. Where observed, the formation seemed to be badly broken, with variable dip but always toward the valley and quite steep. For a distance of one to three miles across the valley the formation is entirely hidden by the terraced river gravels, varying in depth from 100 to 300 feet. The structure and content of the formation here can only be worked out from drill hole records. In Plate I the whole area is mapped as Roslyn formation, no account being taken of the gravel cover, but wherever the depth of the gravel filling could be ascertained it was used in drawing the cross sections of the field in Plate II.

North of Clealum and Roslyn the formation has been left as a prominent ridge, ranging in elevation from 3,300 feet to 3,800 feet, which separates the Teanaway basin from the Roslyn-Clealum basin. (Plate III.) The coal outcrops along the Teanaway side of the ridge dipping gently toward the valley or in the reverse direction from the dip south of the river. It also forms a series of low cliffs along the different branches of the Teanaway river, (Plate IV), where it dips toward the southwest, and is exposed to its base on the Teanaway basalt northeast of the basin. The nature of the rocks comprising the formation is well shown along the Teanaway, and will be described later in connection with that part of the field. (Page 115.)

### ARRANGEMENT AND THICKNESS OF THE COAL BEDS.

A study of the formation as it is exposed, and from drill hole records, indicates clearly that the productive coal measures are confined to the upper 1,000 or 1,200 feet of the series. A cross section of the upper 620 feet, taken at the Roslyn shaft, (Fig. 3) shows six beds of coal above the Roslyn bed and the nature of the interbedded sediments. Only one of these beds,

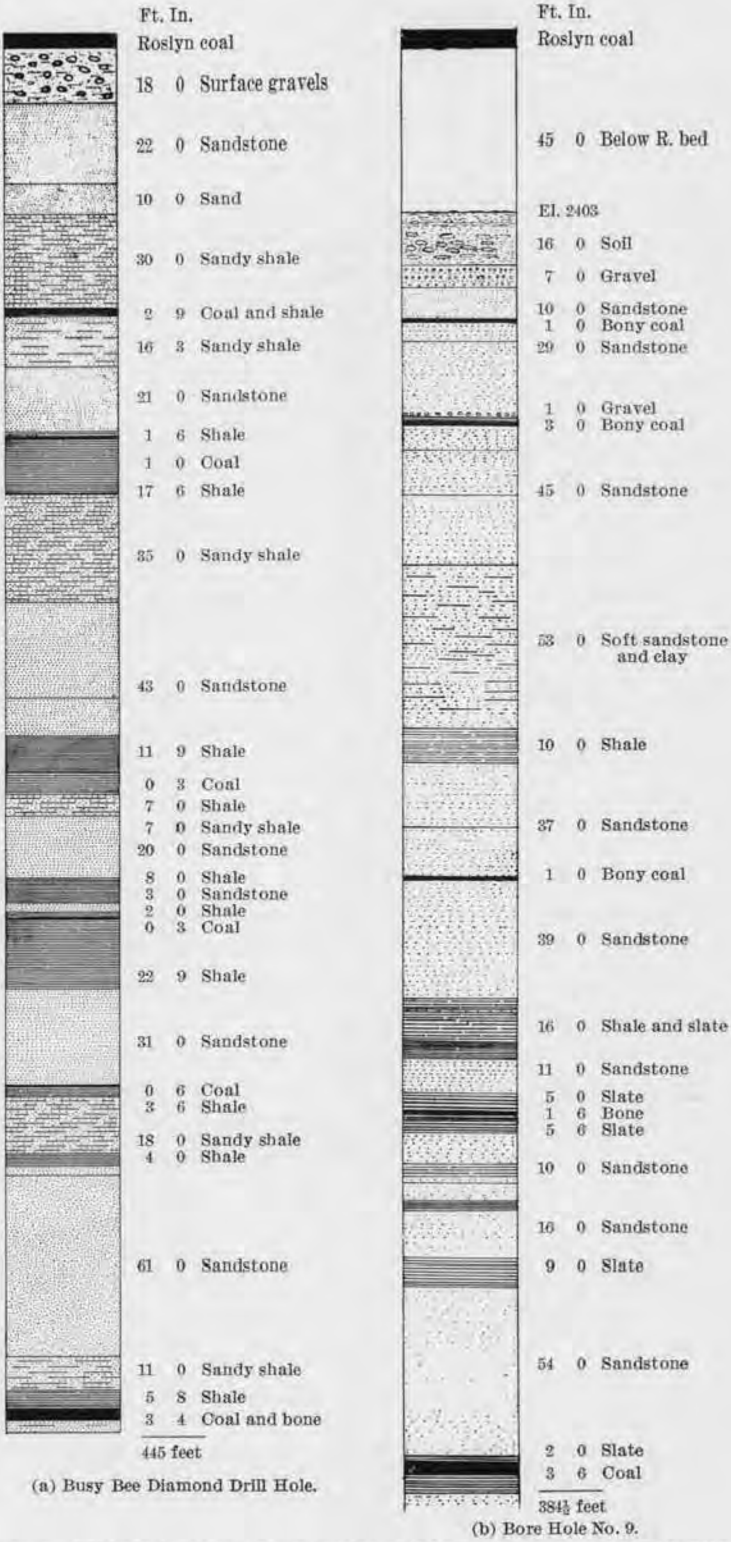



Fig. 4. CROSS-SECTIONS OF MEASURES BELOW THE ROSLYN BED AT THE WESTERN END OF THE ROSLYN-CLEALUM FIELD.

known as the "Big Dirty," about 210 feet above the Roslyn bed, is now being worked. A section taken from drill hole records at Jonesville or the Beekman mine below the Roslyn bed shows at least three seams of coal. (Fig. 4.) One of these beds, 3½ feet thick, about 400 feet vertically below the Roslyn bed, is being worked at Lakedale in what is known as the "Wright" mine and also at "Plant's" mine, about one-quarter of a mile south of the Wright mine. (Plate II.) This bed has been prospected in many places along the Teanaway side of the ridge, but up to date very little work has been done on it. A fourth bed about two feet thick lying below the Lakedale bed, some 350 feet, is exposed in a prospect tunnel about a quarter of a mile northwest of the "Wright" mine (Section A, Plate II), but on account of the poor quality of the coal, and the thinness of the bed, no further work has been done on it.

Figure 5 is a cross section of formation in the NW¼ of Section 13 at Drill Hole No. 35. It was thought that the upper 12-foot bed of coal was the Roslyn bed, and that the other two beds five and six feet respectively, were the beds underlying the Roslyn bed, the intervals, however, allowing for a 45 degree pitch at this point, do not agree with the intervals of any other section below the Roslyn, but they correspond more closely with the section underlying the "Big Dirty" bed and are so used in section B, Plate II.

The total thickness of the eleven beds of coal computed from the cross sections is about 47 feet, of which the Roslyn bed furnishes about four feet six inches of the highest grade coal in the field, and is so easily worked that very little has been done in opening up the other beds. When the Roslyn bed is exhausted these other beds will undoubtedly be used and mines on two of them are already shipping coal.

## STRUCTURE OF THE FIELD.

The shape of the field, the ease with which the coal is mined, and the methods employed in mining, are all due to the simplicity of the structure and the regular and undisturbed nature of the coal throughout the basin. The formation has been fold-

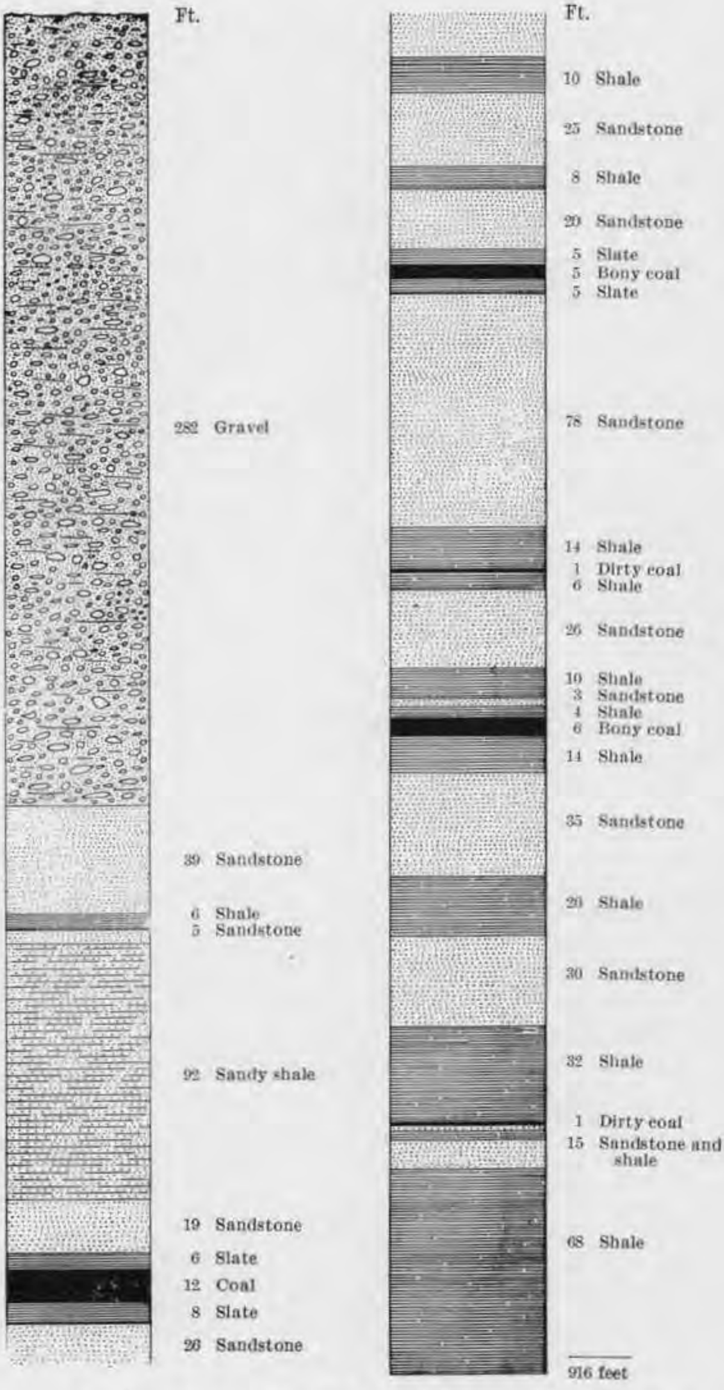



Fig. 5. CROSS-SECTION OF FORMATION AT DRILL HOLE NO. 35.
Section 13, T. 20 N., R. 14 E.

ed up in the form of a large unsymmetrical syncline with low dips on the northeast side and rather steeper dips on the southwest side, thus throwing the axis of the fold nearer the southwest side. (Plate II, Structure Sections.) The syncline pitches and apparently flattens slightly toward the southeast where it passes under the Yakima basalt of Lookout Mountain. The coal seams occurring in the upper part of the formation have escaped erosion for a short distance only, on either side of the central axis of the fold. They outcrop along the northern limb of the fold on the ridge back of Roslyn with strikes varying from N. 45° W. to N. 70° W. and dipping from 8° to 15° SW. At the western end of the field where the pitching fold carries them up to the surface, the strike changes from 70° W. to N. 75° E. and the dip changes from SW. to SE. The coal is entirely hidden on the southern limb of the fold and at the eastern end of the field where the formation is deeply covered with gravels or possibly eroded so deeply before being covered that the coal is not present. A drill hole record in the NE¼ of the NE¼ of section 2, T. 19 N., R. 15 E., put down 1,100 feet, cuts no coal seams similar to those shown in the cross sections in Plate II and Figures 2 and 3. The peculiar irregularities in the northern outcrop line are accounted for by the proximity of the coal to the surface which follows closely the dip of the beds. Small gullies or ravines eroded in the upper part of the formation have removed considerable portions of the Roslyn bed and left the outcrop line very irregular. In some cases as at the Busy Bee property previous erosion channels now filled with sand and gravel interfere with the continuity of the coal under the present surface. (Fig. 2.)

Secondary folds or rolls across the primary fold are shown by the courses of the gangways on the large mine map (Plate II), and drill hole records at Jonesville and Roslyn show a secondary anticline, with axis almost parallel to the general direction of the axis of the main fold where the structure changes from the gentle dips of the northern limb to the steeper dips of the southern limb of the main fold. This fold is probably continuous throughout the field. Records of all the drill holes were not obtainable but from what could be obtained the sections in Plate II were worked out. More accurate sections could be made if all the records held by the different mining companies were available.

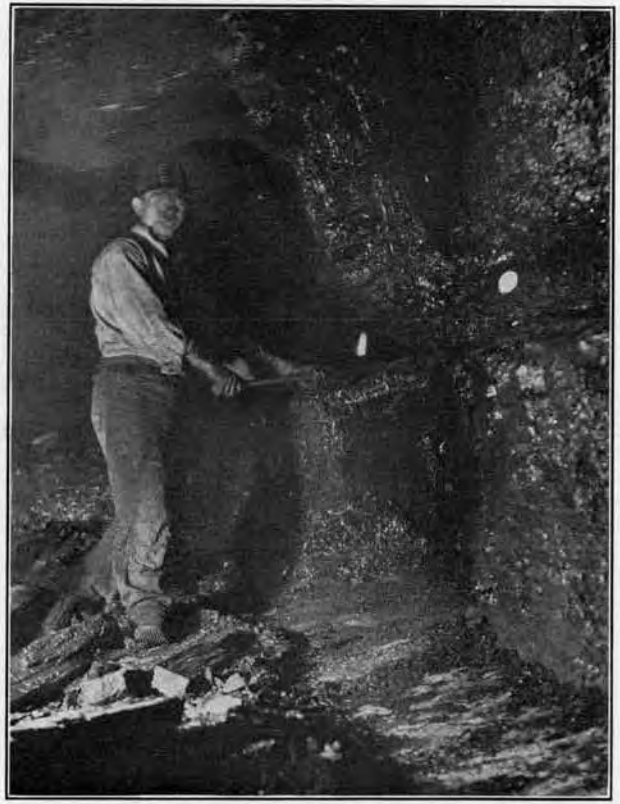
All the folding seems to have occurred with but little disturbance of the coal, and no serious faulting or irregularities were encountered until the lower levels in the different mines were reached. But where the coal is beginning to fold up on the south limb of the syncline it shows slight irregularities. These changes are described in detail later in this chapter under the heading "Folds and Rolls in the Roslyn Seam."

## THE ROSLYN COAL BED.

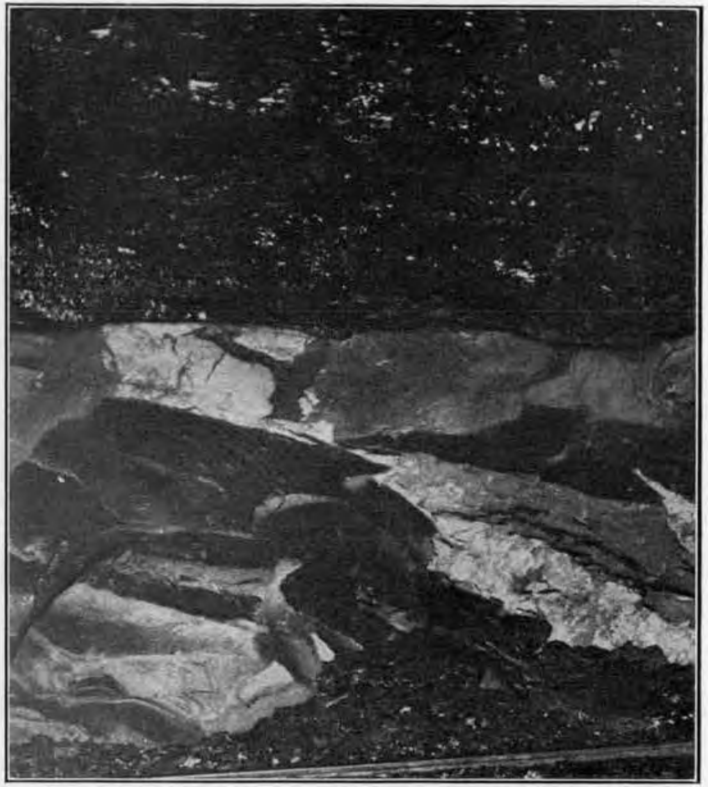
### GENERAL STATEMENT.

The most important bed of the field known as the Roslyn bed, has been worked the full length of the field about seven miles, along the northeastern limb of the fold and round its western end. The directions of the gangways on the mine cap (Plate II) show the changes in strike of this seam. The thickness of the bed including the shale cap rock varies from 4 feet 6 inches to 7 feet as shown in the graphic cross sections (Figs. 26 to 29) and in the tabular cross sections in this chapter; but it contains on the average about 4 feet 3 inches of coal with only one or two thin partings. This measurement has been used as a basis for all computations of tonnage.

The coal changes considerably in character and quality from the eastern, or Clealum, end to the western, or Jonesville, end of the field. Near Clealum the coal is banded or laminated and breaks with a splintery fracture. At Jonesville the coal is denser and less banded, and breaks with a somewhat irregular cubical fracture. It is also more jointed and friable than at the east end. The amount of ash at Clealum runs slightly higher than at Jonesville, and the heating value slightly lower. The coal at the west end of the field makes a fairly good coke, while that at the east end will scarcely coke at all. In other words the coal has undergone further changes at Jonesville than at Clealum.



A. Mining a "Kerf" in the Middle Parting of Roslyn Bed.



B. Bottom Coal and Sandy Shale Floor of Roslyn Bed.

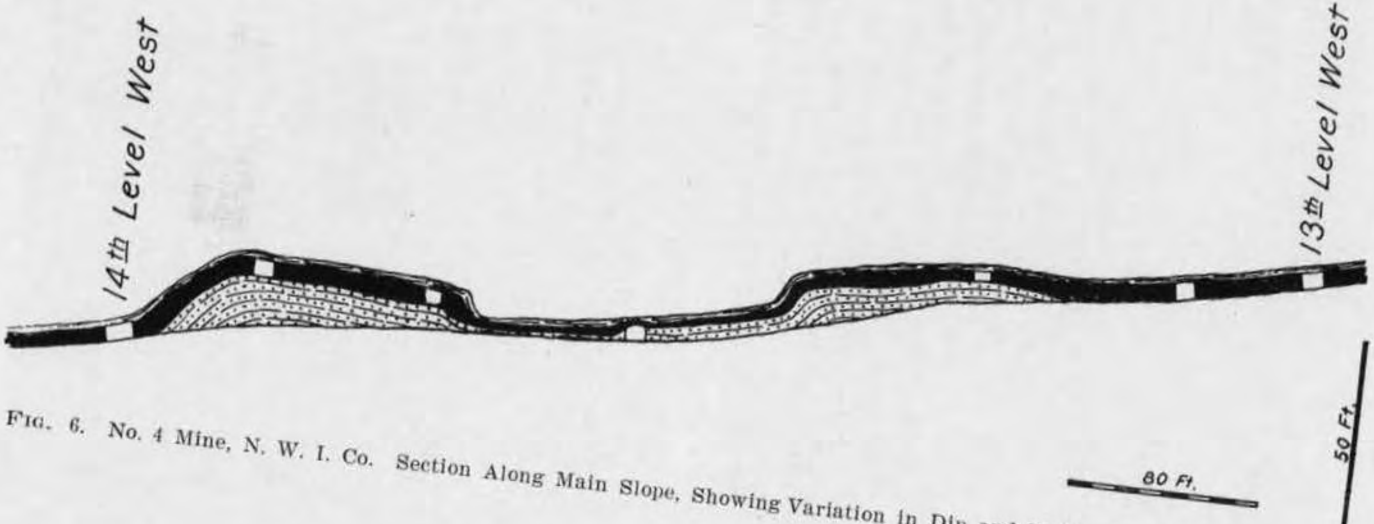



FIG. 6. No. 4 Mine, N. W. I. Co. Section Along Main Slope, Showing Variation in Dip and Thickness of the Roslyn Bed.

The coal of this bed is low in moisture and does not crumble readily during transportation or storage. A large block of the Roslyn bed has been exposed to the atmosphere in the University grounds since the Alaska-Yukon-Pacific Exposition in 1909, and the surface is still in fairly good condition. No preparation for market is necessary beyond the separation of the thicker partings and the sulphur balls in the mine and the picking of the lump coal at the tipple. The percentage of ash would be greatly reduced if the coal was more thoroughly picked and washed after coming from the mine. As it is, it makes a first class steam and gas coal and is also well adapted for domestic use.

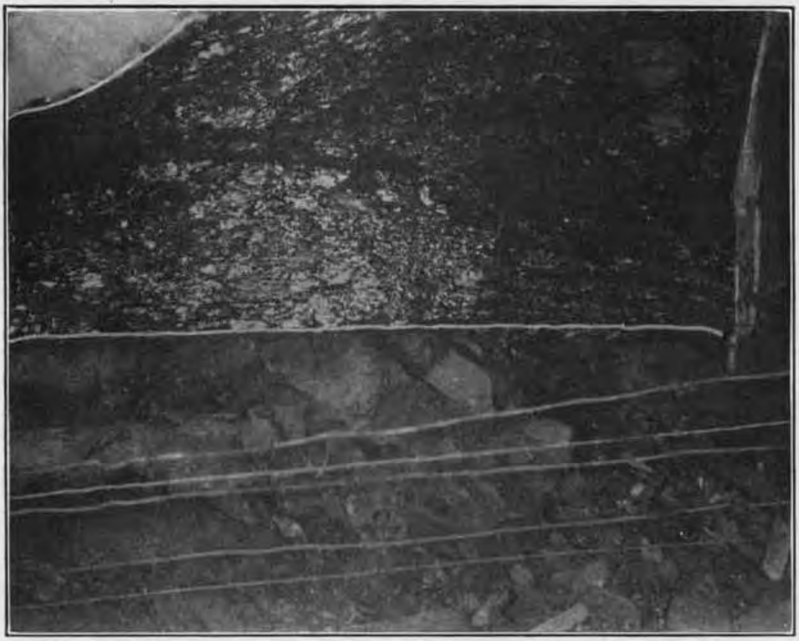
### ESTIMATED FUTURE PRODUCTION.

In working out the estimate of the coal content and probable future production of the Roslyn bed the total area of the probable extent was estimated from the map as 10,000 acres, and the average thickness of the bed, 4 feet 3 inches, was used. An estimate was made of the percentage of coal mined in each part of the field in relation to the known coal of that section as shown by the actual workings. From the information collected it appears that about 70 per cent of the coal present has been recovered in the areas already mined. Improved methods of laying out the workings will return a conservative estimate of 75 per cent for proved areas, which are now being worked, and for the reserve coal a conservative estimate of 80 per cent recovery has been made. There is no reason why these figures should not be exceeded.

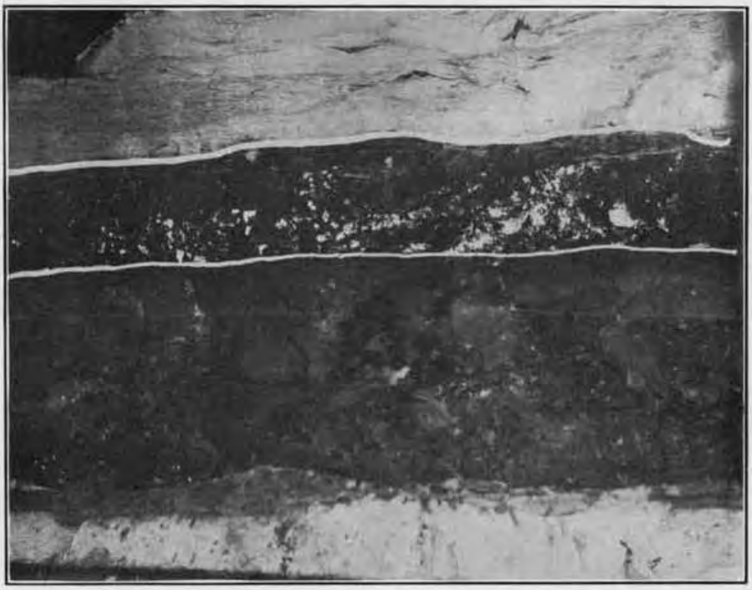
ESTIMATES OF FUTURE PRODUCTION.

| | Acres | Total Tonnage* | Recovery | |
|---|---|---|---|---|
| | | | Per Cent. | Tons |
| Probable area | 2,560 | 19,046,400 | 80 | 15,237,120 |
| Proved area unworked | 3,853 | 28,666,320 | 75 | 21,499,740 |
| Proved area worked | 3,587 | 26,687,280 | 70 | 18,686,096 |
| Totals | 10,000 | 74,400,000 | | 55,422,956 |
| Production to January 1, 1914 | | | | 21,843,176 |
| Estimated future production | | | | 33,579,780 |

* 7,440 tons per acre.



A. No. 4 Mine, N. W. I. Co. Thinning of Coal Along the Main Slope Between 13th and 14th Levels.



B. No. 4 Mine, N. W. I. Co. Thinning of Coal Along the Main Slope Between 13th and 14th Levels at a Point Below Illustration A.

As a tentative conclusion then the estimated coal in the Roslyn bed is 74,400,000 tons, of which by ordinary methods 55,422,956 tons is recoverable. The production up to the end of December, 1913, was 21,843,176 tons, leaving a future estimated production of at least 33,579,780 tons.

Further details of mining operations, figures representing output of individual properties, and the analyses of the coal from different parts of the field are given in Chapter VII and in the appendices of this report.

### FOLDS AND ROLLS IN THE ROSLYN BED.

By Joseph Daniels.

The normal thickness of the Roslyn seam is 4 feet 6 inches, made up of an upper bench of coal 29 inches thick, a parting of coal and shale 4 to 6 inches, and a lower bench 20 inches thick. (Plate XI A.) The cap rock is a soft shale varying in thickness from nothing to 3 feet and above this is the roof of sandstone. The bottom is a sandy shale. The "mining" is done in the middle parting as shown in Plate XII. The character of the sandy shale bottom rock is shown in the same plate. Variations in the thickness of the seam are associated with local changes in the structure of the field. (Figs. 26 to 29.)

The dip varies in different parts of the field from 10 degrees to 30 degrees, gradually flattening in the deeper mines as the synclinal axis is approached and varying in any one mine through the limits indicated. The strike of the measures, generally southeast-northwest, also varies as can be seen from the mine map (Plate II), which shows the direction of the levels or gangways in the coal. The syncline referred to is shown in the geologic sections of the field. (Plate II.) This syncline pitches from the west or upper end of the field toward the southeast, resembling, in general, a spoon with one end removed. Mine workings at the west end of the field in the Beekman No. 1 mine of the Roslyn Fuel Co., show the pitching syncline by the change in the direction of the lower west levels. At the east end of the field, east of Clealum, the coal in the hills has been removed by erosion, but there is little doubt that it will be found under greater cover below the valley floor.

Structurally, the Roslyn field is comparatively simple when judged by the coal fields of the western slope of the Cascades. The major structure of the pitching synclinal fold is com-

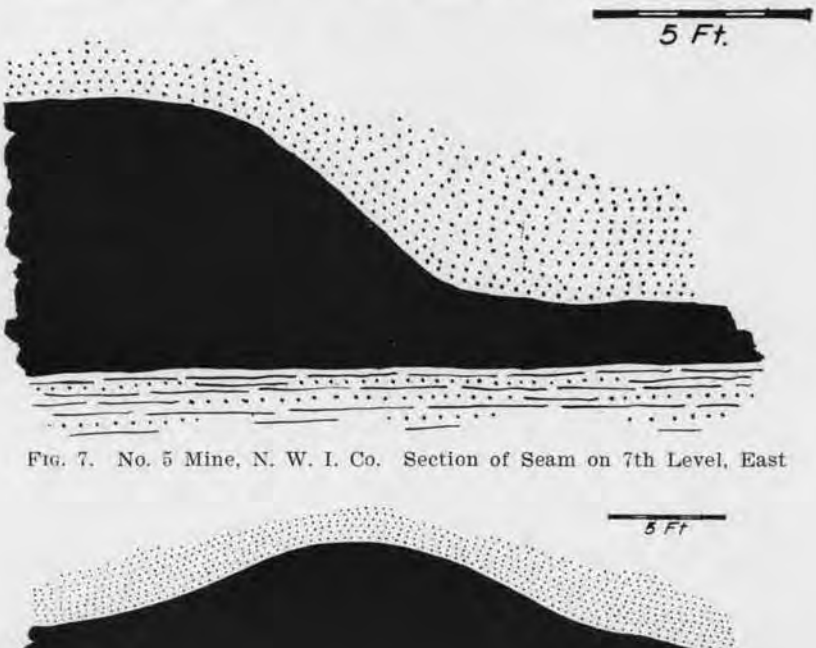



FIG. 7. No. 5 Mine, N. W. I. Co. Section of Seam on 7th Level, East

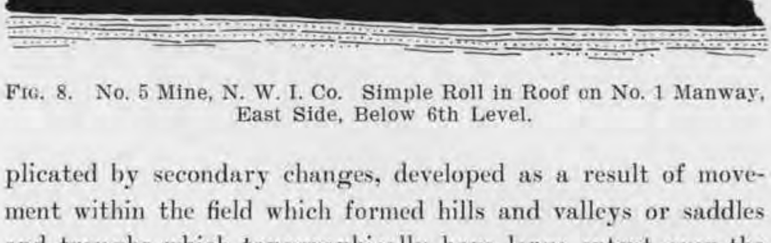



FIG. 8. No. 5 Mine, N. W. I. Co. Simple Roll in Roof on No. 1 Manway, East Side, Below 6th Level.

plicated by secondary changes, developed as a result of movement within the field which formed hills and valleys or saddles and troughs which topographically have large extent over the field. These are best shown in the workings between the Cle-alum Mine No. 1 and Roslyn Mine No. 7 and between Roslyn Mines No. 5 and No. 4. (Plate II.) The swinging in the courses of the mine gangways indicates the contours of these waves. It will be noted that the direction of this change is east-west or slightly north of east from the regular southeast strike of the gangways in most of the mines.

In addition to these changes, local variations of lesser extent are found throughout the entire field. They are locally known as "faults" but are really warpings or small rolls which have thinned and thickened the coal, and have changed the angle of dip as well as the direction of levels and slopes within the affected areas. The method of mining coal, whether in flat rooms, gravity plans or chute breasts, is a factor of this variation in dip. Figure 6, which is a section along a portion of the main slope from the foot of the No. 4 shaft between the thirteenth and fourteenth levels, shows the variations in thickness and dip due to these rolls. Figure 25 is a detail showing the variation in thickness. The longitudinal variation in the strike of the levels has already been referred to.

The larger rolls present no particular problems but the minor rolls are of unusual interest. They may be grouped into three classes:

(1) The roof rock approaches the bottom rock of the seam which remains regular, thinning the coal below its normal thickness; (2) the bottom rock comes up into the coal, the roof re-

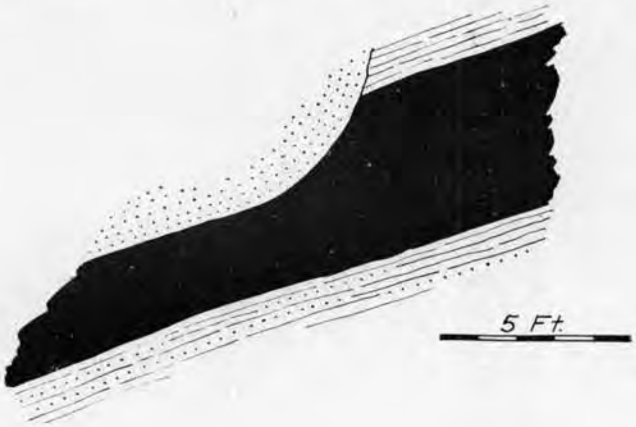



Fig. 9. No. 7 Mine, N. W. I. Co. Roll in Roof, 4th Level, West

maining regular; (3) both top and bottom simultaneously come together. In these cases the pinching is usually accompanied by a local thickening of the coal to a maximum height of seven or eight feet within a comparatively short distance from the zone of thinning. The thickness of the seam at the pinches varies from nearly full height to six inches or less and in some cases is merely a streak of carbonaceous matter which can be followed very easily between its walls to the point at which it widens.

The rolls are of differing extent. In some cases they extend for a comparatively few feet, in others for several hundred feet, and in one case in the southwestern part of the field, section 12, in the properties of the Roslyn Fuel Company the thinning of the coal extends over several acres, completely preventing

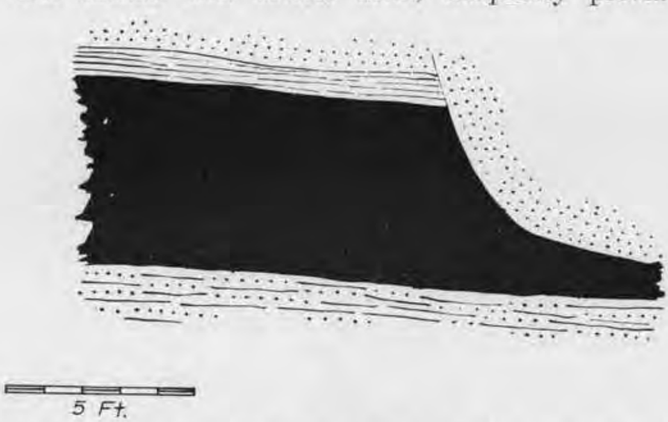



FIG. 10. No. 2 Mine, Roslyn-Cascade Coal Co. Roll in Roof on Main Slope Below 6th Level.

profitable mining. Entries were stopped before reaching the property line on the east side of the Roslyn Fuel Company's mine, and the slope of the Roslyn-Cascade Coal Company's mine No. 2 was turned to the east around the extension of this same pinching roll.

The different phases of the variations noted above are illustrated by a series of figures and photographs. The photographs taken in the mines have been supplemented by diagrams

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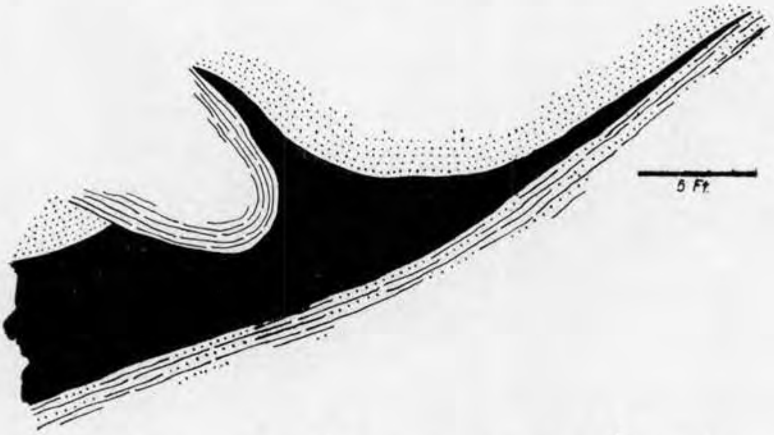



FIG. 11. No. 7 Mine, N. W. I. Co. Section of Roslyn Seam on Manway Above 4th Level, East.


FIG. 12. No. 7 Mine, N. W. I. Co. Section in Room Off 5th Level, West.


FIG. 13. No. 7 Mine, N. W. I. Co. Roslyn Seam on 4th Level, West. Section Looking North.

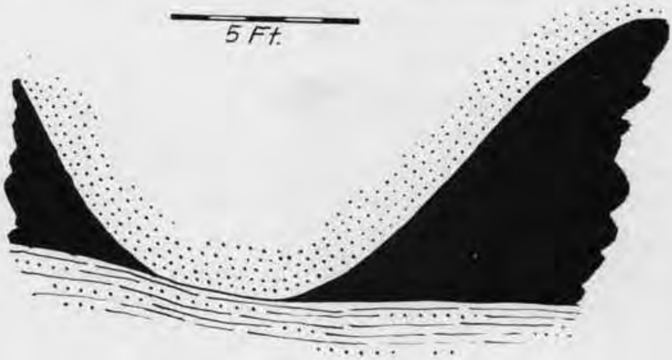



FIG. 14. No. 7 Mine, N. W. I. Co. Roslyn Seam on 4th Level, West. Section Looking South.

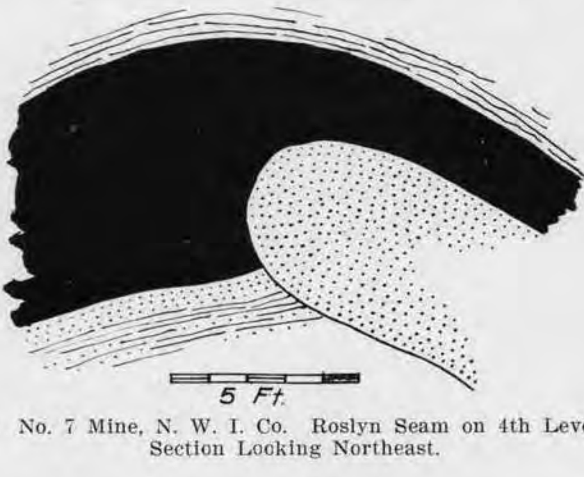



FIG. 15. No. 7 Mine, N. W. I. Co. Roslyn Seam on 4th Level, West. Section Looking Northeast.

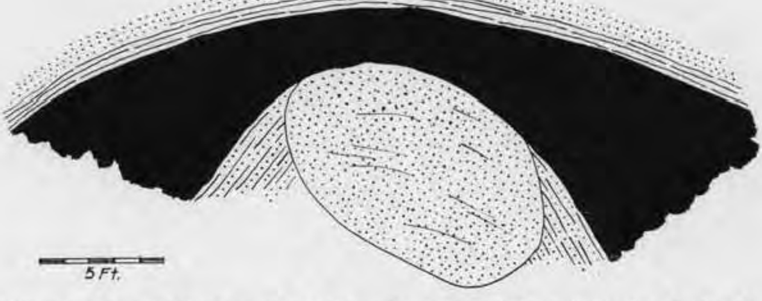


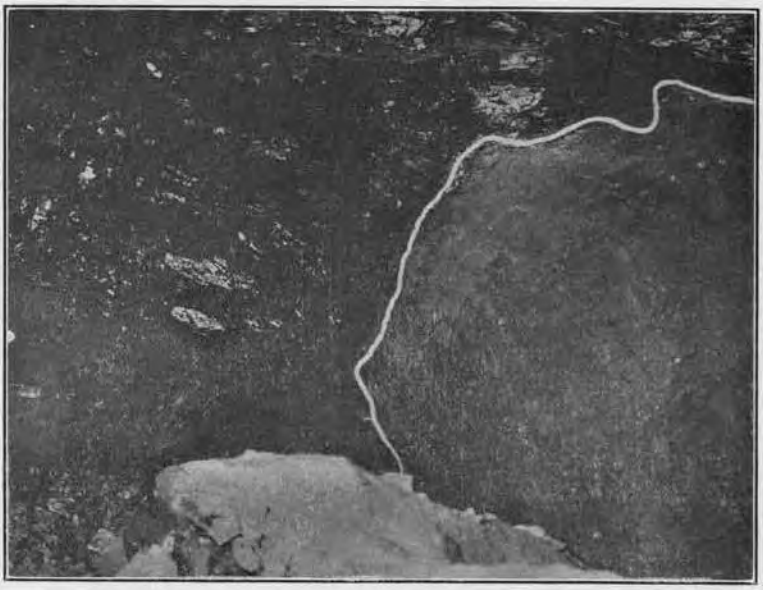

FIG. 16. No. 7 Mine, N. W. I. Co. Sandstone "Horse" in the Coal, 4th Level, West. Section Looking East.

drawn as near to actual scale as possible. In a few cases the illustrations have been idealized. The cases noted and described are those which were opened up during the period covered by the field work on this bulletin and which were striking enough to warrant special study. Many more examples could be given, but those described are most representative of the variations previously classified.

In the first class, that showing the roof rock cutting into the coal seam proper, figures 7 to 16, inclusive, illustrate the general occurrence. Figures 7 and 8 show simple rolls in which the cap rock, normally a soft shale, is absent and the overlying sandstone roof takes its place over the entire extent of the altered thickness. The bottom sandy shale persists very regularly. Plate XIII shows the photographs taken along the slope in the N. W. I. No. 4 mine, illustrated in Figure 6, which show the change in thickness of the seam. In Figures 9 and 10 is shown the normal seam with shale cap rock and the thinned portion with sandstone immediately overlying, the latter having forced its way through the shale. The photograph (Plate XIV-A), taken on the main slope of the No. 2 or Patrick mine of the Roslyn-Cascade Coal Company in Section 12 below the sixth level at a point where the slope swings from its regular course east of south to a nearly east-west course paralleling the upper gangways, clearly shows the character of the roll corresponding to Figure 10. This roll is the same as that shown in Figure 21 and Plate XVI-B, and is a part of the great pinch which extends over into the property of the Roslyn Fuel Company.

Figures 11 to 16 show a similar structure to that last described but in these cases the thinning has been caused by a horse or lens of rock forcing its way into the coal. In Figure 11 a mass of shale or sandy shale has been pressed into the coal which on either side has a sandstone top. Extreme variation in the thickness of coal can be seen here, from the normal height below the lens to a few inches at the pinch above it. The thin wedge of coal forced into the space between the shale and the sandstone shows a foliated structure parallel to the shale.

A. No. 2 Mine Roslyn-Cascade Coal Co. Roll in Roof on Main Slope Below 6th Level.



B. No. 7 Mine, N. W. I. Co. Fourth Level, West, Roll in Roof.

Figure 12 shows the variation in the dip and thickness of the coal within the length of a single room. Starting on a high dip from the gangway the coal flattens and thins at the point where the sandstone roof comes down.

Figures 13 to 16 are illustrative of a peculiar situation in No. 7 mine of the Northwestern Improvement Company. All of these sections are on the Fourth level west just inside the main slope. The seam rises above the general level of the coal at the slope making it necessary to cut into the bottom rock in order to grade the gangway. Projecting into the coal from above the seam is a huge, irregular boulder-shaped horse of sandstone which has a re-entrant angle on the side toward the west. The general course of the gangway is northwest-southeast and the sections shown are taken as follows: Figure 13 is looking north and shows the sandstone cutting out part of the seam. Figure 14 is looking south, toward which point the lens of rock dips, and cuts out the entire thickness of coal except for a thin streak a few inches deep. Figure 15, looking northeast shows the knot or projection which sticks out from the main mass of sandstone and which appears to come up from below. Figure 16 shows a section across this projection. The coal has been squeezed into the irregular space between the knot and the main mass of the sandstone and clearly shows a foliated, flakey structure due to this squeezing. Plate XIV-B shows a photograph corresponding to Figure 15.

This class seems to be the most frequent form of change in the regularity of the seam. The fact that the sandstone replaces the shale seems to indicate that the movement of this firmer rock through the shale and coal has been responsible for the coal thinning.

In the second class under consideration, in which the bottom has moved up into the coal, examples are not so frequent. Figures 17 and 18 illustrate this class. Figure 17 shows a simple roll in the bottom sandy-shale with only a small change in the thickness of the coal. Figure 18 is, strictly speaking, the longitudinal edge of a fault, and is not so typical as Figure 14.

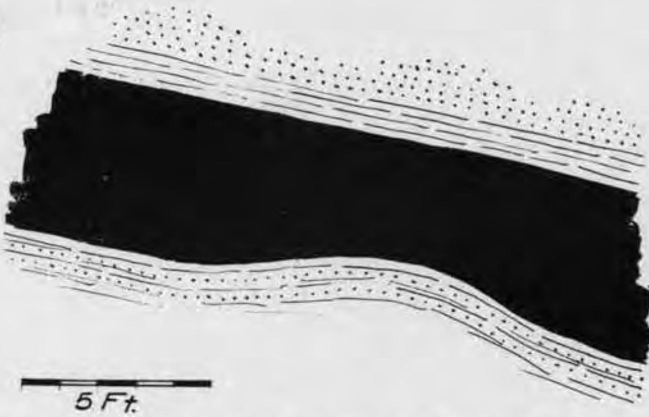



FIG. 17. No. 3 Mine, N. W. I. Co. Simple Roll in Floor on Main Slope.

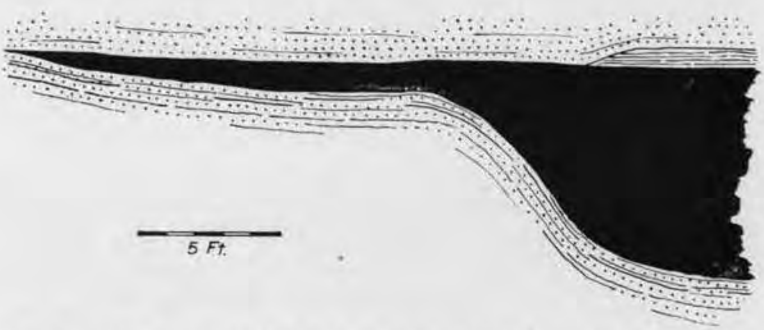


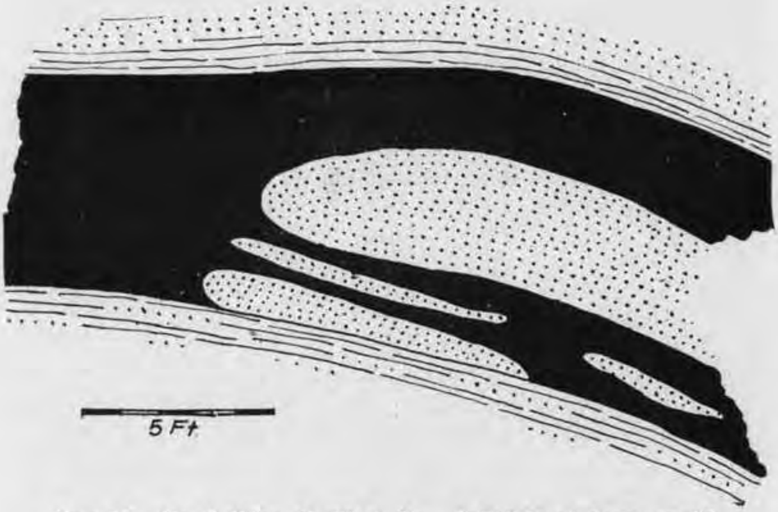

FIG. 18. No. 5 Mine, N. W. I. Co. Pinching of Coal on 6th Level, West.

In Plate XV are shown photographs of a roll in the bottom rock on the fifth level east of No. 3 mine, N. W. I. Company. This roll has thinned the coal below normal thickness, but in addition to this thinning the coal has been broken up by large horses or partings of sandstone within the seam itself. Figures 19 and 20 show idealized sections of this occurrence.

The third type in which top and bottom come together is best shown in No. 2 mine of the Roslyn-Cascade Coal Company. In driving the main slope the coal was found to thicken to 8 feet and then pinch, both roof and floor coming together until the coal was only 22 inches high. Figure 21, a longitudinal section along the slope and the photograph (Plate XVI-B),

A. No. 3 Mine, N. W. I. Co. Fifth Level East, Showing Roll in Bottom and Horses of Rock in Coal.

B. No. 3 Mine, N. W. I. Co. Fifth Level East on Air Course, Showing Pinching in Coal Below Rock in Photo Above.




Figs 19. No. 3 Mine, N. W. I. Co. Splitting of Seam on 5th Level, East.

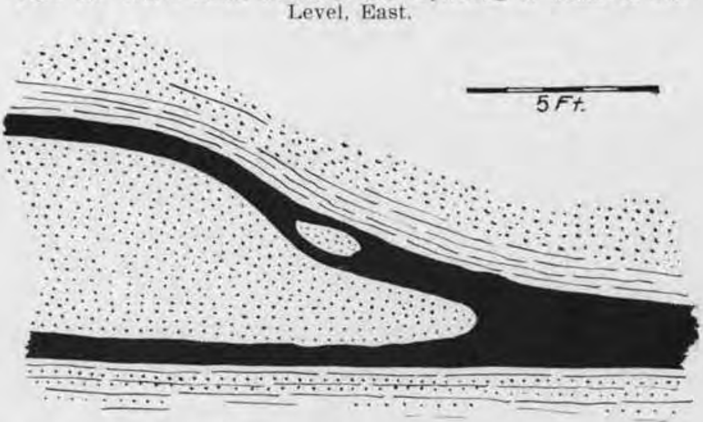



Fig. 20. No. 3 Mine, N. W. I. Co. Splitting of Seam on 5th Level, East, on Air Course

looking down slope show this very clearly. At the point shown in the photograph the slope was turned to the southeast in order to get away from the roll, but the edge of it was again encountered and in driving toward the east the opening in the coal skirted the rock for several hundred feet.

In many places, both top and bottom come together gradually without the abrupt change just noted, thinning the coal

A. No. 5 Mine, N. W. I. Co. Sixth Level East at Edge of Fault.

B. No. 2 Mine, Roslyn-Cascade Coal Co. Roll in Roof and Floor of Slope.

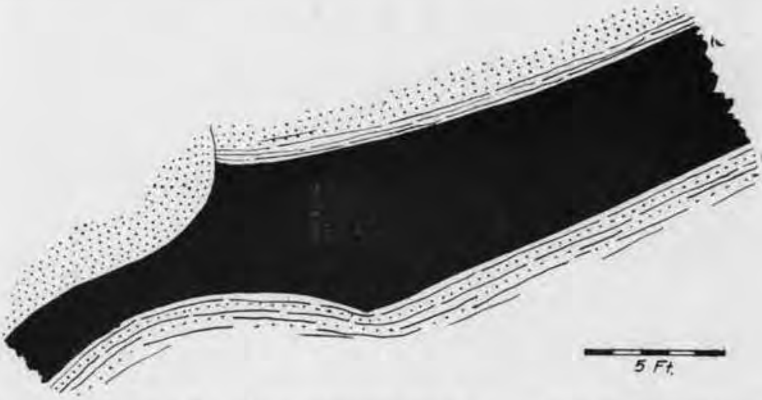



FIG. 21. No. 2 Mine, Roslyn-Cascade Coal Co. Roll in Main Slope at Bend Below 6th Level.

without changing the prevailing character of the walls. Figure 22 shows the character of the pinch on the seventh level east of No. 1 mine of the Roslyn Fuel Company. This pinch is due to the great roll already described as affecting both the Roslyn Fuel and Roslyn-Cascade Coal Company's properties. A similar example is shown in Figure 23 in which a rolling bottom accompanies the thinning of the coal. The cap rock remains and the bottom sandy shale has not disappeared nor has it cut into the coal in the abrupt fashion of the roof sandstone in the other cases previously cited. This would indicate that the movement of the bottom rock has been relatively insignificant. Figure 24 shows a situation in which a small wedge of coal has been squeezed into an opening in the top rock.

Only one true fault has been found in the field. This occurred in No. 5 mine, Northwestern Improvement Company. Plate XVII is a portion of the map of this mine showing the position and extent of the fault. In driving the slope on the regular grade of the coal for that mine the seam was lost at the fifth level but was found in the roof 16 feet above the slope. The slope was continued on its former grade in rock until the coal was again reached at a point between the sixth and seventh levels. Here it passed under the slope forming a "swamp" but

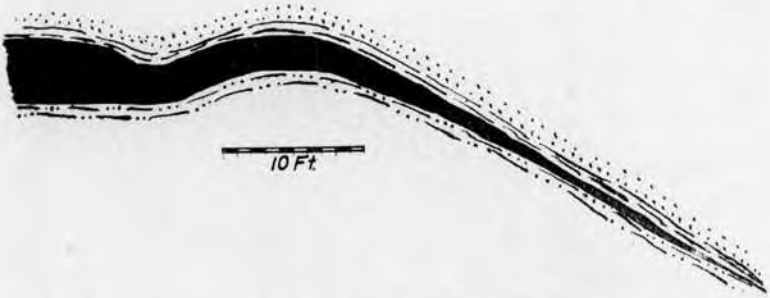



FIG. 22. No. 1 Mine, Roslyn Fuel Co. Roll on 7th Level, East.


FIG. 23. No. 7. Mine, N. W. I. Co. Variation in Roslyn Seam on 5th Level, West.

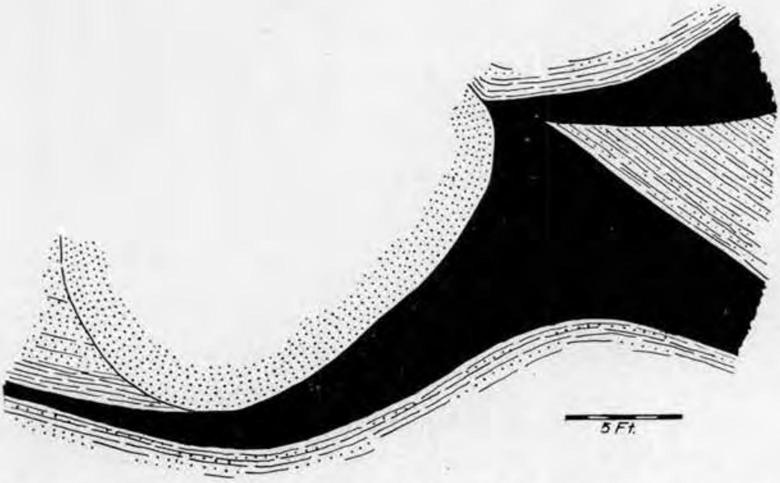



FIG. 24. No. 4 Mine, N. W. I. Co. Detail of Portion of Seam on Main Slope, Looking West.

it soon resumed its regular dip. The fifth east and west levels driven just above the fault were in troubled ground for some distance on each side of the slope but the coal was fairly regular and its dip was progressively increasing. The sixth levels ran into the fault whose plane is at right angles to the direction of the slope.

Study of this development indicates that the coal had locally been crumpled into a recumbent fold and that an overthrust fault with a displacement of about 16 feet had resulted. (Fig. 25.) The fault plane extends several hundred feet in a northeast-southwest direction but instead of intersecting coal of normal thickness, the seam is found to pinch to a feather edge and disappear. Figure 18 shows the appearance of this feather edge and Plate XVIII is a photograph showing the transition from the thick coal to the pinch at the west end of the fault. Plate XIX-A is a photograph showing in more detail the roll in the bottom and the change in the height of the coal. Plate XVI-A shows the appearance of the fault at the east end of the sixth level, east. Plate XX shows two photographs taken on the airway parallel to the main slope just below the fifth east level. Illustration A shows the point at which the coal turns back on itself on the limb of the fold above the fault, and illustration B shows the lower limb of the fold below the fault. The airway was driven as far as possible in the coal following its irregularities and it was thus possible to get photographs illustrating the fold. The photographs in Plate XXI were taken on the main slope below the sixth level at the point where the coal intersects the rock slope. Photograph A shows the seam dipping under the slope, and B is a detail photograph showing the coal which has here been squeezed into an opening or break in the sandstone roof. The photograph in Plate XIX-B shows the normal coal at the face of the seventh east level just above the roll which has developed along this level.

The structure of the faulted section of No. 5 mine indicates that a roll of considerable extent was developed in this area, and in the process of development was pushed beyond its elastic

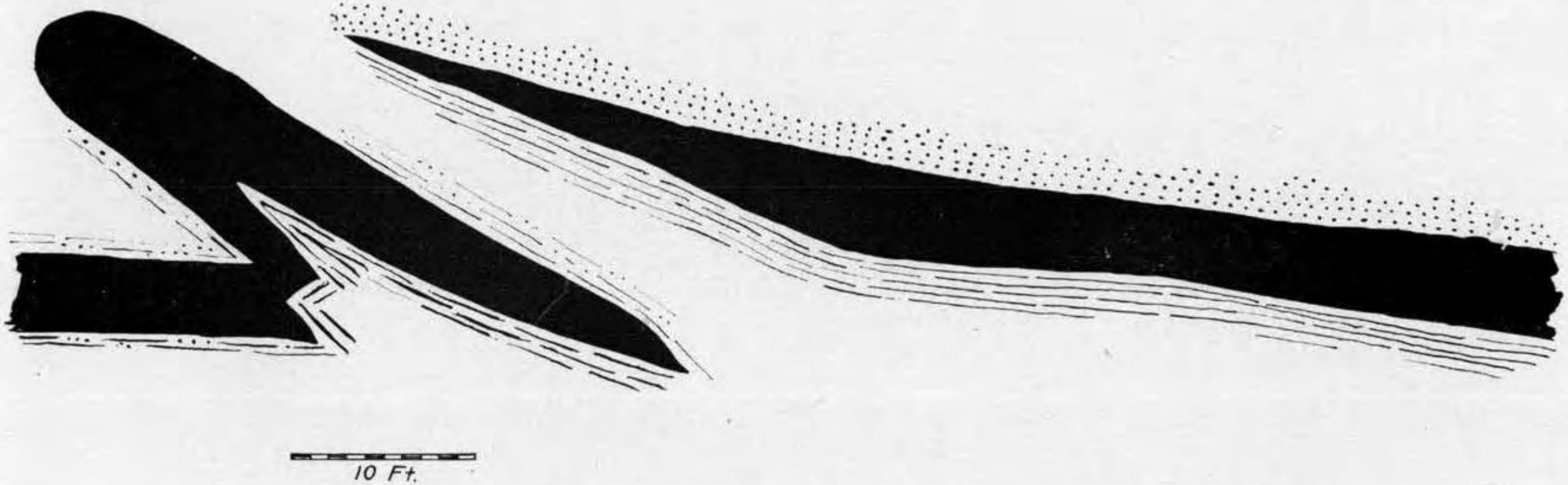
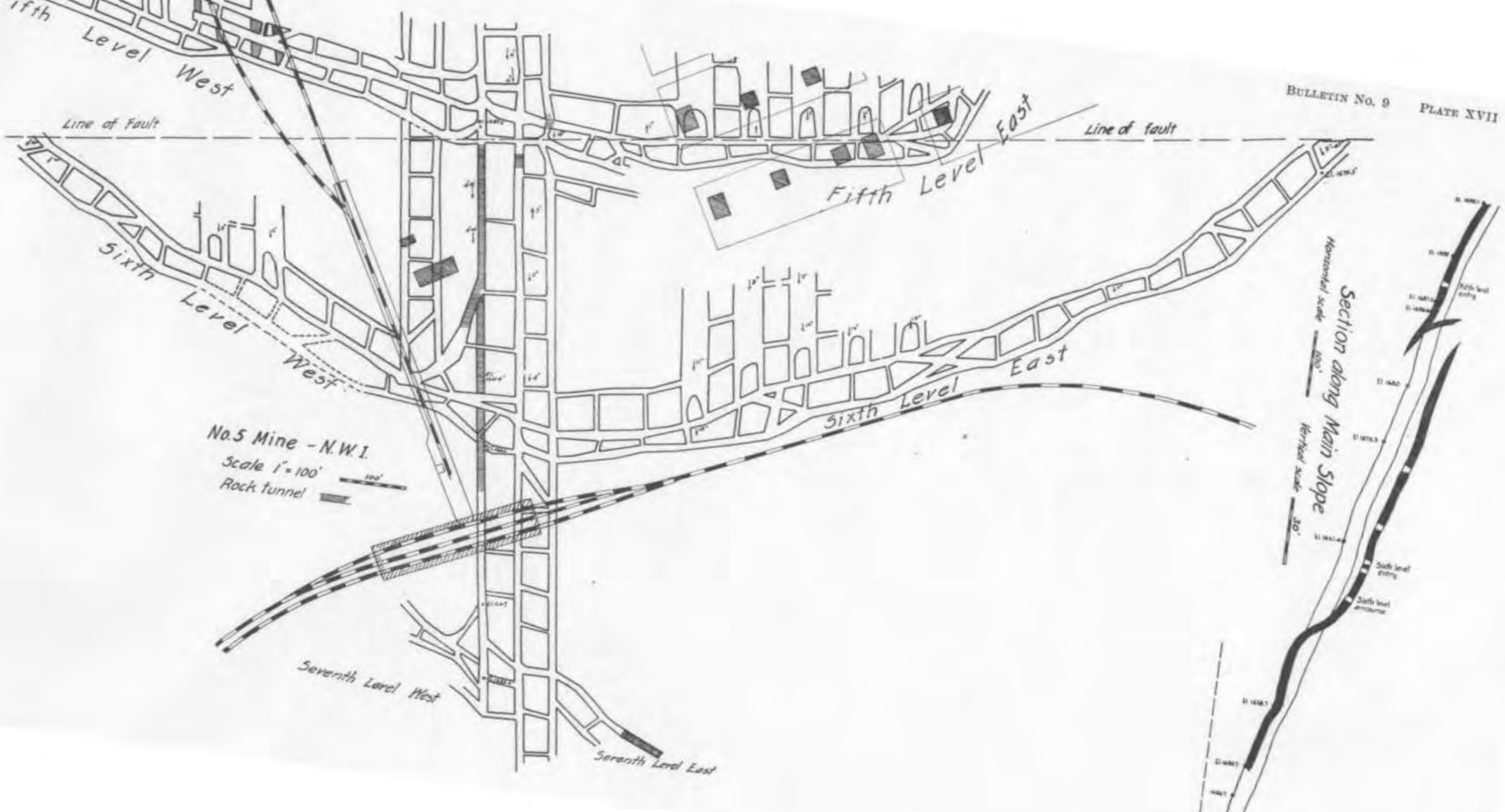



FIG. 25. No. 5 Mine, N. W. I. Co. Section Showing Recumbent Fold and Overthrust Fault on Main Slope.


Fifth Level West
Line of Fault
Line of fault
Fifth Level East
Sixth Level West
Sixth Level East
No. 5 Mine - N.W. I.
Scale 1" = 100'
100'
Rock tunnel
Seventh Level West
Seventh Level East
Section along Main Slope
Horizontal scale
100'
Vertical scale
30'
Fifth level entry
Sixth level entry
Sixth level entrance

limit near the center of the dome, and an overturned or recumbent fold and an overthrust fault resulted, the lateral ends of the fault showing zero displacement.

Whenever studied in the Roslyn seam the coal and soft shale show a regular laminated or flow structure following the small variations and rolls in the harder enclosing strata in the area of disturbance. It would thus appear that the coal had been squeezed or forced out by the movement of the top and bottom rock in coming together when the coal was in a more or less plastic condition and could move or flow without shearing or crushing. There is no evidence that silting or erosion caused the variations in the thickness of the seam. With a homogeneous sandy shale bottom, and a variable shale cap rock overlain by a hard, firm sandstone, we should expect movements to be recorded in the yielding of the softer shale material to the hard sandstone and this is borne out by the examples cited.

In addition to the changes in the thickness of the seam at these various points, the irregularities in strike and dip causing the domes and saucers are further evidences of movement within the great mass of sediments. These topographic expressions point to a gentle, slow, differential movement, for we find no great faults or breaks except the one described. Were the movement severe and rapid and were the sediments in an advanced stage of change we should find conditions resembling those in the coal fields of western Washington where the seams dip at high angles and are extensively faulted.

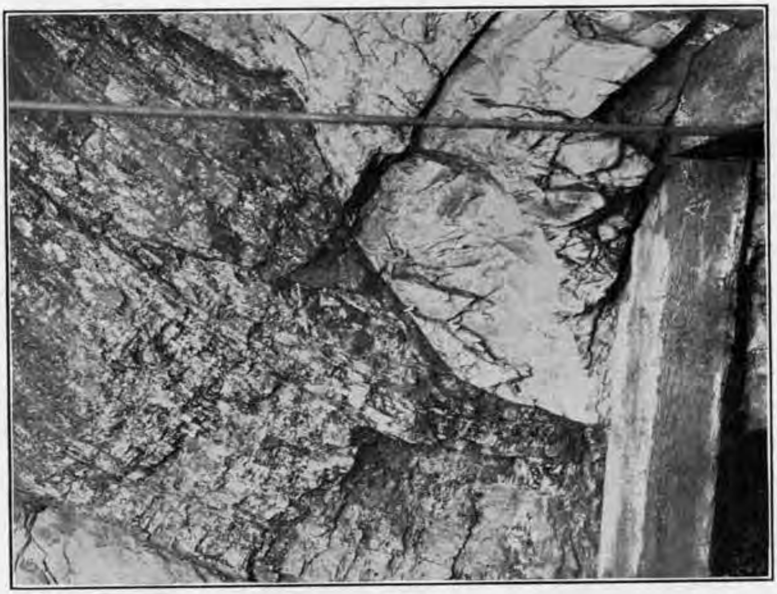
These local disturbances are responsible for much concern on the part of the operating officials of the mines, but they are not of such magnitude or complexity as to prevent immediate solution. The fact that small stringers of coal are usually present and that the bottom is usually regular make it possible to follow the coal to the points where it returns to normal width. Increasing or excessive thickness of coal indicates the presence of nearby thin coal. No regularity in the system of these domes and depressions has been noted, but in some cases the general shape and direction can be foretold and advance or narrow work can be planned more intelligently.

Pinching of the Coal on the 6th Level West at West End of Fault. No. 5 Mine, N. W. I. Co.

A. No. 5 Mine, N. W. I. Co. Detail View Similar to Plate XVIII Showing Change in Thickness of Coal and Roll in the Bottom Rock on 6th Level, West.

B. No. 5 Mine, N. W. I. Co. Coal at Face of 7th Level, East, Just Above the Roll.

A. No. 5 Mine, N. W. I. Co. Overthrust Fold on Airway Near 5th Level, East.



B. No. 5 Mine, N. W. I. Co. Lower Limb of the Overthrust Fold on Airway Near 5th Level, East, Below the Fault Plane.

## SECTIONS AND DESCRIPTION OF COALS IN THE ROSLYN-CLEALUM FIELD.

During the summer of 1909 E. Eggleston Smith of the United States Geological Survey, in co-operation with the State Geological Survey, made cross sections and took samples in the Roslyn-Clealum field and the following descriptions and sections of the samples are taken from his report.* The blue numbers on the large Roslyn field map (Plate II) indicate the location in the mine where the sections and samples were taken.

### Western End of the Field.

#### BEEKMAN. PROSPECT.

*Sample*—Bituminous coal; analysis No. 9,404, page 192.

*Location*—Prospect; in Sec. 2, T. 20 N., R. 14 E., 1¼ miles northwest of Beekman.

*Coal bed*—The bed strikes N. 55° E. and has a dip of 12° SE. It underlies the other beds of the Roslyn field. It is too thin to be of any commercial importance. The section was measured at the end of a 25-foot drift on this bed.

SECTION OF COAL BED IN PROSPECT 1¼ MILES NORTHWEST OF BEEKMAN

Analysis No. 9,404, page 192.

| | | |
|---|---|---|
| Laboratory No. | 9,404 | |
| Roof, hard shale. | Ft. | In. |
| Coal, good | 1 | 2½ |
| Shale † | 0 | 2½ |
| Coal, good † | 0 | 2½ |
| Floor, soft shale. | | |
| Thickness of bed | 1 | 7½ |
| Thickness of coal sampled | 1 | 2½ |

† Not included in sample.

*Notes*—The sample collected was somewhat weathered. The coal should probably be classed as low grade bituminous.

#### BEEKMAN. LAKEDALE MINE.

*Sample*—Bituminous coal; analysis No. 9,405, page 192.

*Mine*—Lakedale; a water level mine in Sec. 2, T. 20 N., R. 14 E., 1 mile northwest of Beekman, on a spur of the Northern Pacific Railway.

*Coal bed*—The bed worked in this mine strikes N. 80° E. and dips 10° SE. It is probably one of the beds underlying the Roslyn bed and outcropping in a number of places farther east.

* Bulletin 474, U. S. Geological Survey, Coals of Washington, by E. Eggleston Smith, pages 130 to 152.

A. No. 5 Mine, N. W. I. Co. Roslyn Seam Passing Under Main Slope Below 6th Level East.

B. No. 5 Mine, N. W. I. Co. Detail Photograph Showing the Coal Squeezed Into Opening in Sandstone Roof Rock at Same Point as Above.

SECTION OF COAL BED IN LAKEDALE MINE.
(Fig. 32)

| | Ft. | In. |
|---|---|---|
| Laboratory No. | 9,405 | |
| Roof, carbonaceous black shale. | Ft. | In. |
| Coal, bony near center | 1 | 0 |
| Shale † | 0 | 6½ |
| Coal | 0 | 6½ |
| Shale, bony | 0 | 1 |
| Coal | 0 | 7½ |
| Coal, bony | 0 | ¼ |
| Coal | 0 | 9¼ |
| Floor, hard, brown shale. | | |
| Thickness of bed | 3 | 7 |
| Thickness of coal sampled | 3 | ½ |

† Not included in sample.

Sample 9,405 was taken 10 feet above the gangway, about 150 feet from the entrance.

*Notes*—Both the roof and the floor are firm and did not mix with the coal. The coal does not weather while being transported to market. The partings can be removed to some extent in mining. At the bunker the coal was passed over bar screens and picked.

BEEKMAN. BEEKMAN MINE NO. 1.

*Sample*—Bituminous coal; analyses Nos. 9,411, 9,412, 9,413, 9,414, 9,415, 9,459, 550-D, 551-D, page 192.

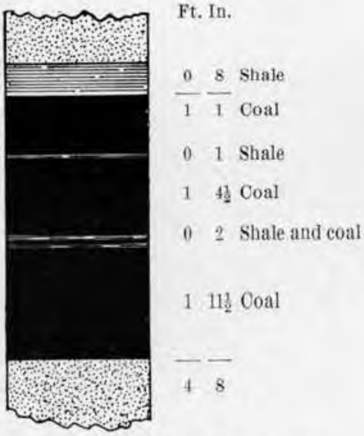
*Mine*—Beekman; a slope mine at Beekman, 3 miles northwest of Roslyn, on a spur of the Northern Pacific Railway, Sec. 12, T. 20 N., R. 14 E., Roslyn Fuel Co. Mine No. 1.

*Coal bed*—Roslyn. Strikes N. 70° W. and dips 14° SW. in eastern part of gangways, but near western end of gangway it strikes S. 75° W. and dips 8° SE. The roof and floor are firm and although one or two inches of the shale cap rock mixes with the coal it can be easily separated from it in mining.

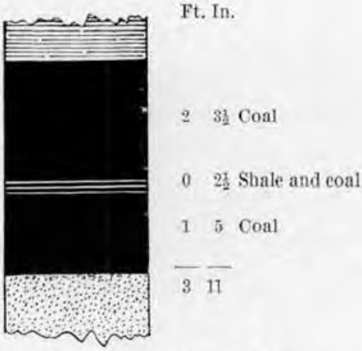
SECTIONS OF COAL BED IN THE BEEKMAN NO. 1 MINE AT BEEKMAN. (FIG. 26.)

| Section | A | | B | | C | | D | | E | |
|---|---|---|---|---|---|---|---|---|---|---|
| Laboratory No. | 9,411 | | 9,412 | | 9,413 | | 9,414 | | 9,415 | |
| Roof, shale. | Ft. | In. | Ft. | In. | Ft. | In. | Ft. | In. | Ft. | In. |
| Coal | 1 | 3 | 2 | 6 | 1 | 1¼ | 2 | 5 | 1 | 3½ |
| Shale, little sulphur | 0 | ¼ | ........ | | ........ | | ........ | | 0 | ½ |
| Coal | 1 | 2½ | ........ | | ........ | | ........ | | 1 | 2½ |
| Shale, carbonaceous | †0 | ½ | 0 | 1 | 0 | ¼ | 0 | ½ | 0 | ½ |
| Coal | 0 | 3 | 0 | 2 | ........ | | 0 | 3½ | 0 | 3 |
| Shale, carbonaceous | 0 | ¼ | 0 | ½ | ........ | | 0 | ½ | ........ | |
| Sandstone, sulphur band | ........ | | ........ | | ........ | | ........ | | 0 | ¼ |
| Coal | 0 | 2½ | ........ | | ........ | | ........ | | 0 | 5 |
| Shale, carbonaceous | †0 | 1 | ........ | | ........ | | ........ | | 0 | ¼ |
| Coal | 1 | 8½ | 1 | 1½ | 3 | 1 | 1 | 9½ | 1 | 9½ |
| Shale, carbonaceous | †0 | 1 | ........ | | †0 | 1 | †0 | 1 | ........ | |
| Shale | ........ | | 0 | 1 | ........ | | ........ | | ........ | |
| Coal | 0 | 2½ | 0 | 5½ | 0 | 2 | 0 | 2½ | ........ | |
| Floor, carbonaceous or sandy shale. | | | | | | | | | | |
| Thickness of bed | 5 | 1 | 4 | 5½ | 4 | 5½ | 4 | 10½ | 5 | 1 |
| Thickness of coal sampled | 4 | 10½ | 4 | 5½ | 4 | 4½ | 4 | 9½ | 5 | 1 |

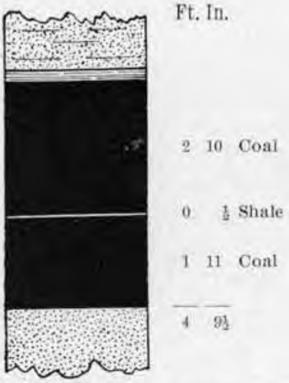
† Not included in sample.



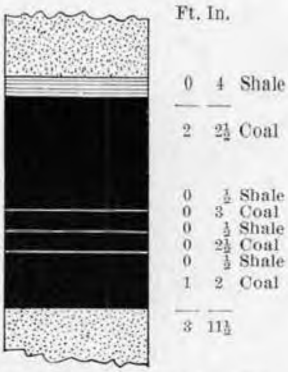

(a) Roslyn Fuel Co. Mine No. 1.
7th Level East at Room 33.



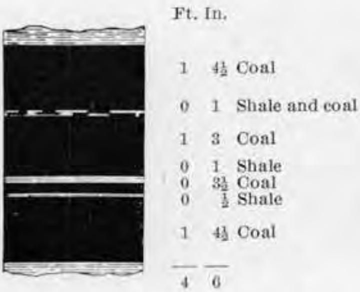

(b) Roslyn Fuel Co. Mine No. 1.
8th Level East, Room 13.



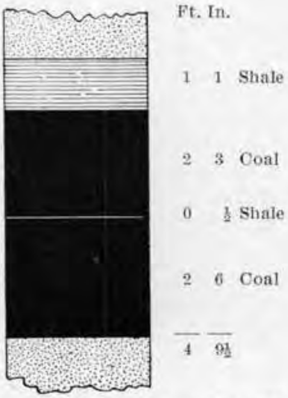

(c) Roslyn Fuel Co. Mine No. 1.
9th Level East, Room 2.




(d) Roslyn Cascade Co. Mine No. 1.
Face of Main North Slope.




(e) Busy Bee Mining & Development Co.
Mine.




(f) Roslyn Cascade Mine No. 2.
3rd Level East.

Fig. 26. SECTIONS OF ROSLYN BED AT WESTERN END OF FIELD.

Section A (sample 9,411) was cut from west level 2 on gangway, between rooms 26 and 27.

Section B (sample 9,412) was cut from east end of level 2.

Section C (sample 9,413) was cut from a point 150 feet beyond room 21 on east level 3.

Section D (sample 9,414) was cut from west level 3 on gangway between rooms 17 and 18.

Section E (sample 9,415) was cut from foot of slope, about 250 feet below the fourth level gangway.

A composite sample was made by mixing samples 9,411, 9,412, 9,413, 9,414 and 9,415 for an ultimate analysis, the results of which are shown under laboratory number 9,459.

The bed was also measured and sampled at two other points in 1908 by K. M. Way, described as follows:

SECTIONS OF COAL BED IN BEEKMAN MINE AT BEEKMAN.

| Section | A | | B | |
|---|---|---|---|---|
| Laboratory No. | 551-D | | 550-D | |
| Roof, shale. | Ft. | In. | Ft. | In. |
| Coal | 2 | 9½ | 0 | 1 |
| Shale, hard † | 0 | ¾ | ........ | |
| Mother coal | ........ | | 0 | ¼ |
| Coal | 1 | 10 | 2 | 3 |
| Shale † | 0 | ½ | 0 | 1 |
| Coal | 0 | 1½ | 0 | 4 |
| Shale † | ........ | | 0 | ¾ |
| Coal | ........ | | 0 | 6¼ |
| Shale † | ........ | | 0 | ¾ |
| Coal | ........ | | 1 | 1½ |
| Shale † | ........ | | 0 | ½ |
| Coal | ........ | | 0 | 2 |
| Floor, shale. | | | | |
| Thickness of bed | 4 | 10¾ | 4 | 9 |
| Thickness of coal sampled | 4 | 9 | 4 | 6 |

† Not included in sample.

*Notes*—The coal was passed over bar screens with ⅞-inch and 1½-inch spaces. The oversize was picked and sold as lump coal, the undersize being sold as steam coal.

RONALD. ROSYLN NO. 3 MINE.

*Sample*—Bituminous coal; analyses Nos. 9,428, 9,429, 9,430, 9,431, 9,432, 9,463, page 194.

*Mine*—Roslyn No. 3; an incline and slope mine in Sec. 7, T. 20 N., R. 15 E., 1½ miles west of Roslyn, on the Northern Pacific Railway.

*Coal bed*—Roslyn. In this case about 2 to 6 inches of capping shale rock comes down after the coal is removed; floor firm.

SECTIONS OF COAL BED IN ROSLYN NO. 3 MINE (FIG. 26).

| Laboratory No. | 9,429 | | 9,428 | | 9,430 | | 9,432 | | 9,431 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Roof, shale. | Ft. | In. | Ft. | In. | Ft. | In. | Ft. | In. | Ft. | In. |
| Coal | 1 | 3½ | 2 | 3 | 1 | 8 | 1 | 0 | 1 | 3 |
| Sulphur band | 0 | ½ | †0 | 1 | 0 | ¼ | 0 | ½ | 0 | ½ |
| Coal | 1 | 1 | 0 | 6 | 0 | 9½ | 1 | 3 | 1 | 3½ |
| Coal, shaly, broken | ... | ... | 1 | 1 | ... | ... | ... | ... | ... | ... |
| Shale (little sulphur) | †0 | ½ | ... | ... | ... | ... | †0 | 1 | †0 | ½ |
| Coal | 0 | 2½ | ... | ... | ... | ... | 0 | 3 | 0 | 3½ |
| Shale | †0 | ½ | ... | ... | †0 | ½ | 0 | ½ | ‡0 | ½ |
| Coal | 1 | 5½ | 1 | 4 | 1 | 10 | 1 | 5½ | 1 | 8½ |
| Coal, bony | ... | ... | ... | ... | ... | ... | ... | ... | 0 | ½ |
| Coal | ... | ... | ... | ... | ... | ... | ... | ... | 0 | 5½ |
| Floor, shale. | | | | | | | | | | |
| Thickness of bed | 4 | 2 | 4 | 3 | 4 | 4¼ | 4 | 1½ | 5 | 2 |
| Thickness of coal sampled | 4 | 1 | 4 | 2 | 4 | 3¾ | 4 | ½ | 5 | 1¼ |

† Not included in sample.

‡ One-half included in sample.

Sample 9,428 was taken on the old fifth water level gangway west, at the entrance to room 48.

Sample 9,429 was taken on the old sixth water-level gangway, between rooms 6 and 7, east of new slope 3.

Sample 9,432 was taken from the first level west, about 150 feet from the gangway up room 3 of the fourth battery.

Sample 9,431 was taken from the face of room 12 of the third battery, on the first level west, 100 feet from the gangway. An additional 5½ inches of coal occurs at the bottom of the bed in this part of the mine.

Sample 9,430 was collected on the east side of manway between the foot of the shaft and the third level, 150 feet up slope from the base of the shaft.

A composite sample was made by mixing the face samples 9,428, 9,429, 9,430, 9,431 and 9,432 for an ultimate analysis, the results of which are shown under laboratory No. 9,463.

*Note*—The partings that separated freely from the coal in the mine and the rock that fell from the roof were thrown in the gob when the cars were loaded. The coal was not picked at the bunkers because it was clean enough for locomotive use.

Section A (sample 551-D) was cut from a rib 1,300 feet southwest of the slope, on second level west.

Section B (sample 550-D) was cut from a point 1,000 feet southwest of the slope.

*Notes*—The coal is considered a good coking and steam coal. In 1909 it was mined either at the bottom or near the center of the bed, and was shot down with black powder. The tipple was provided with shaking screens with 1¾-inch, and 3-inch holes separating the coal into steam coal, special steam coal, and lump.

The shale and "sulphur" were picked from the coal in mining, but large lumps were not broken to remove the impurities they contained. The two men loading the cars at the tipple picked some of the shale from the car during loading. Only a small proportion of the shale and "sulphur" passed through the screens into the steam coal. The capacity of the mine was 1,000 tons and the average output was 800 tons per day. The output was expected to average 90 per cent from advance work. The coal was taken by the Northern Pacific Railroad and by the Chicago, Milwaukee & St. Paul Railroad to Seattle. At Seattle the company owning the mine had bunkers with a capacity of 2,500 tons and capable of loading 500 tons per day into vessels.

For results of washing tests of this coal, see Bureau of Mines Bull. 5, pp. 32, 47.

ROSLYN. BUSY BEE MINE.

*Sample*—Bituminous coal; analysis No. 9,406, page 193.

*Mine*—Busy Bee; strip pit, 2½ miles northwest of Roslyn.

*Coal bed*—Roslyn. The coal bed lies 6 feet below surface at the place where the sample was taken. The cover was removed with scraper.

SECTION OF COAL BED IN BUSY BEE MINE (FIG. 26).

| | | |
|---|---|---|
| Laboratory No. | 9,406 | |
| Roof, shale. | Ft. | In. |
| Coal, weathered † | 0 | 7 |
| Coal | 0 | 9½ |
| Coal, soft, with layers of shale † | 0 | 1 |
| Coal | 1 | 3 |
| Shale † | 0 | 1 |
| Coal | 0 | 3½ |
| Shale † | 0 | ½ |
| Coal | 0 | 9½ |
| Coal † | 0 | 7 |
| Floor, shale. | | |
| Thickness of bed | 4 | 6 |
| Tickness of coal sampled | 3 | 1½ |

*Notes*—The lower 7 inches of the bed was not exposed. The coal is like the Roslyn coal at other mines in the vicinity. The high heating value and low ash content probably result in part from the whole thickness of the bed not being sampled. The coal was passed over bar screens. The oversize was picked and sold as lump coal. The undersize was sold as steam coal.

RONALD. PATRICK-MACKAY MINE NO. 1.

*Sample*—Bituminous coal; analyses Nos. 9,407, 9,416, 9,417, 9,418, 9,460, page 194.

*Mine*—Patrick-MacKay; a slope in Sec. 6, T. 20 N., R. 14 E., 2½ miles northwest of Roslyn, on the Northern Pacific Railway. Roslyn-Cascade Coal Co.

*Coal bed*—Roslyn. Strike N. 75° W. Dip 9° SW. The lower 2 inches of a three-foot layer of shale between the bed and the overlying massive sandstone breaks after the coal is removed and is thrown into the gob. The rest of the shale forms a good roof. The floor is firm and does not mix with the coal.

SECTIONS OF COAL BED IN PATRICK-MACKAY MINE (FIG 26).

| | | | | | | |
|---|---|---|---|---|---|---|
| Laboratory No. | 9,416 | | 9,418 | | 9,417 | |
| Roof, shale or sandstone. | Ft. | In. | Ft. | In. | Ft. | In. |
| Coal | 1 | 2 | 1 | 3 | 1 | 2 |
| Sulphur band | 0 | ¼ | 0 | ¾ | Trace | |
| Coal | 1 | 3 | 1 | 1 | 1 | 3½ |
| Sulphur band | ......... | | Trace | | ......... | |
| Shale, bony | 0 | ¼ | ......... | | 0 | ½ |
| Coal | 0 | 2½ | 0 | 3 | 0 | 2 |
| **Shale** | †0 | 1 | †0 | 1 | †0 | 1 |
| Coal | 1 | 3½ | 1 | 10 | 1 | 5½ |
| Floor, shale. | | | | | | |
| Thickness of bed | 4 | ½ | 4 | 6¼ | 4 | 2½ |
| Thickness of coal sampled | 3 | 11½ | 4 | 5¾ | 4 | 1½ |

† Not included in sample.

Sample 9,418 was taken on the gangway of the first water level west, at the entrance to room No. 18.

Sample 9,416 was taken from the west side of the slope, 50 feet above the entrance to the first water level east.

Sample 9,417 was taken at the end of the gangway on the first water level east, about 1,000 feet from the rock tunnel to the main slope.

A composite sample was made by mixing the face samples 9,416, 9,417, and 9,418 for an ultimate analysis, the results of which are shown under laboratory No. 9,460.

SECTION OF LOWER COAL BED ON PATRICK-MACKAY PROPERTY, 1,300 FEET NORTH OF CENTER OF SECTION 6. (SEE PLATE II).

| | | |
|---|---|---|
| Laboratory No. | 9,407 | |
| Roof, shale. | Ft. | In. |
| Coal, bony † | 1 | 5½ |
| Sandstone † | 0 | 1½ |
| Coal | 0 | 8 |
| Shale, hard † | 0 | ½ |
| Coal | 1 | 5½ |
| Shale † | 0 | 3½ |
| Shale, hard † | 0 | 2 |
| Coal † | 0 | 9 |
| Floor, shale. | | |
| Thickness of coal bed | 4 | 11½ |
| Thickness of coal sampled | 2 | 1½ |

† Not included in sample.

### Central Part of the Field.

ROSLYN. ROSYLN NO. 2 SLOPE MINE.

*Sample*—Bituminous coal; analyses Nos. 9,433, 9,434, 9,435, 9,436, 9,464, page 195.

*Mine*—Roslyn No. 2 slope; a drift and slope mine in Sec. 20, T. 20 N., R. 15 E., at Roslyn, on the Northern Pacific Railway.

*Coal bed*—Roslyn. The bed strikes N. 70° W., dips about 12° SW. Three feet of shale above coal. Large fragments come off with coal.

SECTIONS OF COAL BED IN ROSLYN NO. 2 SLOPE MINE AT ROSLYN (FIG 27).

| Laboratory No. | 9,435 | | 9,434 | | 9,433 | | 9,436 | |
|---|---|---|---|---|---|---|---|---|
| Roof, shale. | Ft. | In. | Ft. | In. | Ft. | In. | Ft. | In. |
| Coal | 1 | 0 | ... | ... | ... | ... | 2 | 6 |
| Sulphur band mixed with coal | †0 | ½ | ... | ... | ... | ... | 0 | ¼ |
| Coal, streaks of sulphur | ... | ... | 1 | 1 | 2 | 6 | ... | ... |
| Coal | 1 | 3 | ... | ... | ... | ... | 0 | 1 |
| Shale | †0 | ½ | ... | ... | †0 | 1 | †0 | 1 |
| Shale, sulphur band | ... | ... | Trace | | ... | ... | ... | ... |
| Coal | 0 | 3 | ... | ... | 0 | 3 | ... | ... |
| Coal, streaks of sulphur | ... | ... | 1 | ½ | ... | ... | ... | ... |
| Shale, soft | 0 | ½ | Trace | | †0 | 1 | ... | ... |
| Coal | 0 | 3 | 0 | 4 | ... | ... | ... | ... |
| Shale | †0 | ½ | †0 | 1 | ... | ... | ... | ... |
| Coal | 1 | 0 | 2 | 0 | 1 | 10 | 1 | 6 |
| Shale | 0 | ½ | ... | ... | ... | ... | ... | ... |
| Coal | 0 | 7 | ... | ... | ... | ... | ... | ... |
| Floor, shale. | | | | | | | | |
| Thickness of bed | 4 | 6½ | 4 | 6½ | 4 | 9 | 4 | 2¼ |
| Thickness of coal sampled | 4 | 5 | 4 | 5½ | 4 | 7 | 4 | 1¼ |

† Not included in sample.

Sample 9,433 was taken on the fifth level west from slope 2, about 250 feet up from room 7 of the second block.

Sample 9,434 was taken on the sixth level west from slope 2, on the side of the barrier pillar separating this mine from No. 3 mine, and 360 feet up the dip from the gangway.

Sample 9,435 was collected on the sixth level west from slope 2, on the gangway between rooms 2 and 3.

Sample 9,436 was taken from the side of the slope between the eighth and the tenth level west from shaft 4, and about 10 feet below the air course below the eighth level.

A composite sample was made by mixing samples 9,433, 9,434, 9,435, and 9436. The results of an ultimate analysis of this sample are shown under laboratory No. 9,464.

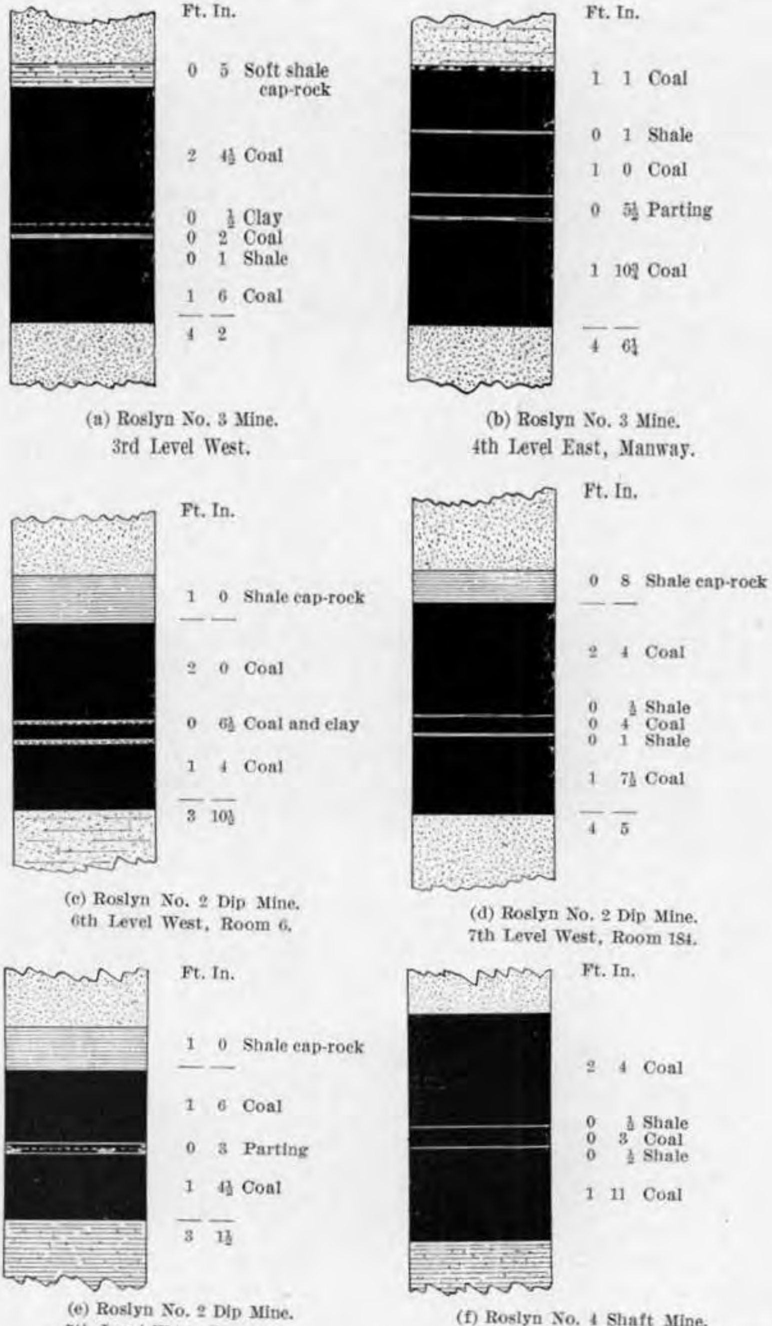
*Note*—The coal was not picked at the bunkers, because it was clean enough for locomotive use.

ROSLYN. ROSLYN NO. 2 MINE.

*Sample*—Bituminous coal; analyses Nos. 2,457 (Washington No. 2) and 9,442, 9,443, 9,444, 9,468, 3,098, page 195.

*Mine*—Roslyn No. 2; an incline in Secs. 8 and 9, T. 20 N., R. 15 E., at Roslyn, on the Northern Pacific Railway.

*Coal bed*—Roslyn. The lower 2 inches of the shale cap rock breaks after the coal is removed and was thrown in the gob. The remainder forms a good roof throughout most of the mine. The floor of the bed is firm. The bed strikes N. 50° W. and dips about 12° SW.




(a) Roslyn No. 3 Mine. 3rd Level West.

(b) Roslyn No. 3 Mine. 4th Level East, Manway.

(c) Roslyn No. 2 Dip Mine. 6th Level West, Room 6.

(d) Roslyn No. 2 Dip Mine. 7th Level West, Room 184.

(e) Roslyn No. 2 Dip Mine. 7th Level West, Room 168.

(f) Roslyn No. 4 Shaft Mine. Face of Slope Below 14th Level.

Fig. 27. SECTIONS OF ROSLYN BED IN CENTRAL PORTION OF THE FIELD.

SECTION OF COAL BED IN ROSLYN NO. 2 MINE, AT ROSLYN. (FIG. 27).

| Laboratory No. | 9,443 | | 9,442 | | 9,444 | | 2,457 | |
|---|---|---|---|---|---|---|---|---|
| Roof, shale. | Ft. | In. | Ft. | In. | Ft. | In. | Ft. | In. |
| Coal | 2 | 3½ | 2 | 3½ | 2 | 3 | 2 | 10½ |
| Sulphur band | ..... | ..... | ..... | ..... | ‡0 | ½ | ..... | ..... |
| Shale | 0 | ¼ | Trace | | ..... | ..... | ..... | ..... |
| Parting | ..... | ..... | ..... | ..... | ..... | ..... | †0 | ¾ |
| Coal | 0 | 2 | 0 | 5 | 0 | 3½ | ..... | ..... |
| Shale, sulphur | Trace | | ..... | ..... | ..... | ..... | ..... | ..... |
| Shale, bony | ..... | ..... | †0 | 2 | ‡0 | ¼ | ..... | ..... |
| Coal | 0 | 5½ | ..... | ..... | 0 | 3½ | ..... | ..... |
| Shale | 0 | ½ | ..... | ..... | ‡0 | ½ | ..... | ..... |
| Coal | 1 | 5 | 1 | 3 | 1 | 5 | 1 | 2¼ |
| Floor, shale. | | | | | | | | |
| Thickness of bed | 4 | 4¾ | 4 | 1½ | 4 | 4¼ | 4 | 1½ |
| Thickness of coal sampled | 4 | 4¾ | 3 | 11½ | 4 | 3⅝ | 4 | ¾ |

† Not included in sample.
‡ One-half included in sample.

Sample 9,442 was taken from the eighth level, about 15 feet west of the east rope slope.

Sample 9,443 was taken from the seventh level west on the gangway at the entrance to room 80.

Sample 9,444 was taken on the tenth level east, 75 feet beyond room 43.

Sample 2,457 was collected from a point about 6,000 feet from the entrance to the mine.

A composite sample was made by mixing the face samples 9,442, 9,443, and 9,444. The results of an ultimate analysis of this sample are shown under laboratory No. 9,468. Analysis No. 3,098 was made from a car sample of lump coal shipped for testing purposes.

*Notes*—The partings and impurities that separate readily from the coal were not loaded in the mine. All the coal was used for locomotives and did not need further picking at the tipple.

ROSLYN. ROSLYN NO. 4 MINE.

*Sample*—Bituminous coal; analysis No. 2,458 (Washington No. 2), and analyses Nos. 9,437, 9,438, 9,465, page 197.

*Mine*—Roslyn No. 4; a shaft in Sec. 20, T. 20 N., R. 14 E., at Roslyn, on the Northern Pacific Railway.

*Coal bed*—Roslyn. The bed strikes N. 70° W. and dips about 15° SW. Roof and floor as in neighboring mines.

SECTIONS OF COAL BED IN ROSLYN NO. 4 MINE AT ROSLYN (FIG 27).

| Laboratory No. | 9,437 | | 9,438 | | 2,458 | |
|---|---|---|---|---|---|---|
| Roof, shale. | Ft. | In. | Ft. | In. | Ft. | In. |
| Coal, streaks of sulphur | †0 | 2½ | ..... | ..... | ..... | ..... |
| Coal | 2 | 5½ | 1 | 3½ | 1 | 4¼ |
| Shale, containing sulphur | ..... | ..... | †0 | 1 | †0 | ½ |
| Shale | †0 | 1 | ..... | ..... | ..... | ..... |
| Coal | 0 | 3 | 1 | 5½ | 1 | 4 |
| Sulphur band | ..... | ..... | 0 | ¾ | ..... | ..... |
| Coal | ..... | ..... | 0 | 1½ | ..... | ..... |
| Parting | ..... | ..... | ..... | ..... | †0 | 4 |
| Shale | †0 | ½ | †0 | 1 | ..... | ..... |
| Coal | 2 | 0 | 2 | 0 | 1 | 9½ |
| Floor, shale. | | | | | | |
| Thickness of bed | 5 | ½ | 5 | ¾ | 4 | 10½ |
| Thickness of coal sampled | 4 | 8½ | 4 | 10¾ | 4 | 6 |

† Not included in sample.

Sample 9,438 was taken from the gangway of west level 11, near the center of the second battery.

Sample 9,437 was taken from the gangway of east level 11, between rooms 3 and 4 of the second battery.

Sample 2,458 was taken from room 3 of the second battery on west level 9, and about 2,000 feet from the base of the shaft.

A composite sample was made by mixing samples 9,438 and 9,437. An ultimate analysis of this sample is shown under laboratory No. 9,465.

*Notes*—The coal in the mine is under considerable pressure from the roof and was worked without shooting. The partings and impurities which separate readily from the coal were not loaded in the mine. All the coal was used for locomotives and did not need further picking at the tipple.

For results of producer-gas tests of this coal, see Bureau of Mines Bull. 13, pp. 214, 276.

### ROSYLN. ROSLYN NO. 6 MINE.

*Sample*—Bituminous coal; analyses Nos. 9,439, 9,440, 9,441, 9,466, page 196.

*Mine*—Roslyn No. 6; a series of drift mines located in Sec. 16, T. 20 N., R. 15 E., ¾ mile northeast of Roslyn, on the Northern Pacific Railway.

*Coal bed*—Roslyn. Roof and floor about as in neighboring mines. The bed strikes N. 65° W. and dips 7° to 10° SW.

SECTIONS OF COAL BED IN ROSLYN NO. 6 MINE (FIG 28).

| Laboratory No. | 9,439 | | 9,440 | | 9,441 | |
|---|---|---|---|---|---|---|
| Roof, shale. | Ft. | In. | Ft. | In. | Ft. | In. |
| Coal | 2 | 6½ | 2 | 3½ | .... | .... |
| Sulphur band | ‡0 | ¼ | .... | .... | .... | .... |
| Shale | .... | .... | †0 | 1 | .... | .... |
| Coal | 0 | 1½ | 0 | 2½ | .... | .... |
| Coal, lenses of sulphur | .... | .... | .... | .... | 2 | 8 |
| Shale | †0 | ½ | 0 | ¼ | ‡0 | ½ |
| Coal | ‡0 | 1½ | 0 | 4 | 0 | 3 |
| Shale | †0 | 1 | †0 | 2 | ‡0 | 1 |
| Coal, lenses of sulphur | .... | .... | .... | .... | .... | .... |
| Coal | 1 | 1 | 1 | 8 | 1 | 6½ |
| Sulphur band | 0 | ¼ | .... | .... | .... | .... |
| Coal | 0 | 6 | .... | .... | .... | .... |
| Floor, shale. | | | | | | |
| Thickness of bed | 4 | 6½ | 4 | 9¼ | 4 | 7 |
| Thickness of coal sampled | 4 | 4⅛ | 4 | 6¾ | 4 | 5½ |

† Not included in sample.
‡ One-half only sampled.

Sample 9,439 was taken from the stump pillar between rooms 1 and 2 on the seventh level.

Sample 9,441 was taken at the east end of the seventh level.

Sample 9,440 was taken from the east end of the fifth level.

A composite sample was made by mixing laboratory samples 9,439, 9,440, and 9,441 for an ultimate analysis, the results of which are shown under laboratory No. 9,466.

*Notes*—The partings and impurities which separate readily from the coal were not loaded in the mine. All of the coal was used for locomotives and did not need further picking at the tipple.

ROSLYN. A. & E. MINE.

*Sample*—Bituminous coal; analysis No. 9,402, page 196.

*Mine*—A. & E.; a drift and slope mine in Sec. 10, T. 20 N., R. 15 E., 1 mile northeast of Roslyn.

*Coal bed*—Roslyn. Roof and floor about as in neighboring mines. The bed strikes N. 70° W. and dips 11° SW.

SECTION OF COAL BED IN A. & E. MINE.

| | | |
|---|---|---|
| Laboratory No. | 9,402 | |
| Roof, soft shale. | Ft. | In. |
| Coal | 2 | 5 |
| Clay † | 0 | ½ |
| Coal | 0 | 2½ |
| Shale, black † | 0 | ½ |
| Coal | 1 | 8 |
| Floor, dark shale. | | |
| Thickness of bed | 4 | 4½ |
| Thickness of coal sampled | 4 | 3½ |

† Not included in sample.

*Notes*—The partings, roof rock, and other impurities that could be readily removed when the mine cars were loaded were thrown in the gob. At the tipple the coal was passed over 3-inch bar screens. The oversize was sold as lump and the undersize as steam coal.

The sample was taken 160 feet up the ninth room from the slope.

ROSLYN. ROSLYN NO. 5 MINE.

*Sample*—Bituminous coal; analyses Nos. 9,423, 9,424, 9,425, 9,426, 9,427, 9,462, page 197.

*Mine*—Roslyn No. 5; a slope mine in Sec. 22, T. 20 N., R. 15 E., 1½ miles southeast of Roslyn, on a spur of the Northern Pacific Railway.

*Coal bed*—Roslyn. Roof and floor about as in neighboring mines. The bed strikes N. 45° W. and dips 20° to 30° SW.

SECTIONS OF COAL BED IN ROSLYN NO. 5 MINE (FIG. 28).

| Laboratory No. | 9,423 | | 9,424 | | 9,425 | | 9,426 | | 9,427 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Roof, shale and coal streak. | Ft. | In. | Ft. | In. | Ft. | In. | Ft. | In. | Ft. | In. |
| Coal | 2 | 8 | 1 | 1 | 1 | 3 | 1 | 2 | 2 | 6½ |
| Sandstone and sulphur | .......... | | 0 | ½ | Trace | | 0 | ¼ | .......... | |
| Coal | .......... | | 1 | 7 | 1 | 2½ | 1 | 6 | .......... | |
| Sulphur band | .......... | | †0 | ½ | 0 | ¼ | 0 | ¼ | 0 | 1 |
| Bone | 0 | 1 | .......... | | .......... | | .......... | | .......... | |
| Coal | 0 | 3 | 0 | 1 | 0 | 1½ | 0 | 2 | 0 | 1 |
| Clay | †0 | ½ | †0 | ½ | †0 | ½ | †0 | 1 | †0 | 1 |
| Coal | 1 | 8½ | 2 | 5 | 2 | 3½ | 0 | 2 | 1 | 11 |
| Bony coal | .......... | | .......... | | .......... | | 0 | ¼ | .......... | |
| Coal | .......... | | .......... | | .......... | | 1 | 7 | .......... | |
| Floor, shale. | | | | | | | | | | |
| Thickness of bed | 4 | 9 | 5 | 3½ | 4 | 11¼ | 4 | 8¾ | 4 | 9½ |
| Thickness of coal sampled | 4 | 8½ | 5 | 2½ | 4 | 10¾ | 4 | 7¾ | 4 | 5½ |

† Not included in sample.

Sample 9,427 was taken from the barrier pillar between No. 5 mine and the old No. 1 mine, and on the gangway of the first level west of the No. 5 slope. A 3-inch parting of broken coal, clay, and pyrite occurs in the center of the bed. This was not included in the sample.

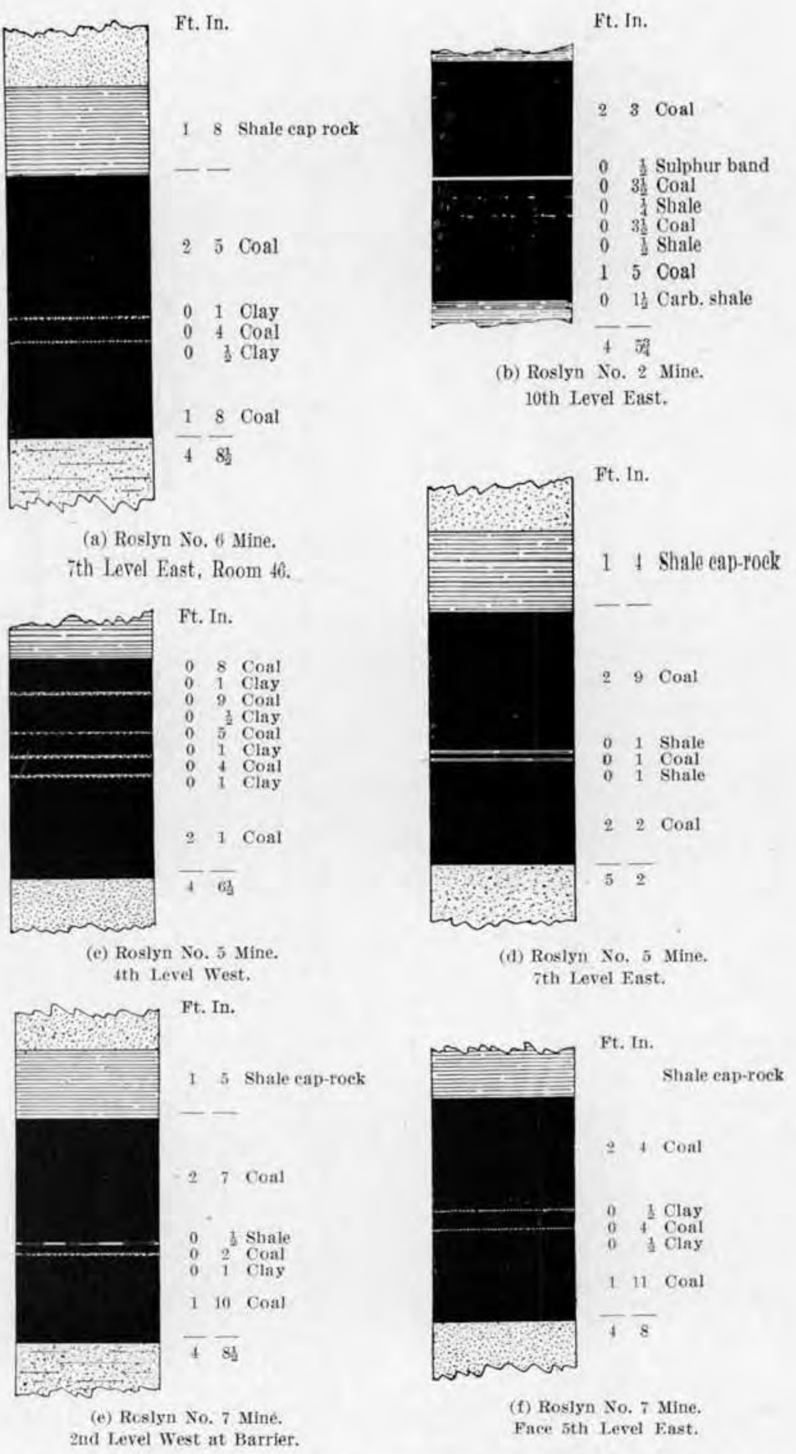



Fig. 28. SECTIONS OF THE ROSLYN BED IN CENTRAL PORTION OF THE FIELD.

Sample 9,423 was taken from the barrier pillar between mines No. 5 and No. 7, about 10 feet above the second level gangway of mine No. 5.

Sample 9,424 was taken on the third level west at the entrance to room No. 50.

Sample 9,426 was taken on the third gangway east at entrance to room 42.

Sample 9,425 was taken from the air course below the fourth level, about 30 feet west from the slope.

A composite sample was made by mixing the five samples, 9,423, 9,424, 9,425, 9,426 and 9,427. An ultimate analysis of this sample is shown under laboratory No. 9,462.

*Notes*—The partings and impurities that separated readily from the coal were not loaded in the mine. All of the coal was used for locomotives and did not need further picking at the tipple.

### Eastern End of the Field.

CLEALUM. ROSLYN NO. 7 MINE.

*Sample*—Bituminous coal; analyses Nos. 9,419, 9,420, 9,421, 9,422, 9,461, page 198.

*Mine*—Roslyn No. 7; a slope mine in Sec. 22, T. 20 N., R. 15 E., ½ mile northwest of Clealum, on a spur from the Northern Pacific Railroad.

*Coal bed*—Roslyn. Roof and floor as described for other mines. The bed strikes N. 65° W. and dips 20° to 30° SW.

SECTIONS OF COAL BED IN ROSLYN NO. 7 MINE (FIG 28).

| Laboratory No. | 9,421 | | 9,422 | | 9,420 | | 9,419 | |
|---|---|---|---|---|---|---|---|---|
| Roof, shale. | Ft. | In. | Ft. | In. | Ft. | In. | Ft. | In. |
| Coal, broken | | | | | 0 | 4 | | |
| Coal | 1 | 2 | 1 | 2 | 0 | 10 | 2 | ½ |
| Shale | | | †0 | ½ | †0 | 1 | †0 | 1 |
| Sulphur band | †0 | ½ | | | | | | |
| Coal, streaks of sulphur | | | 1 | 6½ | | | | |
| Coal | 1 | 2½ | | | 1 | 6½ | 0 | 1½ |
| Shale | †0 | 1 | 0 | ½ | | | 0 | 1 |
| Coal and shale streaks | | | | | †0 | 2 | | |
| Coal | 0 | 1½ | 0 | 2 | 0 | 2 | | |
| Sulphur band | †0 | ¼ | | | | | | |
| Coal | ‡0 | 1 | | | | | | |
| Shale | 0 | ½ | †0 | 1 | 0 | ½ | | |
| Coal | 0 | 4 | | | | | | |
| Shale | †0 | ½ | | | | | 0 | 4 |
| Coal, streaky | | | | | | | 0 | 2 |
| Coal | 1 | 6½ | 1 | 6 | 1 | 8½ | 1 | 6½ |
| Floor, shale. | | | | | | | | |
| Thickness of bed | 4 | 8¾ | 4 | 6½ | 4 | 10½ | 4 | 4½ |
| Thickness of coal sampled | 4 | 5½ | 4 | 5 | 4 | 7½ | 4 | 3½ |

† Not included in sample.

‡ One-half included in sample.

Sample 9,422 was taken on the gangway of west level 2, 6 feet up room 40.

—4

Sample 9,421 was taken on the gangway of east level 2, 15 feet from the barrier between mine No. 7 and mine No. 1 at Clealum. A parting of shale, "sulphur," and coal occurs near the center of the bed. In picking, about one-half of the coal in this parting would be thrown away; hence in sampling only half the coal and the ½-inch band of shale were included in the sample.

Sample 9,420 was taken in the air course below the gangway of west level 4, about 800 feet west of the slope.

Sample 9,419 was taken on the gangway of east level 4, 330 feet beyond the entrance to room 12.

A composite sample was made by mixing the face samples 9,419, 9,420, 9,421, and 9,422. The results of an ultimate analysis are shown under laboratory No. 9,461.

*Note*—All of the coal was used for locomotives and did not need picking at the tipple.

### CLEALUM. SUMMIT MINE.

*Sample*—Bituminous coal; analysis No. 9,403, page 199.

*Mine*—Summit; an incline in Sec. 14, T. 20 N., R. 15 E., 1 mile north of Clealum.

*Coal bed*—Roslyn. The bed dips 11° SW. and strikes N. 75° W.

SECTION OF COAL BED IN SUMMIT MINE (FIG. 29).

| Laboratory No. | 9,403 | |
|---|---|---|
| Roof, shale with streaks of coal. | Ft. | In. |
| Coal | 2 | 5½ |
| Shale † | 0 | ½ |
| Coal | 0 | 2 |
| Shale † | 0 | ½ |
| Coal | 1 | 9½ |
| Floor, shale. | | |
| Thickness of bed | 4 | 6 |
| Thickness of coal sampled | 4 | 5 |

† Not included in sample.

The sample was taken 50 feet down the slant from the new tunnel and about 40 feet below the surface.

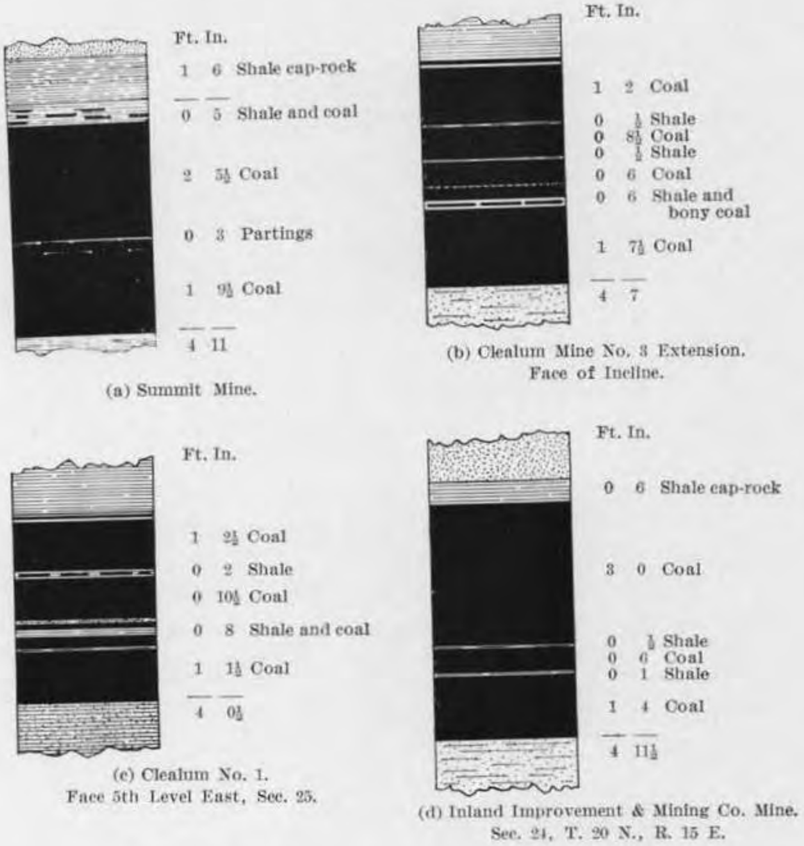
*Note*—At the bunker the coal was passed over 2-inch bar screens. the oversize being picked and marketed as lump coal, and the undersize being sold as steam coal.

### CLEALUM. CLE ELUM NO. 2 MINE.

*Sample*—Bituminous coal; analysis No. 9,472, page 199.

*Mine*—Cle Elum No. 2; ½ mile north of Clealum.

*Coal bed*—Roslyn. The bed is separated by about 3 feet of shale cap rock from a massive layer of sandstone. Pieces of this shale varying up to a foot in thickness broke off after the coal was mined and




(a) Summit Mine.

(b) Clealum Mine No. 3 Extension.
Face of Incline.

(c) Clealum No. 1.
Face 5th Level East, Sec. 25.

(d) Inland Improvement & Mining Co. Mine.
Sec. 24, T. 20 N., R. 15 E.

Fig. 29. SECTIONS OF ROSLYN BED IN EASTERN END OF THE FIELD.

were thrown in the gob. They occasionally broke with the coal and had to be separated before the mine cars were loaded. The floor is firm. The bed dips about 14° SW. and strikes N. 55° W.

SECTION OF COAL BED IN CLE ELUM NO. 2 MINE (FIG. 29).

| | | |
|---|---|---|
| Laboratory No. | 9,472 | |
| Roof, soft shale. | Ft. | In. |
| Coal | 1 | 1 |
| Sulphur band and coal † | 0 | 1 |
| Coal | 0 | 6½ |
| Coal, bony | 0 | ½ |
| Coal | 0 | 7 |
| Shale and coal layers † | 0 | 3½ |
| Coal | 1 | 5½ |
| Floor, shale. | | |
| Thickness of bed | 4 | 1 |
| Thickness of coal sampled | 3 | 8½ |

† Not included in sample.

Sample 9,472 was taken at the face of the gangway of east level 6.

*Notes*—Bony layers in the coal are difficult to separate. All of the coal was used for locomotives and did not need further picking at the tipple.

CLEALUM. CLE ELUM NO. 2 EXTENSION MINE.

*Sample*—Bituminous coal; analysis No. 9,409, page 199.

*Mine*—Cle Elum No. 2 Extension; an incline and drift mine 1 mile north of Clealum.

*Coal bed*—Roslyn bed. Roof and floor as in Cle Elum No. 2 mine. The bed dips 9° S. and strikes N. 80° W.

SECTION OF COAL BED IN CLE ELUM NO. 2 EXTENSION MINE.

| | | |
|---|---|---|
| Laboratory No. | 9,409 | |
| Roof, slightly carbonaceous shale. | Ft. | In. |
| Coal | 1 | 2½ |
| Shale, bony ‡ | 0 | 1 |
| Coal | 1 | 3 |
| Shale, bony | 0 | ¼ |
| Coal | 0 | 1½ |
| Shale † | 0 | ¾ |
| Coal † | 0 | 1 |
| Shale † | 0 | ½ |
| Coal | 0 | 4 |
| Shale, bony | 0 | ½ |
| Coal | 1 | 5 |
| Floor, hard shale. | | |
| Thickness of bed | 4 | 8 |
| Thickness of coal sampled | 4 | 4½ |

† Not included in sample.
‡ One-half included in sample.

The sample was taken on the gangway of east level 8, about 50 feet from the rope slope.

*Note*—All of the coal was used for locomotives and did not need picking at the tipple.

CLEALUM. CLE ELUM NO. 3 EXTENSION MINE.

*Sample*—Bituminous coal; analysis No. 9,408, page 199.

*Mine*—Cle Elum No. 3 Extension; an incline and drift mine in Sec. 23, T. 20 N., R. 15 E., 1 mile north of Clealum.

*Coal bed*—Roslyn. The bed, roof and floor are as in No. 2 mine. The bed dips about 9° S. and strikes N. 70° W.

SECTION OF COAL BED IN CLE ELUM NO. 3 EXTENSION MINE (FIG. 29).

| | | |
|---|---|---|
| Laboratory No. | 9,408 | |
| Roof, shale. | Ft. | In. |
| Coal | 2 | 8½ |
| Shale † | 0 | ½ |
| Coal | 0 | 4 |
| Shale, bony | 0 | 1 |
| Coal | 1 | 2½ |
| Floor, shale. | | |
| Thickness of bed | 0 | 4½ |
| Thickness of coal sampled | 4 | 4 |

† Not included in sample.

The sample was taken just below level 6, from the air course which parallels the incline.

*Note*—All of the coal was used for locomotives and did not need picking at the tipple.

CLEALUM. CLE ELUM NO. 1 MINE.

*Sample*—Bituminous coal; analyses Nos. 9,445, 9,446, 9,447, 9,467, page 199.

*Mine*—Cle Elum No. 1; shaft mine in Sec. 26, T. 20 N., R. 15 E., at Clealum, on the Northern Pacific Railroad.

*Coal bed*—Roslyn. The bed is separated by about 3 feet of shale from a massive layer of sandstone. Pieces of shale broke after the coal was mined and were thrown in the gob. The shale occasionally broke with the coal and had to be separated in loading mine cars. The floor was firm and did not mix with the coal. The bed strikes N. 65° W. and dips 24° SW. in the west end of the workings and strikes N. 55° W. and dips 31° SW. in the east end of the workings.

SECTIONS OF COAL BED IN CLE ELUM NO. 1 MINE AT CLE ELUM (FIG. 29).

| Laboratory No. | 9,445 | | 9,446 | | 9,447 | |
|---|---|---|---|---|---|---|
| Roof, shale. | Ft. | In. | Ft. | In. | Ft. | In. |
| Coal | 2 | 0 | 1 | ½ | 2 | 5½ |
| Shale | †0 | ¼ | †0 | ½ | 0 | 1 |
| Coal | ‡0 | 1 | 1 | 2½ | 0 | 6 |
| Shale | †0 | ½ | 0 | ½ | †0 | 1 |
| Coal | ‡0 | 2 | 0 | 3 | ........ | |
| Shale | †0 | ½ | †0 | 1 | ........ | |
| Coal | 0 | 5½ | 0 | 5½ | ........ | |
| Shale, bony | 0 | ½ | †0 | 1 | ........ | |
| Coal | 1 | 4 | 1 | 2½ | 1 | 0 |
| Shale, bony | 0 | ½ | ........ | | ........ | |
| Coal | 0 | 2 | ........ | | ........ | |
| Shale | 0 | ¼ | ........ | | ........ | |
| Coal | 0 | 1 | ........ | | ........ | |
| Floor, shale. | | | | | | |
| Thickness of bed | 4 | 6 | 4 | 5 | 4 | 1½ |
| Thickness of coal sampled | 4 | 3½ | 4 | 2½ | 4 | ½ |

† Not included in sample.

‡ One-half included in sample.

Sample 9,445 was taken from the gangway on the first level southwest between rooms 32 and 33.

Sample 9,446 was taken from the gangway of the first level southwest 100 feet from the slope.

Sample 9,447 was taken at the east end of the gangway on the first level southeast.

A composite sample was made by mixing the face samples 9,445, 9,446, and 9,447 for an ultimate analysis, the results of which are shown under laboratory No. 9,467.

*Note*—The coal was used for locomotives and did not need picking at the tipple.

## COKING PROPERTIES OF ROSLYN-CLEALUM COALS.

M. A. Pishel* found by examination of a large number of samples of various coals that the best coking coal, when finely pulverized in an agate mortar, adheres very strongly both to the mortar and to the pestle, and can be removed only by rubbing or washing, and that non-coking coal does not adhere either to mortar or pestle. This test was applied to the coals of the Roslyn-Clealum field and the following table shows the results of the tests, compared with the Pocahontas coals of Virginia, and the McKay seam, and the Carbonado coal.

RESULTS OF PISHEL COKING TEST ON BITUMINOUS COALS OF KITTITAS COUNTY.

| MINE | Coal Bed | Kind of Coke Produced | Adherence to Mortar | Ash in Coal | Remarks |
|---|---|---|---|---|---|
| Patrick McKay ....... | Roslyn............ | Good.... | Good.... | Medium | Has been coked |
| Roslyn Cascade ....... | Lower............ | .......... | Good.... | Medium to high. | .................. |
| Beekman No. 1........ | Roslyn............ | Good.... | Good.... | Medium | Has been coked |
| Roslyn No. 3........... | Roslyn............ | Good.... | Good.... | Medium | Has been coked |
| Roslyn No. 2........... | Roslyn............ | Good.... | Medium | Medium | Has been coked |
| Roslyn No. 4........... | Roslyn............ | Good.... | Medium | Medium | Has been coked |
| Roslyn No. 5........... | Roslyn............ | Poor.... | Poor.... | Medium | Cokes slightly on forge |
| Roslyn No. 7........... | Roslyn............ | .......... | Poor.... | Medium | Strong sinter |
| Clealum No. 1......... | Roslyn............ | .......... | Poor.... | Medium | Weak sinter |
| Black Diamond ........ | McKay............ | .......... | Good.... | Low..... | .................. |
| Carbonado ............ | No. 1 coking...... | Good.... | Good.... | High.... | Has been coked |
| Pocahontas, W. Va... | Pocahontas No. 3 | Excellent. | Excellent. | Low..... | Is coked |

* Coals of the State of Washington, by E. Eggleston Smith, U. S. Geol. Surv. Buletin No. 474, pp. 32-33.

THE "BIG DIRTY" BED.

LOCATION AND EXTENT.

The second bed of any importance at present in this field is known as the "Big Dirty" from the fact that the total thickness of the bed is 15 to 19 feet and it contains only five to six feet of workable coal located in the lower part of the seam. It lies about 208 feet above the Roslyn bed (Fig. 2), and has therefore been eroded in many sections where the Roslyn bed is

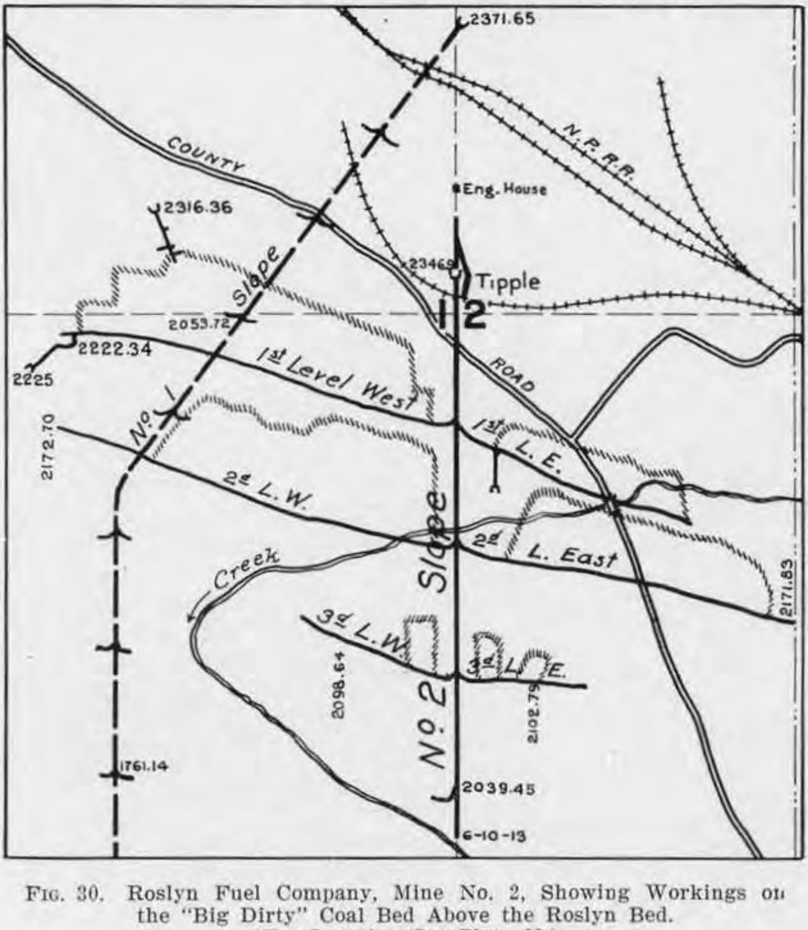



FIG. 30. Roslyn Fuel Company, Mine No. 2, Showing Workings on the "Big Dirty" Coal Bed Above the Roslyn Bed. (For Location See Plate II.)

still present. The total area underlaid by this bed would probably be less than one-half that of the Roslyn bed, or about 5,000 acres. The relations of the two beds are shown in the sections on Plate II.

### HISTORY OF DEVELOPMENT.

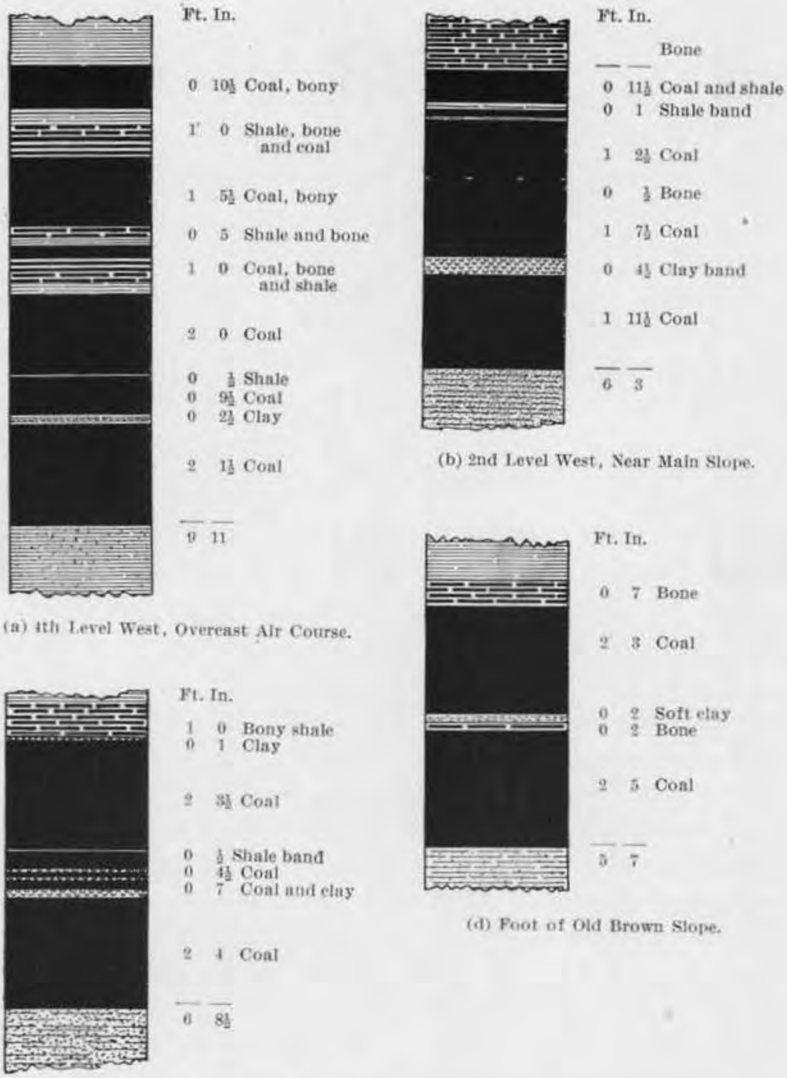
Coal was mined from this bed as early as 1895, and in 1903 a mine known as Brown's Slope was opened on this seam in the NW¼ of the SE¼ of Section 12, T. 20 N., R. 14 E. The production as reported by the state mine inspector from 1903 to 1905 was 7,951 tons, but probably much more was mined at that time. In the spring of 1911 the Roslyn Fuel Company sunk a slope directly on the center line of section 12 to the old Brown workings and began active operations on this seam in what is known as Beekman or Roslyn Fuel Company mine No. 2. (Figure 30.) Four sets of levels east and west have been started from this slope and the reported production for 1911 was 11,906 tons. Up to 1914 the total production of this mine, including the previous production, was 198,914 tons.

### SECTIONS OF "BIG DIRTY" BED.

The sections of the "Big Dirty" show two distinct benches of fairly good coal, separated by a narrow clay band, in the lower part of the coal seam. Above these are bands of shale, carbonaceous shale and bony coal solid enough to make a fairly good roof above the workable coal. (Fig. 31.)

SECTIONS OF THE "BIG DIRTY" BEEKMAN NO. 2.

| | Second Level W. | | First Level W. | | Fourth West | |
|---|---|---|---|---|---|---|
| | Ft. | In. | Ft. | In. | Ft. | In. |
| Roof, hard shale. | | | | | | |
| Bony coal | | | | | 0 | 10½ |
| Shale and bone | | | | | 0 | 7 |
| Soft shale and coal | | | | | 0 | 5 |
| Bony coal | | | | | 1 | 5 |
| Shale and bone | 1 | 1½ | 1 | 3 | 1 | 6 |
| Roof of coal. | | | | | | |
| Coal | 2 | 10½ | 2 | 9½ | 2 | 9½ |
| Soft shale and clay | 0 | 4½ | 0 | 7 | 0 | 2½ |
| Coal | 1 | 11½ | 2 | 4 | 1 | 6½ |
| Bony coal | | | | | 0 | 7 |
| Floor, sandy shale. | | | | | | |
| Total thickness | 6 | 4 | 6 | 10½ | 9 | 11 |
| Coal | 4 | 10 | 5 | ½ | 4 | 11 |




(c) 1st Level West, 850 Feet from Slope.

Fig. 31. SECTIONS OF "BIG DIRTY" COAL BED. ROSLYN FUEL CO. MINE NO. 2.

ANALYSIS.

Samples of this bed were not taken when the Roslyn field was sampled by E. Eggleston Smith in 1909, but a sample of the coal, including the partings in the lower five feet two inches of the bed, reported by Mr. Jones, chief engineer of the Roslyn Fuel Company, gave the following analysis as compared with the Roslyn bed in Beekman No. 1.

| | Moisture | Volatile Matter | Fixed Carbon | Ash | Sulphur | B. T. U. |
|---|---|---|---|---|---|---|
| Beekman No. 2, "Big Dirty".... | 0.93 | 39.60 | 44.36 | 15.11 | 0.42 | 13,000 |
| Beekman No. 1, Roslyn......... | 1.6 | 39.2 | 49.2 | 10.0 | 0.42 | 13,480 |

The analysis shows a lower per cent of fixed carbon and higher per cent of ash, therefore a lower heat value than the coal from the Roslyn bed, but still a good bituminous coal well adapted for domestic use.

COMPUTED PRODUCTION.

The northern outcrop line of this bed has not been definitely worked out and mapped, and the amount of available coal is therefore not worked out for each section. But from the map and sections of Plate II it will be seen that the "Big Dirty" bed will underly, in addition to section 12 where it is being worked, parts of sections 18, 19, 17, 20, 21, 28, 27 and 26, aggregating roughly about six sections, or 3,840 acres. Using 1,800 tons per acre-foot for total weight of coal dipping 10° to 15° and a recovery value of 60 per cent this seam should yield about 1,080 tons per acre-foot. There is then in this bed containing five feet of good coal, about 5,040 tons per acre, or a reserve supply of over 20,000,000 tons, of which only 198,914 tons have been mined up to January 1st, 1914.

THE "LAKEDALE," OR "WRIGHT" BED.

GENERAL STATEMENT.

Of the beds lying below the Roslyn the only one that has been worked to any extent is a 4-foot bed known as the "Lakedale" or "Wright" bed, about 400 feet below the Roslyn. In

Section 2, T. 20 N., R. 14 E., about one mile directly northwest of the Beekman No. 1 mine two mines have been opened on this bed or at least on what is thought to be the same bed. The Wright mine is located at Lakedale on a spur of the Northern Pacific Railroad, in the SE¼ of Section 2 and the Plant mine one-fourth of a mile south of Lakedale, also in the SE¼ of Section 2.

### WRIGHT MINE.

The Wright mine was opened in 1908 and worked for three years, during which time about 8,650 tons of coal were shipped from it. Work was discontinued until 1914, when a new company took over the property and began operations. From an elevation of 2,450 feet a tunnel following the strike of the coal bed as shown in Plate II was driven into the side hill about 800 feet. At intervals of 60 feet gangways were driven up the dip and from rooms opened off these the coal was mined. The strike of the bed varies from N. 40° E. to N. 70° E. and it dips from 10° to 15° SE.

### PLANT MINE.

In 1910 Mr. Plant drove a slope on the outcrop of this same bed farther south at an elevation of 2,328 feet for a distance of 60 feet and was just beginning to take out coal in 1913 when the examination of the bed was made. The strike of the bed at this point is N. 35° E. and the dip 10° SE.

He also prospected near the railroad in Section 2, across from the Wright mine, and found a bed which in this report we have called Plant's prospect, probably on the Lakedale bed as indicated by its location and the section of it which we obtained from Mr. Plant.


Fig. 32. SECTIONS OF COAL BEDS AT LAKEDALE.

SECTIONS OF BEDS AT LAKEDALE (FIG. 32).

Sample 9,405. Analysis page 192.

| | No. 1 Wright Mine 150 Feet from Entry | | No. 2 Wright Mine 350 Feet from Entry | | Plant's Mine Foot of Slope | | Plant's Prospect by Mr. Plant | |
|---|---|---|---|---|---|---|---|---|
| | Ft. | In. | Ft. | In. | Ft. | In. | Ft. | In. |
| Roof, shale. | | | | | | | | |
| Coal (bony) | 1 | 0 | 1 | 4 | 1 | 3¼ | 0 | 9 |
| Shale | 0 | 6½ | 0 | 7 | 0 | 3 | 0 | 3¼ |
| Clay | ..... | ..... | ..... | ..... | 0 | 3 | ..... | ..... |
| Coal | 0 | 6½ | 0 | 5 | 0 | 5½ | 0 | 9 |
| Shale | 0 | 1 | 0 | 2 | 0 | 2½ | 0 | 2 |
| Coal | 0 | 7½ | 0 | 7 | 0 | 6½ | 1 | 7½ |
| Shale | 0 | ¼ | 0 | 2 | 0 | 1 | 0 | 4 |
| Coal | 0 | 9¼ | 1 | 2 | 1 | 1 | 1 | 5 |
| Bone and coal | ..... | ..... | 0 | 9 | ..... | ..... | ..... | ..... |
| Shale | ..... | ..... | 0 | 1 | ..... | ..... | ..... | ..... |
| Bone and coal | ..... | ..... | 0 | 5 | ..... | ..... | ..... | ..... |
| Carb. shale | ..... | ..... | 1 | 1 | 1 | 0 | ..... | ..... |
| Floor, sandy shale. | | | | | | | | |
| Total thickness | 3 | 7 | 6 | 9 | 5 | 1¾ | 5 | 3¾ |
| Coal | 2 | 11¼ | 3 | 6 | 3 | 4¼ | 4 | 6½ |

The difference in thickness of the two sections from the Wright mine is due to differences in amount of the carbonaceous shale included above and below the coal benches. The similarity of arrangement and thickness of the coal benches in the Wright and Plant mines, together with their location and relations in the field, indicates that these mines are on the same bed. Some have thought that this was the Roslyn bed, but comparison of the cross sections and analyses of the two beds will show that it is a different bed, and unless a structural break exists between this and Beekman mine No. 1 it lies below the Roslyn bed.

DESCRIPTION OF COAL.

A sample was taken from the Wright mine where section No. 2 was measured by E. E. Smith of the United States Geological Survey. The analysis No. 9,405 will be found on page 192 Appendix C, and his description of the coal on page 83 of this report. The bed contains two bony layers in the lower part that cannot be readily separated from the coal and they are therefore included in the sample. The high per cent of ash is due to their presence. The coal is massive and breaks with a cubical fracture closely resembling the coal at the western end of the Roslyn bed, but it runs considerably higher in moisture and ash. (See tables in Appendix C.) If carefully picked and washed this coal would be a marketable coal although lower in heat values than the Roslyn coal.

#### EXTENT.

Considering an average of 3 feet 6 inches of workable coal in this bed, it should yield about 3,780 tons per acre. The extent of this bed, however, has not been computed on account of the lack of information regarding its relation to the bed outcropping along the Teanaway ridge, and the question whether or not it continues unbroken through the total area of 26,000 acres lying inside the dotted line.

### BED BELOW THE "LAKEDALE."

A prospect tunnel or drift one-fourth of a mile northwest of the Wright mine is driven 25 feet on a two-foot seam of coal at an elevation of 2,400 feet. A section of the bed was made and a sample taken (Analysis No. 9,404) but the coal was so badly weathered that the analysis is probably higher in ash than a fresh sample would be. The bed strikes N. 60° E. and dips 11° SE., and as shown in Plate II and no doubt underlies the Wright bed. It is too thin to be of any commercial importance but gives the following section:

SECTION OF PROSPECT NORTHWEST OF LAKEDALE (FIG. 32E).

| | Ft. | In. |
|---|---|---|
| Roof, shale. | | |
| Coal | 0 | 3½ |
| Shale | 0 | 1 |
| Coal | 0 | 3 |
| Shale | 1 | ½ |
| Coal | 1 | 0 |
| Shale (carb.) | 0 | 6 |
| Floor, sandy shale. | | |
| Total thickness | 2 | 2 |
| Coal | 1 | 6½ |

### BEDS ON THE TEANAWAY SLOPE.

#### GENERAL STATEMENT.

Numerous prospects have been opened on a 4 foot 6 inch bed which outcrops along the Teanaway slope of the ridge north of Roslyn, about 375 to 400 feet vertically below the Roslyn bed. These extend in an irregular line through sections 35 and

36 of T. 21 N., R. 14 E. and sections 6, 5, 4, 9, and 10, 14 and 13 of T. 20 N., R. 15 E. (Plate II.) In section 10 on the Yakima-Roslyn Coal Co.'s property a slope was driven 184 feet on this bed about four years ago. No further work, however, was done and the coal from this seam will probably not be used until the Roslyn bed is exhausted. Drill hole records in section 12, T. 20 N., R. 15 E. by the Roslyn Fuel Company and the Busy Bee Mining Company show a section of the Roslyn formation from the Roslyn bed to the lower bed. These records vary slightly in the measurements of the sediments and thickness of coal but a comparison of the sections in Figure 3 will show the relation between the sections at different points and will explain the differences in measurements taken at points much farther apart. The strike of the bed varies from N. 70° W. in section 6 to N. 50° W. in section 10, the dip remaining about 10° or 12° SW.

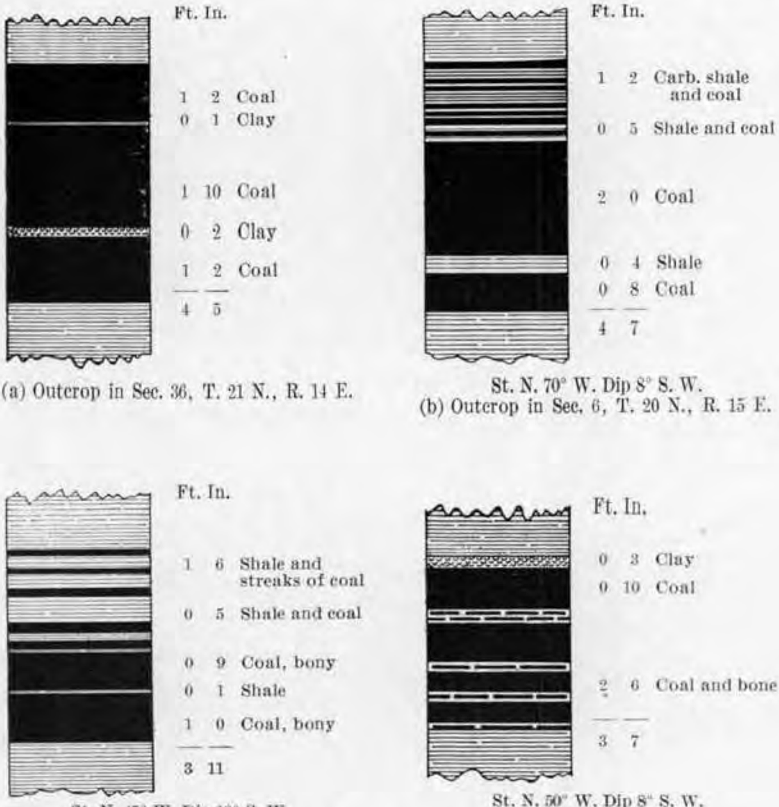
## SECTIONS AND ANALYSES.

For comparison sections of the seam taken in different localities are grouped in the following table.

SECTIONS OF BED ON TEANAWAY SLOPE (FIG. 33).

| | No. 1 In Sec. 36, T. 21 N., R. 14 E. By Mr. Jones | | No. 2 In Sec. 6, T. 20 N., R. 15 E. By Mr. McKay | | No. 3 In Sec. 6, T. 20 N., R. 15 E. Outcrop | | No. 4 In Sec. 10, T. 20 N., R. 15 E. Tunnel | |
|---|---|---|---|---|---|---|---|---|
| Roof, shale. | Ft. | In. | Ft. | In. | Ft. | In. | Ft. | In. |
| Coal, bony | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2½ |
| Shale | 0 | 1 | 0 | 1½ | 0 | 1 | 0 | 2 |
| Coal | 0 | 6½ | 0 | 7 | 0 | 3½ | 0 | 2 |
| Shale | 0 | ½ | 0 | ¼ | 0 | ½ | 0 | 1 |
| Coal | 1 | 3 | 1 | 3 | 2 | 0 | 0 | 9 |
| Shale and clay | 0 | 2 | 0 | 2 | 0 | 4 | 0 | 1 |
| Coal | 1 | 2 | 1 | 2 | 0 | 8 | 1 | 0 |
| Floor, shale. | | | | | | | | |
| Total thickness | 4 | 5 | 4 | 5¾ | 4 | 7 | 3 | 5½ |
| Coal | 4 | 1½ | 4 | 2 | 4 | 1½ | 3 | 1½ |

Samples of the coal from prospects in sections 36 and 6 and from the core of the Diamond drill hole No. 9 (Plate II) in




(a) Outcrop in Sec. 36, T. 21 N., R. 14 E.

St. N. 70° W. Dip 8° S. W.
(b) Outcrop in Sec. 6, T. 20 N., R. 15 E.

St. N. 45° W. Dip 10° S. W.
(c) Tunnel, Sec. 10, T. 20 N., R. 15 E.

St. N. 50° W. Dip 8° S. W.
(d) Patrick Tunnel.
Sec. 28, T. 20 N., R. 16 E.

Fig. 33. SECTIONS OF COAL BED OUTCROPPING ON TEANAWAY SLOPE, BELOW THE ROSLYN BED.

Section 12 have been taken and the analyses furnished by the mine operators are as follows:

| | Moisture | Volatile Matter | Fixed Carbon | Ash | Sulphur | B. T. U. |
|---|---|---|---|---|---|---|
| Section 36 | 2.03 | 36.29 | 43.83 | 19.88 | 0.38 | 11,502 |
| Drill Hole No. 9 | 1.30 | 37.44 | 43.94 | 17.42 | ........ | ........ |
| Section 6 | 1.60 | 33.90 | 47.70 | 16.85 | 0.81 | 12,140 |

The coal occurs in two benches separated by a band of shale of variable thickness up to five or six inches, the upper bench containing a thin parting of shale or clay. The bony coal overlying the upper bench has been considered by some workable, but was not included in the samples. Judging from its appearance it would probably run high in ash and if sold with the coal of the lower benches would greatly decrease its value. It is pitch black, massive, only slightly laminated, and breaks with irregular fracture. It runs higher in ash and sulphur and lower in volatile matter and heat values than the Roslyn coal, but if washed would be a good marketable coal. The moisture content is low and it does not weather readily. The best coal in the benches resembles the Roslyn coal and while not worked at present, it no doubt will furnish a valuable reserve supply of coal after the Roslyn bed is exhausted.

EXTENT AND ESTIMATED PRODUCTION.

The area underlaid by this bed is of course much greater than that of either the Roslyn or "Big Dirty" beds and probably extends over 25,000 to 30,000 acres if the field is not broken up on the south side of the fold. Taking an average of three feet of workable coal this should yield about 3,240 tons per acre, meaning a large reserve after the upper beds have been worked out.

RELATION TO "LAKEDALE" OR "WRIGHT" BED.

Not enough information is available to say definitely at this time that the "Wright" bed at Lakedale and the bed above described are the same, but a comparison of the cross sections while showing slight differences are very similar in arrangement and thickness of the coal benches.

COMPARATIVE CROSS SECTIONS (FIGS. 32 AND 33).

| | Section 6 | | Wright Mine | | Plant's Prospect | |
|---|---|---|---|---|---|---|
| | Ft. | In. | Ft. | In. | Ft. | In. |
| Roof, shale. | | | | | | |
| Coal, bony | 1 | 2 | 1 | 0 | 0 | 9 |
| Shale | 0 | 1½ | 0 | 7 | 0 | 3¼ |
| Coal | 0 | 7 | 0 | 5½ | 0 | 9 |
| Shale | 0 | ¼ | 0 | 2 | 0 | 2 |
| Coal | 1 | 3 | 0 | 7 | 1 | 7½ |
| Shale and clay | 0 | 2 | 0 | 2 | 0 | 4 |
| Coal | 1 | 2 | 1 | 2 | 1 | 5 |
| Floor, shale. | | | | | | |
| Total thickness | 4 | 5¾ | 4 | 11 | 5 | 3¾ |
| Coal | 4 | 2 | 3 | 2 | 4 | 6½ |

As will be seen no greater differences exist than are apt to be found in the same bed at different localities, but further work on the western end of the field is necessary to either prove or disprove that the beds are the same.

RELATION OF LOWER BEDS NORTHEAST OF CLEALUM.

The extent and relations of the underlying beds northeast of Clealum are not so well known as in the northwestern part of the field. Near the northwest corner of section 19, T. 20 N., R. 16 E. an old caved tunnel was found along with several old prospect holes. The tunnel was driven 100 feet on a coal seam, and coal had evidently been mined and hauled to Clealum but no section or sample of the seam outcropping here was obtainable.

Farther east in the NW$\frac{1}{4}$ of section 28, T. 20 N., R. 16 E., a tunnel 105 feet northwest through sandstone and shale cuts a 3 foot 6 inch coal seam, which it follows for 220 feet, almost along the strike of the bed. This has been called the "Patrick" bed or mine. It strikes N. 50° W. and dips 8° to the SW. and is probably the same bed as that exposed in the outcrops in the western end of the field. The section taken (Fig. 33) is somewhat different from that taken in section 6, and the outcrop is much further back of the Roslyn outcrop line on account of the topography of the country in this section. Very little if any coal, except that taken out in driving the tunnel has been mined.

CROSS SECTION OF THE "PATRICK" BED, SECTION 28, T. 20 N., R. 16 E.
(325 Feet From Entrance). (Fig 33).

| | Ft. | In. |
|---|---|---|
| Roof, shale. | | |
| Soft clay | 0 | 3 |
| Coal | 0 | 10 |
| Coal, bony | 2 | 6 |
| Floor, shale. | | |
| Total thickness | 3 | 7 |
| Coal | 3 | 4 |

The lower bench of 2 feet 6 inches may correspond to the two lower benches of the lower bed as measured in sections 10 and 6, including the shale parting. These benches in the other sections (Pages 83 and 109 and Figs. 32 and 33) are 1 foot 3 to 5 inches each, plus a 2-inch parting. The 10-inch bench here may correspond to the second bench or the upper bench, although this bench is the best coal in the seam while the upper bench in the other sections is bony.

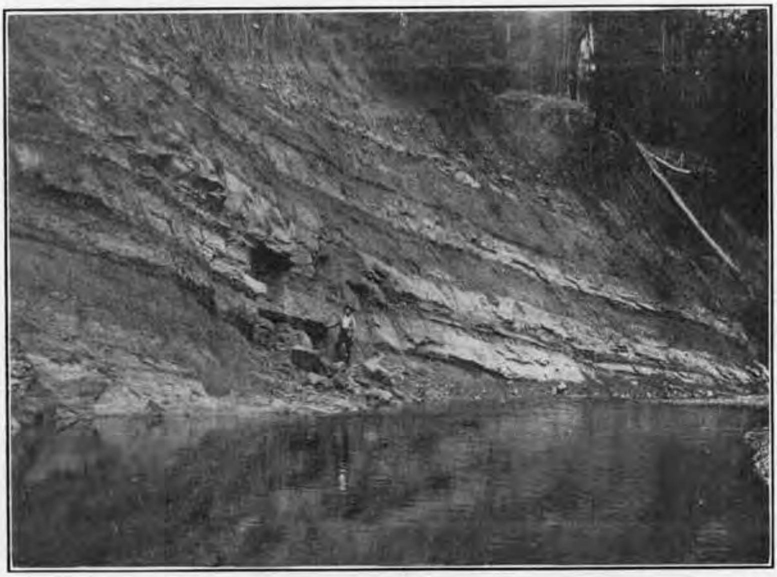
The coal is black and massive with somewhat splintery fracture and slightly bony throughout. It probably would run quite high in ash, but if washed would make a fairly good coal.

To summarize the conditions in the Roslyn-Clealum field, there are at least three beds of coal which are workable and if the Wright bed should prove to be different from the bed in sections 36 and 6 a fourth bed that has already been proven. The total area covered by the lower beds is about 26,000 acres, while that covered by the uppermost bed is only about 5,000 acres, possibly less. As shown by the ownership map and the production tables, the Northwest Improvement Company owns the bulk of the central part of the field and the smaller companies are working along the outcrop of the Roslyn and the lower beds. As long as the Roslyn bed continues to be a large producer the other beds will not be worked extensively. As the Roslyn bed is exhausted the beds already opened, and some of the other beds lying between the "Big Dirty" and the Roslyn, may be worked.

## THE TEANAWAY BASIN.

### GENERAL DESCRIPTION OF THE ROSLYN FORMATION.

An examination of the Roslyn formation was made along the different branches of the Teanaway River, from the Teanaway basalt on the north to the junction of the Teanaway and Yakima Rivers on the south, and up the small tributary valleys draining the Teanaway side of the ridge between the Teanaway and Roslyn basins. (Plate I.) A fairly complete section was obtained along the north fork, from about one mile north of Rye patch, where the Roslyn formation lies conformably on the Teanaway basalt, to the forks of the river. From this point on the river flows more nearly along the strike of the beds and does not give a very good cross section. The section was continued, however, up the small gullies, draining into the Teanaway from the south, to the outcropping coal seams near the top of the ridge.



A. Roslyn Formation Along the Teanaway River, Showing Typical Low Dip and Uniformity.

B. Roslyn Formation Along the Teanaway River, Showing Fault, Upthrow Side on the Right.

The formation here is made up largely of massive yellow or light grey arkosic sandstone grading into a coarse sandy shale and numerous beds of fine grained yellow and dark gray shale with thin beds of carbonaceous material. The sandstones occur in thick, poorly assorted beds showing in many places strong current or cross-bedding. In some of these beds, bands of small pebbles were found but no large conglomerate beds were observed. The stratification is not well marked in all cases, as the formation gradually changes from a sandstone to a sandy shale and then to a fine shale. The structure is very regular showing only slight variations in northwest strike and dipping always to the southwest from 5° to 20°. (Plate XXII A.) A few rolls and small faults were observed in the formation and one of these noted in section 14, T. 20 N., R. 16 E., is shown in Plate XXII B.

COAL BEDS IN THE LOWER PART OF THE ROSLYN FORMATION.

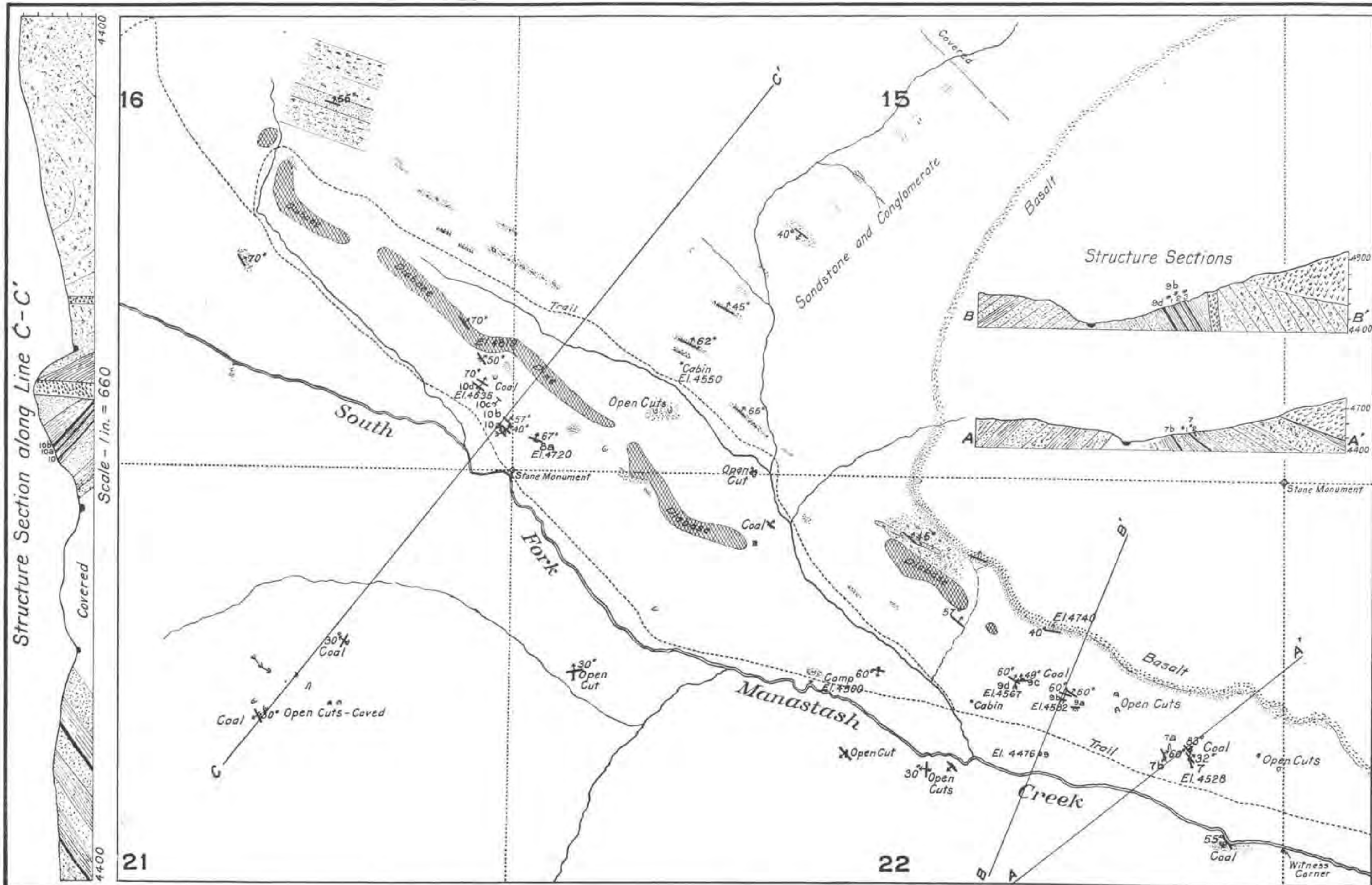
The only carbonaceous beds in this section more than one foot in thickness were found near the base of the series a short distance above the Teanaway basalt north of Rye patch (Plate I.) On one of these seams, known as the "Kilmore" seam, a tunnel, now caved, was driven about 12 years ago. It contains about two feet of a very bony low grade coal and except for local use was never worked.

SECTION OF "KILMORE" SEAM. SECTION 5, T. 21 N., R. 16 E.
Strike N. 45° W., Dip 10° S. W.

| | Ft. | In. |
|---|---|---|
| Roof, yellow shale. | | |
| Carbonaceous shale | 0 | 11 |
| Yellow shale and clay | 0 | 3 |
| Bony brown coal | 2 | 4 |
| Floor, dark gray shale. | | |
| Total thickness | 3 | 6 |
| Coal | 2 | 4 |

About one mile below this outcrop in section 8 a second seam about 1 foot 6 inches thick had been prospected but the old cut was so badly caved and covered that no section of the seam could be obtained. Many small lenses and narrow bands of good bright looking coal are present in the sandstone and shale banks of the main stream. Some of these have been picked out and used locally, but the examination of the entire section along the creek indicates the absence of coal of any commercial value in the lower part of the Roslyn formation.

Several diamond drill holes were put down in 1907 by the Chicago, Milwaukee & St. Paul Railway Company along the valley, but the records of these were not obtainable. One of these near the forks of the creek in the northeast quarter of section 6, T. 20 N., R. 16 E., was drilled 1,900 feet. Another along the middle fork in section 26, T. 21 N., R. 15 E. was sunk 900 feet, and a third was drilled in the northwest quarter of section 14, T. 20 N., R. 16 E. along the main stream. Judging from the fact that no further prospecting was attempted, the indications of coal must have been unsatisfactory. This is also borne out by the absence of coal in the section obtained along the Teanaway River from the base up to the outcrop of the beds near the Roslyn bed.




Map and Structure Sections of Manastash Coal Field. Tn. 18 N., R. 15 E.

# CHAPTER IV.

## DETAILS OF THE MANASTASH FIELD.

### GENERAL DESCRIPTION.

#### LOCATION AND EXTENT.

The Manastash coal field is located in T. 18 N., R. 15 E., about 25 miles west of Ellensburg, the nearest shipping point on the Northern Pacific and the Chicago, Milwaukee & St. Paul railways. It lies along the south fork of the Manastash Creek, a tributary of the Yakima River, flowing from the eastern slope of the Cascade Mountains. The coal is found in the Manastash formation, which is exposed at elevations varying from 4,500 to 5,000 feet over an area of about eight square miles, where the north and south forks of the Manastash Creek have eroded the overlying Taneum andesite and Yakima basalt.

#### HISTORY OF DEVELOPMENT.

According to reports from the oldest settlers in Kittitas County, Mr. Isaiah Buchanan has been prospecting in this field since 1871 or 1872. He had made a great number of open cuts, and judging from the material on the old dumps round the openings, exposed a number of carbonaceous beds, but most of them are caved or filled in and the coal covered up. A few cuts and short tunnels in sections 21, 22, 15 and 16 are still open, and coal is shown at various points in these sections. Some of this coal was taken to Ellensburg about 25 years ago and was used by the blacksmiths there, but no active mining has been carried on in this district.

#### NATURE OF WORK DONE.

Owing to the irregular nature of the beds, the condition of the cuts, and the absence of tunnels through the series, it was impossible to get a cross section of the formation or that portion of it containing coal, and in many cases satisfactory sections of the coal beds themselves could not be obtained. Stadia traverses were run from the section corners along the trails and streams. From stations along the traverses all cuts, tunnels, and outcrops were tied in and definitely located by tape or stadia. From the data thus obtained the map and sections in Plate XXIII were worked out, and the numbers of the stations are used in describing different localities.

### DESCRIPTION OF THE MANASTASH FORMATION.

The Manastash formation exposed in this field is at least 1,900 feet thick, with the coal in the lower part of the section studied. It consists of a series of conglomeratic sandstones containing many white quartz pebbles, thick beds of yellow arkosic sandstone, thinner beds of shaly, laminated sandstone, beds of light gray and almost white shale, with a number of carbonaceous shale and coal beds. Thin beds of white shale or clay rock show presence of small volcanic glass fragments formed from deposition of volcanic ash mixed with very fine clay silt. The leaves found in great abundance in the laminated sandstones and shales have been studied by Dr. Knowlton and, being similar to the flora of the Clarno formation of the John Day basin, this formation has been placed in the upper Eocene age, later than the Roslyn formation.*

### STRUCTURE.

The structure where the coal is exposed is a large anticline, probably part of a still larger syncline (geosyncline) which includes also the Taneum field. On the upwarped portion are still smaller folds with northwest and southeast axes. The south fork of Manastash Creek cuts through one of these anticlinal folds and the coal is exposed on both limbs of the anticline, the rocks in sections 15, 16 and 22 dipping northeast into the hill, those in section 21 and south of the creek in section 22 dipping southwest. (Cross Sections, Plate XXIII.)

Along part of its southern border this formation rests unconformably on the eroded surface of Easton Schist and is overlaid by andesite and basalt along its northern and eastern boundaries. Throughout the length of the field a large diabase dike, with general northwest and southeast trend, cuts the formation

* Mount Stuart folio Number 106, United States Geological Survey.

A. Prospect Tunnels in Section 22, Manastash Coal Field.

B. Open Cut in Coal on South Side of Manastash Creek in Section 22.

north of the creek, and has caused considerable displacement and crushing in this locality. Its presence would interfere with the working of coal here and makes the value of the field problematical.

## COAL IN THE MANASTASH FIELD.

### GENERAL STATEMENT.

As stated above, while much prospecting has been done in sections 15, 16, 21 and 22 and the presence of a number of beds of coal is indicated by coal and carbonaceous shale on the dumps about the openings, only a few are in a condition for satisfactory examination and study. There are no rock tunnels through the series by means of which the beds exposed in different parts of the field can be definitely correlated, and any attempt here made to compare the beds is based on general structural relations and similarities in the beds themselves. In the description of the different beds the numbers of the survey stations will be used to locate them, as indicated on the map. (Plate XXIII.)

### SECTIONS AND RELATION OF COAL BEDS IN SECTION 22.

In the northeast quarter of section 22 on the steep side hill near Mr. Buchanan's cabin two sets of cuts and short tunnels are opened on a series of three or four beds of coal. (Plate XXIV A.) These openings are obout 200 feet in elevation below the edge of the basalt covering the formation, or about 500 feet below the basalt measured across the series. The tunnels run into the hill, across the sedimentary series and are arranged as shown in Figure 34, one above the other. From the beds exposed a small amount of coal has been taken for local use, but little work has been done recently and the exposed surface of the coal is badly weathered, thus making examination and sampling difficult. At

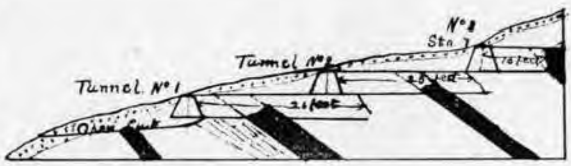



FIG. 34. Tunnels in Manastash Field.

Station 7, (Plate XXIII, map and section A) three beds are exposed and a fourth is said to exist in the upper caved tunnel. (Fig. 34.) The first, at Station 7b, or lowest of these, is a 12-foot bed of carbonaceous shale, with lenses and stringers of good coal scattered through it, strike N. 23° W., dip 30° NE. There is no bench of good coal in this bed as it appears at the surface. The second bed at Station 7, exposed in the lower tunnel is a 3 foot 6 inch bed composed largely of carbonaceous shale and bony coal, strike N. 30° W., dip 32° NE. Both of these beds have shale floor and roof and on digging into them are so badly weathered and crushed that no detailed section or sample can be taken.

At Station 7 the second tunnel runs in about 16 feet, to a third bed of coal, and a slope of 10° or 15° is driven down on the coal. The bottom was filled with water, but a good sample and section was obtained.

SECTION OF BED WHERE SAMPLE WAS TAKEN. STA. 7, NO. 2 (FIG. 35a).
Sample No. 13266. Analysis Page 200.

| | Ft. | In. |
|---|---|---|
| Roof, shale badly crushed. | | |
| Crushed bony coal | 0 | 8½ |
| Coal | 0 | 6 |
| Bone | 0 | 1 |
| Coal | 1 | 4 |
| Bony coal | 0 | 3 |
| Floor, conchoidal shale. | | |
| Total thickness | 2 | 10½ |
| Coal | 2 | 9½ |

The strike of the bed is N. 32° W. and dip is 83° NE. About 10 feet west of the tunnel a fault cuts across this seam running N. 50° E. and hading north, thus interfering with its development. The analysis shows it to be a low grade bituminous coal, high in ash.

About 1,000 feet northwest of Station 7 another set of openings exposes a series of beds as shown at stations 9a, 9b. The short tunnels at 9b are arranged similarly to those at station 7 (Fig. 34b), and the seams are numbered No. 1, No. 2, No. 3, from bottom of series up. At station 9b No. 1 is a bed of carbonaceous shale with stringers of coal, surface exposure strike N. 40° W., dip 55° NE. No detailed section or sample was taken. Bed No. 2, about 30 feet above No. 1 in the second tunnel is only 2 feet 4 inches thick, but contains 18 inches of good coal. The strike is N. 35° W. and dip 60° NE. No sample was taken of this bed.

STATION 9B NO. 2. MANASTASH (FIG. 35b).

| | Ft. | In. |
|---|---|---|
| Roof, dark gray shale. | | |
| Carbonaceous shale | 0 | 5 |
| Clay | 0 | 2 |
| Coal | 1 | 6 |
| Clay | 0 | 3 |
| Floor, sandy shale. | | |
| Total thickness | 2 | 4 |
| Coal | 1 | 6 |

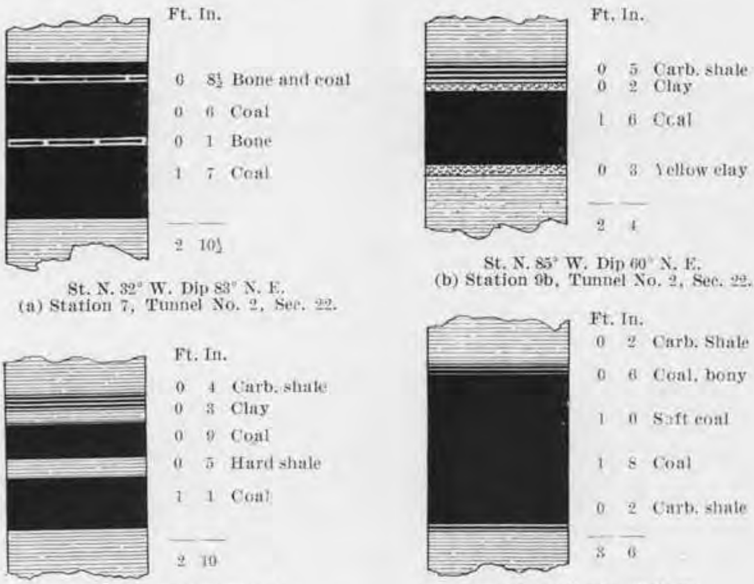
Bed No. 3, about 2 feet 10 inches thick lies 25 feet above No. 2 and is exposed in an open cut above the second tunnel. The coal contained in this bed was badly crushed and weathered and was too near the surface for collection of a good sample or even a good section.

STATION 9B NO. 3. MANASTASH (FIG. 35c).

| | Ft. | In. |
|---|---|---|
| Roof, yellow shale. | | |
| Carbonaceous shale | 0 | 4 |
| Shale | 0 | 5 |
| Clay | 0 | 3 |
| Coal | 1 | 1 |
| Bony coal | 0 | 9 |
| Floor, gray shale. | | |
| Total thickness | 2 | 10 |
| Coal | 1 | 10 |

An open cut at 9a, partly caved, showed a portion of same bed as at 9b No. 1.

At stations 9c and 9d about 400 feet west of 9b, two beds have been opened by means of two short tunnels, one above the other, as at station 7. More coal has been taken from these beds than from any others in this section, and the best lenses of this coal are good hard bright coal, which stand up fairly well under weather. The beds, or benches, are separated by about 7 feet of shale (Fig. 34b), and contain altogether about 5 feet of fairly good coal.




St. N. 32° W. Dip 83° N. E.
(a) Station 7, Tunnel No. 2, Sec. 22.

St. N. 85° W. Dip 60° N. E.
(b) Station 9b, Tunnel No. 2, Sec. 22.

St. N. 57° W. Dip 60° N. E.
(c) Station 9b, Tunnel No. 3, Sec. 22.

St. N. 85° E. Dip 49° N. W.
(d) Station 9c, Sec. 22.

Fig. 35. SECTIONS OF MANASTASH COAL SEAMS.

SECTIONS OF COAL BEDS AT STATIONS 9D AND 9C (FIGS. 36a AND 35d).
Analysis No. 13268 Page 200.

| | No. 9d | | No. 9c | |
|---|---|---|---|---|
| | Ft. | In. | Ft. | In. |
| Roof, dark gray shale. | | | | |
| Carbonaceous shale | 0 | 6 | 0 | 2 |
| Gray shale | 0 | 5 | .... | .... |
| Coal | .... | .... | 0 | 6 |
| Bony coal | 1 | 0 | 1 | 0 |
| Coal | 1 | 2 | 1 | 8 |
| Carbonaceous shale | 0 | 10 | 0 | 2 |
| Floor, dark gray shale. | | | | |
| Total thickness | 3 | 10 | 3 | 6 |
| Coal | 2 | 2 | 3 | 2 |

The sample of 9c, including a cut across the 3 feet 2 inches of coal is higher in fixed carbon, lower in ash, and about the same in volatile matter and sulphur as the Roslyn bed and is therefore a good bituminous coal. The questionable factor would be the presence of the diabase dike already referred to which, although it is not visible at the surface here, may cut across these beds below the surface, as indicated in Section B, Plate I.

The strike and dip of the beds at 9b and 9d are the same and if projected would place the beds at 9d and 9c below the beds at 9a and 9b, but the similarity of the beds would indicate that 9d and 9c are the same as 9a and 9b. The bed at station 7 is very much like the 9b, No. 2 bed, and may be the same, although the strike and dip varies considerably between these two points. Further prospecting in the field is necessary to determine the relations and value of these beds.

Along the south bank of Manastash Creek near witness quarter corner, on the east line of section 22, a coal bed 6 feet thick, badly crushed, but containing thick lenses of good coal is exposed by the undercutting of the stream. (Plate XXIV B.) This bed strikes N. 40° W. and dips 35° SW., is capped with laminated shaly sandstone full of fossil leaves and has a conchoidal shale floor. It is cut by a fault trending N. 6° W. and hading NE 35° with apparent upward movement of the coal on the southeast side of the fault plane.

All the observations made in this section of the field, south of the river, show southerly dipping strata, thus indicating the other side of the anticline shown by northerly dipping beds on the north side of the creek. From the few coal beds exposed here, however, no definite relation between them and those seen on the north side could be determined.

SECTIONS AND RELATION OF COAL BEDS IN SECTION 16.

The other part of the field in which the cuts still remain open and show the coal is located in the southeast quarter of section 16, close to the line between 15 and 16 and also across the line in section 15. The openings are on the side hill about 100 to 150 feet above the creek, and run in across the strike of the formation which dips into the hill.

At station 8a there is a narrow cut on a bed about 6 feet thick, composed largely of carbonaceous shale, but with a central bench of coal and bony coal about 3 feet thick. Figure 36c shows a cross section of this seam, strike N. 70° W., dip 67°

NE. About 200 feet northwest of 8a three beds of coal are exposed in a short tunnel and open cut at 10a and 10b. The lower bed exposed at mouth of cut is a 4-foot seam of carbonaceous shale, with stringers of coal. About 28 feet above this, in an old caved tunnel, is the second bed, 2 feet 10 inches thick with 1 foot of good bright coal even where weathered, strike N. 60° W., dip 40° NE., with shale roof and floor. At 10b an open cut crosses a 6-foot bed, which in cross section is similar to the bed at 8a. (Fig. 36d.) Strike N. 45° W., dip 57° NE. At 10c is an old caved tunnel from which Mr. Buchanan said the best coal was obtained and shipped. At 10d a 31-foot tunnel ends at a 3 foot 9½ inch seam of coal, containing about 2 feet of good coal, of which a sample was taken, but no report obtained. The coal in this bed was as good if not better than sample 13,268, analysis page 200.

SECTION OF BED AT STATION 10D (FIG. 36b).

| | Ft. | In. |
|---|---|---|
| Roof. | | |
| Bony coal | 0 | 3 |
| Shale | 0 | 8 |
| Carbonaceous shale | 0 | 5 |
| Coal | 0 | 3 |
| Bony coal | 0 | 5 |
| Coal | 1 | 5 |
| Carbonaceous shale | 0 | 4 |
| Floor, sandstone. | | |
| Total thickness | 3 | 9½ |
| Coal | 2 | 4½ |

About 30 feet below the bed 10d at the mouth of the tunnel is a bed of carbonaceous shale and coal about 6 feet thick and very similar to the bed exposed on the hill above at 8a. The structural relations and similarity of the beds indicates that the opening at 8a, 10b and 10d are on the same bed. In that case the two seams at 10a are below this 6 foot seam, and the 3 foot 9½ inch bed at 10d is above it, also the bed that was covered in the caved tunnel at 10c, which may be the same as the 3 foot 9½ inch bed at 10d. A cross section of the series on this supposition is shown in Figure 37.

A few open cuts between 10d and the center of section 16 shows the presence of carbonaceous material, probably the continuation of these same beds. Directly above these coal beds and forming the summit of the ridge on which they outcrop is

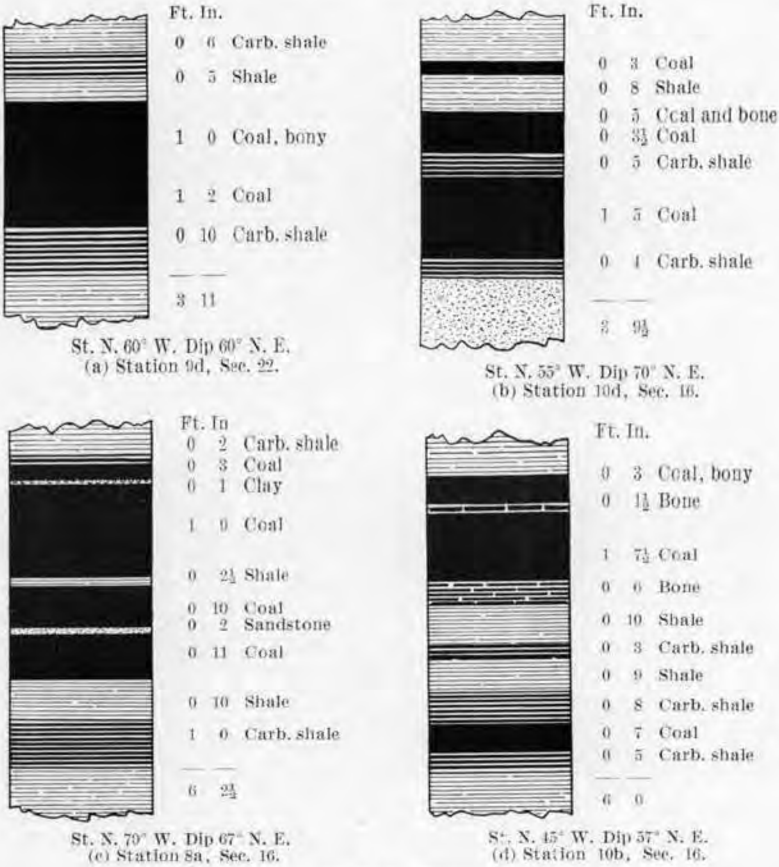



Fig. 36. SECTIONS OF MANASTASH COAL SEAMS.

the large diabase dike, at this point about 60 feet wide, which runs the whole length of the field. It is about 300 feet horizontally from the coal beds and allowing an average dip of 60° for the beds. The dike, if vertical, would cut them off at a depth of 400 feet and greatly interfere with their development. (Plate I, Section C.) The intrusion of the lava has also caused considerable displacement and crushing of the formation as seen at the surface.

GENERAL RELATIONS IN OTHER PARTS OF THE FIELD.

The examination of the cuts in the other parts of this field was very unsatisfactory, and with the exception of obtaining the strike and dip, and thus some idea of the structure no definite information regarding amount of coal present was secured. A number of cuts in section 15, along the small stream valley north of the diabase ridge, indicated by presence of coal on the dumps the occurrence of coal beds, and in a few cases where the structure was shown the strike was northwest and the dip northeast.

In section 21, south of the creek, there was also a large number of old cuts. The dump in most cases was covered with carbonaceous shale and broken up coal but no sections were obtainable. A few measurements of the strike and dip showed this part of the field to be on the other side of the anticline, and no doubt the coal seams are the same as those found north of the creek. Examination was also made of the formation in the adjoining sections, but no coal was found in any of the cuts.

### AREA AND POSSIBLE PRODUCTION.

The total area of sedimentary measures exposed which might possibly contain coal is about 5,400 acres, of which about 300 acres in the southeastern portion are known to contain coal. The beds, however, are thin and are probably cut and badly broken by the diabase dikes. Assuming an average dip of 60° and an aggregate thickness of 10 feet of coal, the yield would be in the neighborhood of 15,000 or 20,000 tons per acre, if the beds were continuous. At present the haul to any shipping point is prohibitive, and the coal in this field will not be available until conditions are such as to warrant the building of a railroad through this district, probably up the Naches valley from Yakima or up the Manastash valley from Ellensburg.

On the north fork of Manastash Creek, about 100 feet from the north line of the northeast quarter of the northwest quarter of section 14, T. 18 N., R. 15 E., the North Manastash Coal Company are prospecting a coal bed reported to be four feet six inches wide. The bed here strikes N. 62° W. and dips 15° SW., and this is probably the southward pitching limb of a syncline of which the formation in section 22 is the northward pitching limb.

# CHAPTER V.

## DETAILS OF THE TANEUM FIELD.

### GENERAL STATEMENT.

The Taneum field, located in township 19 north, ranges 15 and 16 east, includes three distinct sections where Taneum Creek has cut through the overlying igneous rock and exposed the coal-bearing formation beneath. Of these only one is being worked at present. This we have called the lower Taneum field as it lies along the lower part of Taneum valley. The others are spoken of as the upper Taneum or north and south fork fields, where a number of prospects have been opened on the formation laid bare by these two branches of Taneum Creek. (Plate I.)

### LOWER TANEUM FIELD.

#### LOCATION AND EXTENT.

The lower Taneum coal field is located in the south central part of T. 19 N., R. 16 E., along the Taneum valley, about ten miles west of Thorp, the nearest shipping point on the Chicago, Milwaukee & St. Paul and the Northern Pacific railways. The Taneum Creek has at this point cut a deep canyon in the overlying basalt, and exposed what is thought to be the Manastash formation, containing several coal beds, at elevations ranging from 2,200 to 2,500 feet over an area of about 800 or 900 acres. (Plate I.) The coal basin lies about 600 feet above Thorp, from which point a good road of fairly easy grade runs through the valley. If the coal proves worth while, a branch railroad could easily be built up the valley along the river flat. (Plate VI.)

#### HISTORY AND DEVELOPMENT.

Mr. Joseph Wilson, prospecting on his homestead in the southwest quarter of the northeast quarter of section 33 found several coal seams outcropping on the steep slope south of the creek. A number of short prospect tunnels or drifts were driven on these beds, and one of them proved to be about 14 feet thick and contained enough coal to make further prospecting seem worth while. In 1905 work was started on this bed and by working mainly in the coal, more or less has been mined each year for use by the ranchers in Kittitas valley (Fig. 38), who usually haul it by team directly from the mine at a cost of $3.00 per ton. The Chicago, Milwaukee & St. Paul Railway Company leased the property during 1909 and 1910, had charge of the mine and drilled several test holes along the valley above and below this property. Apparently their findings were not very satisfactory, for they ceased operations here, and the property has been worked by smaller companies since that time.

A stadia traverse tied to section and quarter section corners was run along the road through the section, and the various prospects, tunnels, outcrops and stream crossings were tied to stations on this traverse. From data obtained the map, Figure 37, was drawn and the location of the area as shown in Plate I was determined.

### DESCRIPTION OF FORMATION.

The formation in which the coal is found is called the Manastash formation because of its similarity and relation to the formation farther south along the Manastash Creek.* It consists of coarse conglomeratic sandstones, arkosic sandstones, and shales with abundant leaf remains, unlike those found in the Roslyn formation and similar to those found along Manastash Creek. Thin beds of a fine grained white shale containing volcanic glass fragments are interbedded with the other sediments as in the Manastash formation. It is therefore inferred that these beds were laid down in the same lake basin as those exposed on the upper Taneum and on Manastash Creek.

### STRUCTURE.

Reference to the map (Fig. 37), will show that a slight upwarping or anticlinal folding of the formation has caused the river in eroding its canyon to expose this small area of the underlying sediments for several miles along its course. The basin thus eroded is entirely surrounded by basalt, in some places in

* For fuller description of Manastash formation see page 120 of this report.

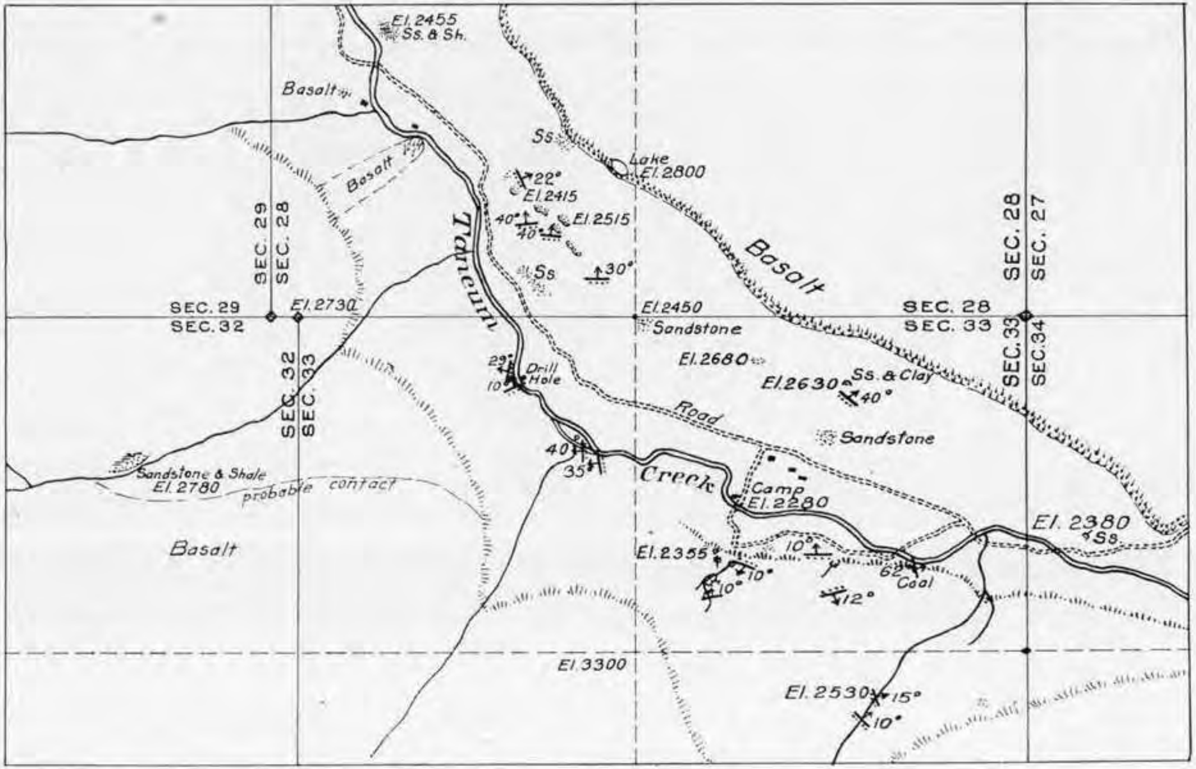



Fig. 37. Map Showing General Relations in Lower Taneum Coal Field, T. 19 N., R. 16 E.

the form of high steep cliffs due to landslides caused by the weathering of the underlying softer rock. In no part of the basin was the rock underlying the sediment exposed, and the thickness of the formation could not therefore be ascertained, but the sandstone was found at elevations of 2,780 feet and a well drilled from an elevation of 2,300 feet to a depth of 660 feet was still in the Manastash formation, thus indicating a vertical depth of 1,140 feet of sediments. The dip of the beds varies from 10° to 40°, but where the drill hole is located (Fig. 37) is less than 30°, so the known thickness of the formation here would be about 1,000 feet.

### WILSON MINE.

#### General Description.

The only coal bed that is being worked in this field outcrops on the side hill, south of the creek at an elevation of 2,355 feet, about 75 feet above the valley floor. The mine is located in the

FIG. 38. Bunker at Wilson Mine, Lower Taneum Valley.

southwest quarter of the northeast quarter of section 33, and consists of a series of tunnels driven on the coal about 600 feet into the hill. On account of the irregular character of the coal bed and the fact that several different companies have been prospecting in the mine, the system of tunneling as shown on the mine map (Fig. 39), is decidedly irregular. Work was begun in 1905 by Mr. Wilson who tunneled into the hill directly on the coal, timbering the tunnel only through the loose surface material. Under the direction of the Chicago, Milwaukee & St. Paul Railway Company a second set of tunnels was started to the left and a series of side tunnels or rooms were opened up. The Northwest Coal Company, of North Yakima, next leased the property and continued the work started by Mr. Wilson. In 1912 they subleased the property to the Hawkins, Murray & Williams Coal Company, and an engineer was put in charge of the workings, with the result that a systematic method of working is now being followed. A rock tunnel was cut through to the coal and the old tunnel is now used as the return air course. New bunkers were built and active operations to ship coal was begun. The workings were developed as far as shown on the mine map (Fig. 39) in September, 1913.

Serious difficulty has so far been encountered in working the coal to the best advantage on account of the great variation in quality and quantity of coal present, and the faulting and rolling of the bed itself. The strike varies considerably, but is generally northwest and southeast and the dip varies from 10° to 20° generally in a northeasterly direction. The bed is badly broken and several faults have already been encountered which have interfered with the development. (Fig. 39.) One of these running northwest and southeast across the tunnel south from station marked El-2356.6 caused the opening of two other branches from this point. In the western branch the same fault has caused difficulty, and in the eastern branch a roll at station El-2358.1 caused an incline to be started to follow the coal, and this soon filled with water. Two tunnels branching from this point passed over the roll and striking the coal beyond, followed

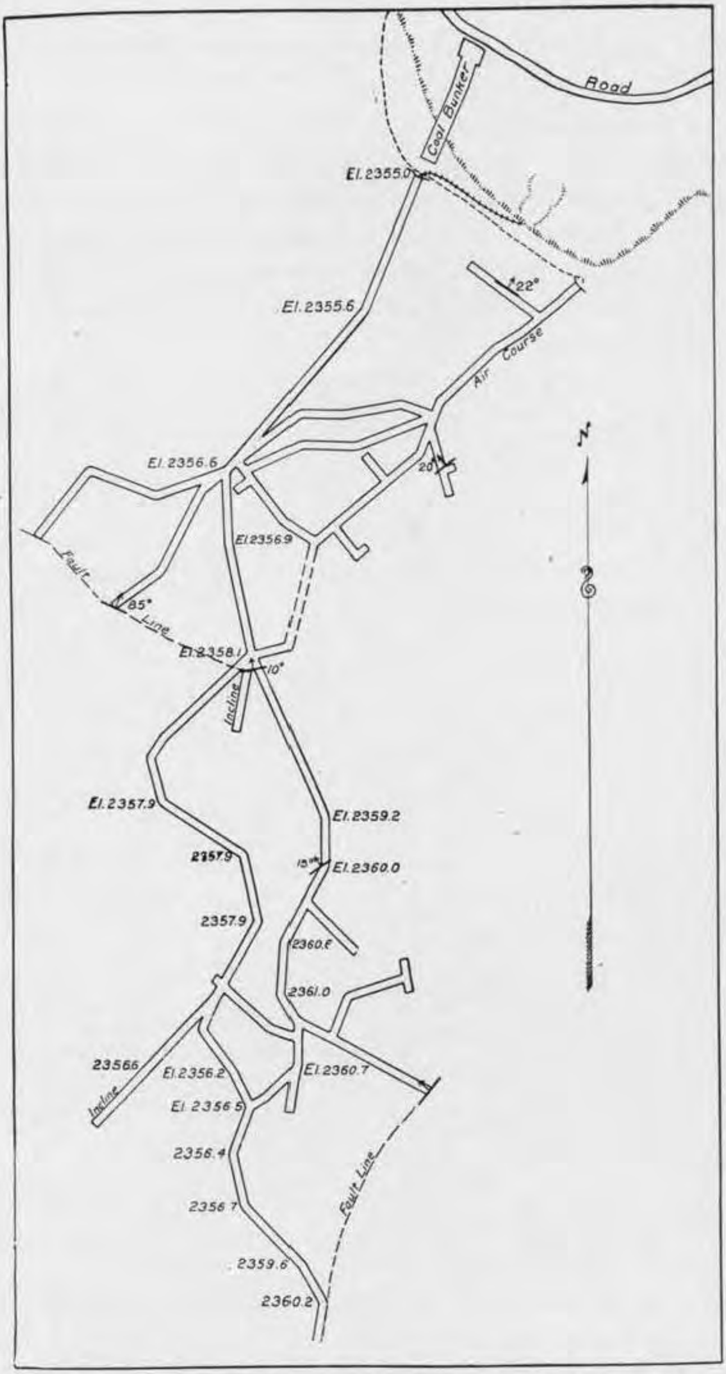



Fig. 39. Mine workings at Wilson Mine, Section 33, T. 19 N., R. 16 E., Taneum Creek.

it as shown on the map. Two branches of the eastern tunnel ended in a fault running northeast and southwest at station 2360.2 and the western one also found a roll where the second incline is marked near station 2356.6. Further prospecting either by tunnels or drill holes is necessary to determine condition of coal at greater depth and the full extent of this bed.

### Sections and Analyses of Coal.

Two sections were taken of this bed, the first near the end of the present air course where the strike N. 50° E. and dip 20° NW. are marked; the second a few feet from the fault plane directly along the line of the present main tunnel. A comparison of these two sections will give some idea of the variation in the bed at different points.

CROSS SECTIONS OF COAL BED AT WILSON MINE.

Analysis 13269, Page 200. Graphic Cross Sections Fig. 40.

| | No. 1 | | No. 2 | |
|---|---|---|---|---|
| Roof, shale badly broken. | Ft. | In. | Ft. | In. |
| Carbonaceous shale | 1 | 1 | 1 | 2 |
| Coal (lenses) | 0 | 2 | 0 | 3 |
| Carbonaceous shale | 0 | 9 | 0 | 6 |
| Coal bony and crushed | 0 | 10 | 1 | 6 |
| Carbonaceous shale | 0 | 11 | ..... | ..... |
| Hard brown shale | ..... | ..... | 0 | 9 |
| Carbonaceous shale | ..... | ..... | 0 | 4 |
| Slate | ..... | ..... | 1 | 10 |
| Coal lenses with brown shale | 1 | 9 | 0 | 6 |
| Carbonaceous shale | 0 | 8 | 1 | 6 |
| Coal | 1 | 8 | 4 | 2 |
| Carbonaceous shale | 5 | 0 | ..... | ..... |
| Floor, shaly standstone. | | | | |
| Total thickness | 12 | 10 | 13 | 6 |
| Coal | 4 | 5 | 6 | 5 |

The sample No. 13,269 for analysis was taken from the bunker after the coal as mined had been picked over ready to sell. Compared with the Roslyn coal it runs higher in volatile matter, higher in ash, and lower in fixed carbon and heat values, and is therefore classed as a lower grade coal. The lenses of good coal

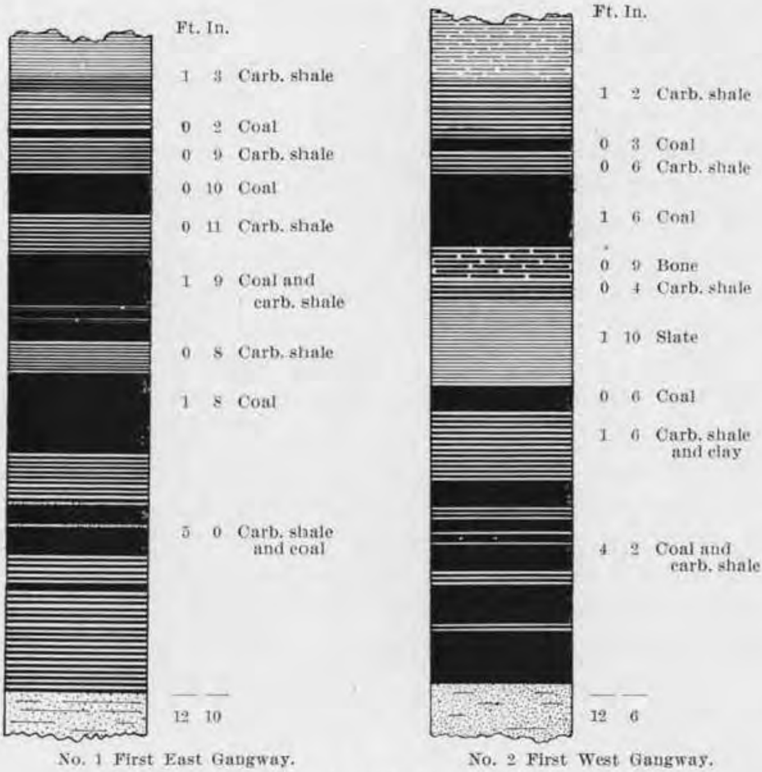



Fig. 40. SECTIONS OF COAL BED AT WILSON MINE.
Section 33, T. 19 N., R. 16 E. Lower Taneum Creek.

in the bed would analyze much higher than the analysis given, as shown in the following table:

ANALYSIS OF COAL FROM WILSON MINE.

| | Moisture | Volatile Matter | Fixed Carbon | Ash | B. T. U. |
|---|---|---|---|---|---|
| Bunker sample | 7.69 | 39.63 | 36.51 | 16.17 | 9,985 |
| Lenses | 6.15 | 44.80 | 44.75 | 4.30 | 12,200 |

**Relation to Other Beds.**

From the outcrops and the character of the bed little can be predicted regarding its extent and the amount of coal available from it. A drill hole about one-half mile northwest of the mine (Fig. 37) cuts through two thick beds of dirty coal, but a churn drill was used and the exact nature of the beds could not be determined.

An 18-foot seam of coal and slate was cut at a depth of 298 to 316 feet, and a 15-foot seam of hard, bony coal and brown shale at a depth of 455 to 470 feet. Between these two a third seam of ten feet of coal and slate was found. The dip of the rocks at the surface near the drill hole varies as at the mine, but the direction is toward the drill hole from the mine, and the bed at 298 feet has the same roof and floor as the bed at the mine. On the other hand the bed cut at 455 feet corresponds more closely in character to the mine coal and may be the same bed. About one-eighth of a mile down stream from the mine an old caved tunnel is reported to cut a coal bed dipping in the same direction as at the mine. But farther down stream a carbonaceous seam is exposed on the south bank of the stream having a strike N. 12° W. and dipping 62° to the northeast. If this latter is in place an anticlinal structure is indicated, and since this dip swings round and is found in outcrops on the north side of the creek this would seem to be the explanation of the exposure in this field.

Up stream the formation was found as far as section 29 where it passed under the basalt. No indication of further coal beds was found. Down stream the formation continues into section 34 where it disappears under the basalt cover. But a diamond drill hole near the southeast corner of section 35, at an elevation of 2,100 feet, near the base of steep basalt cliffs (Plate X A), cuts 1,100 feet of shale, sandstone and conglomerate strata. Several parts of the record are missing but as reported no coal was found in the series.

### Extent and Production.

So far as we could determine the definite boundaries of the field, the coal-bearing measures are exposed over an area of about 800 acres. The limited development of the property makes it difficult to determine the actual extent of the workable coal bed, but if the bed extends to the drill hole from the mine as indicated a rough estimate would be about 35 acres in the northeast quarter and 25 acres in the northwest quarter of section 33. Assuming from the sections measured about five feet of usable coal at a dip of 20° there should be about 5,000 tons of recoverable coal to the acre in this field. The field extending over 60 acres should, if the coal is continuous as described, yield about 300,000 tons. But as stated before, these figures are simply estimates from observable conditions and are subject to correction later.

## UPPER TANEUM FIELD.

The upper Taneum field is located in T. 19 N., R. 15 E., where the north and south forks of Taneum Creek have eroded the capping rock, and caused the sedimentary rocks to be exposed over an area of about 1,800 acres, extending in a narrow strip between and across the two valleys. (Plate I.) The formation here is made up of sandstones, shales, and carbonaceous seams immediately overlying the Easton Schist, and dipping southwest until it disappears under the Taneum andesite.

Stadia traverses were run from the forks of the creek along the different streams but could not be definitely tied to section corners, as the land survey was not completed. Locations shown on the map were determined by running lines from the section corners of the next township south. An examination of the field was made to determine the extent and boundaries of the possible coal-bearing formation, but no indications of coal were found, except where the south and north forks have cut deep valleys in the sedimentary rocks.

## SOUTH FORK OR CAROTHER'S FIELD.

In the northeast quarter of section 33 where the south fork cuts the formation, the Carothers brothers in 1899 prospected several beds which outcrop along the south bank of the stream. (Plate V A.) Several short tunnels have been run into the side hill and one of these at station 16b, 245 feet in length, cuts three thin seams of a low grade coal. (Fig. 41.) The same beds are exposed in open cuts at stations 16c and 16d and in a 26-foot tunnel at 16e. (Fig. 41.) Another bed containing about 18 inches of low grade coal lying above these is exposed in a 22-foot tunnel at station 17b.

The whole formation in this field is badly squeezed and crushed, and must have been subjected to an immense pressure caused by folding or by the intruded and extruded lava masses. The shale shows the effect in the broken masses and slickensided surfaces, and the carbonaceous beds are in many cases in the form of a thin leaf-like or powdery mass. Under these conditions and due to the irregularity and thinness of the coal in the beds no samples were taken. Cross sections of the different coal beds are shown in Figure 42 and in the following tables:

CROSS SECTIONS OF BEDS AT 16B AND 16C, CAROTHERS FIELD.

| | No. 16b Tunnel No. 1 See Fig.— | | No. 16c Surface See Fig.- | |
|---|---|---|---|---|
| Roof, shale. | Ft. | In. | Ft. | In. |
| Carbonaceous shale | 0 | 4 | 0 | 10 |
| Bone and coal | 1 | 0 | ........ | |
| Coal | 0 | 7 | 0 | 4 |
| Bony coal | 0 | 5 | 1 | 3 |
| Carbonaceous shale | ........ | | 0 | 5½ |
| Bony coal | ........ | | 0 | 4½ |
| Carbonaceous shale | ........ | | 0 | 5 |
| Clay | 0 | 4 | 0 | 2 |
| Floor, shale. | | | | |
| Total thickness | 2 | 8 | 3 | 10 |
| Coal | 2 | 0 | 1 | 11½ |

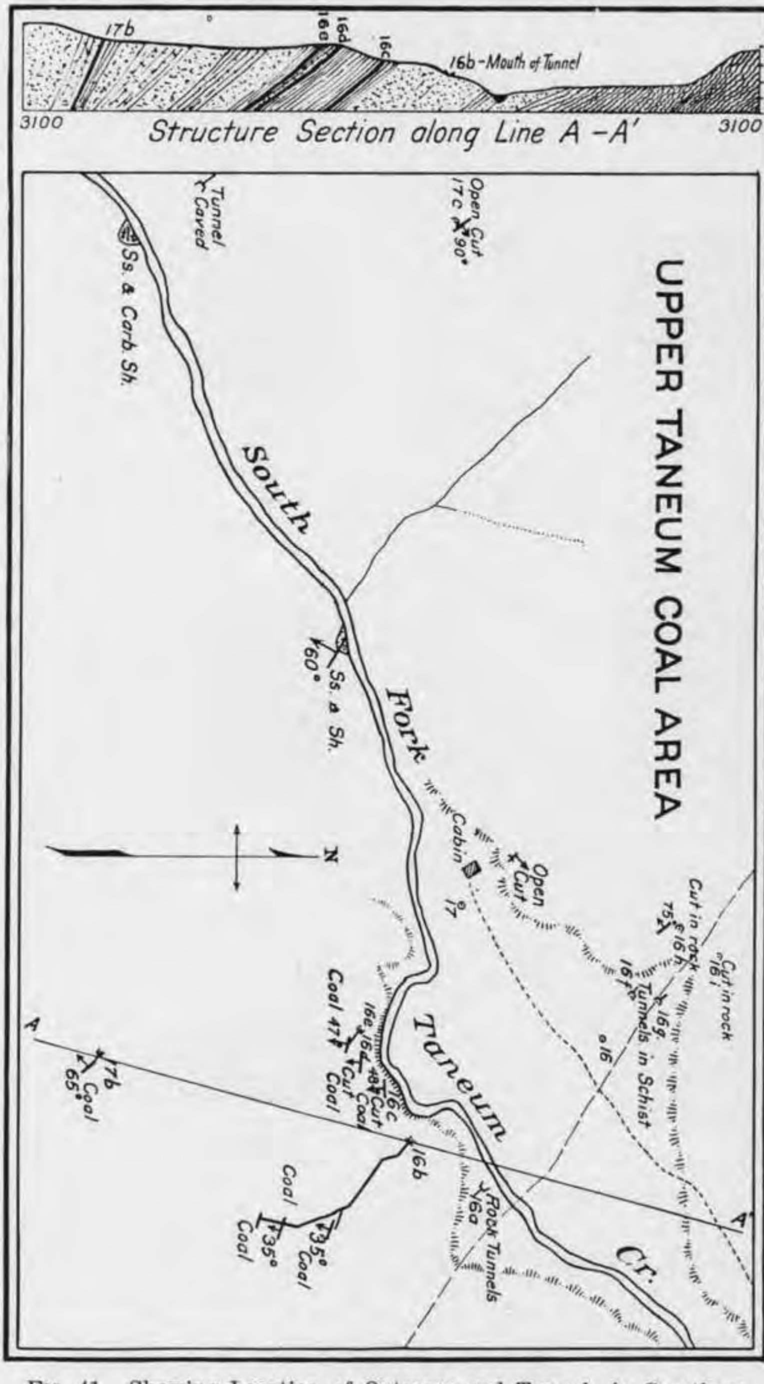



FIG. 41. Showing Location of Outcrops and Tunnels in Carothers Field.

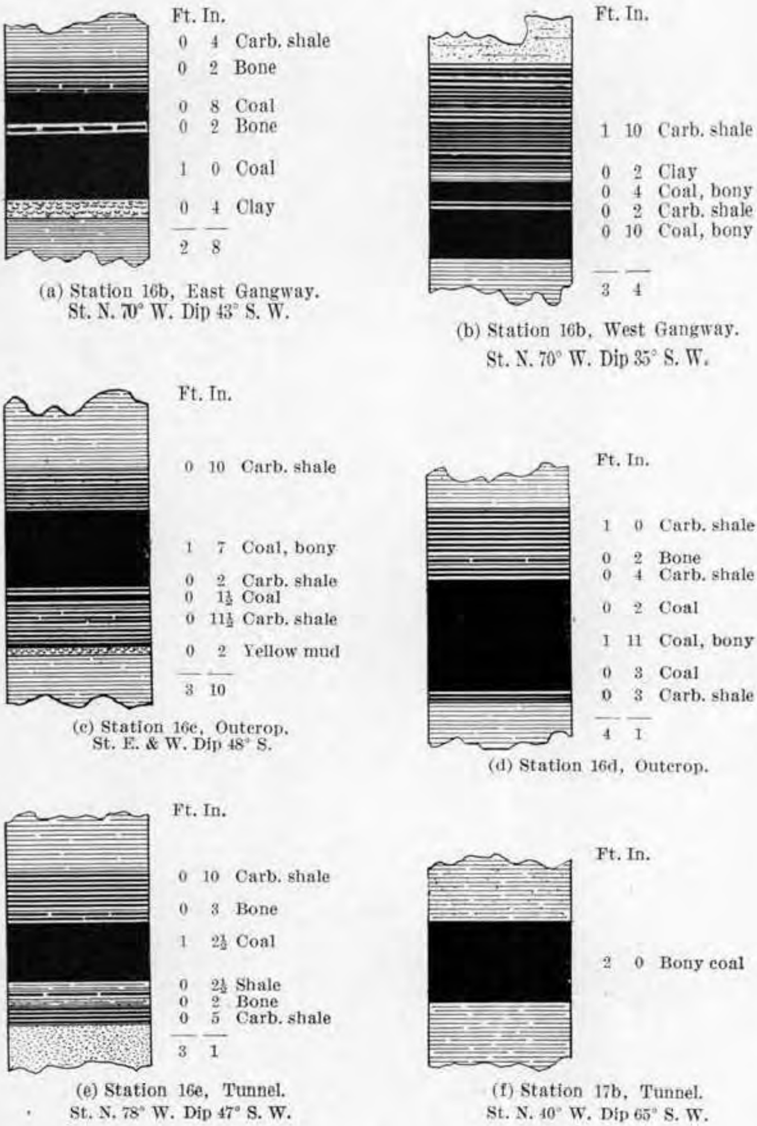



Fig. 42. SECTIONS OF COAL SEAMS, CAROTHERS FIELD, UPPER TANEUM CREEK.

CROSS SECTIONS OF BEDS IN 16B NO. 2, 16D and 16C, CAROTHERS FIELD.
See Also Fig. 42.

| | No. 16b (Tunnel) No. 2 | | No. 16d Surface | | No. 16c Tunnel | |
|---|---|---|---|---|---|---|
| Roof, | Lam. Sand-stone | | Shale | | Shale | |
| | Ft. | In. | Ft. | In. | Ft. | In. |
| Carbonaceous shale | 1 | 10 | 1 | 0 | 0 | 10 |
| Bone | 0 | 2 | 0 | 2 | 0 | 3 |
| Carbonaceous shale | ..... | ..... | 0 | 4 | ..... | ..... |
| Coal | ..... | ..... | 0 | 2 | 0 | 2 |
| Bony coal | 0 | 4 | 1 | 11 | 1 | ½ |
| Coal | ..... | ..... | 0 | 3 | ..... | ..... |
| Shale | ..... | ..... | ..... | ..... | 0 | 2½ |
| Carbonaceous shale | 0 | 2 | 0 | 3 | ..... | ..... |
| Bony coal | 0 | 10 | ..... | ..... | 0 | 2 |
| Carbonaceous shale | ..... | ..... | ..... | ..... | 0 | 6½ |
| Floor, | Shale | | Shale | | Sand-stone | |
| Total thickness | 3 | 4 | 4 | 1 | 3 | 2½ |
| Coal | 1 | 2 | 2 | 4 | 1 | 4½ |

Since none of these beds have a workable bench of good coal 2 feet in thickness, they can hardly be considered commercial seams under present conditions. No coal has been shipped from them and no work is being done at present

In connection with this field an examination was made along Frost Creek, where the sedimentary formation is exposed for about 1,000 feet above the schist, and underlying the andesite. No coal was found in these outcrops but some thin carbonaceous beds were seen. (Fig. 43.)

Reports of coal in sections 2, 3 and 4 of T. 18 N., R. 15 E. were also received, but on examination these sections proved to be entirely covered with andesite and basaltic lavas, with great thick beds of tuff containing fragments of volcanic glass. The coal-bearing formation here must be buried beneath the lavas at least 200 or 300 feet.

## NORTH FORK FIELD.

Along the north fork of Taneum Creek Mr. Hooper has prospected on both sides of the creek and has discovered several

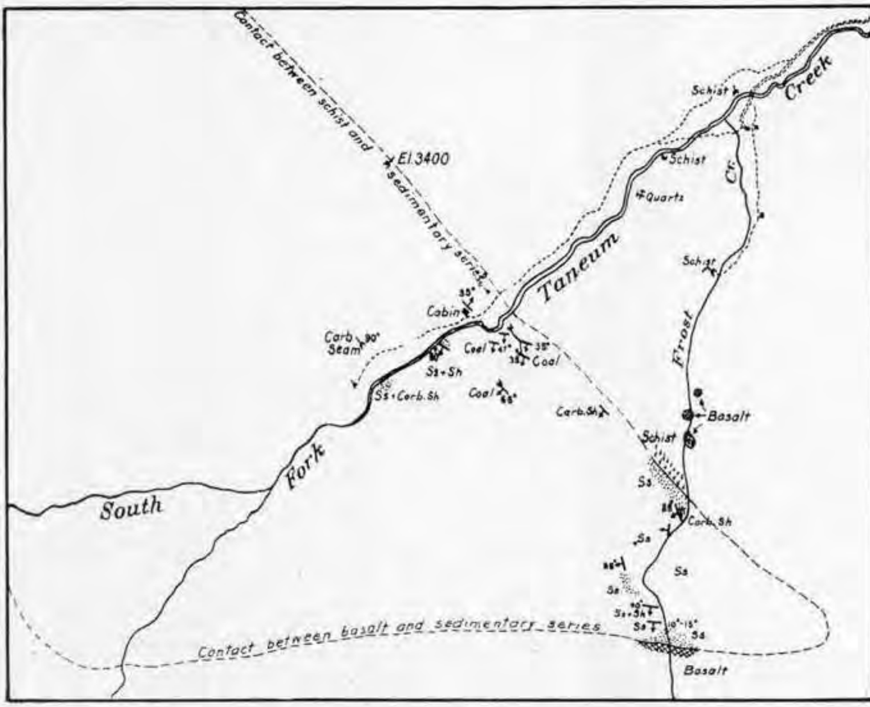



FIG. 43. Showing General Relations of the Manastash Formation in the Upper Taneum or Carothers Coal Field.

thin carbonaceous seams in the southwest quarter of section 20, T. 19 N., R. 15 E. (Fig. 44.) A tunnel driven 70 feet into the south bank of the stream cuts thick beds of badly faulted and broken sandstone and shale, and a 2-foot bed of carbonaceous shale with scattered lenses of good coal. The strike here is northwest and the dip is southwest, the same as on the south fork and on the ridge between the two. Several other cuts on the south side and a number on the north side of the creek have exposed seams of carbonaceous shale, but unless they change considerably with depth and are less broken, none of them contain enough coal to warrant even further prospecting.

The whole upper Taneum field is the exposed edge of a southwest dipping series of rocks on the limb of the geosyncline already referred to in the description of the Manastash field. As shown in the cross section (Plate I) it is probably continuous with that field, but the portion containing the coal seams in the

Carothers field lies at the base of the series close to the Easton Schist, while the coal bearing part in the Manastash field is higher up in the series.

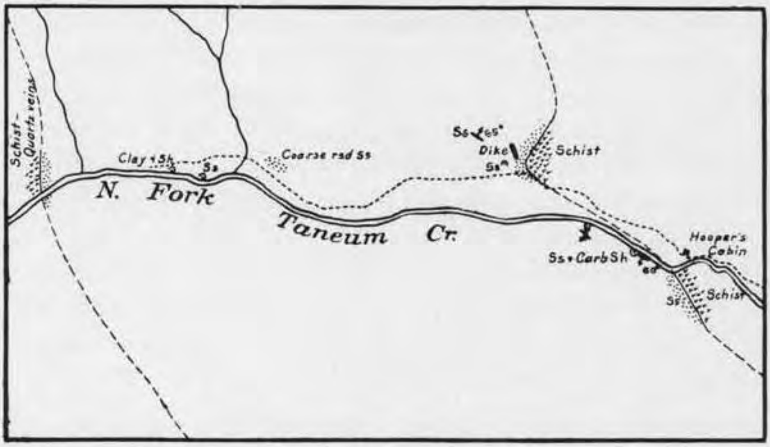



FIG. 44. Outcrops and Contacts Along the North Fork of Taneum Creek in the Upper Taneum Coal Field.

# CHAPTER VI.

## MISCELLANEOUS SMALLER FIELDS.

### FIRST CREEK FIELD.

On First Creek, about two miles east of McCallum in the south half of section 28, T. 21 N., R. 17 E. an old tunnel, now badly caved, was driven on a 12-foot carbonaceous seam (Plate XXV B) running N. 65° W. into the hill on the north side of the creek. It pitches 75° to the southwest, and a shaft was sunk to the same bed about 200 feet down stream. Coal was hauled to Ellensburg from these workings about 1889 or 1890, but they were abandoned as soon as the Roslyn field was opened up and have not been worked since. A section of the bed could not be obtained in the tunnel, but the following section was measured in an open cut above the tunnel.

SECTION OF BED ON LOWER FIRST CREEK. SEE FIG. 45.

Strike N. 65° W., Dip 75° S. W.

| | Ft. | In. |
|---|---|---|
| Roof, gray shale. | | |
| Carbonaceous shale with narrow clay bands... | 3 | 8 |
| Coal slightly bony with thin clay partings..... | 4 | 0 |
| Gray shale | 1 | 3 |
| Carbonaceous shale | 3 | 0 |
| Floor, shale. | | |
| Total thickness | 11 | 11 |
| Coal | 4 | 0 |

Farther up stream in the south half of section 30, T. 20 N., R. 18 E., where First Creek has cut a deep canyon into the soft sandstone and shale, (Plate XV A) a tunnel driven 103 feet into the south bank of the stream cuts a bed of carbonaceous material about three feet thick. The coal contained is very low grade and dirty and is not of commercial value.

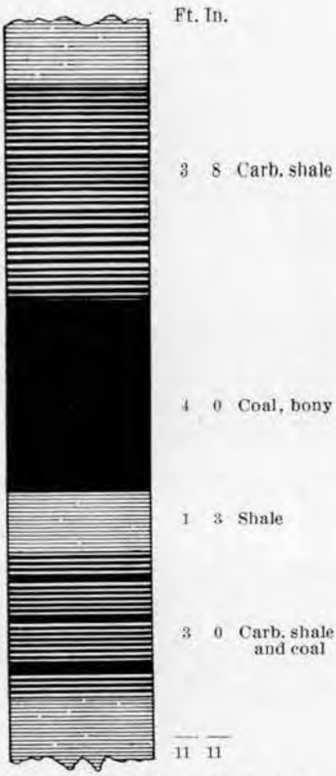
SECTION OF BED IN UPPER FIRST CREEK.

Strike N. 60° W., Dip 58° S. W.

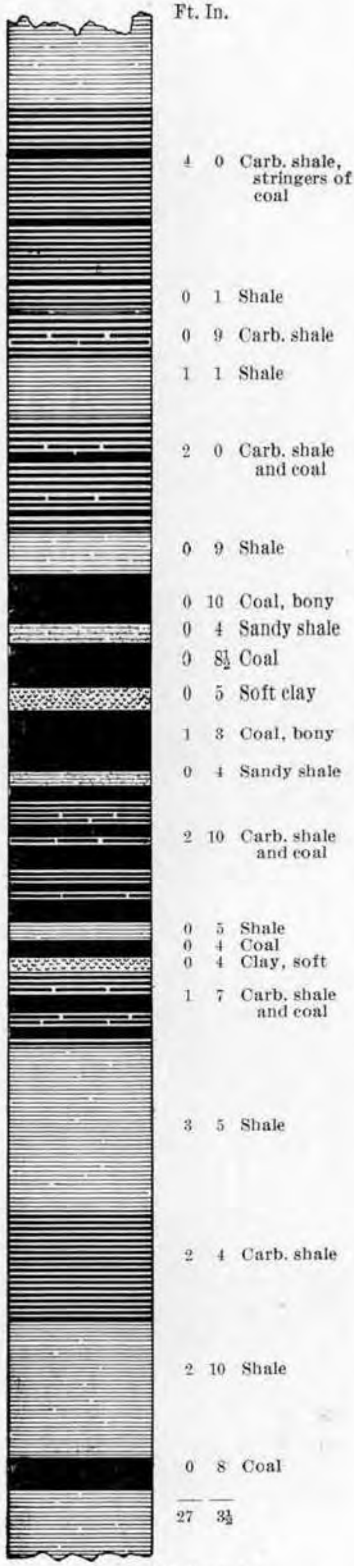
| | Ft. | In. |
|---|---|---|
| Roof, pebbly sandstone. | | |
| Carbonaceous shale | 1 | 8 |
| Sandy shale | 0 | 4 |
| Bony coal | 0 | 8 |
| Carbonaceous shale | 0 | 8 |
| Floor, gray shale. | | |
| Total thickness | 3 | 4 |
| Coal | 0 | 8 |

A. Upper First Creek, Looking South Through Green Canyon, Showing Location of Prospect in Center of Picture.

B. Old Tunnel on Coal in Lower First Creek Valley.




St. N. 65° E. Dip 75° S. E.
Fig. 45. SECTION OF COAL SEAM ON LOWER FIRST CREK.




St. N. & S. Dip 25° E.
Fig. 46. CROSS-SECTION OF SEAM AT HEAD OF WILLIAM'S CREEK.

The formation exposed in this field lies between the Teanaway basalt below and the Yakima basalt above, dips to the southwest and is continuous with the larger area of Roslyn formation to the west of it. (Plate I.) The area exposed is about 1,150 acres but so far as known there are no other prospects in the field and probably no other coal seams occur in this part of the formation.

### WILLIAMS' CREEK FIELD.

About five miles northeast of Meaghersville, in section 28, T. 21 N., R. 18 E., a small area of Roslyn formation outcrops in the steep hills at the head of Williams' Creek. This outcrop extends about a mile along the cliffs, 2,500 feet above the valley floor, in the form of a narrow band between the Teanaway basalt below and the Yakima basalt above it. It contains a carbonaceous seam about 17 feet thick, which can be seen for some distance along the face of the cliffs about 75 feet above the columns of the Teanaway basalt (Plate XXVI), and about 50 to 100 feet below the base of the Yakima basalt cliffs, extending to the summit of Table Mountain. (Plate I.)

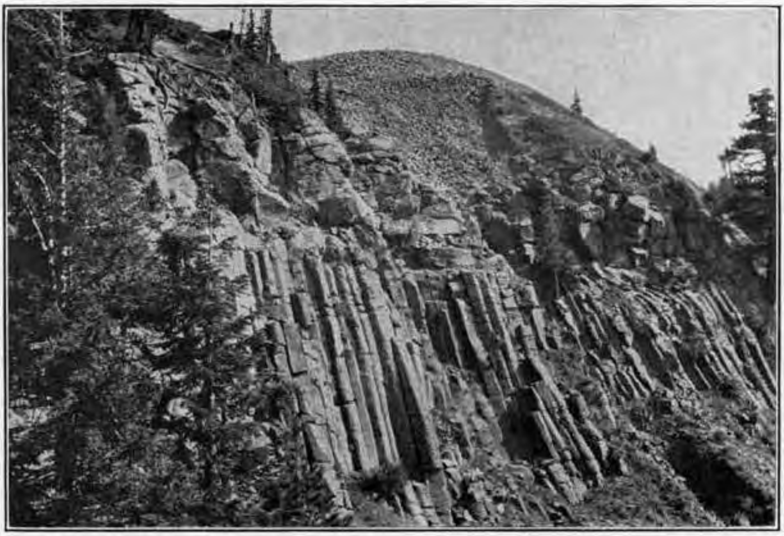
The formation dips toward the east or into the hill about 25°, and two slopes about 500 feet apart have been driven on the coal seam. One of the slopes is filled with water but from the other the following section was obtained:

SECTION OF WILLIAMS CREEK COAL BED. (SEE FIG. 46).

Strike N. and S., Dip 25° E.

| | Ft. | In. |
|---|---|---|
| Roof, gray compact shale. | | |
| Carbonaceous shale, stringers of coal | 7 | 11 |
| Shale | 0 | 9 |
| Bony coal | 0 | 10 |
| Shale | 0 | 2 |
| Bony coal | 0 | 8½ |
| Clay | 0 | 3 |
| Coal | 1 | 0 |
| Sandy shale | 0 | 4 |
| Carbonaceous shale | 2 | 10 |
| Shale | 0 | 5 |
| Coal | 0 | 4 |
| Yellow clay | 0 | 4 |
| Carbonaceous shale | 1 | 7 |
| Floor, yellow clay shale. | | |
| Total thickness | 17 | 5½ |
| Coal | 2 | 10½ |

A. Coal Bed at Head of William's Creek, Immediately Above Basalt Shown Below.



B. Teanaway Basalt at Head of William's Creek Underlying the Roslyn Formation Showing Typical Columnar Structure.

A small amount of coal from these prospects has been used locally at Liberty and Meaghersville, but the formation here is probably a small pocket, and even if the coal were of a higher grade it would be of little commercial value.

NANEUM CREEK FIELD.

In the southwest quarter of section 10, T. 20 N., R. 19 E., about 20 miles north of Ellensburg, Mr. Pearson in 1909 discovered a thin carbonaceous seam in a small pocket of what is

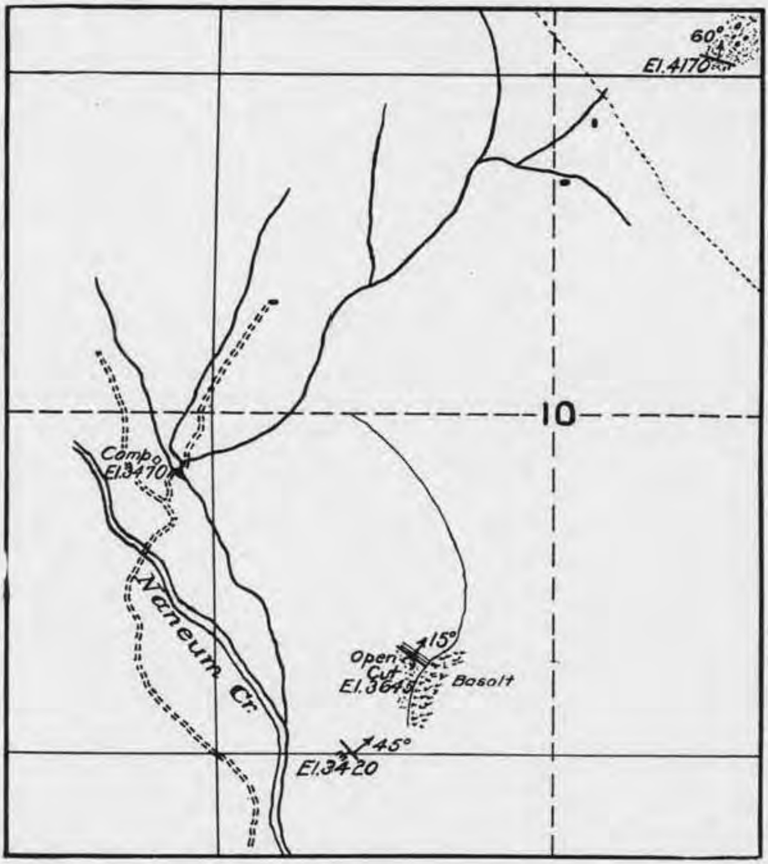



FIG. 47. Showing Location of Prospect and General Relations in the Naneum Creek Field, Sec. 10, T. 20 N., R. 19 E.

apparently the Roslyn formation between the Teanaway and the Yakima basalt. (Plate I.) He drove a prospect tunnel into the hill east of Naneum Creek striking bed rock at 20 feet. Passing through 15 feet of sandy shale he struck a carbonaceous seam about 4 feet thick containing 1 foot 8 inches of soft dirty coal, similar to that found in upper First Creek valley. The tunnel was extended 25 feet beyond the coal seam, but no further work has been done in this field, and little could be learned of the extent of the coal-bearing measures.

SECTION OF NANEUM CREEK BED.

Strike N. 40° W., Dip 45° N. E.

| | Ft. | In. |
|---|---|---|
| Roof, shale. | | |
| Carbonaceous shale | 2 | 6 |
| Bony coal | 1 | 8 |
| Floor, soft sandy shale. | | |
| Total thickness | 4 | 2 |

Examination of other outcrops in this field indicated a small area of sedimentary rocks similar in position to the area at the head of Williams' Creek, but no definite boundaries could be fixed, and further work on this field is necessary before stating full extent and relations of the coal-bearing formation. The beds exposed at present are of no commercial value.

## CHAPTER VII.

## MINING IN THE ROSLYN-CLEALUM FIELD, BY JOSEPH DANIELS.

### HISTORY.

In May, 1886, the Northern Pacific Railway sent a party into the Roslyn District to prospect the field. The railroad at this time extended to Ellensburg only, and it was necessary to bring in prospecting machinery and supplies by team. Some prospecting had been done earlier by the Union Pacific Railway; and some coal from the 12-foot seam overlying the Roslyn had been mined by a local operator and hauled to Ellensburg for blacksmithing purposes. This party undertook systematic exploration, using a diamond drill at the Clealum end of the field, and pick and shovel at Roslyn. Coal was first found in August at the present No. 2 mine on the east side of the draw at the location of the fan drift. Carpenters were sent out from St. Paul, a saw mill was put up, and trestle and bunkers built to handle the coal. The town was named Roslyn by Logan M. Bullett, vice president of the coal company.

No. 1 and No. 2 mines were opened on the east and west sides of the draw above the town, the workings extending up the dip. (Plate XXVII.) The main line of the railroad had been built to Clealum and the Roslyn branch begun in the fall of 1886. The branch road was built by Chinese labor. In December the first car of coal was dumped over the tipple. The coal was at first screened through bar screens spaced 1¼ inches apart, and the undersize was used for ballast on the railroad from Clealum, but this practice was soon stopped. The road was extended west about a year later to a new mine, No. 3.

The Roslyn shaft was begun in 1893 and was sunk to coal, 650 feet, in 1894. Coal was shipped in December of that year and production was maintained up to the time of the explosion in 1909. Since that time no coal has been hoisted from No. 4 mine.

A. Looking South Over Roslyn, Original Discovery of Coal in this Draw. No. 2 Mine, N. W. I. Company.

B. Similar View from Opposite Side of Ravine, Showing General Topographical Relations.

The Clealum mines at this time had not been opened, and the town of Clealum contained very little more than a sawmill and a few houses. The mine was begun in 1894 by private individuals who sunk the Clealum shaft. Coal was shipped in December, 1894. About two years later the Northern Pacific acquired control of this property and also of the present Clealum No. 2 and No. 3 mines, which were opened about 1903. At first it was believed that the seam of coal at Clealum was not the same as that opened at Roslyn, but later developments proved their continuity and identity.

No. 5 mine was started in 1903 by a slope from the outcrop line, but the rock tunnel tapping the first level was not begun until 1904, reaching the coal in 1905. No. 6 mine was opened up in 1905, and No. 7 mine in 1907.

At the western end of the field, the Roslyn Fuel Company opened its Beekman mine on the Roslyn bed in 1907, although the property had been opened as early as 1895. The Roslyn-Cascade Coal Company started to acquire rights in 1902 but did not ship much coal until 1907. A number of smaller companies operated at various times along the upper outcrop of the Roslyn bed, but their operations have not been of major importance. An upper bed lying 210 feet above the Roslyn, commonly known as the "Big Dirty," was early known and coal was hauled to Ellensburg by wagon for blacksmithing purposes. This bed was opened in 1903, but very little was done until 1911, when the Roslyn Fuel Company opened a new mine, Beekman No. 2, on this seam. This is now a regular shipping mine.

The "Lakedale" bed, so called, was opened in 1908-1909 and shipped about 9,000 tons of coal. The Roslyn branch was extended to Lakedale, near Clealum Lake, in 1909. This property was idle between 1911 and 1914. Plant's mine, a prospect south of the Lakedale property, has been developing since 1910. Both these properties are on beds, or a bed, underlying the Roslyn at a distance of 300-400 feet. Prospecting carried on in the Teanaway basin just north of the divide between the Roslyn

A. Clealum, Looking Southeast Across the Yakima Valley.

B. Clealum, Looking Southwest Across the Yakima Valley, Clealum Mine in the Foreground.

and the Teanaway basins has opened this unnamed bed at a number of places, but as yet no mining is carried on.

In the early days of mining in this field, the mine workers were largely English-speaking races. Men came over the Snoqualmie trail from the west side of the Cascades to work in the new field, and a considerable number were drawn from the coal mines of Montana and the east. In 1888 labor troubles developed as a result of trying to introduce tonnage systems in place of the day's wage previously in use, and negroes were brought in from the coal fields of the middle west. The introduction of negro labor brought on intense race strife, but the black labor held on and forms a part of the present working force. South European labor entered the field about 1900 and now constitutes the larger part of the mine workers.

The Roslyn field has easily been the greatest producer, giving Kittitas County first place among the coal mining counties of the state. The following table shows the production of Kittitas County by years as reported by the state mine inspectors.

| Year. | Short Tons. |
|---|---|
| 1887, 1888, 1889 | 230,548 |
| 1890 (for quarter) | 150,000 |
| 1891 | 331,444 |
| 1892 | 271,513 |
| 1893 | 241,441 |
| 1894 | 232,282 |
| 1895 | 276,971 |
| 1896 | 265,938 |
| 1897 | 330,306 |
| 1898 | 564,274 |
| 1899 | 635,318 |
| 1900 | 867,204 |
| 1901 | 1,005,007 |
| 1902 | 1,252,454 |
| 1903 | 1,376,017 |
| 1904 | 1,339,601 |
| 1905 | 1,279,636 |
| 1906 | 1,425,998 |
| 1907 | 1,524,422 |
| 1908 | 1,411,263 |

| *Year.* | *Short Tons.* |
|---|---|
| 1909 | 1,550,500 |
| 1910 | 1,667,453 |
| 1911 | 1,254,845 |
| 1912 | 1,235,690 |
| 1913 | 1,330,596 |
| Total | 22,050,741 |

The statistics of production as reported to the U. S. Geological Survey for its annual volume of "Mineral Resources of the United States" show a total production of 60,581,549 tons for the entire state for the period 1860-1912. It will be seen that the Roslyn field and the Roslyn bed, from which practically all of the coal has come, has produced thirty per cent of the entire output. (Appendix B.)

According to the "Mineral Resources" for 1912 Washington ranks eighteenth in production, contributing 0.6 per cent of the total production, and ranks twelfth in value, contributing 1.2 per cent of the total value of the coal-producing states of the Union.

### STRUCTURE.

The structure of the Roslyn bed has admirably lent itself to easy development and exploitation of the field. In the early days of the camp, after coal had been discovered in some of the draws or ravines in the hills making up the backbone of the ridge between the Yakima River and the Teanaway (Plate XXVII), prospecting for further outcrops was comparatively simple. The timber growth is not so heavy as on the west slope of the Cascades and there is no heavy mantle of glacial drift and forest vegetation to hide the coal. Accurate tracing of the complete crop line was not altogether possible, and some mistakes were made. For example, the seam at Clealum was not believed to be the same as that at Roslyn, but later investigation proved their unity and mine development became simplified.

A study of the maps and sections will show that the outcrop line along the north edge of the field varies in elevation from 3,750 feet north of Roslyn to 2,300 feet north of Jonesville and Clealum at either end of the field. The hills, in which the coal outcrops, have a maximum elevation of 3,300 feet north of Cle-

A. Drift into Hillside Just Above Original Opening to Coal.
No. 1 Mine, N. W. I. Co.

B. Looking up the Incline to No. 6 Mine, N. W. I. Co.

alum, 3,800 feet north of Roslyn, and 3,500 feet north of Jonesville. The general level of the valley, along which the railroad line is located, varies from 1,911 feet at Clealum, and 2,222 feet at Roslyn, to 2,500 feet at Lakedale, the end of the line. The hills are made up of Roslyn sandstone which dips southwest in the same general direction as the slope of the hills, giving fairly uniform cover to the point where the valley level is reached. From this point the cover increases rapidly. The hills are cut by the ravines, previously referred to, exposing the coal outcrop in the irregular lines shown in Plate II. The gravel terraces of the valley cover the coal so that no outcrops are found in the southern portion of the field. Structure in this part is determined from mine workings and bore hole records. The coal at the eastern end of the field above the valley level has been removed by erosion at those points where the elevation of the hills is less than the seam elevation, but the coal is undoubtedly present under the valley floor for some distance east of Clealum. (Plate XXVIII.) At the west end of the field the outcrop line lowers in elevation until it cuts across the level of the valley at Jonesville and then swings to the south and east. Broadly speaking then, the coal field is a spoon-shaped synclinal trough having a southeasterly pitch. As a field, it is completely isolated and forms no part of any other field of the state. The strikes and dips are variable from one end of the field to the other. This is best shown by the map of the mine workings. (Plate II.) The general course of the mine levels, indicated by the black heavy lines, can be regarded as contour lines of the coal bed, corresponding to the course of the strike lines. It will be seen that the bed has hills and valleys and is not a true plane surface. Some of the variations in the directions of the levels are due to local rolls and wrinkles which have been described, but the major structure is due to the folding of the basin as a whole. The dips vary from 9° to 30°.

The thickness of the Roslyn bed varies from 4 feet to 4 feet 9 inches, with a general average of 4 feet 3 inches for the field. Typical sections from various parts of the field are shown in

A. Tipple at No. 7 Mine, N. W. I. Co.

B. No. 3 Mine, N. W. I. Co., and Town of Ronald.

figures 26 to 29. The principal characteristics of the bed is the small middle layer of coal with a band of shale above and below, forming the "mining" bench. (Plate XII A.)

The structure of the field itself, the character of the seam, the topography of the surface with its relationship to the seam have been responsible for the development of the local mining methods.

METHODS OF ENTRY.

The coal has been opened by

(a) Drifts or water levels on the coal from the outcrops along the ravines.

(b) Slopes on the coal from the outcrops on the hillsides.

(c) Rock tunnels to the coal and slopes from the point of intersection to the rise and dip.

(d) Vertical shafts to the coal and slopes from the shaft bottoms.

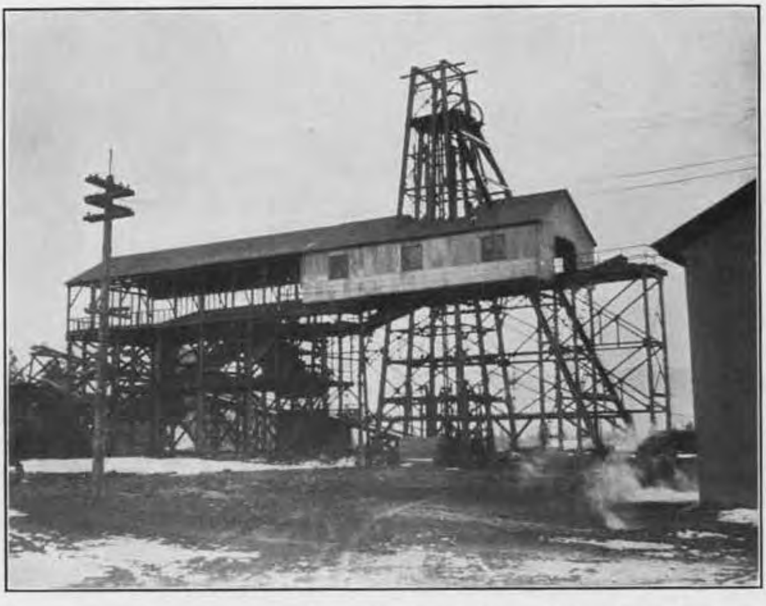
All of these methods are in use in simple form or in combination. (Plate XXIX.) The drift mines (a), known as the "hill workings," are represented by Clealum No. 2 and No. 3 Extension, Roslyn No. 6, Roslyn No. 2 East Side and some smaller mines not now in operation.

The mines in the (b) class are Roslyn No. 8, Beekman No. 1 and Beekman No. 2. Roslyn No. 5 was originally opened as a slope from the outcrop but was later tapped by a rock tunnel.

Slope mines tapped by rock tunnels (c) form the greater part of the operations. Among these are Roslyn No. 7, Roslyn No. 5, Roslyn No. 3, Patrick-MacKay No. 1 and Patrick-MacKay No. 2. (Plate XXX.)

Clealum No. 1 shaft at the east end and Roslyn No. 4 shaft (Plate XXXI) near the center of the field, 250 feet and 625 feet deep, respectively, reach the coal at approximately same elevation. From these shaft bottoms the seams have been devéloped by slopes. Neither of these mines is at present being worked but there is some probability of working Roslyn No. 4 in the near future.

A. Tipple, Head Frame, Power Plant, No. 4 Mine, N. W. I. Co.



B. Head Frame and Tipple, No. 4 Mine, N. W. I. Co.

Clealum No. 2, Roslyn No. 1 and Roslyn No. 2 Dip, represent slope workings connected with drift openings. (Plate II.)

## MINE HAULAGE AND TRANSPORTATION.

It can readily be seen that the problems of surface transportation are directly affected by the type of mine opening and the position of the openings with respect to the railroad line running through the field. The influence of the surface topography is also seen in the solution of the underground transportation, particularly in the case of the drift mines and those opened by rock tunnels.

In general, levels are driven from the main openings at intervals of 350 to 400 feet apart measured on the coal, on usual grades of 1 per cent in favor of the loads. In the case of the drift openings the same method is followed. Landings or gathering stations are located at the entrance of each level and trips are made up or distributed from this point either by mule or electric power. General Electric, Westinghouse, and Jeffrey locomotives operating on 500 volts, D. C., are extensively employed.

In the slope and shaft mines, rope haulage, with steam or electricity as the power, is the general method of bringing the trips to daylight from the levels. Many hoisting arrangements, however, are to be found in the different mines. For example, in the slope mines opened by a rock tunnel to the coal, the hoisting engine is located, in some cases, at the top of the slope on the surface and drops the cars direct to the tunnel, where they are picked up by electric locomotives and taken to the tipple. In another arrangement, the hoisting engine is below the intersection of tunnel and slope and the rope is taken from the drum of the hoisting engine to a bull-wheel inside the mine and from there down the slope. (Plate XXXII.) In this arrangement the trip is dropped right down to the tipple by the drum. The bull-wheel in the mine may be so placed that this arrangement will permit cars to be taken up or dropped down from the levels of the rise workings above the rock tunnel. In the Roslyn shaft,

A. Loaded Trip coming out of tunnel No. 2 Mine, Roslyn Cascade Coal Co.

B. Tipple, showing Gravity Screens, No. 1 Mine, Roslyn Cascade Coal Co.

A. Parting at Center of Tram, No. 1 Mine, Roslyn Cascade Coal Co.

B. Loaded Trip Above Parting on Tram.

the hoisting rope for underground transportation was carried from the engine on the surface down a 10-inch borehole, 500 feet deep, around a sheave and then down the slope. Trips were pulled up to a point above the level of the shaft bottom and then dropped back by gravity to the shaft and hoisted in double-decked cages. At the Dip mine the trip is taken into a drift, used as a rope entry on a rising grade, and then dropped down the slope. The empty trip is taken in by a head-rope passing over sheaves and a bull-wheel to the knuckle at the slope intersection. The other end of the trip carries a tail-rope, connected with the second drum of the hoisting engine, which unwinds as the trip is taken to the knuckle. At this point the head-rope is disconnected and the empty trip is dropped down the slope by the former tail-rope. The reverse operation takes place when the loaded trip is hoisted to the knuckle. In contrast with these arrangements, the simple method of engine haulage on the slope to the outcrop, dropping cars to the tipple from the knuckle point, is also employed. In many of the drift mines, the full cars are dropped to the tipple below and the empties raised by self-acting gravity planes and by engine planes. Some of these planes are a mile in length. (Plate XXXIII.)

The usual weight of rail on the levels is 16 pounds; on the slopes 30 to 40 pounds. The gauge of track is 30 or 36 inches. Mine cars average 1,500 pounds empty; capacity 2,500 pounds of coal. Ten to sixteen cars make up a trip.

### METHOD OF WORKING.

The room-and-pillar methcd is the only one employed in the field. Long-wall was attempted in various parts of the field in the earlier days of mining but it was not successful in meeting the varying conditions and was abandoned. The use of mining machines has never found favor. In general the dip has been too great for the use of pick or chain machines in the rooms, and although pick and post-puncher type machines have been tried, they have been given up for hand picks. At the present time the Roslyn-Cascade Coal Company is operating a chain machine run by alternating current in their No. 1 mine where the dip averages 9°.

The general practice is to drive double slopes and entries, brushing the cap rock and roof to a sufficient height for good head room, usually five feet six inches (5′ 6″) above the rail. Slopes are 10 to 14 feet wide, levels 9, with 30 foot pillar between. In some cases, levels are driven 14 feet wide and brushed for a width of 9 feet and the gob piled in the entry. The air course of the pair of levels is not usually brushed. Barrier pillars 100 feet wide are left between adjacent mines, and strong chain pillars are left to support the slopes. Where two parallel slopes enter the mine, one is used for the haulage way and intake air course, and the other is used for the return air. Some mines have triple slopes, using the third slope either as a manway, or as an additional return.

Rooms are driven to the rise of the levels, the necks are usually 8 feet wide for a distance of 40 feet and then widened out to 40 feet for double rooms (Fig. 48) with a 24-foot pillar between room necks and a 40 foot pillar between the double rooms; or in the case of single rooms, under light cover, 24 feet wide with 20-foot pillar between rooms. (Fig. 49.) There is a local variation in the thickness of pillar and size of room depending on the depth of cover and local conditions. (Figs. 50 and 51.) Crosscuts are 6 feet wide and are alternated by driving the first ones 90 feet on one side and 60 feet on the other side from the level, and then 60 feet apart regularly. The room necks are usually brushed. In single rooms, any accumulated gob is packed along one rib; in double rooms it is packed back of the stump pillar. Six inch props and wedges are generally used throughout the district for timbering in rooms, and are usually spaced four feet six inches (4′ 6″) in each direction. Except in "troubled" areas, very little or no timbering is needed along the levels.

Rooms are not driven for full length but are ended so as to leave a 30 to 50 foot pillar below the upper airway. Wherever the cover will permit rooms are driven up to limit and pillars

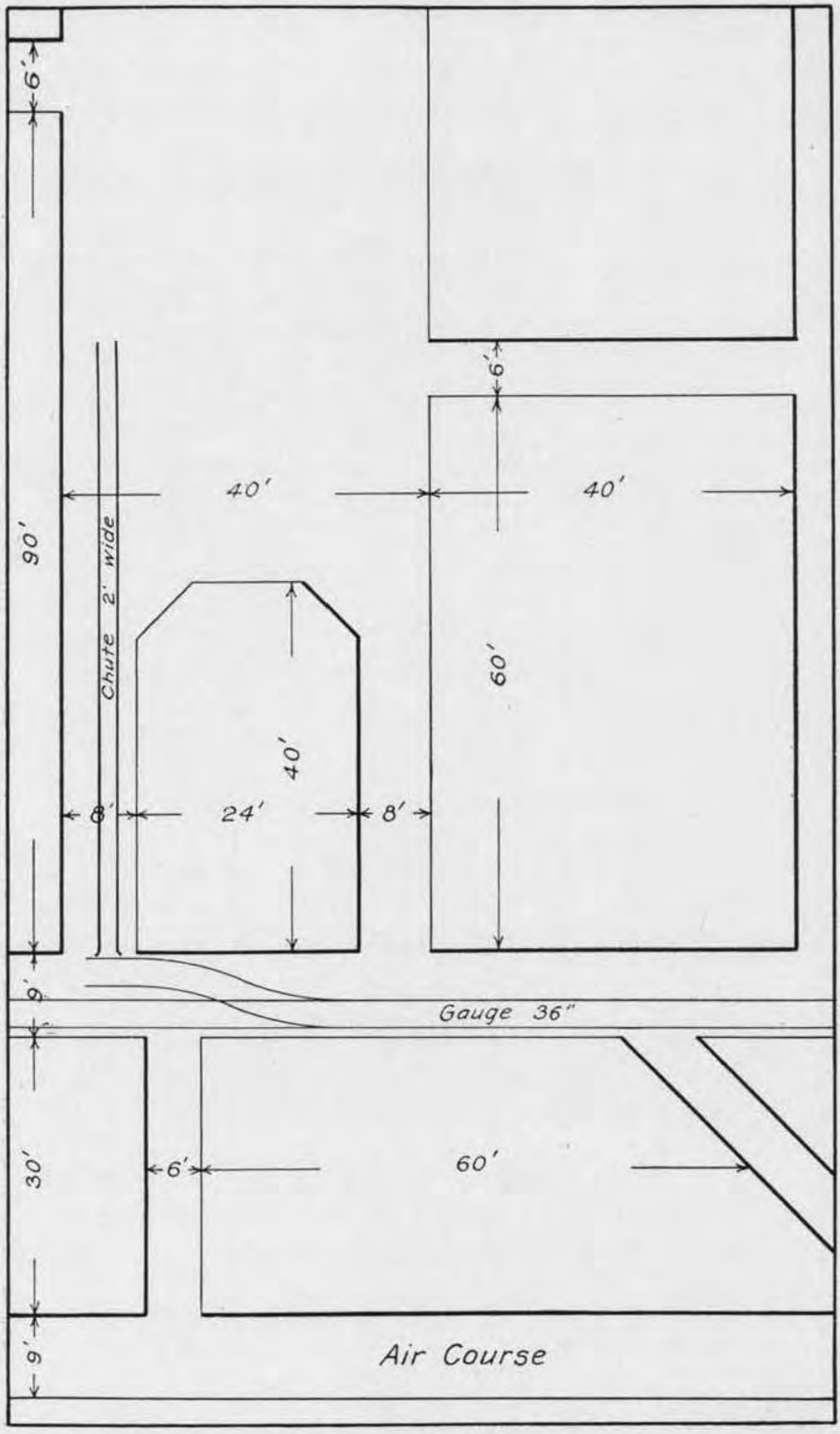



FIG. 48. Chute Rooms on Steep Dip, No. 7 Mine, N. W. I. Co., Roslyn, Wash.

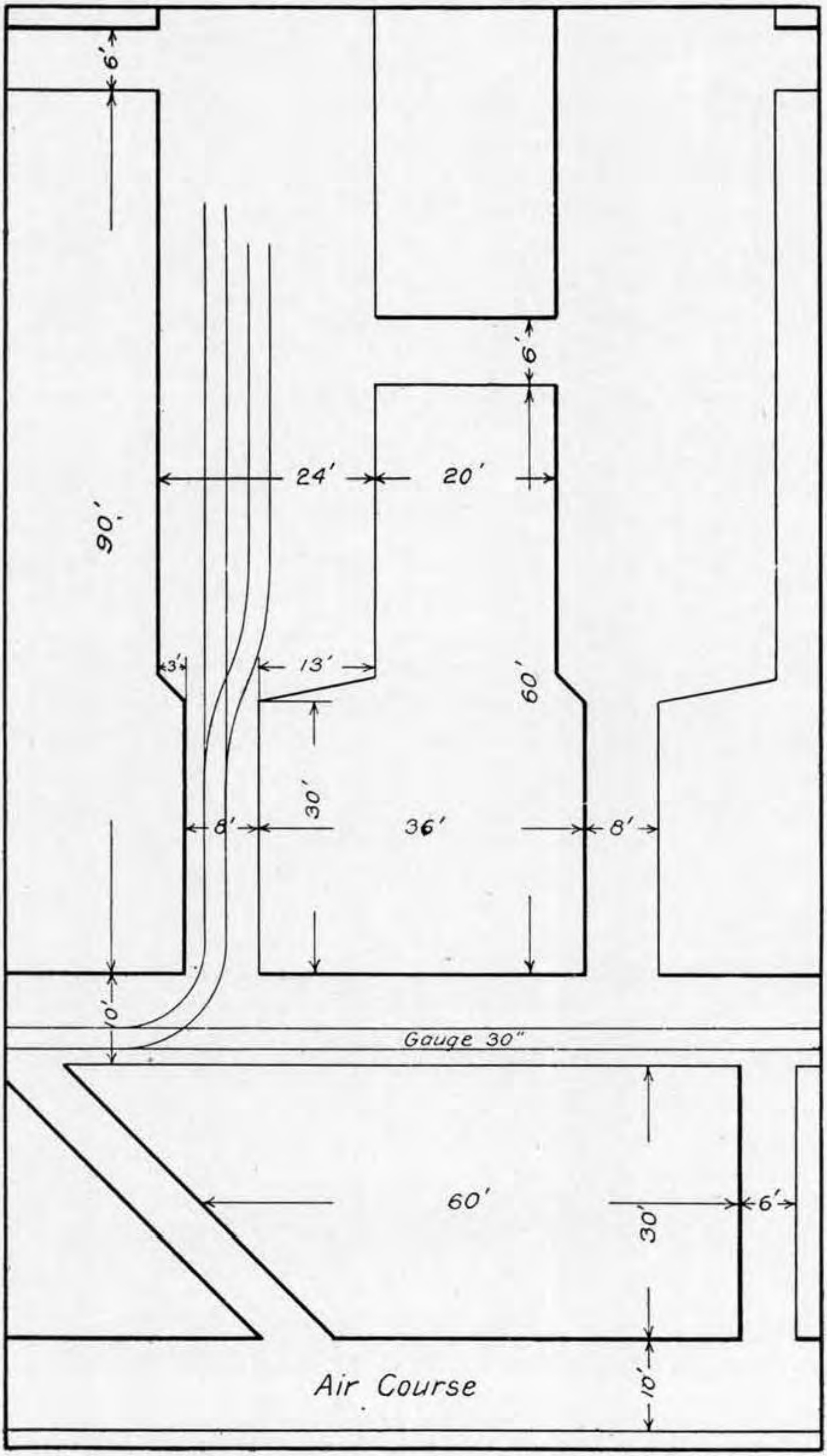



FIG. 49. Single Gravity Room on Flat Dip, No. 6 Mine, N. W. I. Co., Roslyn, Wash.

are immediately drawn back to the entry stump which is left until that level is completed. In some cases, the pillar is left standing. A modification of this method, known as the "battery and block" system, is in use wherever great roof support is required. In the battery and block system, twelve rooms are mined and space is left for twelve rooms as a block or pillar and then twelve rooms more are mined, and so on. The pillars in each room are drawn on the retreat back to the gangway; then the blocks beginning near the ends of the area are mined and robbed. The disadvantage of this method is that it ties up a great deal of coal and requires considerable dead work. Instead of leaving a block equivalent of twelve rooms, a much smaller pillar is left in heavy sections of the mine. Very little coal is lost under the present system of mining in vogue in the Roslyn field.

Some of the older mined areas have squeezed and crushed. Insufficient size of pillar and a soft, shaly phase of the bottom rock seem to have been responsible for this. In these areas wherever pillar coal is being recovered, a skip ten feet wide is taken along the room and stump pillars for a roadway, and the pillars are then attacked on the advance up to the limit of safe working and the rest of the pillar is recovered on the retreat.

Coal is mined by undercutting, shearing, and by shooting from the solid. The mining is sometimes made in the bottom coal above the floor, sometimes in the middle coal and parting of the seam, and sometimes in the top coal. (Plate XII.) Occasionally the room coal is sheared, but this practice is more common in the levels. Hand picks and drills are used. Shooting from the solid is practiced although the method is not in general favor. Black powder fired by squib, and Monobel No. 3 fired by fuse and cap, are generally used. In some of the mines shot lighters are employed, but as a general rule each miner fires his own shots.

The steepest dip in the field is 30°, the average lower dip is 10°. Coal will run in chutes at the higher angle, and this meth-

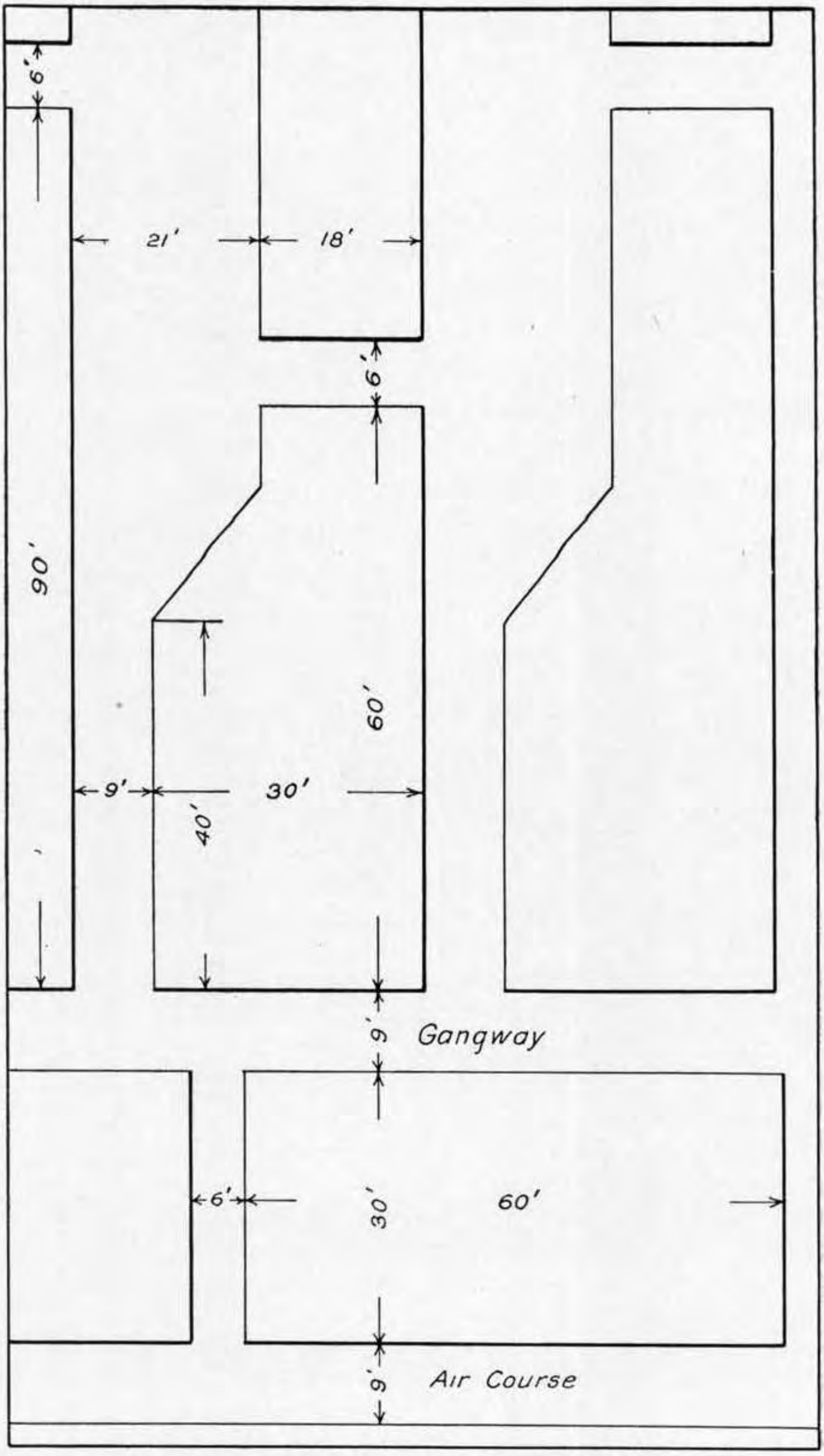



FIG. 50. Single Rooms, No. 1 Mine, Roslyn Fuel Co., Jonesville, Wash.

od is employed wherever the dip permits. The chutes are of steel plate, two feet wide, in convenient lengths, and are carried in the middle of the room necks up to the face. The chutes extend out to the level permitting the cars to be loaded directly from a platform. "Bucking" the coal is sometimes necessary. Four men usually mine in a double room, two on each side.

In the lighter pitches, the cars are taken right up to the face of the room by a gravity plane arrangement. (Figure 52.) The track along the entry is laid so that the low side rail is at a slightly lower elevation than the other in order that the cars may ordinarily pass the room switches, which have fixed points. Cars may be left on the turn for any room by simply forcing the wheels to take the turnout on the high rail. Just inside the neck of the room is another frog and switch with movable latches. One track is carried straight up along the rib; the other parallels it at a distance of 5 feet centers. These rails are usually of wood 4 feet by 4 inches in cross section, laid on ties spaced 5 feet apart. Near the face of the room a wheel post is set up, a 12 inch sheave is fastened to this, and the hoisting rope is given a turn around the sheave and its ends connected, one to the full car at the face and the other to the empty on the turn out in the entry. In this way the full car going down brings up the empty. The sheave is usually spragged by means of a wooden pin and there are few runaways. The descending car always throws the latches so that the next car will take the right track. Excess rope is coiled up and lengthened as required. Instead of having two tracks in each room neck of a double room, one track may be laid in each room, and the rope passed over two sheaves at the face of the double room. This requires a reversed or back switch on the main entry.

## VENTILATION.

The Roslyn seam and the "Big Dirty" workings are generally free from gas, particularly in the upper levels where the cover is light. In the dip workings and in those areas in which pillars are being drawn or where squeezes have occurred, gas and dust are universally present. Several explosions and local

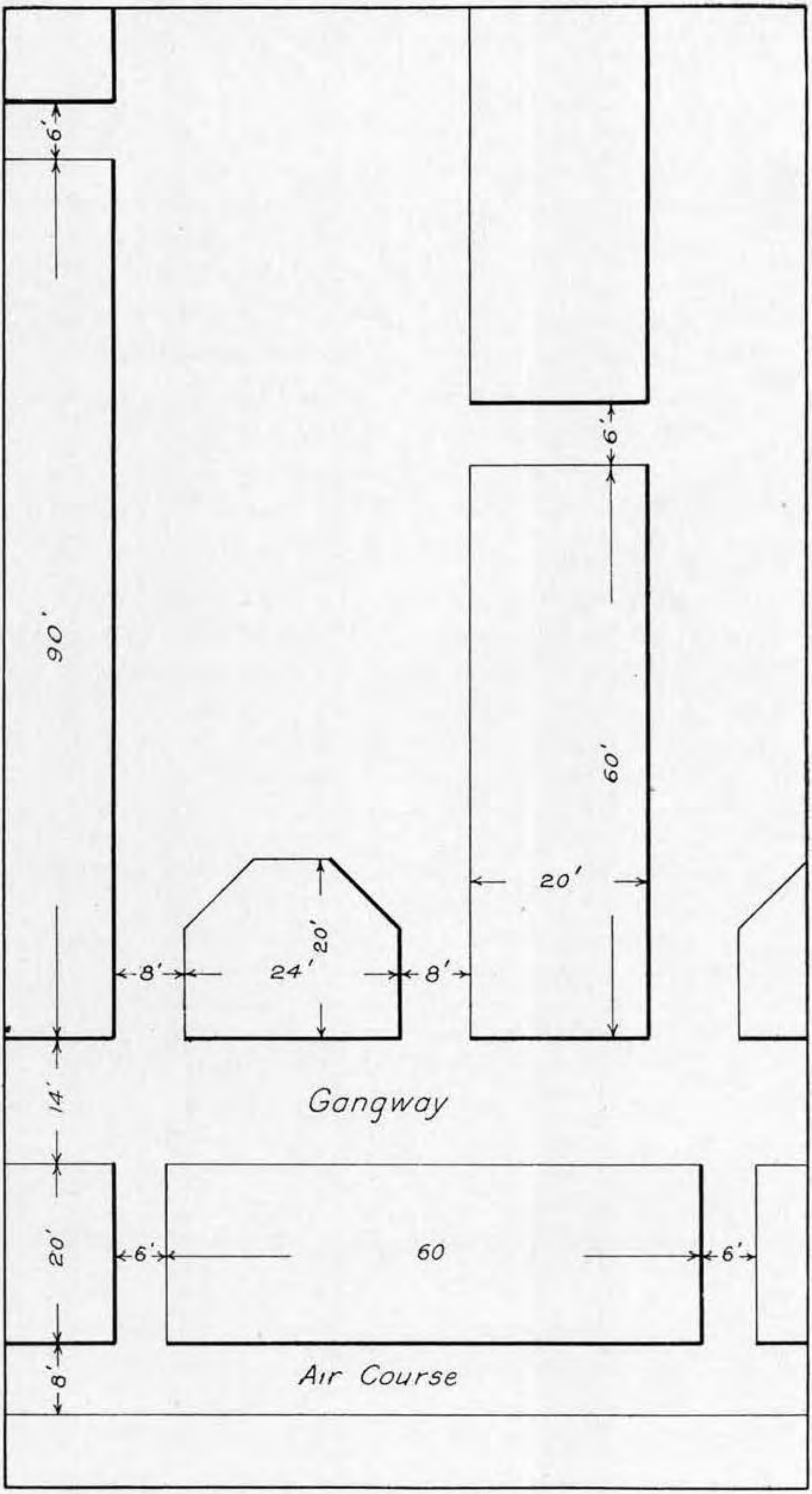



Fig. 51. Double Rooms, No. 1 Mine, Roslyn-Cascade Coal Co., Roslyn, Wash.

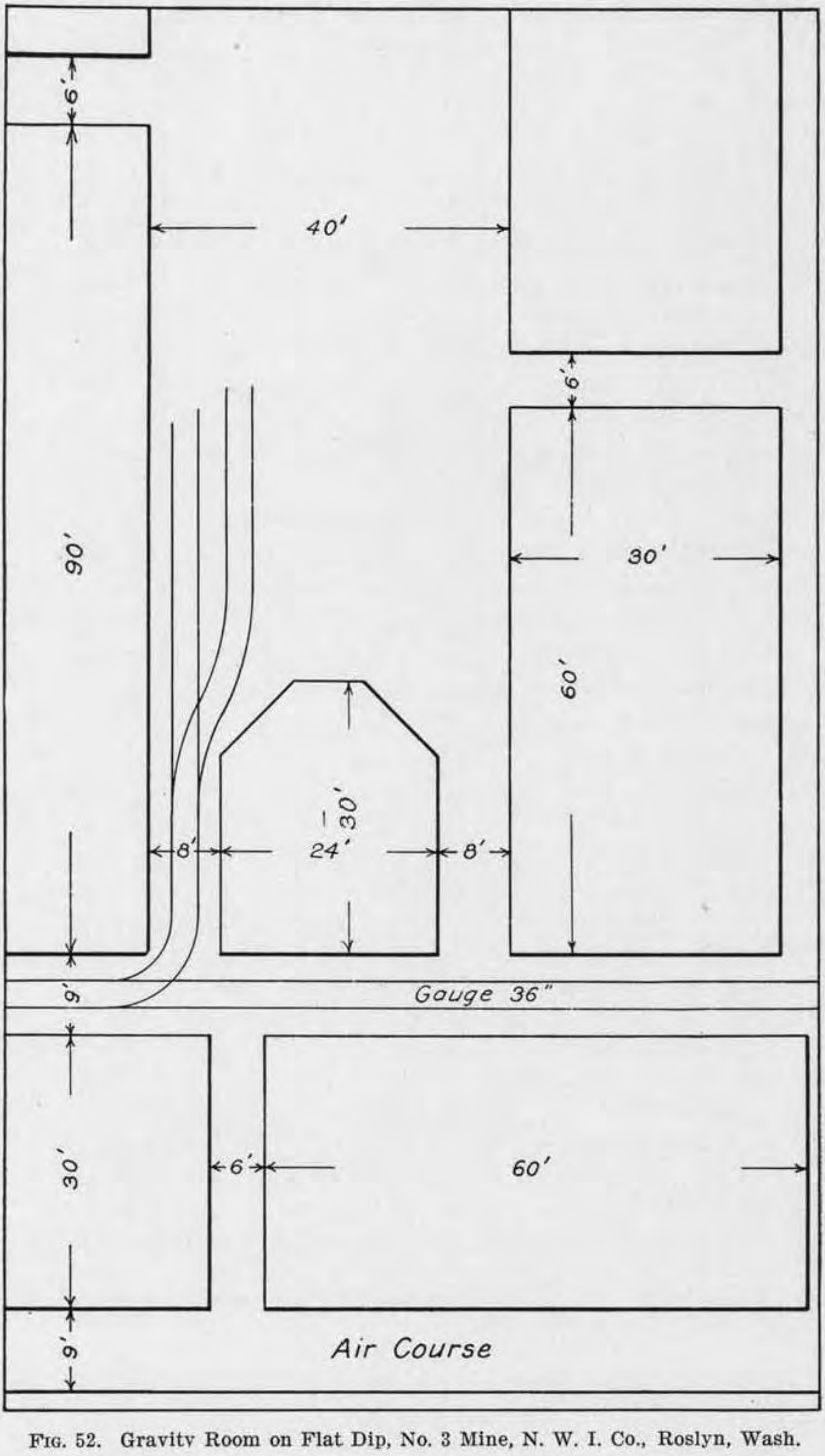



Fig. 52. Gravity Room on Flat Dip, No. 3 Mine, N. W. I. Co., Roslyn, Wash.

fires have occurred, but the field has been remarkably free from these disturbances.

All mines are ventilated by surface fans, assisted in some of the workings by underground boosters. Exhaust fans seem to be in most favor, the air passing into the main haulage road as the intake and being split at each level, passing through the rooms to the face of the upper level of the pair and then to the return airway by way of the aircourse or lower of the levels. The fans used are of various types and makes, both steam and electrically driven. (Plate XXXIV.)

Brick and wood are used for stoppings; overcasts are made of wood, brick or concrete, with the latter finding considerable favor. Canvas cloth is used for curtains and brattices.

In some of the mines spraying is used to lessen the dust, and in some cases exhaust steam is turned into the main slope. Roadways are cleaned systematically to remove the loose coal which tends to make dust.

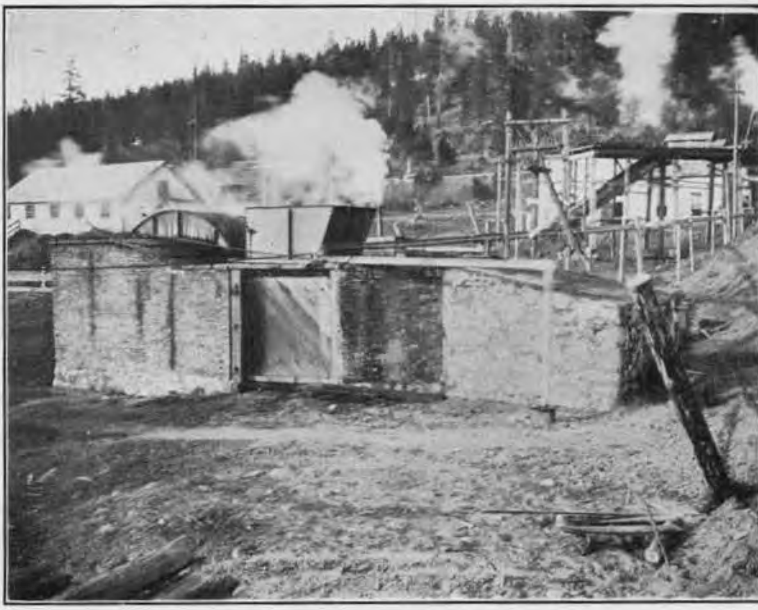
## DRAINAGE.

The mines in the field are comparatively dry, the upper or hill workings containing most of the water. Occasional feeders of water are struck in the lower workings. Electric pumps of the centrifugal and plunger types, operated in relays on 500 volts direct current, handle the water. Only one steam pump was seen in the district.

## SURFACE PLANT.

Surface equipment throughout the district is comparatively simple and uniform. (Plate XXXV.) A boiler and engine house, office, shop and powder house, together with the tipple, make up each unit. Timber, covered with galvanized iron plate is the usual type of construction. Powder houses are of brick construction of approved type. The machinery and equipment at the various mines are up-to-date and efficient. (Plate XXXVI.)

The Northwestern Improvement Company maintains a large machine shop, warehouse, and power plant at Roslyn. The



A. Fan House, No. 1 Mine, Roslyn Fuel Co.

B. Fan House, No. 7 Mine, N. W. I. Co.

power plant, steel head frame and tipple at No. 4 mine is the most pretentious unit in the district. (Plate XXXI.) The central power plant at Roslyn furnishes light and power for the mines at the upper end of the field, and a secondary plant coupled in parallel with this at the lower end of the field supplies light and power around Cle Elum. The Roslyn Fuel Company power plant supplies both mines at Jonesville. The Roslyn-Cascade Coal Company has installed an electric plant to supply current for its coal cutting machines.

## COAL PREPARATION.

Coal from the Roslyn seam is ordinarily clean as it comes from the mine. The center bands of shale are removed in the mining and any cap rock is gobbed in the rooms. The upper and lower benches break out in good sized lumps and the percentage of fine coal is low. Any sulphur balls are eliminated in the mine. The result is a coal which requires little further preparation except screening. The Roslyn Fuel Company is now washing some of the coal from its mines.

Coal mined by the Northwestern Improvement Company is used in the locomotives of the Northern Pacific Railway and is not even screened before loading into the cars. The other companies in the field enter the market and sell the coal for steam, gas, and domestic purposes, and screen the coal before shipping, but that is the only preparation necessary. The usual sizes marketed are run-of-mine, lump, steam, and egg coal, but the screen sizes of these market grades vary with the different operators.

The mine cars are unloaded at the tipples by one of three types of car dump—the simple push-back or horn dump, the crossover, or the rotary type. Gravity screens are in general use; only one mine, Beckman No. 1, employs shaking screens. Rock and waste which come to the tipple are dumped into rock chutes and bins and loaded into side-dump cars which are hoisted by motor-driven drum and rope over a bull-wheel to the top of the rock pile where the cars are automatically discharged by a tripper, or else the waste is hauled away in cars and used for grading around the tipple. (Plate XXXVII.)

A. Power Plant and Tipple, No. 1 Mine, Roslyn Fuel Co.

B. Power Plant and Tipple, No. 2 Mine, Roslyn Fuel Co.

## LABOR.

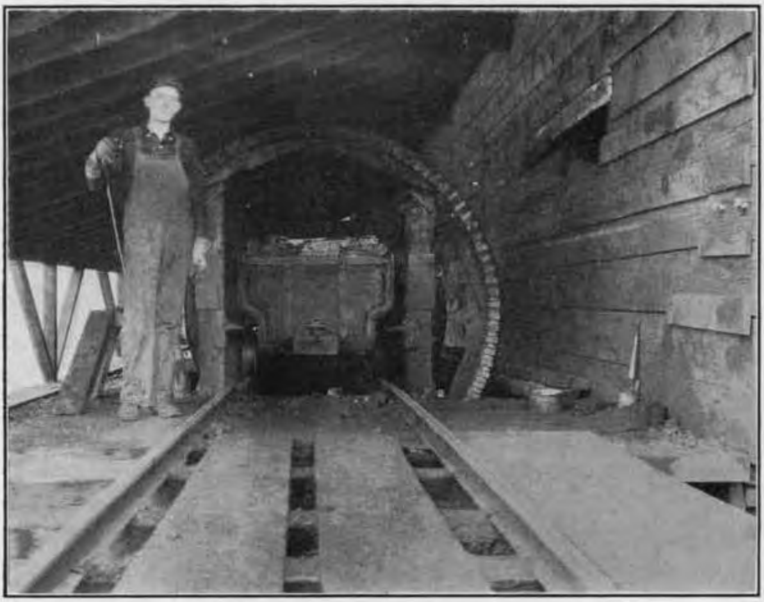
Labor in the field is representative of all coal mining camps with English, Scotch, Italian and other southern European races. In the early days of the district, negroes were brought in to break up labor troubles and since then a fair number of negroes are numbered among the mine workers. The workers are organized under the jurisdiction of the United Mine Workers of America, and are working under the terms of a two-year agreement with the operators which expires in September, 1916.

Living conditions are better than in many of the coal camps of the country. The Northwestern Improvement Company operates stores at Cle Elum and Roslyn. Many of the workers own their own homes, and good schools are provided in the towns. The men maintain a hospital and staff of doctors. There are no change houses at the mines, but one has been installed in the Y. M. C. A. at Roslyn. This organization has recently erected a new building and takes an active part in the social life of the community. Funds for maintenance are supplied by the workers and the operators. The Northwestern Improvement Company and the Roslyn Fuel Company each maintain rescue apparatus, and encourage the training of rescue and first aid squads. Men meet for training at regular intervals and take part in the competitions. The Roslyn team has been a banner organization for several years.

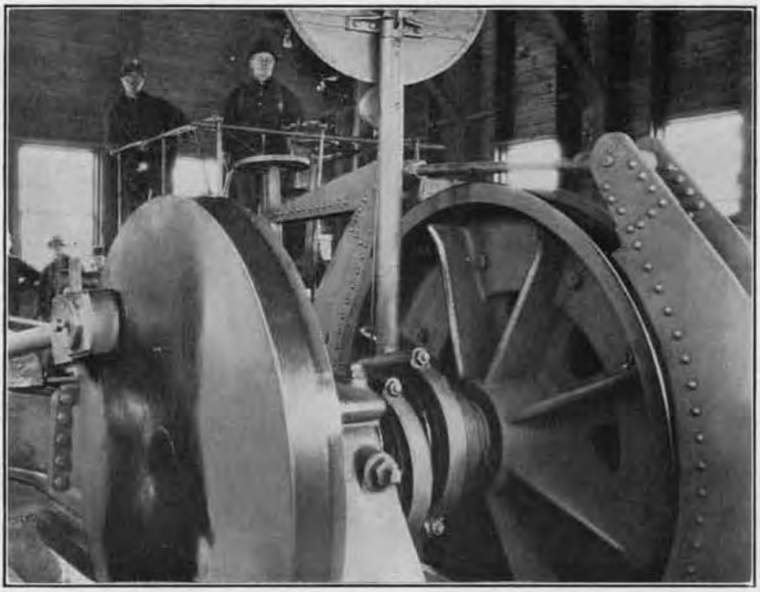
In 1912, 1,495 men were employed on inside work and 248 on outside work at the various mines in the field. The total number of days operated was 1,775 for all mines. Two fatal accidents and 225 injured is the record for that year. The number of tons per man per day for all labor in the field is 3.6.

## MINING COSTS.

The scale of wages paid in the field to both day and contract labor is governed by the agreement between the workers and operators. A copy of the latest agreement follows. The day's wage schedule is common for all the mines in the state:



A. Rotary Dump, Hand Operated, No. 5 Mine, N. W. I. Co.



B. Hoisting Engine, No. 7 Mine, N. W. I. Co.

**Day's Wage Scale.**

INSIDE MINE.

| | |
|---|---|
| Miners | $ 3 80 |
| Timbermen | 3 80 |
| Timbermen's Helpers | 3 15 |
| Tracklayers | 3 80 |
| Tracklayer's Helpers | 3 15 |
| Motormen | 3 35 |
| Drivers | 3 35 |
| Parting Boys.....$1.90 to | 2 40 |
| Greasers | 1 85 |
| Trappers | 1 60 |
| Rope Riders | 3 35 |
| Hoist Men on Development Work | 3 15 |
| Hoist Boys on Development Work | 2 50 |
| Engineers | 3 40 |
| Cagers | 3 40 |
| Cagers' Helpers | 3 15 |
| Inside Labor, not specified | 3 15 |
| Shot Lighter | 3 95 |
| Pumpman | 3 15 |

OUTSIDE MINE.

| | |
|---|---|
| Engineers | 3 40 |
| Firemen | 3 00 |
| Cagers | 3 15 |
| Cagers' Helpers | 2 75 |
| Stablemen, per month | 85 00 |
| Teamsters | 2 90 |
| Greasers | 1 45 |
| Couplers | 1 60 |
| Dumper | 2 75 |
| Blacksmiths, 1st | 3 70 |
| Blacksmiths, 2nd | 3 40 |
| Blacksmiths' Helpers | 2 90 |
| Carpenters, 1st | 3 70 |
| Carpenters, 2nd | 3 15 |
| Car Repairers | 2 90 |
| Choppers | 2 90 |
| Screeners (men) | 2 10 |
| Screeners (boys) | 1 60 |
| Moving Picking Table (men) | 2 20 |
| Moving Picking Table (boys) | 1 70 |
| Outside Labor | 2 60 |
| Development Engineers | 3 15 |
| Machinists | 3 40 |

The mining rates or contract rates for the Roslyn field are as follows:

**Mining Rates.**

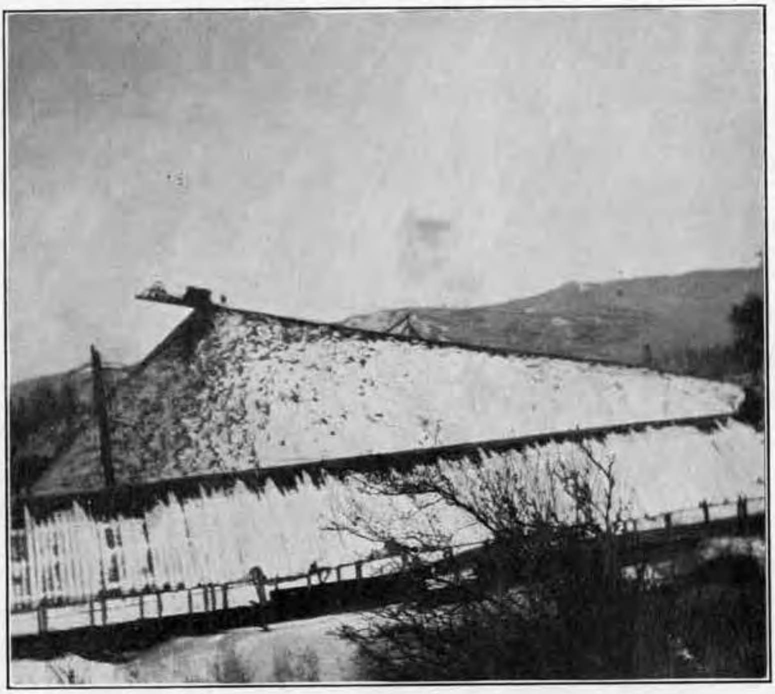
| | |
|---|---|
| At Roslyn No. 5 and other openings on the Roslyn-Clealum seam where 12 inches or less of cap rock is taken down, according to present Roslyn practice, per ton of 2,240 pounds | $1 02 |
| Where more than 12 inches of cap rock is taken down | 1 05 |
| At Clealum, No. 5 and other openings on the Roslyn-Clealum seam where cap rock is left up, according to present Clealum practice, per ton of 2,240 pounds | 95 |
| Chute work on Roslyn-Clealum seam per ton of 2,240 lbs | 92 |
| Cross cuts in rooms, per yard | 1 15 |
| Entry price, 14 ft. wide, per yard | 2 90 |
| Entry price, 8 ft. wide, per yard | 3 40 |
| Entry price, 14 ft. wide, cap rock up, at Clealum | 1 85 |
| Down hill cross cuts, under 40 ft., per yard | 1 60 |
| Down hill cross cuts, over 40 ft., per yard | 2 50 |
| Up hill cross cuts, under 50 ft., per yard | 1 60 |
| Up hill cross cuts, over 50 ft., per yard | 2 50 |
| Room turning, 20 ft | 8 50 |
| Room turning, 40 ft | 10 50 |
| Slope sinking, per yard | 3 70 |

The cost of production at the mine for coal delivered to the cars at the tipple is somewhere in the vicinity of $1.25 to $1.35 per ton, inclusive of all operating expense, but not counting coal royalty, depreciation, or overhead charges. The average value of the coal at the tipple is about $2.50 per ton. The average value for all mines in the state in 1912 was $2.43.

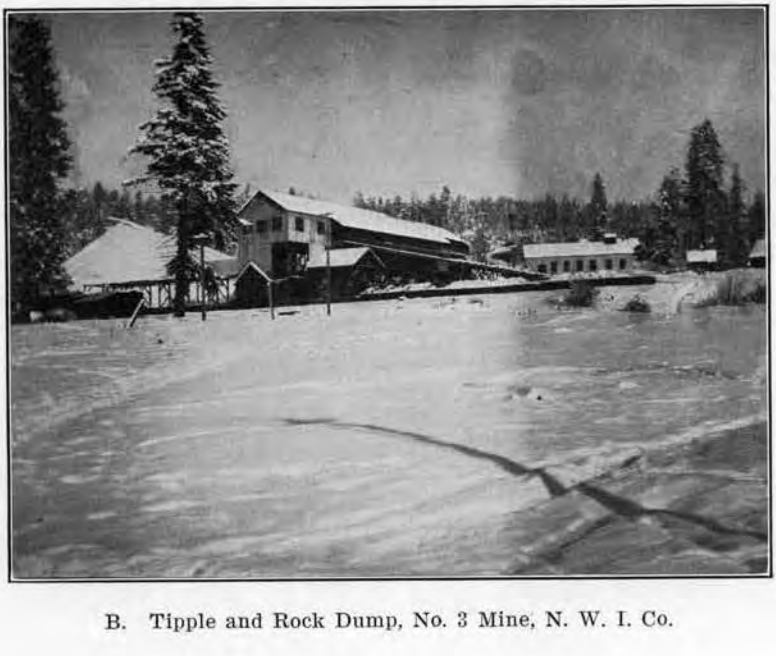
## WASHING AND COKING TESTS.

In the period from July, 1908, to July, 1909, washing and coking tests were made at the Denver Fuel Testing Plant of the U. S. Geological Survey on carload lots of Roslyn coal taken from the seam three miles west of Roslyn, at the Roslyn Fuel Company's mine. The results of these tests are given in Bulletin 5, published by the Bureau of Mines, and are briefly summarized below:

The first sample consisted of 16 tons of run-of-mine, and the second sample of 34 tons of 3/4-inch screenings. These coals were crushed to 3/4 inch and 3/8 inch and washed in a special jig



A. General Type of Rock Dump in Roslyn Field.



B. Tipple and Rock Dump, No. 3 Mine, N. W. I. Co.

and in a Richards pulsating jig. Float-and-sink tests were made on samples of the original and of the washed coals in a Delameter float-and-sink machine. The coal for coking was run both raw and washed in finely crushed condition.

The washed coal averaged 85.5% and the refuse 14.5%, with a loss of 8.25% of good coal in the refuse. The raw coal, containing about 15% ash and 0.70% sulphur, after washing showed a percentage reduction of ash of 23% and sulphur 10%, indicating 35% ash removed and 18% sulphur removed. In general the tests indicated that good separation of waste from coal was possible.

Coking tests were conducted in beehive ovens 12 feet in diameter; time varied from 36 to 51 hours and dry weight of coal charged varied from 8,572 to 11,646 pounds. The total yield of dry coke averaged 65.6%. Coke produced was of fair grade, with good coke resulting from the 51-hour tests. The results of these tests indicate that the Roslyn seam is a good coking coal.

TRANSPORTATION.

The Northern Pacific Railway main line touches the field at Clealum. From this point the Roslyn branch, seven miles long, from Clealum to Lakedale, taps the field and provides an outlet to the main line. A yard (Plate XXXVIII), at Clealum, equipped with a Heyl and Paterson conveying, loading and discharging system, serves as a storage plant and as a local coaling station for locomotives.

MARKETS.

The principal market for Roslyn coal is in the eastern part of the state. This eastern market, which includes the territory traversed by the other trans-state railway lines, uses the coal mainly for domestic purposes, while gas-making and industrial uses are second in importance. Some of the marketed coal is used by the railways on locomotives and in construction work. All of the coal mined by the Northwestern Improvement Company is used on the locomotives and in the shops of the Northern Pacific Railway, and none is sold in open market.

The high freight rate across the Cascades and the competition with western Washington coals has served to partially close the Puget Sound market to coal from this field, but a considerable trade is carried on by the Roslyn Fuel Company, and very recently the Roslyn-Cascade Coal Company has entered this market. The high grade of the Roslyn coal, in spite of the freight differential, enables it to meet the requirements of this market and the coal is extensively used in gas plants, and to a lesser degree for industrial and domestic use. Very little of the coal is used in the steamship trade.

Although this coal possesses excellent coking qualities, none of it is manufactured directly into coke except as the by-product in the manufacture of illuminating gas.

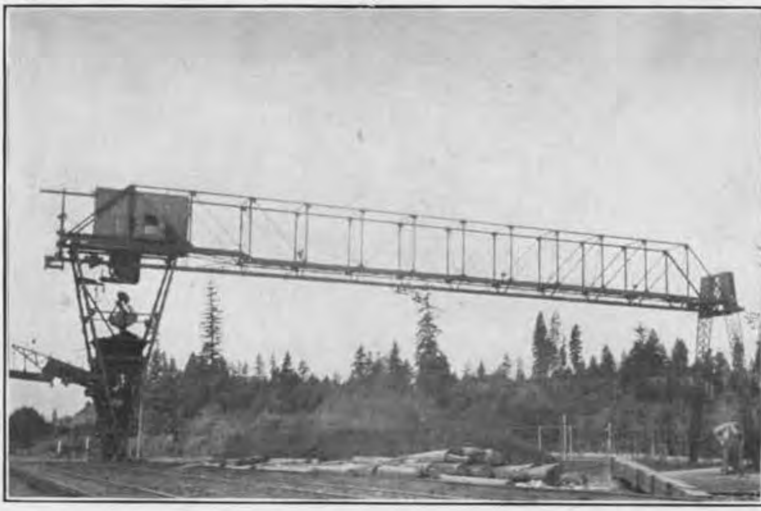
### PRODUCTION.

Records of production of the field have already been cited. These show this field to have been a leader in production for many years. Appendix A gives the record of production by individual mines in the field during the period 1887-1913. During the earlier years many small independent mines were in operation, but these have given way to the three producers now operating. Of these, the Northwestern Improvement Company shows the largest individual tonnage, thus making these mines the largest single producers in the state.

### ECONOMIC FEATURES.

The Kittitas County field did not begin to mine coal as early as the neighboring King and Pierce Counties on account of no railroad transportation. With the advent of the railroad, in spite of the limited extent of the field and its isolation from western Washington, the production began to grow very rapidly.

Conditions have been very favorable for mining in the Roslyn field. The Roslyn seam lies on a moderate dip with fairly light cover, it is very regular in structure and thickness, is easily opened up and mined, requires very little preparation for market, and is high grade in quality. While the timber resources are not as great as in western Washington, the supply is ample and cheaply obtained. The amount of timber required



A. Conveying, Loading and Discharging System at Clealum.

B. Storage Yard, with Conveyor, at Clealum.

for mining is not very great, nor is the cost for pumping high. A high percentage of the total coal is removed in mining and there is practically no loss due to refuse in the coal seam. Under these conditions, the cost of production of Roslyn seam coal is the lowest in the state.

Labor conditions have already been described. In recent years there have been no industrial disturbances in the field, and employment, while subject somewhat to the fluctuations of seasons and business, is very regular. Living conditions are also good when compared with mining camps in other parts of the country.

Future development in the field will be along the lines of exploitation of the lower levels on the Roslyn bed in the center of the basin. A large area of coal can be reached from the No. 4 shaft of the Northwestern Improvement Company. The territory on the Roslyn bed owned by the Roslyn Fuel Company at its Beekman mines will be exhausted in a few years. This company is turning its attention to an overlying seam, the "Big Dirty," and is developing a good mine on this property. The Roslyn-Cascade Coal Company has a large tonnage in reserve. Some work is being done on seams underlying the Roslyn at the western end of the field. At the present time this is largely in the nature of exploration or development. It is too early to prophesy the future of these seams, but they will undoubtedly be the source of a coal supply after the present more accessible seams are exhausted.

The Roslyn coal is not subject to the competition of nearby coal fields or of California oil in its eastern market. Montana coal is its chief competitor for the Inland Empire market. On the west the Cascades serve as an effective barrier against competition from the higher priced coals of Pierce and King Counties, and from oil, and although this prevents the Roslyn coal from gaining a strong foothold in the Puget Sound region it makes stronger its position in the markets of central and eastern Washington. It is to these points that the future production of the field will largely go.

# APPENDIX A.

## MINE PRODUCTION BY YEARS, ROSLYN-CLEALUM FIELD, KITTITAS COUNTY.

REPORTED BY STATE INSPECTORS OF MINES.

| Year | Northwestern Improvement Company | | | | | Ellensburg Co., 2½ Mi. N. Clealum Gunther Mine | Keelan & Ward 4 Miles West Roslyn | Roslyn Coal Co., 3 Mi. W. Roslyn | Swan & Haight 1 Mi. N. Roslyn Coal Co. | D. A. Brown Co. Brown Slope | Summit Coal Co. | Roslyn Coal Co. (A. Patrick, Supt.) | Roslyn-Cascade Co. | Busy Bee Mining & Dev. Co. | Roslyn Fuel Co., Beekman No. 1 | Cons. Fuel Co. Lakedale | Roslyn Fuel Co. Beekman No. 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Roslyn 2* | Roslyn 3 | Roslyn 5 | Roslyn 7 | Clealum‡ | | | | | | | | | | | | |
| 1887 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1888 | 51,316 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1889 | 179,232 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1890 | 150,000 | (for quar | ter) | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1891 | 331,444 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1892 | 271,513 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1893 | 241,441 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1894 | 232,282 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1895 | 267,176 | ... | ... | ... | 7,745 | 1,000 | 200 | 400 | 450 | ... | ... | ... | ... | ... | ... | ... | ... |
| 1896 | 255,358 | ... | ... | ... | 8,420 | 1,200 | 240 | 420 | 300 | ... | ... | ... | ... | ... | ... | ... | ... |
| 1897 | 322,500 | ... | ... | ... | 7,806 | ... | ... | (Mc- | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1898 | 555,774 | ... | ... | ... | 8,500 | ... | ... | Col- | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1899 | 635,318 | (Reporte | d as N. | W. I. Co. | ) | ... | ... | gan) | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1900 | 867,204 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1901 | 1,005,027 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1902 | 1,039,870 | ... | ... | ... | 212,584 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1903 | 1,032,530 | ... | ... | ... | 331,400 | ... | ... | ... | ... | 3,000 | 2,000 | 7,087 | ... | ... | ... | ... | ... |
| 1904 | 954,620 | ... | ... | ... | 377,114 | ... | ... | ... | ... | 1,000 | 5,000 | 1,867 | 8,954 | ... | ... | ... | ... |
| 1905 | 952,353 | ... | ... | ... | 313,987 | Yakima | ... | ... | ... | 3,951 | 9,000 | ... | 345 | ... | ... | ... | ... |
| 1906 | 970,165 | ... | ... | ... | 434,629 | Roslyn | ... | ... | ... | ... | 21,204 | ... | ... | ... | ... | ... | ... |
| 1907 | 802,940 | 33,312 | 204,334 | ... | 443,259 | Coal Co. | ... | ... | ... | ... | 35,022 | ... | ... | 3,614 | 1,941 | ... | ... |
| 1908 | 647,341 | 142,390 | 173,613 | 65,298 | 284,536 | 8,785 | ... | ... | ... | ... | 21,241 | ... | 14,396 | 5,794 | 47,869 | ... | ... |
| 1909 | 510,644 | 182,994 | 160,149 | 130,228 | 314,092 | 25,990 | ... | ... | ... | ... | 23,027 | ... | 26,257 | 7,307 | 168 954 | 798 | ... |
| 1910 | 557,542 | 221,444 | 203,195 | 215,995 | 307,683 | 23,864 | ... | ... | ... | ... | ... | ... | 60,580 | 16,780 | 253,971 | 6,390 | ... |
| 1911 | 229,454 | 177,511 | 155,110 | 174,896 | 157,744 | ... | ... | ... | ... | ... | ... | ... | 82,847 | 22,014 | 241,909 | 1,454 | 11,906 |
| 1912 | 220,320 | 211,976 | 170,224 | 198,954 | 150,207 | ... | ... | ... | ... | ... | ... | ... | 97,001 | ... | 132,484 | ... | 47,515 |
| 1913 | 208,488 | 181,891 | 123,105 | 183,546 | 181,196 | ... | ... | ... | ... | ... | †1,169 | ... | 107,719 | ... | 211,940 | ... | 131,542 |
| Total | 13,291,852 | 1,151,518 | 1,189,730 | 968,917 | 3,540,902 | 60,839 | 440 | 820 | 750 | 7,951 | 117,663 | 8,954 | 398,099 | 55,569 | 1,059,068 | 8,651 | 190,963 |

* Roslyn 2, 4, 6, and Dip Mines. † Roslyn Fuel Co. ‡ Cle Elum 2 and Extension.

| PRODUCTION—ROSLYN BED. | Short Tons. |
|---|---|
| Northwestern Improvement Company mines | 20,142,919 |
| Roslyn Fuel Company mine No. 1 | 1,059,068 |
| Roslyn-Cascade Coal Company mines | 398,099 |
| Summit Coal Company mine | 117,663 |
| Yakima-Roslyn Coal Company mine | 60,839 |
| Busy Bee Mining & Development Company mine | 55,569 |
| Scattered companies | 9,019 |
| Total | 21,843,176 |

| PRODUCTION—BIG DIRTY BED. | Short Tons. |
|---|---|
| D. A. Brown Company | 7,951 |
| Roslyn Fuel Company | 190,963 |
| Total | 198,914 |

| PRODUCTION—LAKEDALE BED. | |
|---|---|
| Consolidated Fuel Company | 8,651 |

Total Production, Roslyn-Clealum Field, Kittitas county..22,050,741

# APPENDIX B.

PRODUCTION OF COAL BY COUNTIES—1904-1913.

| COUNTY | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | 1910 | 1911 | 1912 | 1913 |
|---|---|---|---|---|---|---|---|---|---|---|
| Cowlitz | 1,800 | * 3,706 | * 3,523 | * 7,424 | ........ | ........ | ........ | ........ | ........ | ........ |
| King | 1,219,230 | 1,099,163 | 1,310,530 | 1,445,633 | 931,643 | 1,216,012 | 1,242,340 | 1,259,521 | 1,063,110 | 1,373,699 |
| Kittitas | 1,340,400 | 1,280,845 | 1,422,612 | 1,524,887 | 1,414,621 | 1,550,539 | 1,661,650 | 1,256,745 | 1,237,427 | 1,334,155 |
| Lewis | 1,335 | 1,300 | 25,880 | 103,539 | 73,675 | 121,573 | 179,484 | 172,734 | 128,377 | 151,446 |
| Pierce | 531,589 | 479,912 | 513,639 | 572,169 | 551,678 | 609,467 | 786,096 | 783,196 | 788,293 | 856,425 |
| Skagit | 10,650 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Whatcom | 1,837 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Other counties | 30,840 | ........ | ........ | 26,880 | 53,326 | † 104,672 | 42,329 | ‡ 100,619 | ‡ 143,725 | 162,166 |
| Totals | 3,137,681 | 2,864,926 | 3,276,184 | 3,680,532 | 3,024,943 | 3,602,263 | 3,911,899 | 3,572,815 | 3,360,932 | 3,877,891 |
| Total value | $5,120,258 | $5,141,258 | $5,908,434 | $7,679,801 | $6,690,412 | $9,158,999 | $9,764,465 | $8,174,170 | $8,042,871 | $9,243,137 |
| Average price per ton | $1.63 | $1.79 | $1.80 | $2.40 | $2.21 | $2.54 | $2.50 | $2.29 | $2.39 | $2.38 |

* Includes Whatcom county.

† Includes small mines.

‡ Includes Thurston and Whatcom counties.

PRODUCTION OF COAL IN WASHINGTON, 1860 TO 1913.
Given in short tons (2,000 pounds).

| | | | |
|---|---|---|---|
| 1860 | 5,374 | 1887 | 772,601 |
| 1861 | 6,000 | 1888 | 1,215,750 |
| 1862 | 7,000 | 1889 | 1,030,578 |
| 1863 | 8,000 | 1890 | 1,263,689 |
| 1864 | 10,000 | 1891 | 1,056,249 |
| 1865 | 12,000 | 1892 | 1,140,575 |
| 1866 | 13,000 | 1893 | 1,208,850 |
| 1867 | 14,500 | 1894 | 1,131,660 |
| 1868 | 15,000 | 1895 | 1,163,737 |
| 1869 | 16,200 | 1896 | 1,202,534 |
| 1870 | 17,844 | 1897 | 1,330,192 |
| 1871 | 20,000 | 1898 | 1,775,257 |
| 1872 | 23,000 | 1899 | 1,917,607 |
| 1873 | 26,000 | 1900 | 2,418,034 |
| 1874 | 30,352 | 1901 | 2,464,190 |
| 1875 | 99,568 | 1902 | 2,690,789 |
| 1876 | 110,342 | 1903 | 3,190,477 |
| 1877 | 120,896 | 1904 | 2,905,689 |
| 1878 | 131,660 | 1905 | 2,846,901 |
| 1879 | 142,666 | 1906 | 3,290,523 |
| 1880 | 145,015 | 1907 | 3,722,433 |
| 1881 | 296,000 | 1908 | 2,977,490 |
| 1882 | 177,340 | 1909 | 3,590,639 |
| 1883 | 244,990 | 1910 | 3,979,569 |
| 1884 | 166,936 | 1911 | 3,546,322 |
| 1885 | 380,250 | 1912 | 3,360,932 |
| 1886 | 423,525 | 1913 | 3,877,891 |

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# APPENDIX C.

## ANALYSES OF COAL SAMPLES FROM KITTITAS COUNTY, WASHINGTON

From Bulletin Number 474, United States Geological Survey, pages 55 to 62.

| Name of Mine or Form of Exposure | Laboratory No. | LOCATION | | | | Air-drying loss | Form of Analysis | PROXIMATE | | | | ULTIMATE | | | | | Heat Value | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quarter | Section | Township | Range | | | Moisture | Volatile Matter | Fixed Carbon | Ash | Sulphur | Hydrogen | Carbon | Nitrogen | Oxygen | Calories | British Thermal Units |
| Prospect, 1¼ miles northwest of Beekman. | 9404 | NW. | 2 | 20 N. | 14 E. | 4.1 | As received | 5.3 | 27.5 | 42.6 | 24.6 | 0.38 | ...... | ...... | ...... | ...... | 5,860 | 10,550 |
| | | | | | | | Air dried | 1.2 | 28.7 | 44.4 | 25.7 | .40 | ...... | ...... | ...... | ...... | 6,110 | 11,000 |
| | | | | | | | Dry coal | ...... | 29.1 | 44.9 | 26.0 | .40 | ...... | ...... | ...... | ...... | 6,185 | 11,130 |
| | | | | | | | Pure coal | ...... | 39.3 | 60.7 | ...... | .54 | ...... | ...... | ...... | ...... | 8,355 | 15,040 |
| Lakedale, 1 mile northwest of Beekman. | 9405 | SE. | 2 | 20 N. | 14 E. | 2.5 | As received | 4.5 | 29.5 | 44.5 | 21.48 | .35 | 5.02 | 61.45 | 1.18 | 10.52 | 6,235 | 11,220 |
| | | | | | | | Air dried | 2.0 | 30.3 | 45.7 | 22.03 | .36 | 4.86 | 63.03 | 1.21 | 8.51 | 6,395 | 11,510 |
| | | | | | | | Dry coal | ...... | 30.9 | 46.6 | 22.48 | .37 | 4.74 | 64.31 | 1.23 | 6.87 | 6,525 | 11,740 |
| | | | | | | | Pure coal | ...... | 39.9 | 60.1 | ...... | .48 | 6.11 | 82.96 | 1.59 | 8.86 | 8,415 | 15,150 |
| Beekman at Beekman, Roslyn bed. | 9411 | NW. | 12 | 20 N. | 14 E. | 2.4 | As received | 3.7 | 35.1 | 50.5 | 10.7 | .33 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried | 1.3 | 36.0 | 51.7 | 11.0 | .33 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal | ...... | 36.5 | 52.4 | 11.1 | .33 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal | ...... | 41.0 | 59.0 | ...... | .37 | ...... | ...... | ...... | ...... | ...... | ...... |
| Beekman at Beekman, Roslyn bed. | 9412 | SE. | 12 | 20 N. | 14 E. | 1.8 | As received | 3.5 | 34.6 | 50.2 | 11.7 | .38 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried | 1.8 | 35.2 | 51.1 | 11.9 | .39 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal | ...... | 35.9 | 52.0 | 12.1 | .39 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal | ...... | 40.8 | 59.2 | ...... | .44 | ...... | ...... | ...... | ...... | ...... | ...... |
| Beekman at Beekman, Roslyn bed. | 9413 | SE. | 12 | 20 N. | 14 E. | 1.8 | As received | 3.4 | 35.5 | 49.8 | 11.3 | .37 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried | 1.6 | 36.2 | 50.7 | 11.5 | .38 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal | ...... | 36.8 | 51.5 | 11.7 | .38 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal | ...... | 51.6 | 58.4 | ...... | .43 | ...... | ...... | ...... | ...... | ...... | ...... |
| Beekman at Beekman, Roslyn bed. | 9414 | NW. | 12 | 20 N. | 14 E. | 1.0 | As received | 2.5 | 34.9 | 50.0 | 12.6 | .33 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried | 1.5 | 35.2 | 50.5 | 12.8 | .33 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal | ...... | 35.8 | 51.3 | 12.9 | .34 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal | ...... | 41.1 | 58.9 | ...... | .39 | ...... | ...... | ...... | ...... | ...... | ...... |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Beekman at Beekman, Roslyn bed. | 9415 | SW. | 12 | 20 N. | 14 E. | .8 | As received .... | 2.6 | 34.7 | 48.9 | 13.8 | .34 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Air dried ...... | 1.8 | 35.0 | 49.3 | 13.9 | .34 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Dry coal ...... | ...... | 35.6 | 50.2 | 14.2 | .35 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Pure coal ...... | ...... | 41.5 | 58.5 | ...... | .41 | ...... | ...... | ...... | ...... | ...... | ........ |
| Beekman at Beekman, Roslyn bed, car sample. | 9410 | SW. | 12 | 20 N. | 14 E. | 2.7 | As received .... | 4.4 | 33.2 | 49.5 | 12.94 | 0.35 | 5.46 | 69.83 | 1.56 | 9.86 | 6,960 | 12,520 |
| | | | | | | | Air dried ...... | 1.7 | 34.1 | 50.9 | 13.30 | .36 | 5.30 | 71.77 | 1.60 | 7.67 | 7,150 | 12,870 |
| | | | | | | | Dry coal ...... | ...... | 34.7 | 51.8 | 13.53 | .37 | 5.20 | 73.02 | 1.63 | 6.25 | 7,275 | 13,100 |
| | | | | | | | Pure coal ...... | ...... | 40.2 | 59.8 | ...... | .43 | 6.01 | 84.45 | 1.89 | 7.22 | 8,415 | 15,150 |
| Beekman at Beekman, composite sample. | 9459 | ...... | 12 | 20 N. | 14 E. | 1.8 | As received .... | 3.3 | 34.1 | 50.5 | 12.15 | .35 | 5.61 | 70.67 | 1.65 | 9.57 | 7,175 | 12,910 |
| | | | | | | | Air dried ...... | 1.5 | 34.7 | 51.4 | 12.37 | .36 | 5.51 | 71.97 | 1.68 | 8.11 | 7,305 | 13,150 |
| | | | | | | | Dry coal ...... | ...... | 35.2 | 52.2 | 12.57 | .36 | 5.42 | 73.10 | 1.71 | 6.84 | 7,420 | 13,360 |
| | | | | | | | Pure coal ...... | ...... | 40.3 | 59.7 | ...... | .41 | 6.20 | 83.60 | 1.96 | 7.83 | 8,485 | 15,280 |
| Beekman at Beekman, Roslyn bed. | 550-D | ...... | 12 | 20 N. | 14 E. | 1.9 | As received .... | 3.5 | 38.4 | 48.3 | 9.8 | .41 | ...... | ...... | ...... | ...... | 7,345 | 13,220 |
| | | | | | | | Air dried ...... | 1.6 | 39.2 | 49.2 | 10.0 | .42 | ...... | ...... | ...... | ...... | 7,490 | 13,480 |
| | | | | | | | Dry coal ...... | ...... | 39.8 | 50.0 | 10.2 | .43 | ...... | ...... | ...... | ...... | 7,610 | 13,700 |
| | | | | | | | Pure coal ...... | ...... | 44.3 | 55.7 | ...... | .48 | ...... | ...... | ...... | ...... | 8,470 | 15,250 |
| Beekman at Beekman, Roslyn bed. | 551-D | ...... | 12 | 20 N. | 14 E. | 7.5 | As received .... | 9.0 | 36.2 | 46.1 | 8.7 | .35 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Air dried ...... | 1.5 | 39.2 | 49.8 | 9.5 | .38 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Dry coal ...... | ...... | 39.8 | 50.6 | 9.6 | .39 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Pure coal ...... | ...... | 44.0 | 56.0 | ...... | .43 | ...... | ...... | ...... | ...... | ...... | ........ |
| Beekman at Beekman, Roslyn bed, car sample. | 693-D | ...... | 12 | 20 N. | 14 E. | 5.8 | As received .... | 7.8 | 33.1 | 44.9 | 14.18 | .45 | 5.48 | 64.67 | 1.41 | 13.81 | 6,615 | 11,900 |
| | | | | | | | Air dried ...... | 2.2 | 35.1 | 47.7 | 15.05 | .48 | 5.14 | 68.65 | 1.50 | 9.18 | 7,020 | 12,630 |
| | | | | | | | Dry coal ...... | ...... | 35.9 | 48.7 | 15.38 | .49 | 5.00 | 70.16 | 1.53 | 7.44 | 7,175 | 12,910 |
| | | | | | | | Pure coal ...... | ...... | 42.4 | 57.6 | ...... | .58 | 5.91 | 82.91 | 1.81 | 8.79 | 8,480 | 15,260 |
| Busy Bee, 2½ miles northwest of Roslyn, Roslyn bed. | 9406 | NE. | 12 | 20 N. | 14 E. | 1.4 | As received .... | 3.3 | 36.2 | 51.6 | 8.9 | .41 | ...... | ...... | ...... | ...... | 7,430 | 13,370 |
| | | | | | | | Air dried ...... | 1.9 | 36.7 | 52.3 | 9.1 | .42 | ...... | ...... | ...... | ...... | 7,535 | 13,560 |
| | | | | | | | Dry coal ...... | ...... | 37.5 | 53.3 | 9.2 | .42 | ...... | ...... | ...... | ...... | 7,685 | 13,830 |
| | | | | | | | Pure coal ...... | ...... | 41.3 | 58.7 | ...... | .46 | ...... | ...... | ...... | ...... | 8,465 | 15,240 |
| Patrick-McKay, 3½ miles northwest of Roslyn, Roslyn bed. | 9418 | SW. | 6 | 20 N. | 15 E. | 1.1 | As received .... | 3.3 | 36.0 | 48.8 | 11.9 | .37 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Air dried ...... | 3.2 | 36.3 | 49.4 | 12.1 | .37 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Dry coal ...... | ...... | 37.2 | 50.5 | 12.3 | .38 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Pure coal ...... | ...... | 42.4 | 57.6 | ...... | .43 | ...... | ...... | ...... | ...... | ...... | ........ |
| Patrick-McKay, 3½ miles northwest of Roslyn, Roslyn bed. | 9416 | SW. | 6 | 20 N. | 15 E. | 1.1 | As received .... | 3.0 | 36.9 | 49.6 | 10.5 | .38 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Air dried ...... | 1.9 | 37.4 | 50.1 | 10.6 | .39 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Dry coal ...... | ...... | 38.1 | 51.1 | 10.8 | .39 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Pure coal ...... | ...... | 42.7 | 57.3 | ...... | .44 | ...... | ...... | ...... | ...... | ...... | ........ |

ANALYSES OF COAL SAMPLES FROM KITTITAS COUNTY, WASHINGTON—Continued.

| Name of Mine or Form of Exposure | Laboratory No. | LOCATION | | | | Air-drying loss | Form of Analysis | PROXIMATE | | | | ULTIMATE | | | | | Heat Value | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quarter | Section | Township | Range | | | Moisture | Volatile Matter | Fixed Carbon | Ash | Sulphur | Hydrogen | Carbon | Nitrogen | Oxygen | Calories | British Thermal Units |
| Patrick-McKay, 3½ miles northwest of Roslyn, Roslyn bed. | 9417 | SE. | 6 | 20 N. | 15 E. | 1.1 | As received | 3.0 | 36.2 | 40.3 | 11.5 | .38 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried | 1.9 | 36.6 | 49.9 | 11.6 | .38 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal | ...... | 37.3 | 50.8 | 11.9 | .39 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal | ...... | 42.3 | 57.7 | ...... | .44 | ...... | ...... | ...... | ...... | ...... | ...... |
| Patrick-McKay, 3½ miles northwest of Roslyn, composite sample. | 9460 | ...... | 6 | 20 N. | 15 E. | 1.1 | As received | 3.1 | 35.6 | 50.0 | 11.27 | .41 | 5.63 | 70.18 | 1.44 | 11.07 | 7,140 | 12,850 |
| | | | | | | | Air dried | 2.0 | 36.0 | 50.6 | 11.40 | .41 | 5.57 | 70.96 | 1.46 | 10.20 | 7,215 | 12,990 |
| | | | | | | | Dry coal | ...... | 36.7 | 51.7 | 11.63 | .42 | 5.46 | 72.41 | 1.49 | 8.59 | 7,365 | 13,260 |
| | | | | | | | Pure coal | ...... | 41.6 | 58.4 | ...... | .48 | 6.18 | 81.94 | 1.69 | 9.71 | 8,335 | 15,000 |
| Patrick-McKay, 3½ miles northwest of Roslyn, lower bed. | 9407 | NW. | 6 | 20 N. | 15 E. | 2.5 | As received | 4.1 | 33.0 | 46.5 | 16.43 | .80 | 5.29 | 65.09 | 1.21 | 11.18 | 6,575 | 11,830 |
| | | | | | | | Air dried | 1.6 | 33.9 | 47.7 | 16.85 | .81 | 5.14 | 66.76 | 1.25 | 9.19 | 6,745 | 12,140 |
| | | | | | | | Dry coal | ...... | 34.4 | 48.5 | 17.13 | .83 | 5.04 | 67.87 | 1.26 | 7.87 | 6,855 | 12,340 |
| | | | | | | | Pure coal | ...... | 41.5 | 58.5 | ...... | 1.00 | 6.07 | 81.90 | 1.52 | 9.51 | 8,270 | 14,890 |
| Roslyn No. 3 at Ronald, Roslyn bed. | 9428 | NW. | 7 | 20 N. | 15 E | 1.3 | As received | 3.4 | 36.4 | 49.5 | 10.7 | .40 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried | 2.2 | 36.8 | 50.2 | 10.8 | .41 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal | ...... | 37.6 | 51.3 | 11.1 | .41 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal | ...... | 42.3 | 57.7 | ...... | .46 | ...... | ...... | ...... | ...... | ...... | ...... |
| Roslyn No. 3 at Ronald, Roslyn bed. | 9429 | NE. | 7 | 20 N. | 15 E. | 1.1 | As received | 3.2 | 36.5 | 49.2 | 11.1 | .37 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried | 2.1 | 36.9 | 49.8 | 11.2 | .37 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal | ...... | 37.7 | 59.8 | 11.5 | .38 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal | ...... | 42.6 | 57.4 | ...... | .43 | ...... | ...... | ...... | ...... | ...... | ...... |
| Roslyn No. 3 at Ronald, Roslyn bed. | 9432 | NW. | 7 | 20 N. | 15 E. | 1.0 | As received | 3.2 | 36.4 | 49.8 | 10.6 | .23 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried | 2.2 | 36.8 | 50.3 | 10.7 | .33 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal | ...... | 37.6 | 51.4 | 11.0 | .34 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal | ...... | 42.2 | 57.8 | ...... | .38 | ...... | ...... | ...... | ...... | ...... | ...... |
| Roslyn No. 3 at Ronald, Roslyn bed. | 9431 | SE. | 7 | 20 N. | 15 E. | 1.0 | As received | 3.2 | 36.1 | 46.7 | 14.0 | .39 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried | 2.2 | 36.4 | 47.2 | 14.2 | .39 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal | ...... | 37.3 | 48.2 | 14.5 | .40 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal | ...... | 43.6 | 56.4 | ...... | .47 | ...... | ...... | ...... | ...... | ...... | ...... |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Roslyn No. 3 at Ronald, Roslyn bed. | 9430 | SW. | 7 | 20 N. | 15 E. | 1.1 | As received .... | 3.3 | 35.2 | 51.1 | 10.4 | .33 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Air dried ...... | 2.2 | 35.6 | 51.7 | 10.5 | .33 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Dry coal ...... | ...... | 36.4 | 52.9 | 10.7 | .34 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Pure coal ...... | ...... | 40.8 | 59.2 | ...... | .38 | ...... | ...... | ...... | ...... | ...... | ........ |
| Roslyn No. 3 at Ronald, composite sample. | 9463 | ...... | 7 | 20 N. | 15 E. | 1.1 | As received .... | 3.1 | 35.6 | 49.9 | 11.37 | .40 | 5.53 | 70.29 | 1.54 | 10.87 | 7,145 | 12,860 |
| | | | | | | | Air dried ...... | 2.0 | 36.0 | 50.5 | 11.50 | .40 | 5.47 | 71.07 | 1.56 | 10.00 | 7,225 | 13,010 |
| | | | | | | | Dry coal ...... | ...... | 36.8 | 51.5 | 11.73 | .41 | 5.36 | 72.53 | 1.59 | 8.38 | 7,375 | 13,270 |
| | | | | | | | Pure coal ...... | ...... | 41.6 | 58.4 | ...... | .47 | 6.07 | 82.17 | 1.80 | 9.49 | 8,350 | 15,030 |
| Roslyn No. 2 slope at Roslyn, Roslyn bed. | 9433 | SE. | 18 | 20 N. | 15 E. | 0.9 | As received .... | 2.9 | 35.8 | 48.7 | 12.6 | .37 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Air dried ...... | 2.0 | 36.1 | 49.2 | 12.7 | .37 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Dry coal ...... | ...... | 36.8 | 50.2 | 13.0 | .38 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Pure coal ...... | ...... | 42.3 | 57.7 | ...... | .44 | ...... | ...... | ...... | ...... | ...... | ........ |
| Roslyn No. 2 slope at Roslyn, Roslyn bed. | 9434 | NW. | 18 | 20 N. | 15 E. | 1.8 | As received .... | 3.4 | 34.6 | 50.5 | 11.5 | .36 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Air dried ...... | 1.6 | 35.2 | 51.5 | 11.7 | .37 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Dry coal ...... | ..... | 35.8 | 52.3 | 11.9 | .37 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Pure coal ...... | ...... | 40.7 | 59.3 | ...... | .42 | ...... | ...... | ...... | ...... | ...... | ........ |
| Roslyn No. 2 slope at Roslyn, Roslyn bed. | 9435 | SW. | 17 | 20 N. | 15 E. | 1.8 | As received .... | 3.3 | 35.9 | 48.5 | 12.3 | .37 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Air dried ...... | 1.6 | 36.6 | 49.3 | 12.5 | .38 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Dry coal ...... | ...... | 37.2 | 50.1 | 12.7 | .38 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Pure coal ...... | ...... | 42.6 | 57.4 | ...... | .44 | ...... | ...... | ...... | ...... | ...... | ........ |
| Roslyn No. 2 slope at Roslyn, Roslyn bed. | 9436 | SE. | 18 | 20 N. | 15 E. | 1.1 | As received .... | 3.1 | 35.9 | 47.7 | 13.3 | .31 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Air dried ...... | 2.0 | 36.3 | 48.2 | 13.5 | .31 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Dry coal ...... | ...... | 37.1 | 49.2 | 13.7 | .32 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Pure coal ...... | ...... | 43.0 | 57.0 | ...... | .37 | ...... | ...... | ...... | ...... | ...... | ........ |
| Roslyn No. 2 slope at Roslyn, composite sample. | 9464 | ...... | .... | 20 N. | 15 E. | 1.4 | As received .... | 3.1 | 35.6 | 48.8 | 12.47 | .35 | 5.47 | 69.08 | 1.53 | 11.10 | 7,025 | 12,640 |
| | | | | | | | Air dried ...... | 1.8 | 36.1 | 49.5 | 12.65 | .35 | 5.39 | 70.06 | 1.55 | 10.00 | 7,125 | 12,820 |
| | | | | | | | Dry coal ...... | ...... | 36.7 | 50.4 | 12.88 | .36 | 5.29 | 71.33 | 1.58 | 8.56 | 7,255 | 13,060 |
| | | | | | | | Pure coal ...... | ...... | 42.2 | 57.8 | ...... | .41 | 6.07 | 81.87 | 1.81 | 9.84 | 8,325 | 14,980 |
| Roslyn No. 2 at Roslyn, Roslyn bed. | 9442 | SW. | 9 | 20 N. | 15 E. | 1.9 | As received .... | 4.5 | 37.0 | 46.5 | 12.0 | .42 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Air dried ...... | 2.6 | 37.7 | 47.5 | 12.2 | .43 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Dry coal ...... | ...... | 38.7 | 48.7 | 12.6 | .44 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Pure coal ...... | ...... | 44.3 | 55.7 | ...... | .50 | ...... | ...... | ...... | ...... | ...... | ........ |
| Roslyn No. 2 at Roslyn, Roslyn bed. | 9443 | NE. | 8 | 20 N. | 15 E. | 1.8 | As received .... | 4.4 | 35.4 | 47.2 | 13.0 | .41 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Air dried ...... | 2.7 | 36.1 | 48.0 | 13.2 | .42 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Dry coal ...... | ...... | 37.1 | 49.3 | 13.6 | .43 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Pure coal ...... | ...... | 42.9 | 57.1 | ...... | .50 | ...... | ...... | ...... | ...... | ...... | ........ |

ANALYSES OF COAL SAMPLES FROM KITTITAS COUNTY, WASHINGTON—Continued.

| Name of Mine or Form of Exposure | Laboratory No. | LOCATION | | | | Air-drying loss | Form of Analysis | PROXIMATE | | | | ULTIMATE | | | | | Heat Value | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quarter | Section | Township | Range | | | Moisture | Volatile Matter | Fixed Carbon | Ash | Sulphur | Hydrogen | Carbon | Nitrogen | Oxygen | Calories | British Thermal Units |
| Roslyn No. 2 at Roslyn, Roslyn bed. | 9444 | SE. | 9 | 20 N. | 15 E. | 2.2 | As received | 5.4 | 36.5 | 46.2 | 11.9 | .39 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried | 3.3 | 37.3 | 47.2 | 12.2 | .40 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal | ...... | 38.6 | 48.8 | 12.6 | .41 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal | ...... | 44.2 | 55.8 | ...... | .47 | ...... | ...... | ...... | ...... | ...... | ...... |
| Roslyn No. 2 at Roslyn, composite sample. | 9468 | ...... | ...... | 20 N. | 15 E. | 2.0 | As received | 4.7 | 36.0 | 46.8 | 12.46 | .38 | 5.87 | 66.86 | 1.34 | 13.09 | 6,800 | 12,240 |
| | | | | | | | Air dried | 2.7 | 36.8 | 47.8 | 12.71 | .39 | 5.77 | 68.22 | 1.37 | 11.54 | 6,940 | 12,490 |
| | | | | | | | Dry coal | ...... | 37.8 | 49.1 | 13.07 | .40 | 5.61 | 70.13 | 1.41 | 9.38 | 7,135 | 12,840 |
| | | | | | | | Pure coal | ...... | 43.4 | 56.6 | ...... | .46 | 6.45 | 80.67 | 1.62 | 10.80 | 8,205 | 14,770 |
| Roslyn No. 2 at Roslyn, Roslyn bed. | 2457 | ...... | ...... | 20 N. | 15 E. | .9 | As received | 3.4 | 36.1 | 46.6 | 13.9 | .36 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried | 2.5 | 36.5 | 47.0 | 14.0 | .36 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal | ...... | 37.4 | 48.2 | 14.4 | .37 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal | ...... | 43.7 | 56.3 | ...... | .43 | ...... | ...... | ...... | ...... | ...... | ...... |
| Roslyn No. 2 at Roslyn, lump coal. | 3098 | ...... | ...... | ...... | ...... | 1.5 | As received | 3.1 | 36.5 | 48.1 | 12.26 | .38 | 5.15 | 69.35 | 1.24 | 11.62 | 6,990 | 12,590 |
| | | | | | | | Air dried | 1.9 | 37.0 | 48.7 | 12.42 | .38 | 5.08 | 70.26 | 1.26 | 10.60 | 7,085 | 12,750 |
| | | | | | | | Dry coal | ...... | 37.7 | 49.6 | 12.66 | .39 | 4.96 | 71.62 | 1.28 | 9.09 | 7,220 | 13,000 |
| | | | | | | | Pure coal | ...... | 43.2 | 56.8 | ...... | .45 | 5.68 | 81.99 | 1.47 | 10.41 | 8,270 | 14,880 |
| A. & E. mine, 1 mile northeast of Roslyn, Roslyn bed. | 9402 | SW. | 10 | 20 N. | 15 E. | 2.5 | As received | 5.7 | 36.9 | 44.7 | 12.69 | .45 | 5.47 | 65.55 | 1.28 | 14.56 | 6,630 | 11,930 |
| | | | | | | | Air dried | 3.3 | 37.9 | 45.8 | 13.02 | .46 | 5.32 | 67.23 | 1.31 | 12.66 | 6,800 | 12,240 |
| | | | | | | | Dry coal | ...... | 39.2 | 47.3 | 13.46 | .48 | 5.13 | 69.51 | 1.36 | 10.06 | 7,030 | 12,650 |
| | | | | | | | Pure coal | ...... | 45.3 | 54.7 | ...... | .55 | 5.93 | 80.32 | 1.57 | 11.63 | 8,125 | 14,620 |
| Roslyn No. 6 at Roslyn, Roslyn bed. | 9439 | NE. | 16 | 20 N. | 15 E. | 1.9 | As received | 4.4 | 36.7 | 46.4 | 12.5 | .41 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried | 2.6 | 37.4 | 47.3 | 12.7 | .42 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal | ...... | 38.4 | 48.6 | 13.0 | .43 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal | ...... | 44.2 | 55.8 | ...... | .49 | ...... | ...... | ...... | ...... | ...... | ...... |
| Roslyn No. 6 at Roslyn, Roslyn bed. | 9441 | NE. | 16 | 20 N. | 15 E. | 1.8 | As received | 4.5 | 36.4 | 46.5 | 12.6 | .42 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried | 2.7 | 37.1 | 47.4 | 12.8 | .43 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal | ...... | 38.1 | 48.7 | 13.2 | .44 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal | ...... | 43.9 | 56.1 | ...... | .51 | ...... | ...... | ...... | ...... | ...... | ...... |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Roslyn No. 6 at Roslyn, Roslyn bed. | 9440 | NE. | 16 | 20 N. | 15 E. | 2.1 | As received .... | 4.8 | 37.3 | 45.6 | 12.3 | .38 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried ...... | 2.8 | 38.0 | 46.6 | 12.6 | .39 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal ...... | ...... | 39.1 | 47.9 | 13.0 | .40 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal ...... | ...... | 45.0 | 55.0 | ...... | .46 | ...... | ...... | ...... | ...... | ...... | ...... |
| Roslyn No. 6 at Roslyn, composite sample. | 9466 | ...... | 16 | 20 N. | 15 E. | 1.9 | As received .... | 4.6 | 36.1 | 46.8 | 12.53 | .40 | 5.37 | 67.42 | 1.30 | 12.98 | 6,755 | 12,150 |
| | | | | | | | Air dried ...... | 2.8 | 36.8 | 47.6 | 12.77 | .40 | 5.26 | 68.73 | 1.33 | 11.51 | 6,885 | 12,390 |
| | | | | | | | Dry coal ...... | ...... | 37.9 | 49.0 | 13.14 | .42 | 5.09 | 70.71 | 1.36 | 9.28 | 7,085 | 12,750 |
| | | | | | | | Pure coal ...... | ...... | 43.6 | 56.4 | ...... | .48 | 5.86 | 81.41 | 1.57 | 10.68 | 8,155 | 14,680 |
| Roslyn No. 4 at Roslyn, Roslyn bed. | 9438 | NW. | 20 | 20 N. | 15 E. | 2.2 | As received .... | 3.7 | 33.8 | 48.0 | 14.5 | .35 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried ...... | 1.6 | 34.6 | 49.0 | 14.8 | .36 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal ...... | ...... | 35.1 | 49.8 | 15.1 | .36 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal ...... | ...... | 41.3 | 58.7 | ...... | .42 | ...... | ...... | ...... | ...... | ...... | ...... |
| Roslyn No. 4 at Roslyn, Roslyn bed. | 9437 | NE. | 20 | 20 N. | 15 E. | 1.4 | As received .... | 3.7 | 35.8 | 48.2 | 12.3 | 0.37 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried ...... | 2.3 | 36.4 | 48.9 | 12.4 | .38 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal ...... | ...... | 37.2 | 50.0 | 12.8 | .38 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal ...... | ...... | 42.7 | 57.3 | ...... | .44 | ...... | ...... | ...... | ...... | ...... | ...... |
| Roslyn No. 4 at Roslyn, composite sample. | 9465 | ...... | 20 | 20 N. | 15 E. | 1.8 | As received .... | 3.7 | 34.3 | 48.6 | 13.40 | .36 | 5.43 | 67.57 | 1.28 | 11.96 | 6,805 | 12,250 |
| | | | | | | | Air dried ...... | 1.9 | 35.0 | 49.5 | 13.65 | .37 | 5.33 | 68.81 | 1.30 | 10.54 | 6,935 | 12,480 |
| | | | | | | | Dry coal ...... | ...... | 35.6 | 50.5 | 13.91 | .37 | 5.21 | 70.15 | 1.33 | 9.03 | 7,065 | 12,720 |
| | | | | | | | Pure coal ...... | ...... | 41.4 | 58.6 | ...... | .43 | 6.05 | 81.49 | 1.54 | 10.49 | 8,210 | 14,780 |
| Roslyn No. 4 at Roslyn, Roslyn bed. | 2458 | ...... | 17 | 20 N. | 15 E. | 1.3 | As received .... | 3.4 | 37.3 | 48.9 | 10.4 | .33 | ...... | ...... | ...... | ...... | 7,135 | 12,850 |
| | | | | | | | Air dried ...... | 2.1 | 37.9 | 49.5 | 10.5 | .33 | ...... | ...... | ...... | ...... | 7,230 | 13,020 |
| | | | | | | | Dry coal ...... | ...... | 38.6 | 50.6 | 10.8 | .34 | ...... | ...... | ...... | ...... | 7,385 | 13,300 |
| | | | | | | | Pure coal ...... | ...... | 43.3 | 56.7 | ...... | .38 | ...... | ...... | ...... | ...... | 8,280 | 14,900 |
| Roslyn No. 5, 1½ miles southeast of Roslyn, Roslyn bed. | 9427 | SW. | 16 | 20 N. | 15 E. | 1.9 | As received .... | 4.7 | 36.9 | 47.4 | 11.0 | .35 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried ...... | 2.9 | 37.6 | 48.3 | 11.2 | .36 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal ...... | ...... | 38.7 | 49.7 | 11.6 | .37 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal ...... | ...... | 43.8 | 56.2 | ...... | .42 | ...... | ...... | ...... | ...... | ...... | ...... |
| Roslyn No. 5, 1½ miles southeast of Roslyn, Roslyn bed. | 9423 | SW. | 22 | 20 N. | 15 E. | 1.6 | As received .... | 5.4 | 35.7 | 46.9 | 12.0 | .36 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried ...... | 3.9 | 36.3 | 47.7 | 12.1 | .37 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal ...... | ...... | 37.7 | 49.6 | 12.7 | .38 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal ...... | ...... | 43.2 | 56.8 | ...... | .44 | ...... | ...... | ...... | ...... | ...... | ...... |
| Roslyn No. 5, 1½ miles southeast of Roslyn, Roslyn bed. | 9424 | NW. | 21 | 20 N. | 15 E. | 1.4 | As received .... | 4.2 | 35.3 | 47.2 | 13.3 | .37 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried ...... | 2.9 | 35.8 | 47.8 | 13.5 | .38 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal ...... | ...... | 36.9 | 49.2 | 13.9 | .39 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal ...... | ...... | 42.8 | 57.2 | ...... | .45 | ...... | ...... | ...... | ...... | ...... | ...... |

ANALYSES OF COAL SAMPLES FROM KITTITAS COUNTY, WASHINGTON—Continued.

| Name of Mine or Form of Exposure | Laboratory No. | LOCATION | | | | Air-drying loss | Form of Analysis | PROXIMATE | | | | ULTIMATE | | | | | Heat Value | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quarter | Section | Township | Range | | | Moisture | Volatile Matter | Fixed Carbon | Ash | Sulphur | Hydrogen | Carbon | Nitrogen | Oxygen | Calories | British Thermal Units |
| Roslyn No. 5, 1½ miles southeast of Roslyn, Roslyn bed. | 9426 | SW. | 22 | 20 N. | 15 E. | 1.7 | As received | 5.2 | 36.6 | 46.4 | 11.8 | .38 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried | 3.6 | 37.2 | 47.2 | 12.0 | .39 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal | ...... | 38.6 | 49.0 | 12.4 | .40 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal | ...... | 44.1 | 55.9 | ...... | .46 | ...... | ...... | ...... | ...... | ...... | ...... |
| Roslyn No. 5, 1½ miles southeast of Roslyn, Roslyn bed. | 9425 | SE. | 21 | 20 N. | 15 E. | 1.5 | As received | 5.0 | 34.9 | 49.6 | 10.5 | .39 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried | 3.5 | 35.5 | 50.3 | 10.7 | .40 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal | ...... | 36.8 | 52.1 | 11.1 | .41 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal | ...... | 41.3 | 58.7 | ...... | .46 | ...... | ...... | ...... | ...... | ...... | ...... |
| Roslyn No. 5, 1½ miles southeast of Roslyn, composite sample. | 9462 | ...... | ...... | 20 N. | 15 E. | 1.6 | As received | 4.9 | 36.0 | 47.3 | 11.77 | .40 | 5.54 | 67.68 | 1.27 | 13.34 | 6,810 | 12,250 |
| | | | | | | | Air dried | 3.4 | 36.5 | 48.1 | 11.97 | .41 | 5.45 | 68.78 | 1.29 | 12.10 | 6,920 | 12,450 |
| | | | | | | | Dry coal | ...... | 37.8 | 49.8 | 12.38 | .42 | 5.25 | 71.21 | 1.34 | 9.40 | 7,165 | 12,890 |
| | | | | | | | Pure coal | ...... | 43.2 | 56.8 | ...... | .48 | 5.99 | 81.27 | 1.53 | 10.73 | 8,175 | 14,710 |
| Roslyn No. 7, ½ mile northeast of Clealum, Roslyn bed. | 9422 | SE. | 22 | 20 N. | 15 E. | 1.5 | As received | 5.5 | 36.2 | 46.5 | 11.8 | .33 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried | 4.1 | 36.8 | 47.2 | 11.9 | .33 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal | ...... | 38.3 | 49.2 | 12.5 | .35 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal | ...... | 43.8 | 56.2 | ...... | .40 | ...... | ...... | ...... | ...... | ...... | ...... |
| Roslyn No. 7, ½ mile northeast of Clealum, Roslyn bed. | 9421 | NW. | 26 | 20 N. | 15 E. | 2.0 | As received | 7.0 | 34.5 | 44.9 | 13.6 | .37 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried | 5.1 | 35.2 | 45.8 | 13.9 | .38 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal | ...... | 37.1 | 48.3 | 14.6 | .40 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal | ...... | 43.5 | 56.5 | ...... | .47 | ...... | ...... | ...... | ...... | ...... | ...... |
| Roslyn No. 7, ½ mile northeast of Clealum, Roslyn bed. | 9420 | SE. | 22 | 20 N. | 15 E. | 2.4 | As received | 6.3 | 35.8 | 46.3 | 11.6 | .35 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried | 4.0 | 36.6 | 47.5 | 11.9 | .36 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal | ...... | 38.2 | 49.4 | 12.4 | .37 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal | ...... | 43.6 | 56.4 | ...... | .42 | ...... | ...... | ...... | ...... | ...... | ...... |
| Roslyn No. 7, ½ mile northeast of Clealum, Roslyn bed. | 9419 | NE. | 27 | 20 N. | 15 E. | 2.0 | As received | 6.0 | 34.9 | 47.2 | 11.9 | .34 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Air dried | 4.1 | 35.7 | 48.1 | 12.1 | .35 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal | ...... | 37.2 | 50.2 | 12.6 | .36 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Pure coal | ...... | 42.6 | 57.4 | ...... | .41 | ...... | ...... | ...... | ...... | ...... | ...... |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Roslyn No. 7, ½ mile northeast of Clealum, composite sample. | 9461 | ...... | ..... | 20 N. | 15 E. | 2.0 | As received .... | 5.0 | 36.1 | 46.8 | 12.15 | .36 | 5.60 | 66.00 | 1.29 | 14.60 | 6,610 | 11,900 |
| | | | | | | | Air dried ...... | 3.0 | 36.8 | 47.8 | 12.40 | .37 | 5.49 | 67.35 | 1.32 | 13.07 | 6,745 | 12,140 |
| | | | | | | | Dry coal ...... | ...... | 38.0 | 49.2 | 12.79 | .38 | 5.31 | 69.46 | 1.36 | 10.70 | 6,955 | 12,520 |
| | | | | | | | Pure coal ..... | ...... | 43.5 | 56.5 | ....... | .44 | 6.09 | 79.65 | 1.56 | 12.26 | 7,975 | 14,360 |
| Summit, 1 mile north of Clealum, Roslyn bed. | 9403 | SW. | 14 | 20 N. | 15 E. | 2.6 | As received .... | 7.6 | 35.2 | 45.2 | 12.01 | .44 | 5.65 | 63.88 | 1.32 | 16.70 | 6,430 | 11,580 |
| | | | | | | | Air dried ...... | 5.2 | 36.1 | 46.4 | 12.33 | .45 | 5.50 | 65.59 | 1.36 | 14.77 | 6,605 | 11,890 |
| | | | | | | | Dry coal ...... | ...... | 38.1 | 48.9 | 13.01 | .48 | 5.20 | 69.18 | 1.43 | 10.70 | 6,965 | 12,540 |
| | | | | | | | Pure coal ..... | ...... | 43.8 | 56.2 | ....... | .55 | 5.98 | 79.53 | 1.64 | 12.30 | 8,010 | 14,410 |
| Cle Elum, No. 3 Extension, 1 mile north of Clealum, Roslyn bed. | 9408 | NW. | 23 | 20 N. | 15 E. | 3.0 | As received .... | 8.5 | 34.9 | 44.5 | 12.15 | .47 | 5.53 | 62.68 | 1.48 | 17.69 | 6,305 | 11,340 |
| | | | | | | | Air dried ...... | 5.7 | 36.0 | 45.8 | 12.53 | .48 | 5.36 | 64.62 | 1.53 | 15.48 | 6,500 | 11,700 |
| | | | | | | | Dry coal ...... | ...... | 38.1 | 48.6 | 13.28 | .51 | 5.01 | 68.52 | 1.62 | 11.06 | 6,890 | 12,400 |
| | | | | | | | Pure coal ..... | ...... | 44.0 | 56.0 | ....... | .59 | 5.78 | 79.01 | 1.87 | 12.75 | 7,945 | 14,300 |
| Cle Elum, No. 2 Extension, 1 mile north of Clealum, Roslyn bed. | 9409 | SE. | 23 | 20 N. | 15 E. | 2.8 | As received .... | 8.5 | 35.0 | 44.6 | 11.94 | .43 | 5.52 | 63.35 | 1.43 | 17.33 | 6,350 | 11,430 |
| | | | | | | | Air dried ...... | 5.9 | 36.0 | 45.8 | 12.28 | .44 | 5.36 | 65.18 | 1.46 | 15.28 | 6,535 | 11,760 |
| | | | | | | | Dry coal ...... | ...... | 38.3 | 48.7 | 13.05 | .47 | 5.00 | 69.23 | 1.56 | 10.69 | 6,940 | 12,490 |
| | | | | | | | Pure coal ..... | ...... | 44.0 | 56.0 | ....... | .54 | 5.75 | 79.62 | 1.79 | 12.30 | 7,980 | 14,370 |
| Cle Elum No. 2, ½ mile north of Clealum, Roslyn bed. | 9472 | NE. | 25 | 20 N. | 15 E. | 3.9 | As received .... | 8.0 | 34.5 | 45.5 | 12.04 | 0.45 | 5.50 | 63.64 | 1.39 | 16.98 | 6,365 | 11,450 |
| | | | | | | | Air dried ...... | 4.3 | 25.9 | 47.3 | 12.53 | .47 | 5.28 | 66.22 | 1.45 | 14.05 | 6,620 | 11,920 |
| | | | | | | | Dry coal ...... | ...... | 37.5 | 49.4 | 13.09 | .49 | 5.02 | 69.17 | 1.51 | 10.72 | 6,915 | 12,450 |
| | | | | | | | Pure coal ..... | ...... | 43.1 | 56.9 | ....... | .56 | 5.78 | 79.59 | 1.74 | 12.33 | 7,960 | 14,330 |
| Cle Elum No. 1 at Clealum, Roslyn bed. | 9445 | NW. | 26 | 20 N. | 15 E. | 2.7 | As received .... | 6.6 | 35.9 | 44.4 | 13.1 | .35 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Air dried ...... | 4.0 | 36.9 | 45.6 | 13.5 | .36 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Dry coal ...... | ...... | 38.4 | 47.6 | 14.0 | .37 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Pure coal ..... | ...... | 44.7 | 55.3 | ....... | .43 | ...... | ...... | ...... | ...... | ...... | ........ |
| Cle Elum No. 1 at Clealum, Roslyn bed. | 9446 | SE. | 26 | 20 N. | 15 E. | 2.3 | As received .... | 7.5 | 35.2 | 44.1 | 13.2 | .42 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Air dried ...... | 5.3 | 36.0 | 45.2 | 13.5 | .43 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Dry coal ...... | ...... | 38.0 | 47.7 | 14.3 | .45 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Pure coal ..... | ...... | 44.4 | 55.6 | ....... | .53 | ...... | ...... | ...... | ...... | ...... | ........ |
| Cle Elum No. 1 at Clealum, Roslyn bed. | 9447 | NE. | 25 | 20 N. | 15 E. | 5.1 | As received .... | 9.9 | 33.5 | 44.8 | 11.8 | .39 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Air dried ...... | 5.1 | 35.3 | 47.2 | 12.4 | .41 | ...... | ...... | ...... | ...... | ...... | ...... |
| | | | | | | | Dry coal ...... | ...... | 37.2 | 49.7 | 13.1 | .43 | ...... | ...... | ...... | ...... | ...... | ........ |
| | | | | | | | Pure coal ..... | ...... | 42.8 | 57.2 | ....... | .49 | ...... | ...... | ...... | ...... | ...... | ........ |
| Cle Elum No. 1 at Clealum, composite sample. | 9467 | ...... | ..... | 20 N. | 15 E. | 3.4 | As received .... | 7.9 | 34.6 | 44.8 | 12.68 | .43 | 5.76 | 62.84 | 1.31 | 16.98 | 6,340 | 11,410 |
| | | | | | | | Air dried ...... | 4.7 | 35.8 | 46.4 | 13.13 | .44 | 5.57 | 65.05 | 1.36 | 14.45 | 6,565 | 11,820 |
| | | | | | | | Dry coal ...... | ...... | 37.6 | 48.6 | 13.77 | .47 | 5.30 | 68.23 | 1.42 | 10.81 | 6,885 | 12,390 |
| | | | | | | | Pure coal ..... | ...... | 43.6 | 56.4 | ....... | .54 | 6.15 | 79.13 | 1.65 | 12.53 | 7,985 | 14,370 |

ANALYSES OF COAL SAMPLES FROM KITTITAS COUNTY, WASHINGTON—Concluded.

| Name of Mine or Form of Exposure | Laboratory No. | LOCATION | | | | Air-drying loss | Form of Analysis | PROXIMATE | | | | ULTIMATE | | | | | Heat Value | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quarter | Section | Township | Range | | | Moisture | Volatile Matter | Fixed Carbon | Ash | Sulphur | Hydrogen | Carbon | Nitrogen | Oxygen | Calories | British Thermal Units |
| Manastash No. 7 tunnel....... | 13266 | NE. | 22 | 18 N. | 15 E. | 6.70 | As received .... | 10.42 | 30.33 | 36.43 | 22.82 | 1.13 | ....... | ....... | ....... | ....... | 4,988 | 8,978 |
| | | | | | | | Air dried ...... | 3.99 | 32.51 | 39.04 | 24.46 | 1.21 | ....... | ....... | ....... | ....... | 5,346 | 9,623 |
| | | | | | | | Dry coal ...... | ...... | 33.86 | 40.67 | 25.47 | 1.26 | ....... | ....... | ....... | ....... | 5,568 | 10,022 |
| | | | | | | | Pure coal ..... | ...... | 45.43 | 54.57 | ....... | 1.69 | ....... | ....... | ....... | ....... | 7,471 | 13,448 |
| Manastash No. 9c tunnel...... | 13268 | NE. | 22 | 18 N. | 15 E. | 4.10 | As received .... | 7.45 | 37.52 | 47.88 | 7.15 | .64 | ....... | ....... | ....... | ....... | 6,701 | 12,062 |
| | | | | | | | Air dried ...... | 3.49 | 39.12 | 49.93 | 7.46 | .67 | ....... | ....... | ....... | ....... | 6,988 | 12,578 |
| | | | | | | | Dry coal ...... | ...... | 40.54 | 51.73 | 7.73 | .69 | ....... | ....... | ....... | ....... | 7,240 | 13,032 |
| | | | | | | | Pure coal ..... | ...... | 43.94 | 56.06 | ....... | .75 | ....... | ....... | ....... | ....... | 7,847 | 14,125 |
| Taneum, Wilson's mine...... | 13269 | NE. | 33 | 19 N. | 16 E. | 3.10 | As received .... | 7.69 | 39.63 | 36.51 | 16.17 | .43 | ....... | ....... | ....... | ....... | 5,547 | 9,985 |
| | | | | | | | Air dried ...... | 4.74 | 40.90 | 37.67 | 16.69 | .44 | ....... | ....... | ....... | ....... | 5,724 | 10,303 |
| | | | | | | | Dry coal ...... | ...... | 42.93 | 39.55 | 17.52 | .47 | ....... | ....... | ....... | ....... | 6,009 | 10,816 |
| | | | | | | | Pure coal ..... | ...... | 52.05 | 47.95 | ....... | .57 | ....... | ....... | ....... | ....... | 7,285 | 13,113 |

# INDEX.

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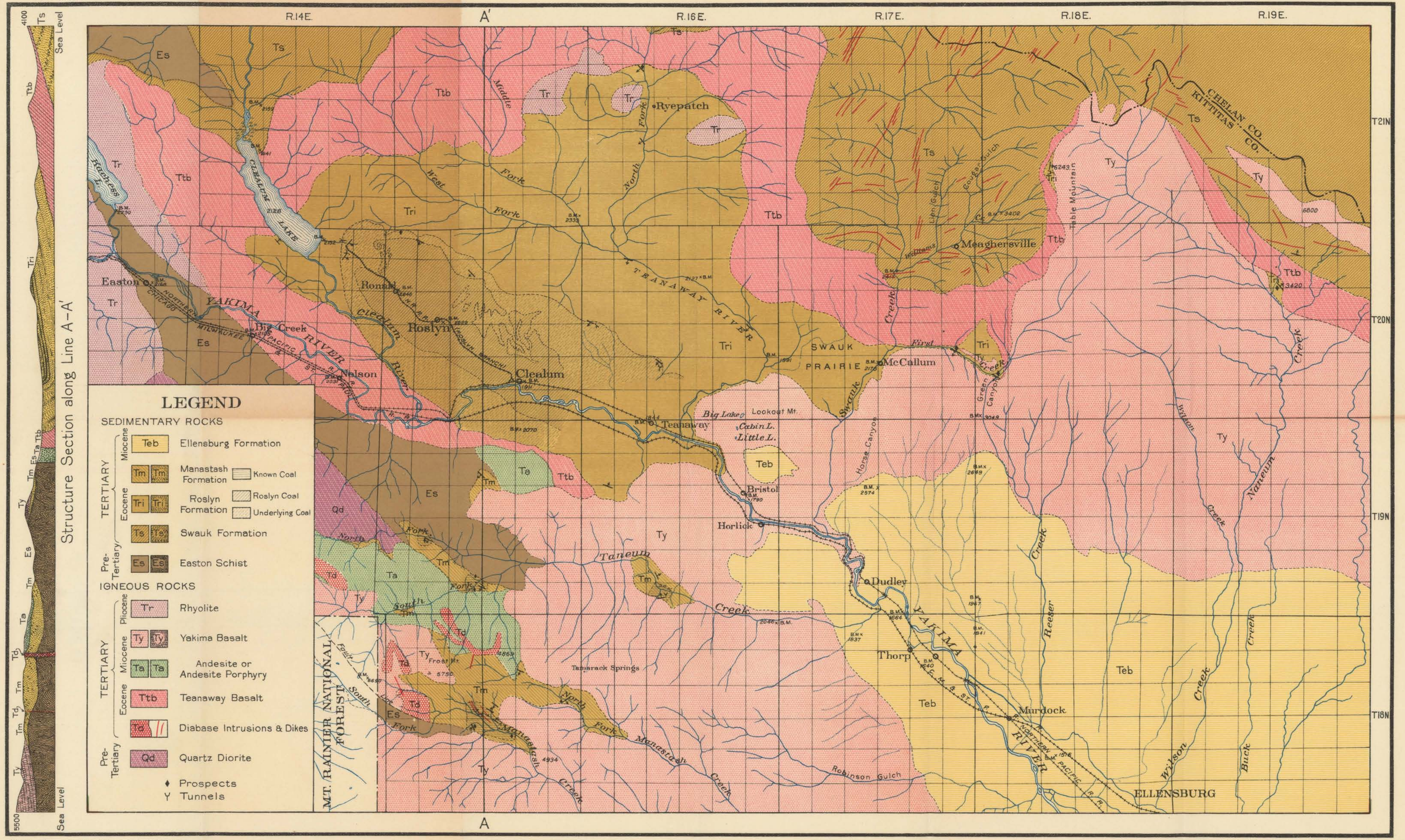
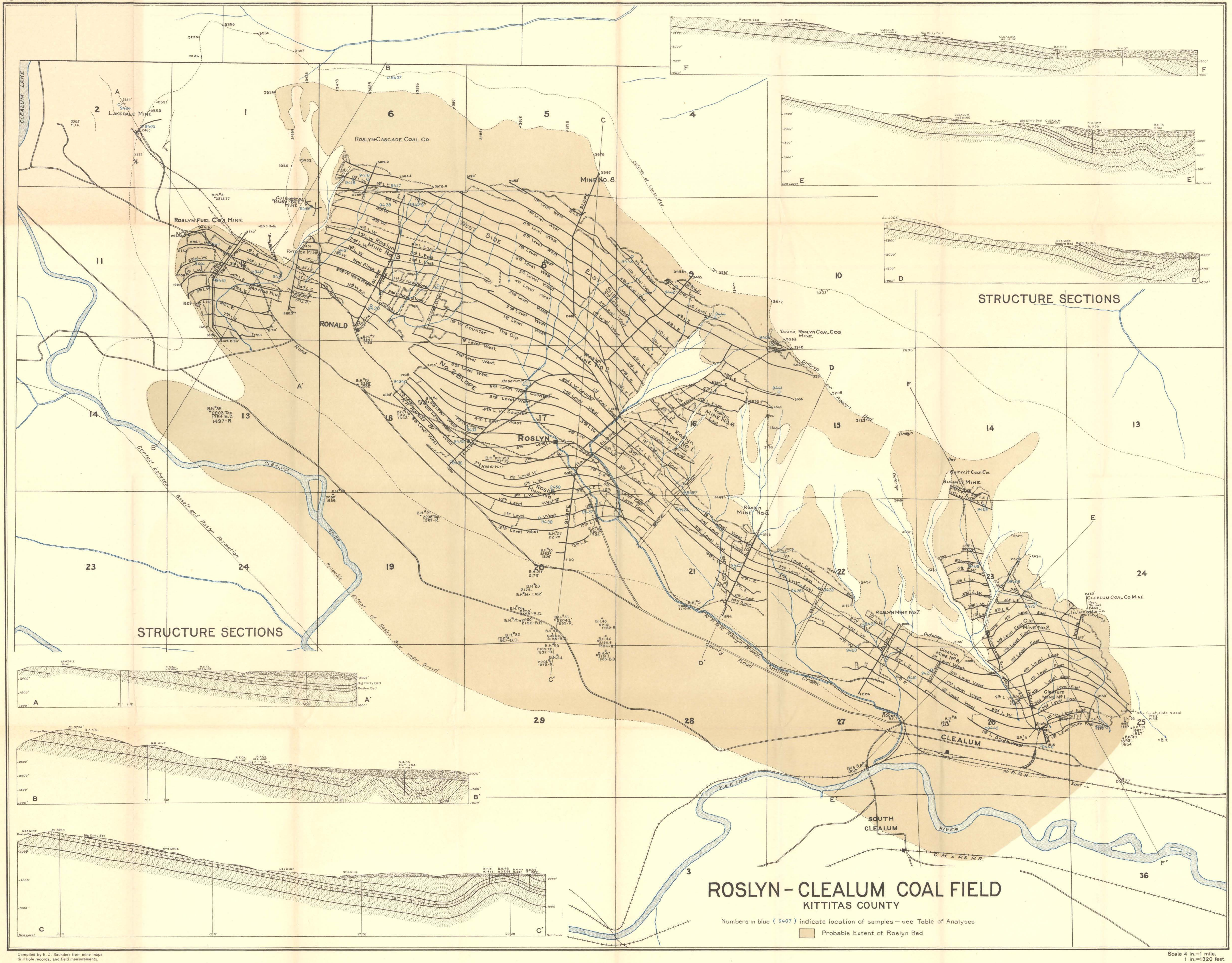



Scale, $\frac{1}{125,000}$, or approximately 2 miles to 1 inch

GEOLOGICAL MAP OF THE COAL AREAS OF KITTITAS COUNTY

Geology by I. C. Russell, George Otis Smith, G. C. Curtis, and W. C. Mendenhall of the U. S. Geological Survey, and by E. J. Saunders of the Washington Geological Survey.




Compiled by E. J. Saunders from mine maps,
drill hole records, and field measurements.

Scale 4 in.=1 mile.
1 in.=1320 feet.