Geology and Coal Deposits in Part of the Coos Bay Coal Field, Oregon

By DONALD C. DUNCAN

A CONTRIBUTION TO ECONOMIC GEOLOGY

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Geological investigations, sample data, and estimated reserves in part of the Coos County coal field

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GEOLOGY AND COAL DEPOSITS IN PART OF THE COOS BAY COAL FIELD, OREGON

By Donald C. Duncan

ABSTRACT

Coal in the Coos Bay field, southwest Oregon, was an important source of fuel along the western seaboard of the United States from about 1855 to the early 1920's when the largest operating mine in the field was closed. In an effort to stimulate production of coal to meet the increased war-induced needs of 1943–45 for the Pacific Northwest a core drilling program and geologic investigation of one of the more promising areas, about 21 square miles, occupying the central part of the Coos Bay coal field, was undertaken by field units of the Geological Survey and Bureau of Mines, cooperating agencies of the U. S. Department of the Interior.

Sedimentary rocks of the Coos Bay Coal field include a series of sandstones and shales of Tertiary age mostly concealed by a mantle of Quaternary terrace deposits, alluvium, or deep soil. The coal beds penetrated by drilling in the central part of the coal field are confined to a sequence of beds about 1,100 feet thick in a sandstone member of the Coaledo formation, of late Eocene age. Attempts at correlating the drilled sequence, about 2,200 feet thick in the report area, with a stratigraphic section of the Coaledo formation, about 5,600 feet thick, exposed about 10 miles to the northwest along the sea cliffs at the mouth of Coos Bay, indicate that the main coal-bearing member of the drilled area may be correlated with either the upper (sandstone) member of the Coaledo or the lower (sandstone) member of the Coaledo in the coast section. These correlations suggest that the upper and lower members of the Coaledo formation in the coast section may be approximately the same stratigraphic unit, which has been duplicated by faulting in the middle (shale) member of the Coaledo.

The Coos Bay Coal field occupies a structural basin about 15 miles wide and 30 miles long, elongate north-south. Tertiary sedimentary rocks in the basin have been deformed into several steep, and almost parallel folds which trend northward. One of these folds, the Beaver Slough syncline, underlies most of the map area of this report and the coal-bearing sequence is exposed mainly along the flanks of the syncline. Northward-trending faults in the northern part of the map area are interpreted to be high-angle thrust faults. Several smaller west-, northwest-, and northeast-trending faults with displacements of less than 100 feet offset the coal beds in the mined areas. These faults and adjacent sheared zones have limited the size of several of the smaller mines and prospects in the area.

The main coal-bearing member of the Coaledo formation in the drilled area is about 500 feet thick. It consists mainly of alternating sandstone, shaly sandstone, and minor shale and contains 7 or 8 coals in most sections. The coal beds range from about 1 foot to 20 feet in thickness. Coal of the area is of sub-bituminous B rank. Heat values of 65 coal samples range from about 5,300 Btu per pound for the impure coals to about 10,000 Btu per pound for the better coals,

on as-received basis. The Beaver Hill coal bed at the base of the main coal-bearing member is the most persistent bed of minable thickness and good quality in the drilled area. The bed ranges from 3.6 to 8.2 feet in thickness and its average heat value on as-received basis ranges from 9,000 to 10,000 Btu per pound.

Coal reserves were estimated for beds 30 inches or more thick, yielding 8,000 Btu or more per pound, and extending to depths as much as 1,500 feet below the surface. Based on spacing and completeness of sample data and reliability of other observations, the reserves are divided into measured, indicated, and inferred categories.

Estimated remaining reserves of coal in the report area, including all categories, aggregate about 63 million tons as of July 1945. Remaining reserves in the Beaver Hill coal bed, underlying 5,355 acres of the map area, total about 56.5 million tons of coal, including 17.2 million tons of measured reserves, 26.6 million tons of indicated reserves, and about 12.6 million tons of inferred reserves. Other coal beds in the area are too thin or of too low grade to be of value except at a few localities. These coal beds contain an estimated 6.2 million tons of measured reserves. Recoverable coal reserves from the report area are believed to be one-fourth to one-half of the estimated remaining reserves.

INTRODUCTION

Coal has been mined from the Coos Bay field, southwest Oregon, at intervals since about 1855, and it was an important source of fuel for railways, coastal shipping, and industrial and domestic heat in Oregon until the early 1920's when the largest operating mine, the Beaver Hill mine, was closed. At about the same time, less expensive fuel oil from California became available, resulting in a curtailed market for coal along the west coast. With a reduced demand for coal, no large-scale coal-mining operations were carried on in the Coos Bay area until 1944, when mining was resumed to meet the war-induced needs for fuel in the Pacific Northwest. An acute shortage of fuel developed in Washington and Oregon during the war period from 1942 to 1945 when many coal mines in western Washington curtailed production or ceased operations for lack of men, and shipments of fuel oil from California were reduced. As a means of stimulating fuel production in the Pacific Northwest a program of mapping and prospecting was begun in 1942 by the Geological Survey and the Bureau of Mines, U. S. Department of the Interior. This program included the investigation of the area in the Coos Bay field herein described. The Bureau of Mines and the Geological Survey cooperated in the work in the Coos Bay field, examining mines and prospects, and core-drilling to obtain samples and learn the extent and depth of the coal beds. This report describes the geologic results of the investigation, and a report by the U. S. Bureau of Mines (Toenges, A. L., and others, 1948) supplies complementary data on the quality and mining possibilities of the coal.

Reports on the geology and coal resources of the Coos Bay quadrangle by Diller (1899, 1901) and Diller and Pishel (1911) supplied the first comprehensive data on the coal resources of the area. More recent reports by the Oregon State Department of Geology and

Mineral Industries and by the U. S. Bureau of Mines have added to knowledge of the coal in the field. The most comprehensive of these is a report by Allen and Baldwin (1944), which supplies a full account of the geology and coal resources of the Coos Bay quadrangle.

The examination carried on by the Oregon State Department of Geology and Mineral Industries during 1943 and 1944 was planned to locate and test near-surface coal deposits and to reappraise the entire coal field. The Oregon State investigation preceded and overlapped that of the Geological Survey and Bureau of Mines, and much helpful information was supplied the Federal agencies by Messrs. Allen and Baldwin prior to publication of their results. Thanks are due also to several local men who supplied information and contributed their efforts as guides to some of the exposures and coal prospects in the area. H. E. Vokes, of the U. S. Geological Survey, identified fossils obtained from the drill cores and supplied opinion on correlation of the faunas.

The investigation by the Geological Survey and the Bureau of Mines was confined largely to an area of 20 square miles near the center of the Coos Bay field between the towns of Coos Bay and Coquille, Oregon (pl. 4). D. A. Andrews, assisted by R. C. Robeck, started the geologic examination in November, 1943. In May, 1944, Andrews and Robeck received other assignments and Duncan was assigned to the Coos Bay project. The field investigation, including the drilling, was completed in June, 1945. A map, originally on a scale of 1 : 31,680, was compiled from aerial photographs. Many of the section corners in the area were located on the photos, and a land net, compiled from Bureau of Land Management and Coos County engineers' records, served as the base. Spot locating of prospects and mine entries was made with reference to the photos; some prospects, especially those in heavily wooded sectors, were difficult to locate accurately; but points in or near clearings, roads, or other identifiable places on the photos were located with greater accuracy. A few prospects, particularly those in the wooded areas, were located by planetable traverse. Many coal prospects were found. Of these, some were opened and a face of coal exposed for examination, measurement, and sampling. Others, particularly those in the thinner and relatively impure beds, were not opened, as the work necessary to prepare adequate exposures of the coal, or to dewater a mine or prospect, would have been more costly than was justified by the value of the information to be obtained.

Drilling began at about the same time that geologic mapping started. Each drill site was selected jointly by the geologist and the engineer. Cores from the drilling were logged in detail by careful inspection at the drill site. Samples of all coal beds and most carbonaceous shale beds were then packaged and sent to the coal-constitution laboratories of the U. S. Bureau of Mines for further examination and analysis. Fossils and rock samples were saved for later study and comparison.

Holes 1–23 and 2–23 were put down to test the continuity of coal at depth in the Southport mine (pl. 4). When it was found that these initial holes were located on the upthrown side of a fault, and that they penetrated rocks below the main coal-bearing member of the Coaledo formation, drilling was moved south to the vicinity of the Delmar, Overland, and Martin mines. Here holes 3–3, 4–9, 5–9, 6–3, and 8–3 were drilled deep enough to penetrate the principal coal bed, the Beaver Hill coal bed, at the base of the main coal-bearing member. Attempts to trace the Beaver Hill coal bed eastward across the narrow, shallower part of the Beaver Slough syncline were unsuccessful, in part due to drilling difficulties caused by soft and friable rocks that sloughed into the drill holes with resulting slow drilling and poor core recovery, and in part due to an initial incorrect correlation of the coal beds eastward. As learned by later drilling, holes 7–10, 9–15, and 10–15 stopped short of the depth necessary to test the Beaver Hill bed. The remainder of the holes, holes 11–10, 12–16, 13–16, 14–3, and 15–3, served to supply information on extent, depth, and quality of the Beaver Hill and overlying coal beds along the west side of the syncline, between the Beaver Hill mine and the Henryville mine (pl. 4).

STRATIGRAPHY

The consolidated rocks underlying the Coos Bay coal field are mostly shale and sandstone of Tertiary age. These rocks are concealed in most places by a mantle of plant debris, deep soil, alluvium, and landslide material of Recent age, or by marine terrace deposits of Pleistocene age. Igneous rocks of early Tertiary (Eocene) age are exposed east of the coal field, and metamorphic rocks of Jurassic and Cretaceous age, which lie below the coal-bearing rocks, are exposed south of the coal field.

The Tertiary sedimentary rocks of the Coos Bay field were first subdivided into the Empire beds of upper Tertiary age and Arago beds of lower Tertiary age by Diller (1896, pp. 458–462, 475), who later assigned the rocks to the Empire formation and the Arago formation (1899, pp. 319, 320). In the later report Diller proposed that the Arago formation be subdivided into (1) a main coal bearing unit, mostly of fresh or brackish water origin, which he designated the Coaledo formation for its exposures in the vicinity of the town of Coaledo, and (2) a predominantly marine facies exposed west and south of the Coaledo formation. The second unit, characterized by dark shales and absence of thick coal beds, he designated the Pulaski formation, a name that had been used elsewhere (Wilmarth, 1938, pp. 1743, 1744) and is therefore invalid according to rules of stratigraphic nomenclature. In more detailed studies of the coal field

Diller and Pishel (1911, pp. 190–228) mapped the rocks of the lower Tertiary of the Coos Bay area as undifferentiated Arago formation. Turner (1938, pp. 27–29) described the sequence of rocks cropping out along the Coos Bay coast and proposed that part of the Eocene section, about 6,000 feet thick, be assigned to the Coaledo formation, which he divided into the lower, middle, and upper members. Several later reports of other authors give additional detailed information on the stratigraphy and fauna of the Coos Bay coast section. Summaries of stratigraphic conclusions of most of these reports are included in the reports by Allen and Baldwin (1944, pp. 8–32) and by Weaver (1945, pp. 31–62). The following subdivisions of the Tertiary rocks of the Coos Bay coast section are essentially those recognized by Allen and Baldwin (1944, pp. 8, 9, 12), who mapped the selected rock units:

Classification of Tertiary formations, Coos Bay coast section, Oregon

Age	Unit		
Pliocene.	Empire sandstone.		
	—Angular unconformity—		
Oligocene.	Tunnel Point sandstone.		
	Bastendorf shale.		
Eocene.	Arago group	Coaledo formation	Upper member.
			Middle member.
			Lower member.
		Umpqua formation.	

Northeast of Coos Bay the Tyee sandstone, which has been included in the Arago group (Wilmarth, 1938, p. 65), is interpreted to underlie the Coaledo formation (Allen and Baldwin, 1944, p. 12, pl. 1).

The rocks in the drilled area are assigned to the Coaledo formation as orginally defined by Diller (1899, p. 320). The section explored by drilling (see pl. 5) is thin as compared to the total thickness of rocks assigned by Turner and by Allen and Baldwin to the Coaledo formation exposed at the mouth of Coos Bay, and the position of the drilled section within the Coos Bay coast section cannot be determined with certainty from data available at present. It appears, however, that the main part of the sequence penetrated by drilling is correlative with either the lower or the upper member of the Coaledo of the coast section, or possibly with both upper and lower members of the Coaledo if the coast section is duplicated by faults. Evidence bearing on the possible stratigraphic positions of the rocks penetrated by drilling is presented in the following paragraphs.

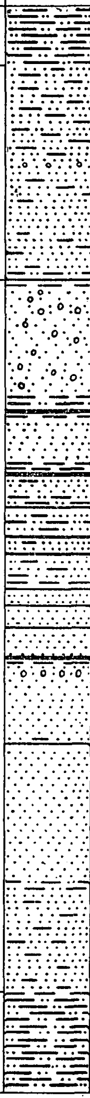
The rocks cropping out through the mantle of soil and alluvium in the map area are sandstone, pebble conglomerate, shale and minor coal. Exposures are scattered within the area of drilling and no continuous surface section was found on which to base a satisfactory correlation of the coal beds or the associated rocks. The rock sections encountered in the drilling, however, supplied enough data to establish a stratigraphic section adequate for the correlation of most beds. This section as interpreted from the drill data is about 2,200 feet thick (fig. 19). At the base is a distinctive dark-gray laminated sandy marine shale unit, 205 feet thick, containing scattered calcareous sandstone nodules. This unit may be the equivalent of either the upper part of the Umpqua formation or the upper part of the middle member of the Coaledo formation of the Coos Bay coast section (pl. 5). Overlying the lower sandy shale unit is a sequence of fine- to coarse-grained sandstone beds interbedded with minor pebble conglomerate, shale, and a few coal beds. This sequence is about 1,875 feet thick and in this report is divided into four members of the Coaledo formation. They are equivalent to either the lower or the upper member of the Coos Bay coast section. Above these members of the Coaledo is a sequence of soft sandy gray shale containing a few beds of calcareous siltstone.

Hole 7–10 penetrated about 120 feet of this upper sandy shale unit. Scattered exposures in road cuts in the vicinity of hole 7–10 indicate that at least 200 feet of similar sandy shale beds overlie the top unit penetrated by the drill. Still younger beds are, no doubt, present in the valleys of Beaver Creek and Isthmus Slough in the vicinity of Green Acres, but these are concealed by alluvium and deep soil. These younger beds may be the equivalent of either the lower part of the middle member of the Coaledo formation, or the lower concealed part of the Bastendorf shale of the Coos Bay coast section (pl. 5).

MEMBERS OF THE COALEDO FORMATION

The sandstone sequence of the Coaledo formation is, for the purpose of this report, subdivided into four members which are, from bottom to top: (1) the lower sandstone member; (2) a main coal-bearing member; (3) a conglomeratic sandstone member; and (4) a shaly sandstone member.

1. The lower sandstone member is about 675 feet thick. It was encountered in several drill holes, but only holes 1–23 and 2–23 passed through its base. The base consists of shaly sandstone, which grades rapidly upward to medium- to coarse-grained sandstone characteristic of the member. A few thin beds of carbonaceous shale, coal, and conglomeratic sandstones are found in the upper 250 feet.



Series	Formation	Member, unit, and main coal beds designated by letters	Thickness in feet	Description of rocks
EOCENE	COALEDO FORMATION OR BASTENDORF SHALE	Upper sandy shale unit	120	Sandy shale with a few thin beds of calcareous siltstone. Marine
	COALEDO FORMATION	Shaly sandstone member	430	Shaly sandstone with interbedded fine to coarse sandstone and minor shale; few conglomeratic sandstone lenses. Member contains few foraminifera and abundant molluscan fossils. Marine. Mollusks include *Nuculana cowlitzensis* (Weaver and Palmer), *Exilia dickersoni* (Weaver), *Acila decisa* (Conrad), *Perse sinuata aragoensis* (Turner), *Cymatium washingtoniana* (Weaver)
		Conglomeratic sandstone member	270	Predominantly pebble conglomerate and interbedded coarse sandstone; thin coal and carbonaceous shale beds at top. Member contains both marine and brackish water molluscan fossils and few foraminifera. Marine mollusks include *Nuculana cowlitzensis* (Weaver and Palmer), *Spicula* sp., *Plagiocardium breweri* (Gabb)
		Main coal-bearing member (J, H, G, F, E, D, C, B)	500	Sandstone and sandy shale with coal and carbonaceous shale beds and a few pebble conglomerate lenses. Member contains all coal beds of economic value in the drilled section. Member contains molluscan fossils and is of brackish water, swamp, and fluviatile origin. Mollusks include *Corbicula* n. sp., "Corbula"? sp., *Potomides* sp. aff. *P. fettkei* (Weaver)
		Beaver Hill coal bed; Thin coal; Lower sandstone member	675	Predominantly sandstone grading downward to shaly sandstone; few thin carbonaceous shale and coal beds in upper part. Member contains few molluscan fossils and is, perhaps, mostly of fluviatile and brackish water origin
	COALEDO FORMATION OR UMPQUA FORMATION	Lower sandy shale unit	205	Predominantly dark-gray shale banded with abundant thin laminae of fine-grained, light-gray sandstone; contains scattered fine-grained, calcareous-sandstone nodules. Unit presumably of marine origin; no fossils observed

FIGURE 19. Generalized columnar section of rocks penetrated by core drilling in Tps. 26 and 27 S., R. 13 W., Coos Bay coal field, Coos county, Oregon.

Some of the sandstone beds near the top are mottled white and gray and are readily distinguished from other sandstones in the drilled section. A few mollusks collected from the upper beds of the member were of brackish water origin and the unit as a whole is interpreted to be mostly of fluviatile and brackish water origin.

2. The main coal-bearing member, about 500 feet thick, makes up the middle part of the Coaledo formation. It consists mostly of fine- to coarse-grained sandstone, with minor lenticular beds of conglomeratic sandstone, gray shale, carbonaceous shale, and as many as nine coal beds. The Beaver Hill coal bed, the thickest and most continuous of these, lies at the base; and coal bed J, the uppermost thick coal, marks the top of the coal-bearing member. The lower 150–200 feet of the main coal-bearing member consists mostly of clean, coarse, indurated sandstone that was easier to penetrate in drilling; whereas the sandstone beds in the upper 300–350 feet are tuffaceous and are soft and poorly sorted. Core samples of these sands deteriorated rapidly on exposure to moisture and air, and this part of the section was very difficult to penetrate with the drills, as the beds continually caved and sloughed to fill the holes. Abundant fossils collected throughout this member are of fresh- and brackish-water origin, and the unit as a whole is thought to have been deposited in rivers, swamps, and estuaries.

3. Overlying the main coal-bearing member is a persistent unit of pebble conglomerate and conglomeratic sandstone about 270 feet thick. Thin beds of carbonaceous shale and thin, shaly coal marks its top. The conglomeratic sandstone member consists mostly of coarse, poorly sorted sandstone containing varying amounts of pebbles, ranging from one-half inch to two inches in diameter. The pebbles are rounded to subangular and consist of sandstone, indurated shale, and, in places, several varieties of fine-textured igneous rock, which are gray, black, red, and green in color. A few thin shale beds in the member contain foraminifera, whereas mollusks collected from the cores are of both marine and brackish water types. The conglomeratic sandstone member is thought to be a shore line deposit representing a transition from brackish-water sediments below to marine sediments above.

4. Above the conglomeratic sandstone member is a sequence of shaly sandstone and shale with a few thin lenticular pebble conglomerate beds. This shaly sandstone member is approximately 430 feet thick as penetrated in hole 7–10. It contains abundant marine mollusks and rare foraminifera and is perhaps entirely a marine deposit.

AGE AND CORRELATION OF ROCKS PENETRATED IN DRILLING

The mollusk fossils from the core samples were examined by H. E. Vokes, who found that they made up two kinds of assemblages—an undescribed brackish-water assemblage from the main coal-bearing member (2) and a described marine assemblage of late Eocene age from the shaly sandstone member (4). (See fig. 19). Both assemblages were also found in the intermediate conglomeratic sandstone member (3).

The brackish-water assemblage from the main coal-bearing member (2) and from some beds in the middle and upper parts of the conglomeratic sandstone member (3) includes undescribed species of *Corbicula*, undescribed species of a "*Corbula*"-like genus, and a species of *Potomides* resembling *P. fettkei* (Weaver). Collections of marine fossils taken from the middle of the conglomeratic sandstone member (3) include *Nuculana cowlitzensis* (Weaver and Palmer), *Spicula* sp., and *Plagiocardium breweri* (Gabb). Diagnostic forms of the marine assemblage from the shaly sandstone member (4) include *Nuculana cowlitzensis* (Weaver and Palmer), *Exilia dickersoni* (Weaver), *Acila decisa* (Conrad), *Perse sinuata aragoensis* (Turner), and *Cymatium washingtoniana* (Weaver). On the basis of his preliminary examination, Vokes indicated that the marine fauna from the shaly sandstone member (4) and from the conglomeratic sandstone member (3) was similar to the faunas found in both the upper and lower members of the Coaledo formation of the Coos Bay coast section, about 10 miles northwest of the drilled area. Therefore, it could not be determined from molluscan fossils whether the assemblage from the drilled section was assignable to the upper member or to the lower member of the Coaledo as exposed along the ocean cliffs.

A comparison of the lithologic features of the sequence penetrated in the drilled area with the thicker sequence exposed in the coast section shows that the rocks in the drilled area are also similar in most general stratigraphic features and many stratigraphic details to rocks in both the upper member and lower member of the Coaledo formation in the coast section. It appears, therefore, that there are two possible correlations of the drilled section with rocks exposed along the sea cliffs at the mouth of Coos Bay, as shown graphically in plate 5. The many similarities in the sandy phases of the upper member of the Coaledo and of the lower member of the Coaledo also suggest the possibility that the coast section may be duplicated by one or more major faults cutting the predominantly shale middle member of the Coaledo formation, and that the upper and lower members are actually merely two exposures of a single unit. If this postulate is correct it may follow that the main coal beds in the Coos Bay field are confined to a single stratigraphic unit about 500 feet thick and do not occur in two or more widely separated stratigraphic units as indicated by the earlier reports on the coal deposits of the area. (See Diller and Pishel, 1911, p. 192; Allen and Baldwin, 1944, pp. 67-138.) According to this interpretation, the total thickness of the Coaledo formation would be much less than 5,600 feet as observed along the coast, and possibly no more than 2,000 to 3,000 feet.

STRUCTURAL FEATURES

The Coos Bay coal field is a structural basin about 15 miles wide and 30 miles long (pl. 4), elongate from north to south. The rocks in the basin have been compressed into several northward-trending, steep, parallel folds, which are the conspicuous structural features of the field. The beds on the flanks of these folds have moderate to steep dips and in a few places are overturned. The Beaver Slough syncline, which occupies most of the map area of plate 4, is one of these northward-trending folds. It is flanked on both east and west by subparallel anticlines. The beds along the flanks of the Beaver Slough syncline within the map area generally have maximum dips of 40 degrees or less.

A northward-trending fault of large displacement is interpreted to offset beds in Beaver Slough syncline north of Green Acres, and a similar fault extending southward from the South Port mine appears to be essentially coextensive with the axis of an anticline. These faults are interpreted to be high-angle thrust faults that coincide roughly with the crests and troughs of the major folds.

Several west-, northwest-, and northeast-trending faults, with displacements of less than 100 feet, offset the coal beds in the area. Such faults have been encountered in most of the mines in the district and, in many of the smaller mines, have been a factor limiting the size of the workings. Other similar faults, which have not been observed at the surface, can be expected in any extensive future mining in the area. Hole 6–3 penetrated a sheared zone from a depth of 165 feet to the bottom at 353 feet. The sheared zone is interpreted to be adjacent to a northwest-trending high angle fault of small displacement. A similar fault or sheared zone with the down-thrown side on the south is interpreted as extending east from a point north of the Delmar mine, passing along a line near but south of steeply dipping beds in the coal prospect at locality 10, plate 4, continuing eastward, and passing south of hole 3–3.

Structure contours drawn at intervals of 500 feet show the general configuration of the top of the Beaver Hill coal bed as interpreted from available outcrop, mine, and drill hole data. The contours are believed to be accurately located along the west flank of the Beaver Slough syncline between the Maxwell mine and the Beaver Hill mine. Contours on the east flank and bottom of the syncline are based on less reliable data, however, and may be less accurately located.

COAL

The coal in the Coos Bay field is of subbituminous B rank. The coal beds range from a few inches to about 20 feet in thickness. Heat values of 65 samples of coal from 9 beds ranged from 5,300 to 10,370 Btu per pound on an as-received basis. The Beaver Hill coal bed, which is the thickest and best bed in the field, ranges from 4 to 8 feet in thickness in most of the sections measured and has an ash content ranging from 5 to 10 percent on an as-received basis. Most of the coals overlying the Beaver Hill bed, however, contain alternating thin layers of clean coal and impure coal or carbonaceous shale, and at only a few localities were they found to be relatively free of conspicuous impure layers through minable thicknesses. The ash content of the beds overlying the Beaver Hill coal bed is generally high, ranging from 10 to 45 percent and averaging nol ess than 15 to 20 percent on an as-received basis for the better samples. In general, the Coos Bay coal beds contain only small amounts of sulphur, the percentages varying from 0.5 to 5.0 and averaging less than 2.0 percent. A more complete description of the physical and chemical properties of the Coos Bay coals is included in the report by Toenges and others (1948, pp. 10–22; 50–56), and a description of some of the plant constituents of the coal is contained in a paper by Schopf (1947, pp. 335–345).

Table 1 shows the heat values, length of sample, thickness of bed, thickness of coal, and depth below the surface for beds more than 1 foot thick penetrated by drilling and exposed in operating mines. The stratigraphic relationships of the coal beds and intervening rocks penetrated in drilling are shown graphically in the columnar sections on plate 6, and detailed features of the individual beds are shown on plate 7. Characteristics of the Beaver Hill bed in most of the open mines and prospects in the area are also shown on plate 7.

TABLE 1.—*Sample data and heat values of coals in parts of the Coos Bay coal field, Coos County, Oreg.*

Coal bed	Sample location (see plates 4, 6, and 7),	Bureau of Mines laboratory No.	Interval sampled in drill holes		Elevation of top of interval sampled—datum is sea level	Length of sample [1]	Amount of sample rejected in making analysis	True thickness of coal beds sampled [2]	True thickness of coal represented by analyzed sample [3]	Heat value of coal Btu per lb.	
			From—	To—						As received	Air dried
	Channel samples		(*Ft. in.*)	(*Ft. in.*)		(*Ft. in.*)	(*Ft. in.*)	(*Ft. in.*)	(*Ft. in.*)		
Beaver Hill	2 Southport Mine.	C-15323	----------	----------	----------	----------	7½	4 3	3 9½	10,100	10,800
Do	3 Big Dipper Mine.	C-17770	----------	----------	----------	----------	1 8½	6 10	5 1½	10,100	11,170
Do	12 Overland Mine.	C-18545	----------	----------	----------	----------	1 8	6 7	4 11	9,690	10,340
Do	13 Martin Mine.	C-23446	----------	----------	----------	----------	8	4 6	3 10	10,050	10,420
	Core samples										
Do	3-3a	C-18249	720 0	728 4	−715.0	6 2	1 2	8 4	6 9	9,500	9,730
Do	4-9a	C-17124	611 7	618 0	−588.3	5 0	7	5 9	5 2	9,500	10,260
Do	5-9a	C-19045	630 8	637 8	−600.1	7 0	1 5	6 2	5 2	9,390	9,710
Do	6-3a	C-19988	229 6	232 0	−227.5	(4)	(4)	2 2	2 2	7,780	9,120
Do	6-3a	C-20469	232 0	233 0	−230.0	(4)	(4)	10	10	6,600	9,580
Do	6-3a	C-20470	235 0	236 0	−233.0	(5)	(5)	10	10	9,810	11,190
Do	8-3a	C-22150	506 3	509 11	−497.8	3 4	11	3 6	2 6	9,400	9,710
Do	8-3a	C-22151	515 2	518 0	−506.2	2 2	0 0	2 8	2 8	9,950	10,230
Do	12-16a	C-34596	1,356 0	1,358 3	−1,249.1	1 2	0 0	2 2	2 2	8,570	9,000
Do	12-16a	C-34597	1,358 9	1,360 9	−1,251.8	1 0	0 0	1 11	1 11	9,340	9,790
Do	13-16a	C-41049	1,018 6	1,020 2	−740.5	1 8	4	1 10	1 7	9,640	----------
Do	13-16a	C-41050	1,020 2	1,027 6	−742.2	5 7	0 0	6 4	6 4	9,820	----------
Do	14- 3a	C-40398	369 2	374 0	−242.2	3 1½	10	4 7	3 9	9,690	9,960
Do	15- 3a	C-42997	340 5	343 8	−269.4	2 10	1½	3 1	2 11	10,370	10,530
Do	15- 3a	C-42996	343 11	345 6	−272.9	11½	0 0	1 6	1 6	8,350	8,480
Bed B	3- 3b	C-18089	663 0	664 0	−657.8	1 0	4	1 9	1 2	8,950	9,390
Do	3- 3b	C-18090	672 0	673 6	−667.0	1 5½	1 1	1 6	5	10,000	----------
Do	6- 3b	C-19987	160 6	162 0	−158.5	1 3½	0 0	1 3	1 3	9,080	9,430
Do	13-16b	C-41048	926 0	927 7	−648.0	1 7	0 0	1 7	1 7	7,430	----------
Do	15- 3b	C-42995	262 0	264 6	−191.0	1 9	2	2 6	2 3	9,220	9,370
Bed C	6- 3c	C-19986	123 0	127 3	−121.0	2 4	1 8½	3 7	11	8,910	9,230
Do	9-15a	C-23329	686 0	690 6	−679.5	3 11½	9	4 1	3 4	5,530	5,690
Bed D	3- 3c	C-17844	590 0	595 2	−585.0	3 11½	2 2½	4 8	2 2	9,200	9,750
Do	4- 9b	C-16999	419 8	424 1	−396.3	2 10	1 7	3 11	1 8	9,060	9,360
Do	6- 3d	C-19807	80 0	82 7	−78.0	2 4	0 0	2 4	2 4	9,750	10,080
Do	6- 3d	C-19808	82 7	84 2	−80.7	1 5	2	1 2	1 2	8,000	8,350
Do	9-15b	C-23328	651 2	653 2	−644.7	1 3	0 0	1 10	1 10	8,360	8,580
Do	10-15b	C-24991	758 0	762 10	−754.0	3 6½	1 5½	4 10	3 0	8,820	9,010
Do	12-16b	C-33337	1,174 6	1,176 6	−1,067.5	1 9	0 0	1 11	1 11	9,600	----------

Do	13–16c	C–40397	814	0	816	6	−536.0	1	10		2	2	4	2	1	8,920	9,280
Do	14– 3b	C–39739	252	0	256	0	−125.0	2	6	0	0	3	9	3	9	8,230	8,520
Do	15– 3c	C–42994	201	10	205	8	−130.8	1	10	0	0	3	8	3	8	8,140	8,340
Bed E	3– 3d	C–17526	520	3	522	3	−515.3	1	10½	1	2	2	0		9	7,850	8,450
Do	4– 9c	C–16918	349	8	351	2	−326.3	1	0		2½	1	4	1	1	8,740	9,410
Do	8– 3c	C–21635	324	4	327	0	−315.8	2	4½		3½	2	6	2	2	8,850	8,980
Do	9–15c	C–23327	598	3	591	4	−583.7	2	1		8½	1	11	1	3	8,712	8,850
Do	10–15c	C–24990	692	0	695	3	−688.0	3	1		7	3	3	2	8	8,760	8,870
Do	12–16c	C–32569	1,107	0	1,109	0	−1,000.0	1	6	0	0	1	11	1	11	9,080	9,760
Do	13–16d	C–39741	726	6	729	6	−448.5	2	11	0	0	2	8	2	8	9,270	9,560
Do	15– 3d	C–42993	124	0	127	0	−53.0	1	8	0	0	2	11	2	11	8,820	9,020
Bed F	3– 3e	C–17525	500	0	502	0	−495.0	1	10½	0	5¼	2	0	1	6	8,480	9,120
Do	4– 9d	C–16640	312	6	315	6	−289.1	1	7	0	2½	2	8	2	4	8,370	8,900
Do	8– 3d	C–21634	278	0	280	11	−269.5	2	5¼	0	6	2	9	2	2	9,200	9,360
Do	9–15d	C–23090	531	0	532	8	−524.5	1	5¾	0	1¼	1	6	1	4½	9,240	9,450
Do	10–15d	C–24863	653	4	654	6	−649.3	1	2½	0	½	1	2	1	2	8,920	9,190
Do	11–10d	C–28979	1,056	0	1,057	0	−822.0	1	0	0	0		11		11	9,110	9,940
Do	13–16e	C–39740	707	2	709	6	−429.2	1	10	0	7	2	1	1	5	9,550	9,930
Bed G	10–15c	C–24862	577	8	579	8	−573.7	1	1½	0	5	2	0	1	3	7,860	8,110
Bed H	3– 3f	C–16997	420	4	425	10	−415.3	4	6⅝	1	6⅞	5	6	3	7	8,670	8,960
Do	3– 3f	C–16998	420	4	425	10	−415.3	4	6⅝	0	7⅝	5	6	4	9	8,110	8,440
Do	3– 3f	C–17000	429	6	432	9	−424.5	2	1	1	½	3	3	1	6	7,490	8,580
Do	4– 9f	C–16638	141	2	144	2	−117.8	1	0	0	2	2	9	2	3	9,040	9,740
Do	8– 3e	C–21336	166	10	168	6	−158.3	1	5	0	0	1	7	1	7		
Do	8– 3e	C–21387	168	10	169	10	−160.3		8½	0	0		11		11	8,830	8,990
Do	9–15e	C–23089	375	4	376	4	−368.8		10¼	0	2¼		11		9	8,730	8,990
Do	11–10e	C–27728	934	10	939	3	−700.8	3	10¾	1	4	4	2	2	9	8,490	8,820
Bed J	3– 3g	C–16639	280	0	283	0	−275.0	2	7	0	0	3	0	3	0	6,510	6,700
Do	7–10b	C–22526	878	0	879	6	−858.0	1	2	0	1½	1	6	1	4	7,320	7,550
Do	9–15f	C–22726	268	3	272	4	−261.8	4	1	1	0	3	10	2	11	8,750	9,030
Do	9–15f	C–22780	272	4	275	10	−265.8	3	2	0	0	3	2	3	2	6,860	7,050
Do	10–15f	C–24388	445	9	447	9	−441.7	1	2	0	0	2	0	2	0	7,310	7,500

[1] The length of a core-drill sample may be less than the interval it represents, as soft or friable layers are frequently ground to sludge and washed away. The sample length therefore represents the amount of core recovered from the designated drill interval.
[2] Bed thickness is computed from core-drill log and average dip.
[3] Thickness of coal is computed thickness of coal represented by core-drill sample after shale and other impure parts are discarded.
[4] Coal washings.
[5] Crushed coal.

BEAVER HILL COAL BED

The Beaver Hill coal bed (Newport bed of some reports) is named for its occurrence at an abandoned townsite and mine in Beaver Slough, Sec. 17, T. 27 S., R. 13 W. It has been the most productive coal bed in the field and the unworked portions of it still contain the largest coal reserves. The approximate outcrop of the Beaver Hill coal as determined from mines, prospects, and scattered exposures is shown in plate 4. Bed characteristics are shown graphically in plate 7. The bed generally consists of two main benches—together, 4–5 feet thick—separated by a shaly sandstone parting 6–8 inches thick. A third, top bench of impure coal and shale 8–18 inches thick is normally present, but it is usually left in the roof in mining. The coal in the bed ranges from 3.6 to 8.2 feet in thickness, and yields 9,000–10,000 Btu per pound. The extent of the minable portions of the bed are shown in figure 20.

BED D

Bed D which lies 110–175 feet above the Beaver Hill coal bed, is perhaps the second most important and persistent coal in the area. It ranges from 2.3 to 5.0 feet in thickness, and generally contains about 2 feet of clean coal with a varying amount of dirty coal. On the basis of several core-sample analyses, workable portions of the bed contain coal with heat values of 8,140–9,000 Btu. The bed is somewhat more variable in quality and thickness than the Beaver Hill bed, however, as is shown by sample data in table 1 and coal sections on plate 7. Areas underlain by minable portions of the bed are shown on figure 21.

OTHER COAL BEDS

Of the remaining coal beds penetrated by the drills, only a few were locally thick enough or sufficiently free of ash to be considered workable. Beds E, H, and J appear to be of possible minable thickness and quality at one or more places, but as the beds are variable in thickness and quality, even these deposits may not be workable. Sample data, bed characteristics, and extent of the better portions of beds E, H, and J are shown in table 1, plate 7, and figure 21.

TONNAGE ESTIMATES

Reserves of economically valuable coal in the map area were calculated from drill-hole and outcrop data for the Beaver Hill coal bed, and mostly from drill-hole data alone for the overlying coal beds. As a basis for reserve calculations it was assumed that a bed containing 30 inches or more of coal having a heat value of 8,000 Btu or more per pound on the as-received basis is of possible economic value under existing conditions. It is also assumed that the bed measurement made from the drill hole or outcrop represents the thickness and quality of coal throughout an area half way to the next nearest measured section,

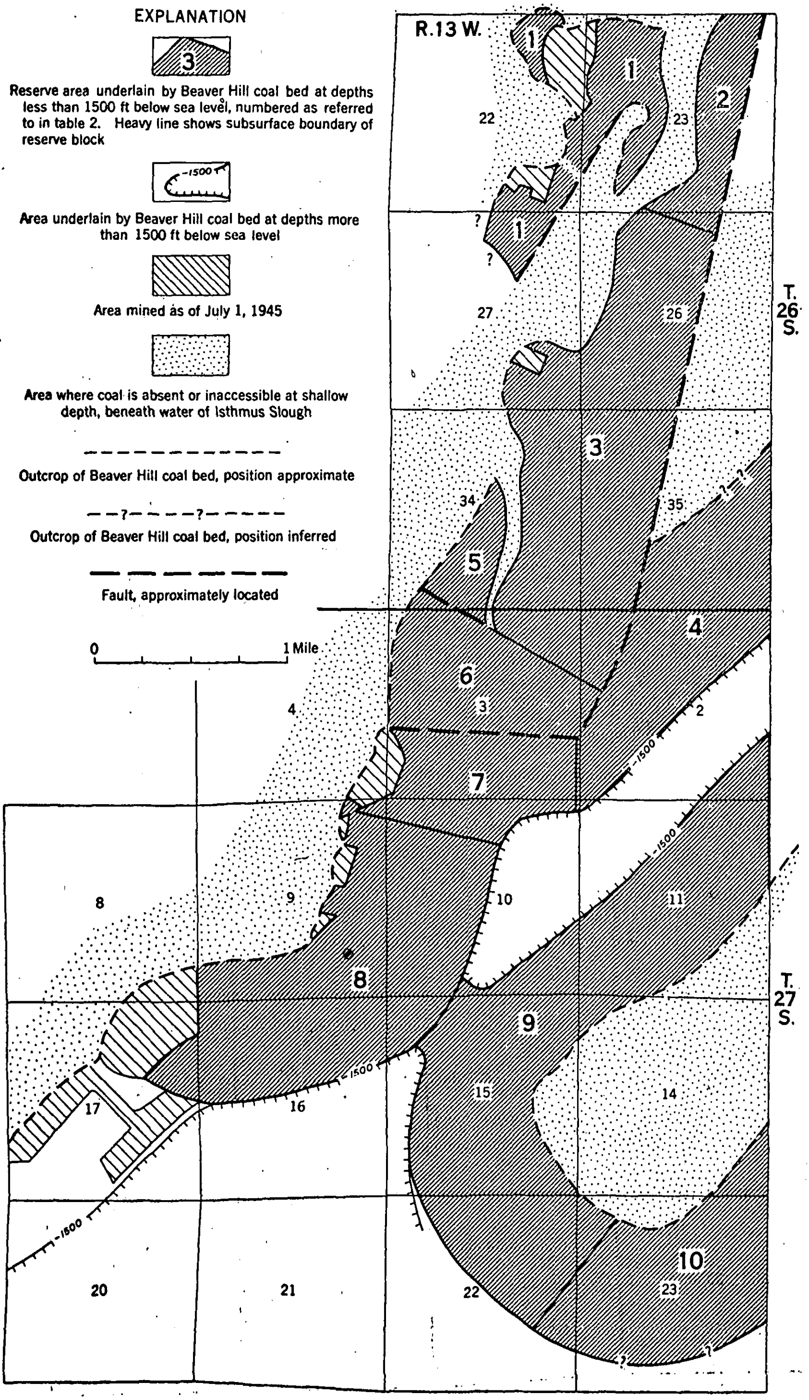


FIGURE 20. Map of part of the Coos Bay coal field, Coos County, Oreg., showing reserve areas underlain by the Beaver Hill coal bed.

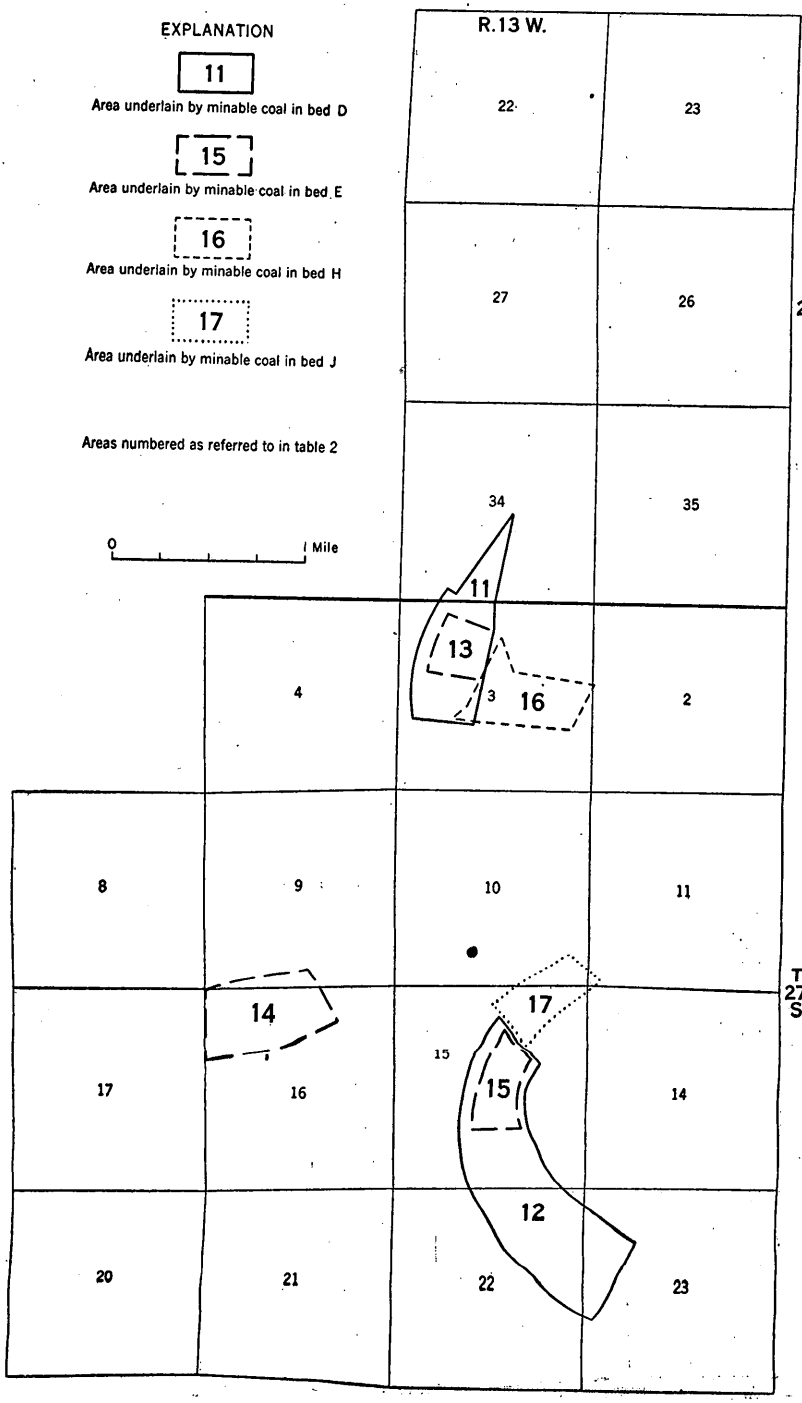


FIGURE 21. Map of part of the Coos Bay coal field, Coos County, Oreg., showing areas underlain by minable portions of coal beds overlying the Beaver Hill coal bed.

or to an approximate distance of one-half a mile from the sample location where no other factors such as thinning, lowering of quality, faults, or thickness of overburden were used to limit a reserve block. Experience has shown that the depth to which the beds can be worked profitably may be unusually limited for those coals overlain or underlain by shale beds; squeezing in of the shale adjacent to coal in the lowest level of the Beaver Hill mine, at a depth of about 1,400 feet, made mining costly in that area. For this reason a limit of 1,500 feet in depth is used in calculating reserves in the Beaver Hill bed. For the relatively impure beds of low heat value that overlie the Beaver Hill coal bed, limits in depth based on thickness and heat value of the coal were established, following methods formerly used in the classification of coal in public lands (Smith and others, 1913, pp. 75, 76). These methods provide a convenient, arbitrary means of limiting the assumed maximum usable depths of these thin, high-ash coals, and they were employed in calculating reserve tonnages in the selected parts of beds D, E, H, and J. The limits of depth used in calculating the reserves in beds D, E, H, and J are given in table 2.

In estimating tonnages the specific gravity of the coal was assumed to be 1.504, the average specific gravity of 15 core samples of the Beaver Hill coal. A cubic foot of coal with a specific gravity of 1.504 weighs 94 pounds; 21.3 cubic feet of such coal weighs 1 short ton; and an acre-foot of such coal weighs approximately 2,050 short tons.

Table 2 shows the estimated tonnage of measured, indicated and inferred coal reserves remaining in the area covered by this report on July 1, 1945, by selected reserve areas. The extent of the selected reserve areas in each bed is shown in figures 20 and 21. According to the estimates in table 2, remaining reserves in the Beaver Hill coal bed total about 56.5 million tons, including 17,245,000 tons of measured reserves, 26,636,000 tons of indicated reserves and 12,611,000 tons of inferred reserves. Measured reserves in coals overlying the Beaver Hill bed total about 6.2 million tons.

The remaining reserves of the Beaver Hill coal bed for areas 1, 5, 6, and 8 (fig. 20) are thought to be minable from the viewpoint of thickness, quality, and accessibility. In reserve area 7, the Beaver Hill bed was tested only by holes 8–3 and 11–10 down dip from the abandoned Delmar mine. The bed in much of this area may not be minable, as the coal encountered in hole 8–3 contained a thick middle parting, and perhaps only the lower bench, 2 feet 8 inches thick, would be extracted by mining in the vicinity of the drill hole. As no core was recovered from the main benches of the Beaver Hill bed in hole 11–10, the quality and exact thickness of coal at this point were not determined. The Beaver Hill bed in reserve areas 3 and 9 were not adequately tested by the drilling program for the potential operator to know the quality of the coal and sufficient detail of

TABLE 2.—*Estimated remaining coal reserves in parts of the Coos Bay coal field, Coos County, Oreg.*

[Reserve areas shown in figures 20 and 21.]

Coal bed	Reserve area	Size of reserve area (acres)	Range in thickness of coal (feet)		Average thickness of coal (feet)	Overburden (feet)		Remaining reserves, July 1, 1945 (in thousands of short tons)			
			From—	To—		From—	To—	Measured	Indicated	Inferred	Total
Beaver Hill	1	290	3.6	5.2	4.3	0	200	2,556			2,556
	2	185			4.0	500	1,000			1,517	1,517
	3	975	4.8	6.1	5.0	0	1,200		9,993		9,993
	4	525			5.0	0	1,500			5,400	5,400
	5	95	5.3		5.3	0	300	1,032			1,032
	6	340	3.9	7.5	5.1	0	1,200	3,555			3,555
	7	290	2.8	4.9	4.1	0	1,500		2,437		2,437
	8	880	4.1	8.2	5.6	0	1,500	10,102			10,102
	9	1,260	5.3	5.7	5.5	0	1,500		14,206		14,206
	10	505			5.5	0	1,000			5,694	5,694
Total								17,245	26,636	12,611	56,492
Bed D	11	175	3.5	3.8	3.6	0	400	1,291			1,291
	12	380	3.0		3.0	0	900	2,337			2,337
Bed E	13	50	2.9		2.9	0	300	297			297
	14	140	2.7		2.7	0	900	775			775
	15	60	2.7		2.7	0	650	332			332
Bed H	16	100	3.6		3.6	0	750	738			738
Bed J	17	80	2.9		2.9	0	750	475			475
Total								6,245			6,245
Grand total								23,490	26,636	12,611	62,737

structure to plan an extensive mine. Knowledge of the coal in these areas is based on only a few observations in abandoned mines and prospects. In order to complete an estimate for reserves of coal in the map area, estimates were made for the amount of coal in the Beaver Hill bed in areas 2, 4, and 10. The bed was not visible at the surface in these areas, however, and the reserves are classed as inferred.

RECOVERABLE RESERVES

The amount of coal recoverable from the reserves considered in this report is difficult to predict, as recovery is dependent on factors beyond the scope of the report. The total amount of coal in the map area greatly exceeds the amount included in the estimate, as low grade coal, thin beds, or deeply buried parts of coal beds are excluded from the estimated reserves. The estimated reserves are therefore restricted to the thicker, better quality, and more accessible coals. The recoverable coal from the parts of the deposits for which estimates were made is, however, much less than the estimated coal reserves remaining in the ground.

Calculation of the amount of coal recovered from the mined areas is limited by the incompleteness of maps and production records. From available detailed maps of 7 mined areas, including the Southport, Big Dipper, Maxwell, Delmar, Overland, Martin, and Beaver Hill mines (Allen and Baldwin, 1944, pp. 19, 21–25), but not including the abandoned Utter mine, it is calculated that 326 acres of the Beaver Hill bed has been mined, which originally contained about 3 million tons of coal. Assuming that about 60 percent of the coal in the 7 areas was produced, it is probable that about 1.8 million tons of coal reached the surface.

For several reasons some of the coal adjacent to the mined areas cannot be recovered. Barrier pillars are normally left to wall off abandoned flooded mines; coal in sheared zones adjacent to faults is normally lost in mining; and coal down dip from the larger workings may be inaccessible. Coal thus lost may locally be as much as half of the original reserve of an area. If small-scale mining were continued intermittently as in the past, or without an integrated program, the amount of coal recoverable from the remaining reserves (table 2) would be small, perhaps as little as 25 percent of the total. If well planned, sustained, and integrated mining is practiced in the area as a whole, as much as 50 percent of the estimated remaining reserves may be recovered. For selected mine areas, recovery as high as 80 percent of the coal in the ground has been estimated by Toenges and others (1948, p. 9), but this figure seems high for the area as a whole, in view of the mining difficulties characteristic of the field.

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