OREGON GEOLOGY

published by the

Oregon Department of Geology and Mineral Industries

VOLUME 43, NUMBER 5

MAY 1981

OREGON GEOLOGY
(ISSN 0164-3304)

VOLUME 43, NUMBER 5 MAY 1981

Published monthly by the State of Oregon Department of Geology and Mineral Industries (Volumes 1 through 40 were entitled *The Ore Bin*).

Main Office: 1005 State Office Building, Portland 97201, phone (503) 229-5580.

Baker Field Office: 2033 First Street, Baker 97814, phone (503) 523-3133.
Howard C. Brooks, Resident Geologist

Grants Pass Field Office: 312 S.E. "H" Street, Grants Pass 97526, phone (503) 476-2496.
Len Ramp, Resident Geologist

Mined Land Reclamation Program: 1129 S.E. Santiam Road, Albany 97321, phone (503) 967-2039.
Paul F. Lawson, Supervisor

Subscription rates: 1 year, $4.00; 3 years, $10.00. Single issues, $.40 at counter, $.75 mailed.
Available back issues of *The Ore Bin*: $.25 at counter, $.50 mailed.

Address subscription orders, renewals, and changes of address to *Oregon Geology*, 1005 State Office Building, Portland, OR 97201.

Send news, notices, meeting announcements, articles for publication, and editorial correspondence to the editor, Portland office. The Department encourages author-initiated peer review for technical articles prior to submission. Any review should be noted in the acknowledgments.

Second class postage paid at Portland, Oregon.
Postmaster: Send address changes to *Oregon Geology*, 1005 State Office Building, Portland, OR 97201.

COVER PHOTO

Gregory Point and Sunset Bay, southwest of Coos Bay on the Oregon coast. Steeply dipping beds belong to the lower member of the Coaledo Formation of late Eocene age. The potential for oil and gas in the Coos Bay area is the subject of a study published recently by the Oregon Department of Geology and Mineral Industries (see article in right-hand column of this page). (Photo courtesy Oregon Highway Division)

Coos Basin oil and gas study completed

Coastal and offshore areas of southwestern Oregon may have potential for the commercial production of oil and gas. This conclusion highlights a comprehensive synthesis and interpretation of a variety of oil exploration-related data just released by the Oregon Department of Geology and Mineral Industries as Oil and Gas Investigation 6: *Prospects for Oil and Gas in the Coos Basin, Western Coos, Douglas, and Lane Counties, Oregon*, by V.C. Newton, Jr.

The 74-page report and accompanying maps are the results of several years of investigation supported in part by local government, private industry, and the Office of Coastal Zone Management through the Department of Land Conservation and Development. Similar reports in the Department's oil and gas investigation series, notably those on the Mist area and on portions of Linn County, preceded recent commercial discoveries in those areas.

Major sections of the report deal with the geology of the Coos Basin and of the continental margin, with plate-tectonic, geochemical, geophysical, petrographic, and paleontological data, partly in analyses of samples and well cuttings.

Lithologic logs and foraminiferal species lists used in the preparation of Oil and Gas Investigation 6 have also been released in the Department's 81-page Open-File Report 0-80-13, *Lithologic Logs of Eleven Wells and Foraminiferal Species Lists of Four Wells in Southwestern Oregon*. The species lists, including paleobathymetric interpretations, were prepared by D.R. McKeel, Consulting Micropaleontologist. The four wells for which foraminiferal studies were made are included among the eleven wells of the lithologic report. Two of the wells are offshore wells.

Price of Oil and Gas Investigation 6 is $9.00; price of 0-80-13 is $4.00. Both may be purchased from the Oregon Department of Geology and Mineral Industries, 1005 State Office Building, Portland, OR 97201. Payment must accompany orders of less than $20. □

Mailed single copies of magazine to cost more

Because postal rates have increased, the price of a mailed single issue of *Oregon Geology* has been raised from $.50 to $.75. The over-the-counter price of a single issue and subscription rates remain the same. □

CONTENTS

Oregon's coal and its economic future

by Michael E. Brownfield, Research Geologist, Oregon Department of Geology and Mineral Industries

INTRODUCTION

Coal has been mined intermittently in Oregon since the 1850's (Figure 1). Most of the coal prospects were opened to provide fuel for local consumption. The Coos Bay field is the only coal-bearing area in Oregon that has had a consistent history of commercial production; its recorded production from 1880 to 1920 was 2.38 million tons (Allen and Baldwin, 1944). Although other areas have produced coal for local consumption, mining operations have been limited because of the limited reserves and the poor quality of the coal. The total commercial production of the State up to the present has amounted to about 3 million tons. At present, there is no commercial production of coal in Oregon.

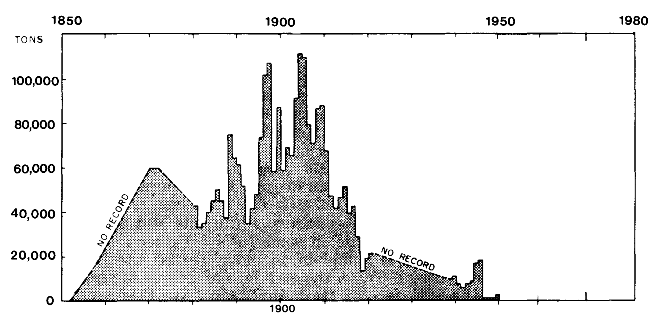


Figure 1. Coal produced in Oregon 1854 to 1980.

There are three important potential coal resource areas in Oregon: the Coos Bay field, central Coos County; the Eden Ridge field, southern Coos County; and the Flora area, northern Wallowa County (Figure 2). Other areas that have produced small tonnages of coal include the Squaw Basin and Eckley fields of southern Coos County, the Rogue River area in Jackson County, the Vernonia area of Columbia County, the Wilhoit area of Clackamas County, the Waldo Hills area of Marion County, and the Shasta Costa area of Curry County. Other Oregon counties in which thin seams of low-grade coal are known to crop out include Tillamook, Lincoln, Yamhill, Douglas, Grant, Morrow, Wheeler, and Wasco Counties.

COOS BAY COAL FIELD

The Coos Bay coal field is located in the west-central part of Coos County. It lies within a roughly elliptical structural basin measuring approximately 35 mi from north to south and 11 mi from east to west. Over 12,000 ft of sediments were deposited in the basin beginning in the early Eocene and ending in the Pleistocene (Figure 3).

About 6,000 ft of upper Eocene coal-bearing sediments of the Coaledo Formation are confined to this complex structural basin. The lower and upper Coaledo members consist of medium-bedded tuffaceous sandstones, separated by the middle Coaledo member consisting of as much as 2,500 ft of dark tuffaceous shale (Allen and Baldwin, 1944; Baldwin, 1966). The following passages are abstracted from Allen and Baldwin (1944) and refer to the coal-bearing members only.

"The coals within the upper member of the Coaledo formation are known as the upper coal group. Of these coals, the Beaver Hill bed is the most prominent. This bed lies at or near the base of the coal group; only one thin bed is known to underlie it in the Newport basin and west of Beaver Hill. Attempts to mine other beds (Henryville, Empire, Gibbs) have in most cases been unsuccessful, the beds being either too thin or too dirty. However, the Riverton or Timon bed which lies several hundred feet above the Beaver Hill has been mined for many years. The upper coal group consists of as many as six or seven coals in a stratigraphic distance of from 600 to 1,000 feet.

"The Beaver Hill bed is characterized by three benches of coal, which are about 6, 20 (top), and 30 (bottom) inches thick, although these vary considerably. The lower bench is generally bony in its lower portion. The roof is usually firm, which is not generally true of other upper coals.

"Toward the southern end of the Beaver Slough basin, the Beaver Hill bed becomes dirty, although it maintains its thickness (Panter, Lyons). Toward the north end of the basin it splits and the benches are widely separated (Englewood, Reservoir)" (p. 67).

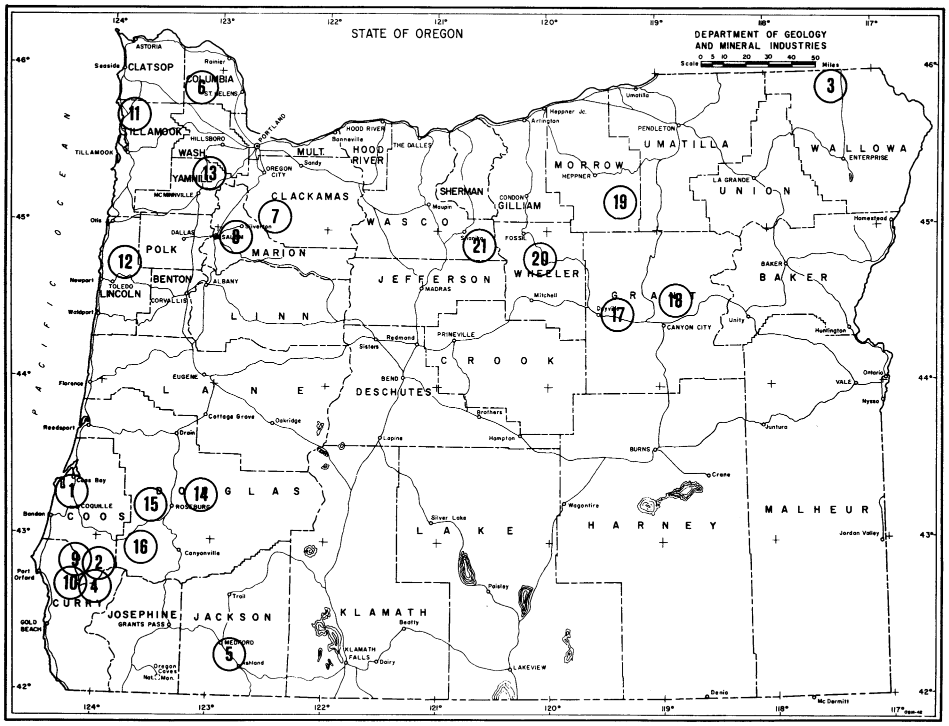
"The coals occurring within the lower Coaledo member are known as the lower coal group and lie stratigraphically far below the Beaver Hill bed of the upper group, being separated by the middle Coaledo shale and much of the lower Coaledo formation. At least seven coals are known, but only a few of these have ever been mined successfully, and these only on a limited scale. Several attempts have been made to mine these coals, especially in the Lampa Creek area. . . .

"The coals of the lower group have numerous and thick shaly partings. . . and a high content of bone. Their B.t.u. content and rank, when a clean sample is analyzed, are usually higher than those of the upper coals. Most of the beds have shaly or otherwise unfavorable roof conditions. The cleavage of these coals is more likely to be platy than blocky" (p. 131).

The coals in the Coos Bay field are of subbituminous rank and have heat values ranging from 9,260 to 10,080 Btu per pound on an "as received" basis. The coals are characterized by a relatively high moisture content, a moderate percentage of ash, and a low sulfur content (Allen and Baldwin, 1944).

The Coaledo and the later Oligocene formations were compressed during the Miocene into several parallel northward-trending folds and faulted by north-trending faults and by numerous transverse faults. Although the displacement of the coal-bearing strata has not been great, the offset produced by this faulting has been the deciding factor on limiting the size of several of the mines. Because of the steepness of the dip, mining operations were forced to considerable depth, where the weight of overlying strata caused the mine floor to heave. These mining problems were contributing factors in the eventual closure of such main producers as the Beaver Hill (Figure 4) and Libby (Figure 5) Mines.

Estimates of coal resources in parts of the Coos Bay field



PRINCIPAL COAL FIELDS IN OREGON

1. Coos Bay
2. Eden Ridge
3. Flora

MINOR COAL LOCALITIES

4. Squaw Basin
5. Rogue River
6. Vernonia
7. Wilhoit
8. Waldo Hills
9. Eckley
10. Shasta Costa
11. Neahkahnie
12. Yaquina
13. Yamhill
14. Cavitt Creek
15. Lookingglass
16. Camas Valley
17. Stewart Ranch
18. Davis Creek
19. Willow Creek
20. Dry Hollow
21. Dry Creek

Figure 2. Coal occurrences in Oregon

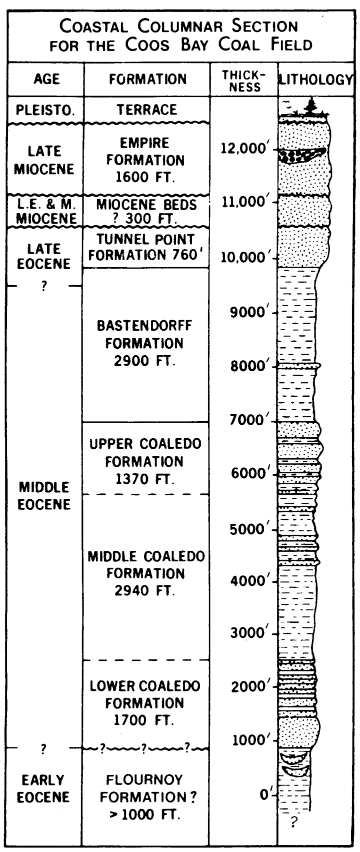


Figure 3. Coastal columnar section from the Coos Bay coal field. (Modified from Armentrout, 1980)

were made by Allen and Baldwin (1944), Duncan (1953), Toenges and others (1948), and Mason and Hughes (1975). Their estimates were based on information from extensive test drilling, outcrops, and studies of mines in the area. Mason and Hughes (1975) estimated the existing coal resources to a depth of 1,500 ft and concluded that the total resources were approximately 119.38 million tons, with about 87 million tons calculated to be in the Beaver Hill bed.

EDEN RIDGE COAL FIELD

The Eden Ridge coal field is located in southern Coos County. The South Fork of the Coquille River cuts through the south end of Eden Ridge, a prominent ridge east of Powers, Oregon. The coal field occupies an area along the divide between the Coos and Rogue Rivers, where the relief is about 3,000 ft.

The Eden Ridge coal field was first investigated by Lesher (1914). Since Lesher's initial report, other investigations by Mason and Erwin (1955), Mason (1956), and Wayland (1964) have been published.

The coal-bearing sediments found in the Eden Ridge coal field are part of the middle Eocene Tyee Formation. In addition to the graded sandstone and carbonaceous siltstone typical of the Tyee Formation to the north, the coal-bearing strata at Eden Ridge also contain conglomerate, flaggy sandstone, and graywacke. In the finer units between the massive sandstones, black shales are common. Siltstones and shales are characterized by abundant plant debris. Carbonized logs and tree stumps in place (Born, 1963), as well as the several known coal beds, indicate a swampy, nonmarine environment. A locally continuous 40-ft-thick conglomerate bed, originally described by Lesher (1914) and named informally the Blue conglomerate, consists of pebbles of altered andesite, quartzite, and slate ranging in size from one-eighth of an inch to 2 in. in diameter. Lesher (1914) mapped coal above the Blue conglomerate in the Eden Ridge field at four horizons. Drilling on

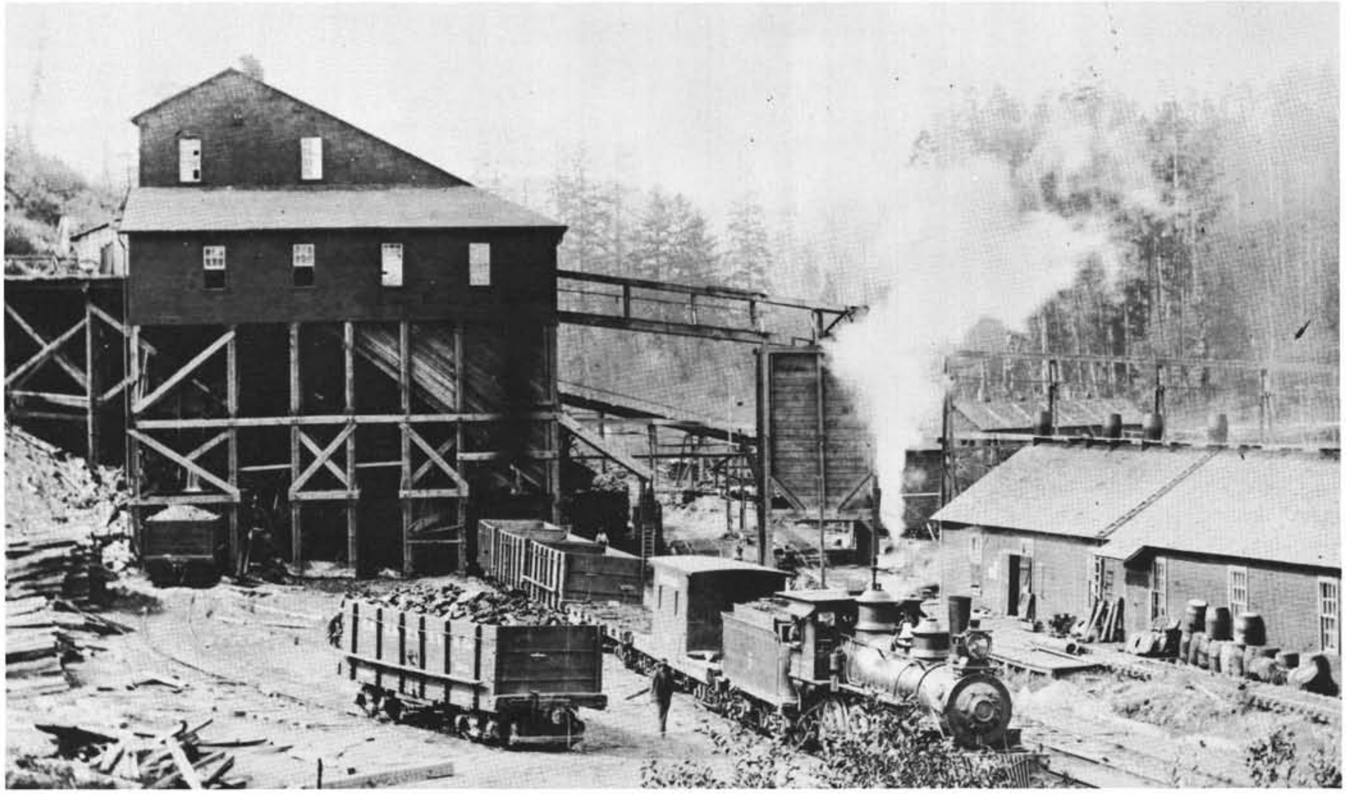
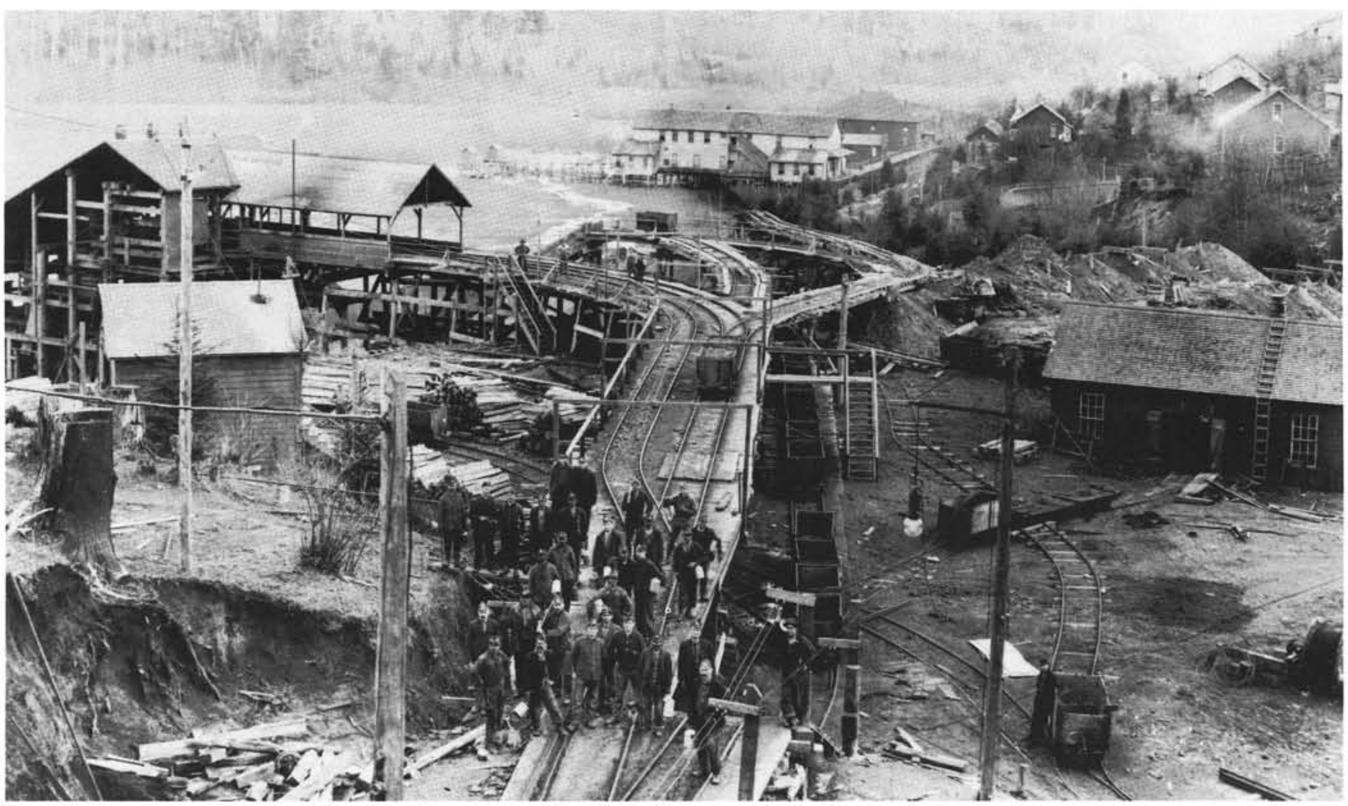


Figure 4a. Beaver Hill coal mine tipple and screening facilities, around 1895. Entrance to mine is at the left edge of photograph. Between 1903 and 1920, at least half of the total production of the Coos Bay field came from this mine, which was owned and operated by the Southern Pacific Company. (Photo courtesy Jack's Photo Service, Coos Bay)

Figure 4b. View from above the Beaver Hill screening facilities and town of Beaver Hill, on Beaver Slough. (Photo courtesy Oregon Historical Society)



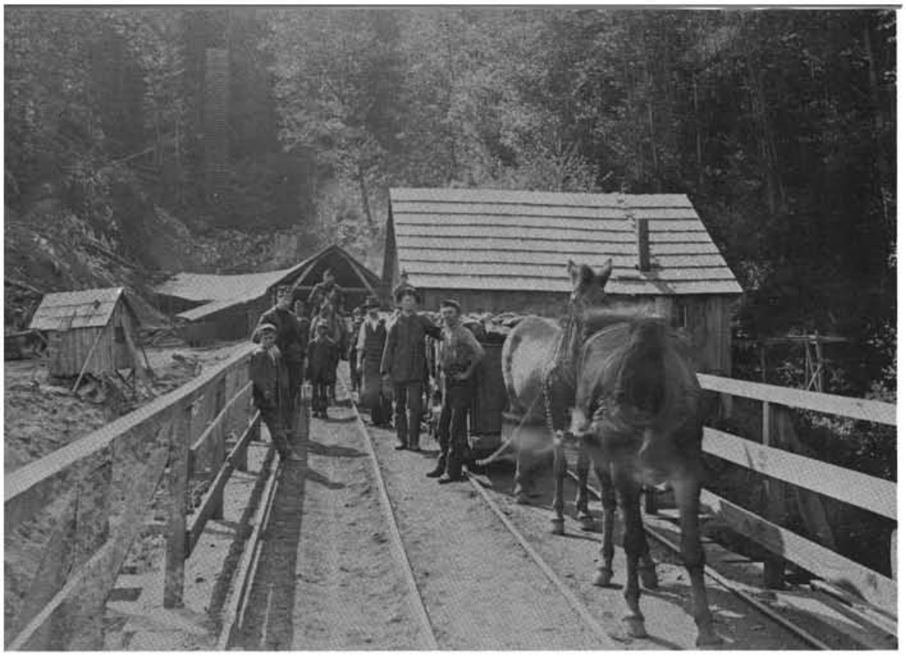


Figure 5a. A group of miners standing in front of the Libby Mine, known originally as the Newport Mine and operated by Goodall, Perkins, and Co. of San Francisco. Note small boys who also worked underground. (Photo courtesy Jack's Photo Service, Coos Bay)

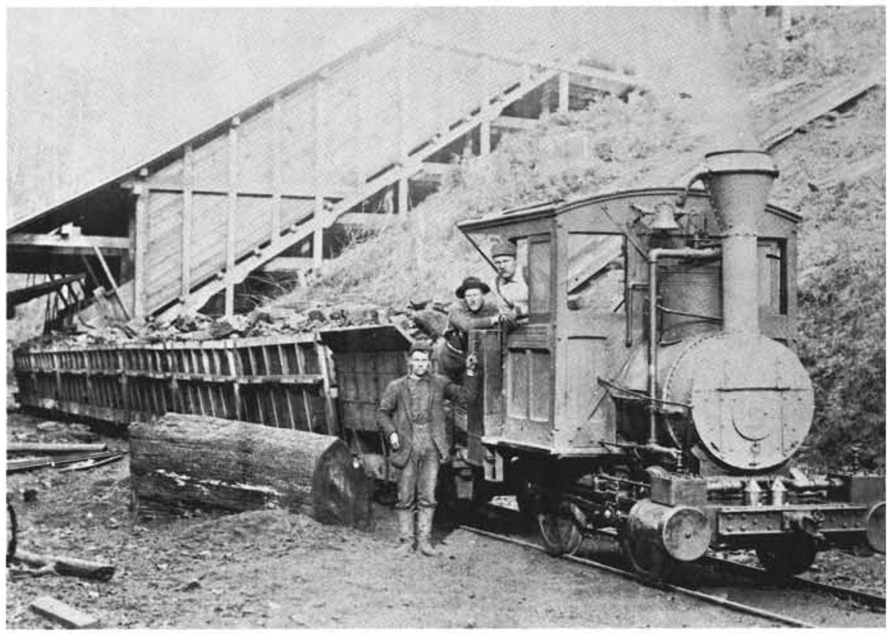


Figure 5b. Screening, storage, and loading facility, located below Libby Mine portal in Boatman Gulch, around 1895. Here coal was loaded into cars and hauled by train to coal bunker on Coalbank Slough. (Photo courtesy Jack's Photo Service, Coos Bay)

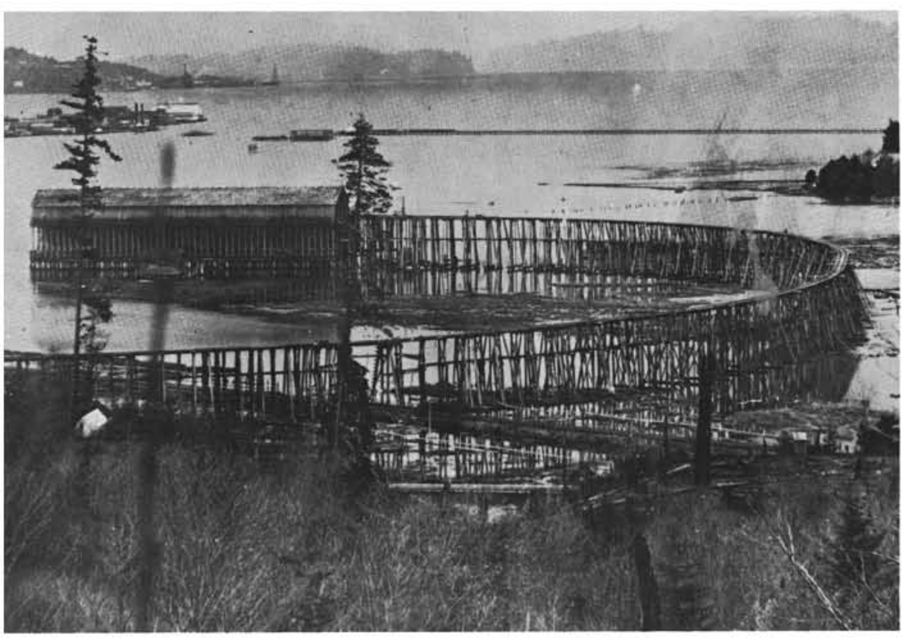


Figure 5c. Libby coal bunker on Coalbank Slough. From facilities such as these, coal was loaded onto ships and transported to the San Francisco Bay area. (Photo courtesy Jack's Photo Service, Coos Bay)

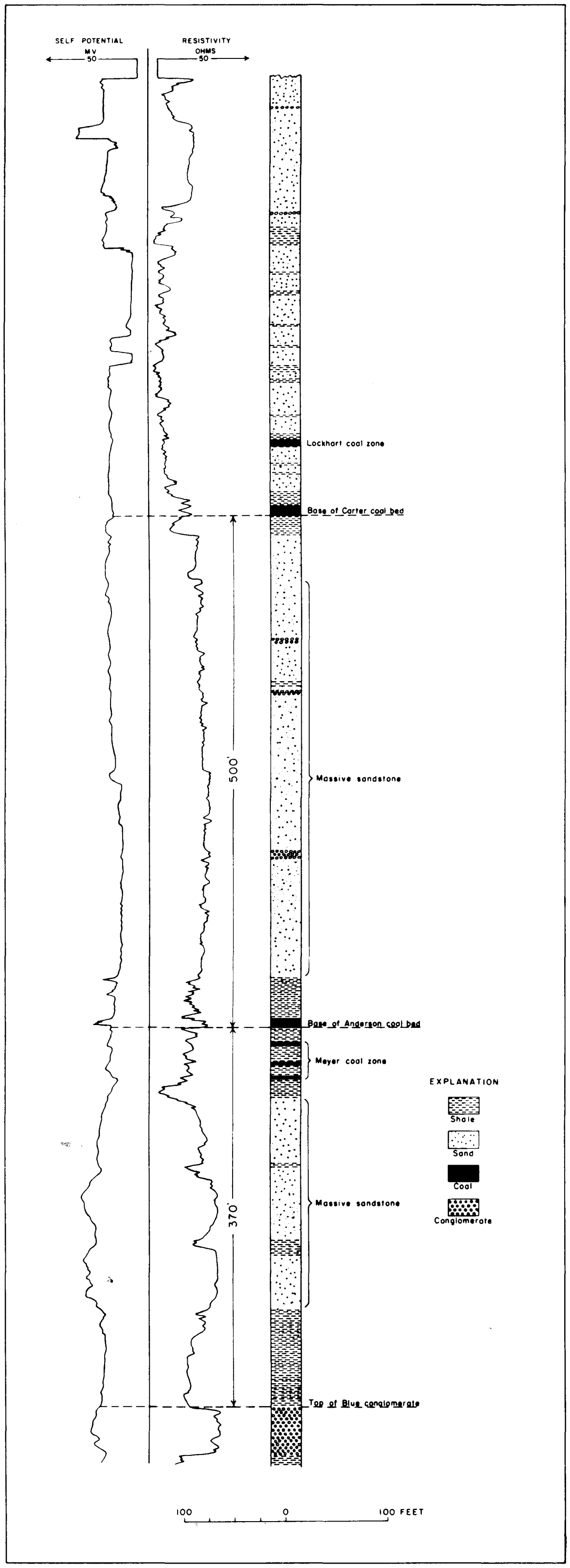


Figure 6. Composite stratigraphic section, upper portion of the Tyee Formation in the Eden Ridge coal field. Data furnished by Pacific Power and Light Company (Russell G. Wayland, 1964)

the ridge by Pacific Power and Light Company has confirmed his observations (1980, written communication). Wayland (1964) published a composite stratigraphic section and electric log (Figure 6) that corresponds well with the section described by Lesher (1914, p. 26). The Meyers coal zone is shown by the drilling to consist of three thin beds within a 50-ft interval below the base of the Anderson bed. The Anderson coal, which is 370 ft above the Blue conglomerate, and the Carter coal, 500 ft above the Anderson bed, are both finely interbedded with shale and impure coal partings. The maximum measured thickness of the Anderson bed is 9 ft, but its average is slightly over 6.5 ft. The Carter bed is more shaly and has an average thickness of 6.1 ft (Pacific Power and Light Company, 1980, written communication). The Lockhart bed, about 70 ft above the Carter bed, is mainly carbonaceous shale and thin layers of coal.

The Eden Ridge coals are subbituminous and lignitic in rank. The average heating value for the Anderson bed is 8,350 Btu per pound on an "as received" basis, and the Carter bed averages considerably less at 6,900 Btu per pound, "as received." The coals are characterized by low moisture, high ash, and low sulfur contents.

Structurally, the Eden Ridge coal field is located on a slightly asymmetrical syncline which forms an elliptical basin (Lesher, 1914). The basin is divided by three major east-west-trending faults with displacements from 80 to 600 ft (Pacific Power and Light Company, 1980, written communication). The synclinal nature of the coal basin suggests extremely wet mining conditions. This possible water problem is shown by the water conditions in old tunnels and by artesian flow from drill holes.

Pacific Power and Light Company has estimated the coal resources in the Eden Ridge field at approximately 50 million tons, with about 70 percent of the total estimated from the Anderson bed and the remainder from the underlying Carter bed (1980, written communication).

FLORA, WALLOWA COUNTY

A possible new extensive coal field has been found in the northeast corner of the State in Wallowa County, near the communities of Flora and Paradise. The region is a semiarid plateau lying at altitudes of 3,000 to 5,000 ft.

The coal-bearing sediments found near Flora are sedimentary interbeds in the Columbia River basalt and consist of thin-bedded tuffs and tuffaceous sediments composed of silicic volcanic detritus and clay minerals (Figure 7). Minor carbonaceous zones, charred logs and limb fragments, and a few interbeds of well-sorted sandstone composed of quartz, feldspar, and mica are also found. The sediments were deposited in lacustrine and fluvial environments during quiescent periods that occurred during late middle Miocene time. This sequence of continental interbeds has been named the Grouse Creek interbed by Ross (1978) for outcrops west of Troy, Oregon. Walker (1979) also mapped a sequence of sedimentary interbeds between flows in the upper Yakima Basalt Subgroup of the Columbia River Basalt Group of Swanson and others (1979). The Grouse Creek (?) sediments overlie the Umatilla flow of Wright and others (1973) and underlie the Buford flow of Walker (1973, 1979) in the Flora area.

The Flora coal is lignitic in rank and has a heating value of 7,900 Btu per pound, "as received" (Stoffel, 1981, oral communication). The lignitic coal bed is reported to have a thickness of 20 ft or more. Keith Stoffel, Washington Department of Natural Resources, reports that north of Troy, Oregon, in the State of Washington, there is a 40-ft-thick lignitic coal seam with a heating value ranging from 5,000 to

8,000 Btu per pound, "as received."

The coal-bearing sedimentary interbeds at Flora are related to a regional subsidence of the Columbia Plateau that started with the eruption of the Grande Ronde Basalt flows (14.0-16.5 million years ago) of the Columbia River Basalt Group and continued through the eruption of the Wanapum and Saddle Mountains Basalt flows, also of the Columbia River Basalt Group. Starting in early Saddle Mountains Basalt time (13.5 million years ago), quiescent periods occurred during which the sediments accumulated. Continuing deformation of the area resulted in the eruption of the overlying flows (approximately 10.5 million years ago). Most of the faulting and uplift of the Blue Mountains occurred after the end of volcanism in the area.

Because of the lack of surface and subsurface data, the coal resources for the Flora area cannot be estimated at the present time.

FACTORS INFLUENCING COAL DEVELOPMENT IN OREGON

Coal beds are mined by either surface or underground methods. Many factors enter into the problem of determining whether a coal prospect may be developed into a mine. Physical factors, mine development costs, and environmental factors all contribute to the minability and marketability of the coal deposit.

Several physical factors contribute directly to the development of the mine plan and influence the type of preparation facilities, the mine size and life, the type of transportation system, and the marketability of the coal. These factors include the character of the coal, thickness of the coal, number and thickness of partings of either clay or bony material, attitude or dip of the coal, the type and amount of faulting, the competency of the roof and floor rock, the amount of water and gas encountered, availability of power, and distance and difficulty of transportation to the nearest market.

The character of the coal includes information on its rank, friability, slacking characteristics, heat value, coking ability, and other analytical data. The rank of a coal seam describes the stage of carbonification or coalification attained by a given coal during diagenesis and metamorphism and is the basis for a classification series from lignite to anthracite. Friability, as applied to coal, is the tendency of a coal to break down in size during storage and handling while being mined or transported. Slacking is the degradation of coals during exposure to the weather, particularly when alternately wetted and dried or subjected to hot sunshine. The heat value of a coal is its caloric value expressed in British thermal units per pound (Btu per pound). The ability of a bituminous coal to form coke is its ability to fuse and form porous masses of carbon and ash which burn very slowly and create intense heat. Coke is commonly formed artificially, but natural coke is known, for example, where an igneous dike has intersected a bituminous coal seam and has converted the bordering coal to natural coke. Other important analytical data acquired during testing of a coal seam are the amounts of sulfur, moisture, volatile matter, and fixed carbon.

In underground mining, the thickness of a coal seam determines the kind of mining equipment that can be used. Thin seams require additional expense for brushing out the roof or floor of an underground mine to allow access for equipment and miners. Special, expensive equipment has been developed for underground mining of thin, flat-lying seams of coal in the eastern United States. Thick seams may require benching and costly extra support for the roof.

The occurrence of numerous partings in a coal seam raises production costs, as larger tonnages must be mined to produce a ton of finished product. Clay and bony coal partings must be removed by washing and sorting methods before the coal can be transported. Special equipment may be needed to mine the coal seam because partings may damage conventional mining equipment.

The dip of the coal seam is one of the factors that determine the minability of the prospect. In most cases today, coal seams exceeding 15° in dip cannot be mined. Steeply dipping coal beds pose a number of problems compared to flat or gently dipping coal seams. Mining steep coal beds is inefficient due to the greater effort needed to remove the coal from the mine, the effort in pumping out mine water if present, the increased effort and safety problems incurred by miners when working on steeply inclined surfaces, the lack of efficient equipment when compared to flatter slopes, and the need for greater roof and floor support as the mine is developed downdip.

Faulting within a coal prospect will strongly influence the minability of the coal seam. Even though the displacement along faults may not be great, added mining expense can be a factor. Underground mining may require inclines to follow the displaced coal seam, and damage to coal-mining equipment may occur when a fault zone is encountered. Surface-mining expenses increase when the overburden changes because of faulting.

The roof and floor conditions in underground mining have frequently determined the minability of a given coal prospect. The roof rock may require bolting or timbering to prevent caving. The floor may swell, causing added expense to remove the floor rock. Because of poor roof and floor conditions, the size of the rooms must be smaller, thereby reducing the amount of coal that may be removed from the mine.

Drainage of both underground and surface mines is an added potential expense in mining a coal seam. Large amounts of water must be controlled. Water in underground mines must be pumped out; in surface mines, the water must be controlled and prevented from entering streams and rivers.

The amount of gas encountered in underground mines is an obvious safety problem. The gas needs to be ventilated to prevent explosions and bad air.

The availability of power definitely influences the mining of a coal prospect. Without power, none of the underground and surface facilities for mining, processing, and transporting the coal could be used.

The location and type of market greatly influence the development of a coal property. Long-distance transportation of the coal to market is one of the greatest expenses in coal production. The distance to the market and the degree of difficulty in transporting the coal are determining factors in the future of any coal basin. At present, the railroads are the most common means of transporting large quantities of coal to market. The building of new rail routes is expensive and requires the development of large mines and dependable markets to justify the expense.

Modern mining is a highly mechanized and automated operation with large output coupled with large preparation facilities and high-speed transportation systems. A large capital outlay is necessary to achieve operating economies, and small companies cannot afford the capital outlay necessary to compete. A large mine operation is developed for long-term productivity and long-term delivery contracts. The small mine, on the other hand, has difficulty in finding a dependable market because of the relatively small number of tons produced.

There have been many improvements in mining technology over the past few years. Although surface mining has

EXPLANATION OF MAP UNITS

Qtg *TERRACE GRAVELS (PLEISTOCENE)*

Qls *LANDSLIDE DEBRIS (PLEISTOCENE)*

QTl *LOESS (PLEISTOCENE AND PLIOCENE)*

COLUMBIA RIVER BASALT GROUP (MIOCENE)

Tba *Basalt and andesite—Includes the Buford and Wenaha flows of Walker (1973) and part of upper Yakima Basalt of Wright and others (1973)*

Tls *Lacustrine and fluviatile sedimentary rocks—Tuffaceous sediments including lignitic coal beds*

Tbf *Basalt—Includes portions of the lower, middle, and upper Yakima Basalt of Wright and others (1973)*

1:250,000

5 0 5 Miles

NORTH

GEOLOGIC SYMBOLS

—— *CONTACT—Approximately located*

FAULT—Dashed where approximately located (ball and bar on downthrown side)

ANTICLINE

SYNCLINE

Figure 7. Geologic map of Flora and surrounding area, northeastern Oregon. (From Walker, 1979)

received the greatest share of attention, there have been improvements in underground mining as well. For the most part, all of these improvements have been developed for the large, relatively flat, moderately thick, near-surface coal seams which have been subjected to a minimum of faulting or folding. In contrast, few, if any, advances in mining technology have been made for mining thin, steeply dipping seams at depths greater than 1,000 ft.

Mining operations of any kind must be studied as to their effect on the various elements of the environment. Surface mining has the greatest initial effect on the environment and is addressed with sound mined-land reclamation practices. Underground mining has a lesser impact.

Before any large-scale coal-mining operation can be undertaken in Oregon, a significant amount of exploratory drilling, coal-sampling and analysis, and geologic mapping would have to be done to determine definitely the minability and marketability of the particular coal deposit. Environmental concerns dealing with the impact of coal mining would have to be addressed. Additional research and development of new mining technologies and the development of new coal markets at some future time may lead to the development of a commercial coal operation in Oregon.

SELECTED BIBLIOGRAPHY

Allen, J.E., and Baldwin, E.M., 1944, Geology and coal resources of the Coos Bay quadrangle, Oregon: Oregon Department of Geology and Mineral Industries Bulletin 27, 160 p.

Andrews, D.A., Hendricks, T.A., and Huddle, J.W., 1947, Analyses of Arizona, California, Idaho, Nevada, and Oregon coals: U.S. Bureau of Mines Technical Paper 696, p. 9-12, 20-22, 40-47.

Armentrout, J.M., 1980, Cenozoic stratigraphy of Coos Bay and Cape Blanco, southwestern Oregon, *in* Oles, K.F., Johnson, J.G., Niem, A.R., and Niem, W.A. (eds.), Geologic field trips in western Oregon and southwestern Washington: Oregon Department of Geology and Mineral Industries Bulletin 101, p. 175-216.

Baldwin, E.M., 1966, Some revisions of the geology of the Coos Bay area, Oregon: Oregon Department of Geology and Mineral Industries, Ore Bin, v. 28, no. 11, p. 189-203.

Baldwin, E.M., Beaulieu, J.D., Ramp, L., Gray, J.J., Newton, V.C., Jr., and Mason, R.S., 1973, Geology and mineral resources of Coos County, Oregon: Oregon Department of Geology and Mineral Industries Bulletin 80, 82 p.

Born, S.M., 1963, The geology of the southeast third of the Powers quadrangle, Oregon: Eugene, Oreg., University of Oregon master's thesis, 83 p.

Butler, G.M., and Mitchell, G.J., 1916, Preliminary survey of the geology and mineral resources of Curry County, Oregon: Oregon Bureau of Mines and Geology, Mineral Resources of Oregon, v. 2, no. 2, p. 69-71.

Campbell, M.R., 1913, The coal resources of the world: International Geological Congress, Toronto, 12th session, v. 2, p. 538.

Collier, A.J., 1914, The geology and mineral resources of the John Day region: Oregon Bureau of Mines and Geology, Mineral Resources of Oregon, v. 1, no. 3, 47 p.

Diller, J.S., 1895, A geological reconnaissance in northwestern Oregon: U.S. Geological Survey 17th Annual Report, pt. 1, p. 441-520.

——— 1897, The Coos Bay field, Oregon: U.S. Geological Survey 19th Annual Report, pt. 3, p. 309-376.

——— 1898, Roseburg folio, Oregon, folio 49 *of* Geologic Atlas of the United States: U.S. Geological Survey.

——— 1901, Coos Bay folio, Oregon, folio 73 *of* Geologic Atlas of the United States: U.S. Geological Survey.

——— 1903, Port Orford folio, Oregon, folio 89 *of* Geologic Atlas of the United States: U.S. Geological Survey.

——— 1909, The Rogue River valley coal field, Oregon: U.S. Geological Survey Bulletin 341-C, p. 401-405.

——— 1914, Mineral resources of southwestern Oregon: U.S. Geological Survey Bulletin 546, 147 p.

Diller, J.S., and Pishel, M.A., 1911, Preliminary report on the Coos Bay coal field, Oregon: U.S. Geological Survey Bulletin 431-B, p. 190-228.

Diller, J.S., and others, 1915, Guide book of the western United States, part D, The Shasta Route and Coast Line: U.S. Geological Survey Bulletin 614, 142 p.

Duncan, D.C., 1953, Geology and coal deposits in part of the Coos Bay coal field, Oregon: U.S. Geological Survey Bulletin 982-B, p. 53-73.

Goodyear, W.A., 1877, The coal mines of the western coast of the United States: San Francisco, Calif., A.L. Bancraft and Co., 153 p.

Green, S.H., 1949, Industrial coal available to Pacific Northwest industries: Portland, Oreg., Raw Materials Survey Resource Report No. 4, 22 p.

Lesher, C.E., 1914, The Eden Ridge coal field, Coos County, Oregon: U.S. Geological Survey Bulletin 541-I, p. 399-418.

Libbey, F.W., 1938, Progress report on Coos Bay coal field: Oregon Department of Geology and Mineral Industries Bulletin 2, 14 p.

Mason, R.S., 1956, Eden Ridge coal to be investigated: Oregon Department of Geology and Mineral Industries, Ore Bin, v. 18, no. 8, p. 67-69.

——— 1969, Coal, *in* Mineral and water resources of Oregon: Oregon Department of Geology and Mineral Industries Bulletin 64, in cooperation with the U.S. Geological Survey, p. 272-278.

Mason, R.S., and Erwin, M.I., 1955, Coal resources of Oregon: U.S. Geological Survey Circular 362, 7 p.

Mason, R.S., and Hughes, P., 1975, Economic factors affecting the mining, processing, gasification, and marketing of the Coos Bay coals: Oregon Department of Geology and Mineral Industries Open-File Report 0-75-6, 61 p.

Mendenhall, W.C., 1909, A coal prospect on Willow Creek, Morrow County, Oregon: U.S. Geological Survey Bulletin 341-C, p. 406-408.

Newberry, J.S., 1856, Exploration and surveys for a railroad from the Mississippi River to the Pacific Ocean: 33rd U.S. Congress, Second Session, Senate Executive Document 78, v. 6, pt. 2, p. 62-64.

Oregon Department of Geology and Mineral Industries, 1951, Oregon metal mines handbook, northwestern Oregon: Bulletin 14-D, 166 p.

Parks, H.M., and Swartley, A.M., 1916, Handbook of the mining industry of Oregon; alphabetical list of properties; description of mining districts: Oregon Bureau of Mines and Geology, Mineral Resources of Oregon, v. 2, no. 4, 306 p.

Rockwell, C., 1902, The Coos Bay coal fields: Engineering and Mining Journal, v. 73, pt. 1, p. 238-240; pt. 2, p. 270-271.

Rooth, G.H., 1974, Biostratigraphy and paleoecology of the Coaledo and Bastendorff Formations, southwestern Oregon: Corvallis, Oreg., Oregon State University doctoral dissertation, 270 p.

Ross, M.E., 1978, Stratigraphy, structure, and petrology of Columbia River basalt in a portion of the Grande Ronde River-Blue Mountains area of Oregon and Washington: Richland, Wash., Rockwell Hanford Operations, RHO-SA-58 (also University of Idaho doctoral dissertation), 460 p.

Smith, G.O., 1900, The Pacific Coast coal fields: U.S. Geological Survey 22nd Annual Report, pt. 3, p. 473-513.

Stovall, D.H., 1905, Coal mining in Oregon: Mines and Minerals, v. 26, no. 5, p. 203.

Swanson, D.A., Wright, T.L., Hooper, P.R., and Bentley, R.D., 1979, Revisions in stratigraphic nomenclature of the Columbia River Basalt Group: U.S. Geological Survey Bulletin 1457-G, 59 p.

Toenges, A.L., Dowd, J.J., Turnbull, L.A., Schopf, J.M., Cooper, H.M., Abernethy, R.F., Yancey, H.F., and Geer, M.R., 1948, Minable reserves, petrology, chemical characteristics, and washability tests of coal occurring in the Coos Bay coal field, Coos County, Oregon: U.S. Bureau of Mines Technical Paper 707, 56 p.

U.S. Bureau of Mines, 1948, Bituminous coal distribution, calendar year 1946: Mineral Industries Survey, p. 17.

——— 1953, Bituminous coal and lignite in 1952: Mineral Market Summary No. 2222, p. 69.

——— 1944-1951, Minerals yearbooks: eight annual volumes.

U.S. Geological Survey, 1882-1920: Mineral resources of the United States: Annual and biannual volumes.

Vokes, H.E., Snavely, P.D., Jr., and Myers, D.A., 1951, Geology of the southern and southwestern border areas of the Willamette Valley, Oregon: U.S. Geological Survey Oil and Gas Investigations Map OM-110, scale 1:62,500.

Walker, G.W., 1973, Contrasting compositions of youngest Columbia River basalt flows in Union and Wallowa Counties, northeastern Oregon: Geological Society of America Bulletin, v. 84, no. 2, p. 425-429.

——— 1979, Reconnaissance geologic map of the Oregon part of the Grangeville quadrangle, Baker, Union, Umatilla, and Wallowa Counties, Oregon: U.S. Geological Survey Miscellaneous Investigations Map I-1116, scale 1:250,000.

Washburne, C.W., 1914, Reconnaissance of the geology and oil prospects of northwestern Oregon: U.S. Geological Survey Bulletin 590, 111 p.

Wayland, R.G., 1964, The correlation of coal beds in Squaw Basin and part of Eden Ridge, T. 33 S., R. 11 W., W.M., southwestern Oregon: U.S. Geological Survey open-file report, 34 p.

Weaver, C.E., 1937, Tertiary stratigraphy of western Washington and northwestern Oregon: Seattle, Wash., University of Washington Publications in Geology, v. 4, 266 p.

Williams, I.A., 1914, The occurrence of coal in Squaw Creek Basin, Coos County, Oregon: Oregon Bureau of Mines and Geology, Mineral Resources of Oregon, v. 1, no. 1, p. 28-48.

Winchell, A.N., 1914, Petrology and mineral resources of Jackson and Josephine Counties, Oregon: Oregon Bureau of Mines and Geology, Mineral Resources of Oregon, v. 1, no. 5, 265 p.

Wright, T.L., Grolier, M.J., and Swanson, D.A., 1973, Chemical variation related to stratigraphy of the Columbia River basalt: Geological Society of America Bulletin, v. 84, no. 2, p. 371-385.

Yancey, H.F., and Geer, M.R., 1940, Analyses and other properties of Oregon coals as related to their utilization: Oregon Department of Geology and Mineral Industries Bulletin 20, 38 p. □

Abstract of Department paper given at OAS

The following abstract of a paper presented at the Oregon Academy of Science in February 1981 at Portland State University summarizes some of the Oregon Department of Geology and Mineral Industries' current mapping projects in northeastern Oregon.

GEOLOGY AND MINERALIZATION OF THE BOURNE AND MT. IRELAND QUADRANGLES, NORTHEASTERN OREGON, *by M.L. Ferns and H.C. Brooks, Baker Field Office, Oregon Department of Geology and Mineral Industries, 2033 First St., Baker, Oregon 97814.*

DOGAMI geologists are remapping parts of the Elkhorn Mountains of northeastern Oregon. The Bourne and Mt. Ireland quadrangles contain mostly pre-Tertiary rocks of the oceanic terrane of Brooks and Vallier. These rock units include the Elkhorn Ridge Argillite which is comprised of argillite, chert, and tuff; limestone; a metagabbro-metadiorite complex; altered ultramafic rocks; mafic to silicic volcanic rocks; and a melange terrane which contains blocks of all the aforementioned rock types. Fold features and faults generally strike easterly and dip steeply to the south. The Bald Mountain Batholith, mostly granodiorite of Late Jurassic age, intrudes the oceanic terrane. Gold-bearing quartz veins and lodes occur within and peripheral to the batholith. They generally fill high-angle fractures which cross-cut pre-batholith structures. The largest such vein, the North Pole-Columbia lode, is a composite vein comprised of silicified argillite breccia cut by several strands of quartz. The vein averages 25 ft in width and can be traced for over 4½ mi. Total production from the lode is estimated to be in excess of 370,000 oz gold and 360,000 oz silver. □

TRGS to discuss Pacific Northwest geology at September meeting

The Tobacco Root Geological Society (TRGS) will hold its Sixth Annual Field Conference and Technical Session at Idaho State University, Pocatello, Idaho, September 9-12, 1981. Papers on any aspect of northwest geology are invited for the technical session. Please submit GSA-style abstracts to address below by June 30, 1981.

An interesting field trip schedule is being planned. The proposed trips include a phosphate mine tour, Tertiary geology of the Pocatello area, tour of the ISU vertebrate collection, thrust belt field trip, volcanics of the Snake River Basin, and glacial features of the Sawtooth Mountains.

TRGS is a regional society interested in all aspects of northwest geology (Montana, Idaho, Wyoming, Oregon, and Washington). Members receive a subscription to the journal *Northwest Geology*. Send abstracts and requests for more information to Dr. William J. Fritz, Corresponding Secretary, The Tobacco Root Geological Society, Inc., c/o Amoco Production Company, Amoco Building, Denver, Colorado 80202; phone (303) 830-5032. □

ABSTRACTS

The Department maintains a collection of theses and dissertations on Oregon geology. From time to time we will print abstracts of new acquisitions that we feel are of general interest to our readers.

AEROMAGNETIC MEASUREMENTS, MAGNETIC SOURCE DEPTHS, AND THE CURIE POINT ISOTHERM IN THE VALE-OWYHEE, OREGON, GEOTHERMAL AREA, by Francis Michele Boler (M.S., Oregon State University, 1979)

An aeromagnetic survey, conducted in December 1976 and April 1977 by Oregon State University's Geophysics Group in the Vale-Owyhee, Oregon, geothermal area at the Oregon-Idaho border, provides data for analysis which yield a subsurface structural and thermal picture of the area. An overall RMS uncertainty for the survey of only 3.5 gammas resulted from using a magnetic base station to monitor the diurnal magnetic variation for removal from the survey values, and a transponder navigation system which provided horizontal data position determinations accurate to ± 15 m.

Fourier transformation of the two-dimensional aeromagnetic anomaly data provides a frequency domain representation, or spectrum, of the data which is useful for depth-to-source and Curie point isotherm depth calculations. Such source depth calculations show that the magnetic basement level of the crust, where the deepest magnetic sources are located, varies from about 1.5 km below sea level in the southern part of the area, where the terrain averages 1.2 km above sea level, to more than 4.1 km below sea level in the northeast part of the area, where the terrain averages 0.8 km above sea level. The Snake River Downwarp to the east of the area probably plays a role in the deepening of the basement level in the northeast. A prominent N. 40° W. trend in the magnetic anomalies of the northeast part of the area coincides with a major fault interpreted from previous gravity, heat flow, and ERTS photo studies. Some normal movement along this fault with a down-to-the-northeast component is implied by the depth of the magnetic sources in the northeast part of the area.

Basin and Range type tectonics may be related to the uplift of the southern part of the area relative to the north. Normal faults trending in N. 5° W. and N. 50° E. directions, interpreted from low pass filtered aeromagnetic data (retaining only wavelengths longer than 12 km), indicate that Basin and Range structures extend deeper than the uppermost layers of the crust.

A Curie point isotherm depth of 11 ± 3 km below sea level is implied by calculations of the depth to the bottom of sources based on the spectrum of data from the northeast part of the area. Spectra from the remainder of the Vale-Owyhee data do not yield source bottom depths, perhaps because (1) the Curie isotherm depth is too deep to have an influence on the low-frequency part of the spectrum, or (2) extensive basaltic magnetic sources occur nearly everywhere in the area except the northeast and influence the low-frequency part of the spectrum, masking the low-frequency effects of source bottoms. For the Curie point isotherm depth in the northeast part of the area, a temperature close to 580°C (the Curie point of magnetite) is reasonable because it results in thermal gradients of 45°C km^{-1} and surface heat flow values of 90-110 mW m^{-2}, which are consistent with those measured in this area.

Mean source depth calculations show sources within 1 km of sea level occurring throughout the area. With probable thermal gradients greater than 50°C km^{-1} in some areas, economically valuable geothermal waters may be found in basaltic sources at 2 km below the surface.

GEOLOGY AND MINERALIZATION OF THE NORTH SANTIAM MINING DISTRICT, MARION COUNTY, OREGON, by James Peter Olson (M.S., Oregon State University, 1979)

The North Santiam Mining District is located approximately 50 km east of Salem in the Western Cascade Subprovince of Oregon. Although the district has produced only $10,000 in metals and all mines are now presently dormant, the presence of widespread hydrothermal alteration and mineralization of a type associated with many porphyry copper-molybdenum deposits now renders this area above average in exploration significance.

Bedrock in the district consists of flow and pyroclastic volcanics of the Miocene Sardine Formation that have been intruded by dikes and plugs of diorite, quartz diorite, quartz monzodiorite, and granodiorite. The volcanic rocks in the center of the district were domed upward during the emplacement of these intrusions. An alkali-lime index of 60.5 for these plutonic rocks indicates they are representative of a highly calcic calc-alkalic sequence of magmatism. In addition, their distribution on AFM and NKC diagrams is atypical compared with normal calc-alkalic trends. These plutonic rocks are deficient in K_2O and potassium feldspar relative to average rocks of similar modal composition, and they are chemically and mineralogically similar to plutons associated with porphyry-type metallization in island arc environments.

Hydrothermal alteration and mineralization were closely associated in time and space with the emplacement of the youngest intrusions of granodiorite. Metallization consists of a central area of disseminated chalcopyrite and minor bornite that is surrounded by a zoned system of sulfide-bearing veins. The location and orientation of these veins was controlled by pre-existing northwest-trending fault and fracture zones. Chalcopyrite, the dominant sulfide near the center, grades laterally outward into assemblages dominated by pyrite and then by sphalerite and galena. A central zone of potassium silicate alteration is coincident with the area of disseminated mineralization. This zone, in turn, grades laterally outward into alteration zones characterized by phyllic and then propylitic assemblages. At least six tourmaline-bearing breccia pipes, interpreted to have formed by collapse into solution voids, were developed concurrently with mineralization and alteration.

ANALYSIS OF AEROMAGNETIC MEASUREMENTS FROM THE CENTRAL OREGON CASCADES, by Gerald George Connard (M.S., Oregon State University, 1980)

To assist in the assessment of potential geothermal resources, the Geophysics Group at Oregon State University conducted an aeromagnetic survey of the Central Oregon Cascades from 43°00′ to 44°15′N and 121°00′ to 122°30′W. This area includes three major centers of Holocene silicic volcanism and extends from the Basin and Range province in the east to the transition zone between the Western and High Cascades mountain ranges in the west. The aeromagnetic data were obtained using a high-quality transponder navigation system to accurately locate the position of each measurement and a magnetic base station to monitor the diurnal magnetic variation for removal from the survey values. These survey techniques yielded 60,000 data points with an RMS uncertainty of only 4.2 gammas.

Fourier transformation of the two-dimensional aeromagnetic anomaly data provides a frequency domain representation, or spectrum, of the data which is useful for depths-to-source and Curie point isotherm depth calculations. The frequency domain representation also facilitates low-pass filtering of the magnetic anomaly data to enhance regional trends. When wavelengths shorter than 15 km are suppressed, the resulting map shows a number of northwest-southeast trends in the anomalies, particularly in the southeast portion of the area. Suppressing the wavelengths shorter than 25 km reveals a N. 25° E. trend along the eastern side of the High Cascades which is obscured by the northwest-southeast trends prominent in the unfiltered anomaly map.

The magnetic source depth calculations show that the depth of the magnetic basement in the survey area varies from as deep as 6 km below sea level in the northwest portion of the area, where the terrain averages 1.1 km above sea level, to sea level in the southern half of the area, where the terrain averages 1.5 km above sea level.

Only four of nine subdivisions of the study area yield estimates of the lower boundaries of the crustal magnetized layer which relate to the Curie point isotherm depths. Spectra from the other five subdivisions do not produce source bottom depths, possibly because the Curie point isotherm is too deep to have an influence on the low-frequency part of the spectrum, or because sources with large horizontal dimensions may mask the low-frequency effects of source bottoms. The calculations show an elongate zone of elevated Curie point isotherm depths extending from the Crater Lake area to Bend, Oregon, and averaging 9 to 12 km below sea level. Assuming a Curie temperature of 580°C (the Curie point of magnetite), these shallow Curie depths predict temperature gradients greater than 50°C/km and surface heat-flow values greater than 100 mW/m^2. The limited heat-flow data available in the area support these conclusions. □

Book review

by Ralph S. Mason, former State Geologist

The Making of Oregon by Samuel N. and Emily F. Dicken (Oregon Historical Society, 1979, 208 p., paperback $12.95).

Two centuries of Oregon geography are deftly ensnared between the covers of this most informative and handsomely designed book. The Dickens have devoted 30 years of bushwhacking about the State in their search for data and understanding of the ways in which geography has shaped the destiny of the region.

Subtitled "*A Study in Historical Geography*," the volume is much more than a compendium of place names and much-repeated data. Rather, this volume explores and assesses the cultural, ethnic, economic, and industrial impacts on the State and the ways each of them, in turn, was conditioned by the region's geography.

Early on, the authors provide the reader with an overview of the entire State by taking him on an aerial tour of Oregon in which the great diversity of geographic forms is displayed by a stunning series of photographs. Even dyed-in-the-wool Oregonians will enjoy this grand tour which reaches from the coastal scenery through the High Cascades, the vast lava plains of eastern Oregon, the Blue Mountains, the Owyhee Uplands, and the Basin and Range province where flowing streams never reach the sea. This chapter ties it all together and is reason enough to have the volume on your reference shelf.

In addition to the discussion of the attractive geographic features of Oregon, the book also includes a great deal of information on the development of the State, the early-day patterns, and the shifts as social and economic pressures waxed and waned.

Transportation is vital to a region's growth, and the authors devote considerable attention to the influences of seaports, rivers, wagon roads, railroads, and modern highways on the location of growth centers. The justly famous Oregon Trail was only one of many similar routes, or variations of routes, used in the first half of the 1800's by western-moving settlers. Additional roads were opened up in response to, first, the discovery of gold in California, and, soon after, discoveries of the yellow metal in the streams of southwestern and eastern Oregon.

The Columbia, Snake, Willamette, and other rivers at one time resounded to steamboat whistles, and a network of railroads proliferated out into the rapidly developing portions of the State. Numerous historic photographs illustrate these activities as well as many of the other subjects covered in this carefully crafted work.

One can only await with considerable anticipation the appearance of the Dickens' companion volume, "*Oregon Divided, A Regional Geography*," which should be available by the end of June. □

USGS study shows nation's gas resources up, oil steady

A recently completed study by the U.S. Geological Survey (USGS) shows an increase in the mean estimate of the nation's undiscovered natural gas resources, while the mean estimate for oil resources remains the same as the last study in 1975.

USGS Open-File Report 81-192, summarizing the results of a sixteen-month investigation, sets mean estimates for undiscovered recoverable conventional petroleum resources at 594 trillion cu ft of gas and 83 billion barrels of oil. This compares with the mean estimates of the 1975 USGS study of 484 trillion cu ft of gas and 82 billion barrels of oil.

In the 1975 study, the offshore areas were assessed out to 200-m water depth. The 1980 study includes offshore provinces on the U.S. continental slopes out to 2,500 m water depth, thereby increasing the offshore areas assessed for the 1980 study by an additional 400,000 sq mi. The deeper water areas were included in the new assessment because current offshore technology has made these areas more accessible to possible development.

The undiscovered recoverable conventional oil resource estimates are provided again by the USGS at the 95 and 5 percent probability levels and are estimated to range from at least 64 billion barrels on the low side to more than 105 billion barrels of oil on the high side. The undiscovered recoverable conventional gas resources at the 95 and 5 percent probabilities range from at least 475 trillion cu ft to more than 739 trillion cu ft. This compares to the 1975 estimates of at least 50 to more than 127 billion barrels of oil, and a resource estimate for gas of at least 322 to more than 655 trillion cu ft.

Compared to the 1975 estimates, the 1980 USGS estimates show no significant change in the mean estimate for undiscovered oil resources and about a 22 percent increase in the mean estimate for undiscovered gas resources.

New information for some provinces resulted in an increase in the estimates of the regional petroleum potential; in other cases it resulted in a reduction of the resource estimates. For example, drilling in the Rocky Mountain Overthrust Belt of the Western United States has revealed a larger potential for both oil and gas than was projected in the 1975 estimates. This is also true for probable gas potential in the deeper waters offshore for the Atlantic East Coast, the deeper Gulf of Mexico, and the offshore North Slope of Alaska on the Beaufort Sea Shelf. On the other hand, results of exploratory drilling in the Gulf of Alaska, the offshore southern California Borderland, and eastern Gulf of Mexico have been disappointing to date, and geologic information obtained from these provinces indicates a reduced petroleum potential compared to the 1975 studies.

An 18-page report summarizing the results of the revised estimates, entitled "Estimates of Undiscovered Recoverable Resources of Conventionally Producible Oil and Gas in the United States, A Summary," has been released for public purchase and inspection as USGS Open-File Report 81-192. The report includes tables and maps describing the broad regional appraisals.

Copies of the summary report may be purchased from the Open-File Services Section, Branch of Distribution, USGS, P.O. Box 25425, Federal Center, Denver, Colo. 80225. Prices are $2.25 for each paper copy and $3.50 for each microfiche copy. Orders must specify the open-file report identification number and include check or money order payable to the U.S. Geological Survey. □

Gravity and aeromagnetic maps of northern and southern portions of Oregon Cascade Range now available

Geophysical maps of the entire Oregon portion of the Cascade Mountain Range are now available through the Oregon Department of Geology and Mineral Industries (DOGAMI). DOGAMI has just released three sets of such maps in its Geological Map Series: GMS-15 (gravity), covering the northern portion of the Cascades from the Washington state line to about Redmond, and GMS-16 (gravity) and GMS-17 (aeromagnetic), covering the southern portion from about Crater Lake to the California state line. The area in between, the central portion of the Cascade Range, is already covered by maps published by DOGAMI in 1978 as GMS-8 and GMS-9.

Studies of the magnetism and gravity of the earth's crust yield basic information about density, structure, faults, and temperatures, which is used in assessing geothermal potential, mineralization, and basic geology. The new maps are compilations of new and previously existing geophysical data and were prepared by the Geophysics Group of the Oregon State University School of Oceanography.

Titles and prices of the new maps (scale 1:250,000) are listed below. The maps are available at the Oregon Department of Geology and Mineral Industries, 1005 State Office Building, Portland, OR 97201. Payment must accompany orders for less than $20.

GMS-15 (2 maps): *Free-air Gravity Anomaly Map and Complete Bouguer Gravity Anomaly Map, Cascade Mountain Range, Northern Oregon*. Price: $3.00.

GMS-16 (2 maps): *Free-air Gravity Anomaly Map and Complete Bouguer Gravity Anomaly Map, Cascade Mountain Range, Southern Oregon*. Price: $3.00.

GMS-17 (1 map): *Total-field Aeromagnetic Anomaly Map, Cascade Mountain Range, Southern Oregon*. Price: $3.00. □

PUBLICATIONS ORDER	OREGON GEOLOGY
Omission of price indicates publication is in press. Minimum mail order 50¢. All sales are final. Publications are sent postpaid. Payment must accompany orders of less than $20.00. Fill in appropriate blanks and send sheet to Department (see address on reverse side). YOUR NAME ____________ ADDRESS ____________ ____________ Zip ________ Amount enclosed $ ________	____ Renewal ____ Subscription ____ Gift ____ 1 Year ($4.00) ____ 3 Years ($10.00) NAME ____________ ADDRESS ____________ ____________ ZIP ________ (If Gift, From: ____________)

ORDER FORM – CUT ON DASHED LINE

Available publications

MISCELLANEOUS PAPERS	Price	No. Copies	Amount
1. A description of some Oregon rocks and minerals, 1950: Dole	$ 1.00	____	____
5. Oregon's gold placers (reprints), 1954	.50	____	____
8. Available well records of oil and gas exploration in Oregon, rev. 1980: Olmstead and Newton	2.00	____	____
11. Collection of articles on meteorites, 1968 (reprints from *The Ore Bin*)	1.50	____	____
13. Index to *The Ore Bin*, 1950-1974	1.50	____	____
14. Thermal springs and wells, 1970: Bowen and Peterson (with 1975 supplement)	1.50	____	____
15. Quicksilver deposits in Oregon, 1971: Brooks	1.50	____	____
16. Mosaic of Oregon from ERTS-1 imagery, 1973	2.50	____	____
18. Proceedings of Citizens' Forum on potential future sources of energy, 1975	2.00	____	____
19. Geothermal exploration studies in Oregon – 1976, 1977	3.00	____	____
20. Investigations of nickel in Oregon, 1978: Ramp	5.00	____	____
GEOLOGIC MAPS			
Geologic map of Galice quadrangle, Oregon, 1953	1.75	____	____
Geologic map of Albany quadrangle, Oregon, 1953	1.00	____	____
Reconnaissance geologic map of Lebanon quadrangle, 1956	1.50	____	____
Geologic map of Bend quadrangle and portion of High Cascade Mountains, 1957	1.50	____	____
Geologic map of Oregon west of 121st meridian, 1961	2.25	____	____
GMS-3: Preliminary geologic map of Durkee quadrangle, Oregon, 1967	2.00	____	____
GMS-4: Oregon gravity maps, onshore and offshore, 1967 (folded)	3.00	____	____
GMS-5: Geologic map of Powers quadrangle, Oregon, 1971	2.00	____	____
GMS-6: Preliminary report on geology of part of Snake River Canyon, 1974	6.50	____	____
GMS-7: Geology of the Oregon part of the Baker quadrangle, Oregon, 1976	3.00	____	____
GMS-8: Complete Bouguer gravity anomaly map, Cascade Mountain Range, central Oregon, 1978	3.00	____	____
GMS-9: Total field aeromagnetic anomaly map, Cascade Mountain Range, central Oregon, 1978	3.00	____	____
GMS-10: Low- to intermediate-temperature thermal springs and wells in Oregon, 1978	2.50	____	____
GMS-12: Geologic map of the Oregon part of the Mineral quadrangle, 1978	2.00	____	____
GMS-13: Geologic map of the Huntington and part of the Olds Ferry quadrangles, Oregon, 1979	3.00	____	____
GMS-15: Free-air gravity anomaly map and complete Bouguer gravity anomaly map, Cascade Mountain Range, northern Oregon, 1981	3.00	____	____
GMS-16: Free-air gravity anomaly map and complete Bouguer gravity anomaly map, Cascade Mountain Range, southern Oregon, 1981	3.00	____	____
GMS-17: Total-field aeromagnetic anomaly map, Cascade Mountain Range, southern Oregon, 1981	3.00	____	____
OIL AND GAS INVESTIGATIONS			
3. Preliminary identifications of foraminifera, General Petroleum Long Bell #1 well	2.00	____	____
4. Preliminary identifications of foraminifera, E.M. Warren Coos County 1-7 well, 1973	2.00	____	____
5. Prospects for natural gas production or underground storage of pipeline gas, upper Nehalem River Basin, Columbia-Clatsop Counties, Oregon, 1976	5.00	____	____
MISCELLANEOUS PUBLICATIONS			
Landforms of Oregon (17 × 12 inches)	.50	____	____
Mining claims (State laws governing quartz and placer claims)	.50	____	____
Geological highway map, Pacific NW region, Oregon-Washington (published by AAPG)	5.00	____	____
Fifth Gold and Money Session and Gold Technical Session Proceedings, 1975	5.00	____	____
Sixth Gold and Money Session and Gold Technical Session Proceedings, 1978	6.50	____	____
Back issues of *The Ore Bin*	25¢ over the counter; 50¢ mailed	____	____
Colored postcard, *Geology of Oregon*	10¢ each; 3 for 25¢; 7 for 50¢; 15 for 1.00	____	____

Available publications (continued)

BULLETINS	Price	No. Copies	Amount
33. Bibliography (1st supplement) geology and mineral resources of Oregon, 1947: Allen	$ 1.00		
36. Papers on Tertiary foraminifera: Cushman, Stewart and Stewart, 1949: v. 2	1.25		
44. Bibliography (2nd supplement) geology and mineral resources of Oregon, 1953: Steere	2.00		
46. Ferruginous bauxite deposits, Salem Hills, 1956: Corcoran and Libbey	1.25		
49. Lode Mines, Granite mining district, Grant County, Oregon, 1959: Koch	1.00		
53. Bibliography (3rd supplement) geology and mineral resources of Oregon, 1962: Steere and Owen	3.00		
57. Lunar Geological Field Conference guidebook, 1965: Peterson and Groh, editors	3.50		
62. Andesite Conference guidebook, 1968: Dole	3.50		
63. Sixteenth biennial report of the Department, 1966-1968	1.00		
65. Proceedings of the Andesite Conference, 1969: (copies)	10.00		
67. Bibliography (4th supplement) geology and mineral resources of Oregon, 1970: Roberts	3.00		
68. Seventeenth biennial report of the Department, 1968-1970	1.00		
71. Geology of selected lava tubes in Bend area, Oregon, 1971: Greeley	2.50		
76. Eighteenth biennial report of the Department, 1970-1972	1.00		
77. Geologic field trips in northern Oregon and southern Washington, 1973	5.00		
78. Bibliography (5th supplement) geology and mineral resources of Oregon, 1973: Roberts	3.00		
81. Environmental geology of Lincoln County, 1973: Schlicker and others	9.00		
82. Geologic hazards of Bull Run Watershed, Multnomah, Clackamas Counties, 1974: Beaulieu	6.50		
83. Eocene stratigraphy of southwestern Oregon, 1974: Baldwin	4.00		
84. Environmental geology of western Linn County, 1974: Beaulieu and others	9.00		
85. Environmental geology of coastal Lane County, 1974: Schlicker and others	9.00		
86. Nineteenth biennial report of the Department, 1972-1974	1.00		
87. Environmental geology of western Coos and Douglas Counties, 1975	9.00		
88. Geology and mineral resources of upper Chetco River drainage, 1975: Ramp	4.00		
89. Geology and mineral resources of Deschutes County, 1976: Peterson and others	6.50		
90. Land use geology of western Curry County, 1976: Beaulieu	9.00		
91. Geologic hazards of parts of northern Hood River, Wasco, and Sherman Counties, Oregon, 1977: Beaulieu	8.00		
92. Fossils in Oregon (reprinted from *The Ore Bin*), 1977	4.00		
93. Geology, mineral resources, and rock material of Curry County, Oregon, 1977	7.00		
94. Land use geology of central Jackson County, Oregon, 1977: Beaulieu	9.00		
95. North American ophiolites, 1977	7.00		
96. Magma genesis: AGU Chapman Conference on Partial Melting, 1977	12.50		
97. Bibliography (6th supplement) geology and mineral resources of Oregon, 1971-75, 1978	3.00		
98. Geologic hazards of eastern Benton County, 1979: Bela	9.00		
99. Geologic hazards of northwestern Clackamas County, Oregon, 1979: Schlicker and Finlayson	10.00		
100. Geology and mineral resources of Josephine County, Oregon, 1979: Ramp and Peterson	9.00		
101. Geologic field trips in western Oregon and southwestern Washington, 1980	9.00		
SPECIAL PAPERS			
1. Mission, goals, and purposes of Oregon Department of Geology and Mineral Industries, 1978	2.00		
2. Field geology of SW Broken Top quadrangle, Oregon, 1978: Taylor	3.50		
3. Rock material resources of Clackamas, Columbia, Multnomah, and Washington Counties, Oregon, 1978: Gray and others	7.00		
4. Heat flow of Oregon, 1978: Blackwell, Hull, Bowen, and Steele	3.00		
5. Analysis and forecasts of the demand for rock materials in Oregon, 1979: Friedman and others	3.00		
6. Geology of the La Grande area, Oregon, 1980: Barrash and others	5.00		
7. Pluvial Fort Rock Lake, Lake County, Oregon: Allison	4.00		
8. Geology and geochemistry of the Mt. Hood volcano, 1980: White	2.00		
9. Geology of the Breitenbush Hot Springs quadrangle, Oregon, 1980: White	4.00		
10. Tectonic rotation of the Oregon Western Cascades, 1980: Magill and Cox	3.00		
12. Geologic linears of the northern part of the Cascade Range, Oregon, 1980: Venkatakrishnan, Bond, and Kauffman	3.00		
SHORT PAPERS			
18. Radioactive minerals the prospector should know, 1976: White, Schafer, Peterson	.75		
21. Lightweight aggregate industry in Oregon, 1951: Mason	.25		
24. The Almeda Mine, Josephine County, Oregon, 1967: Libbey	3.00		
25. Petrography, type Rattlesnake Formation, central Oregon, 1976: Enlows	2.00		
27. Rock material resources of Benton County, 1978: Schlicker and others	4.00		

OREGON GEOLOGY

1005 State Office Building, Portland, Oregon 97201

Second Class Matter
POSTMASTER: Form 3579 requested