The ORE BIN
Volume 25, No. 1
January, 1963

OREGON'S MINERAL INDUSTRY IN 1962

By

Ralph S. Mason*

Despite severe economic stresses suffered by many segments of the national economy during the year, Oregon's mineral industry maintained its stabilizing role of nearly uniform monthly payrolls in sharp contrast to the largely seasonal agricultural, logging, and tourist industries. Total value of minerals mined in the state will not be known for several months, but preliminary estimates indicate activity during the past year at about the same level as in 1961. A growing awareness of the importance of mineral raw materials to the local economy has resulted in the instituting by several county planning commissions of surveys to identify existing and potential deposits, particularly of sand and gravel, and to take steps toward their protection from urbanization until they can be utilized to their fullest extent. A growing complex of exotic metals producers, fabricators, and research testing facilities further bolstered local and state economies with rock-solid payrolls. The recent discovery in Oregon of large quantities of a mineral which has possible use in absorbing atomic wastes aroused much interest, despite the lack of any markets at present or in the near future.

Metals

Copper

Survey of the state's copper resources was continued by the department, which started the long-term project 3 years ago. Ultra-sensitive geochemical techniques capable of detecting 2 parts of copper per million in surface soils are being employed as an aid in determining possible hidden deposits. Copper contained in base metal ores was the only red metal produced during the year.

Gold and silver

The Oregon King Consolidated Mines, Inc., reopened the Oregon

*Mining Engineer, State of Oregon Dept. Geology & Mineral Industries

King mine in Crook County following publication of a report by the department, marking the first time in many years that any ore has been mined in the state principally for its silver content. The company has been sampling and reconditioning the old workings. Emerald Empire Mines completed 1,450 feet of tunnel near the Musick mine under a contract with the Office of Minerals Exploration. Upon completion of this work, Emerald continued 212 feet farther before ceasing work. Exploration was also conducted underground on the 600 level of the Musick, the 700 of the Helena, and the 900 and 1,200 of the Champion. All of the mines are located in close proximity in the Bohemia Mining District of Lane County. The Buffalo mine in Grant County continued development of its low-level tunnel started 4 years ago. Production of gold in the state reached an all-time low with most of the metal coming from numerous small seasonal placer operations. The accompanying graph shows Oregon gold production during the past 25 years.

Uranium

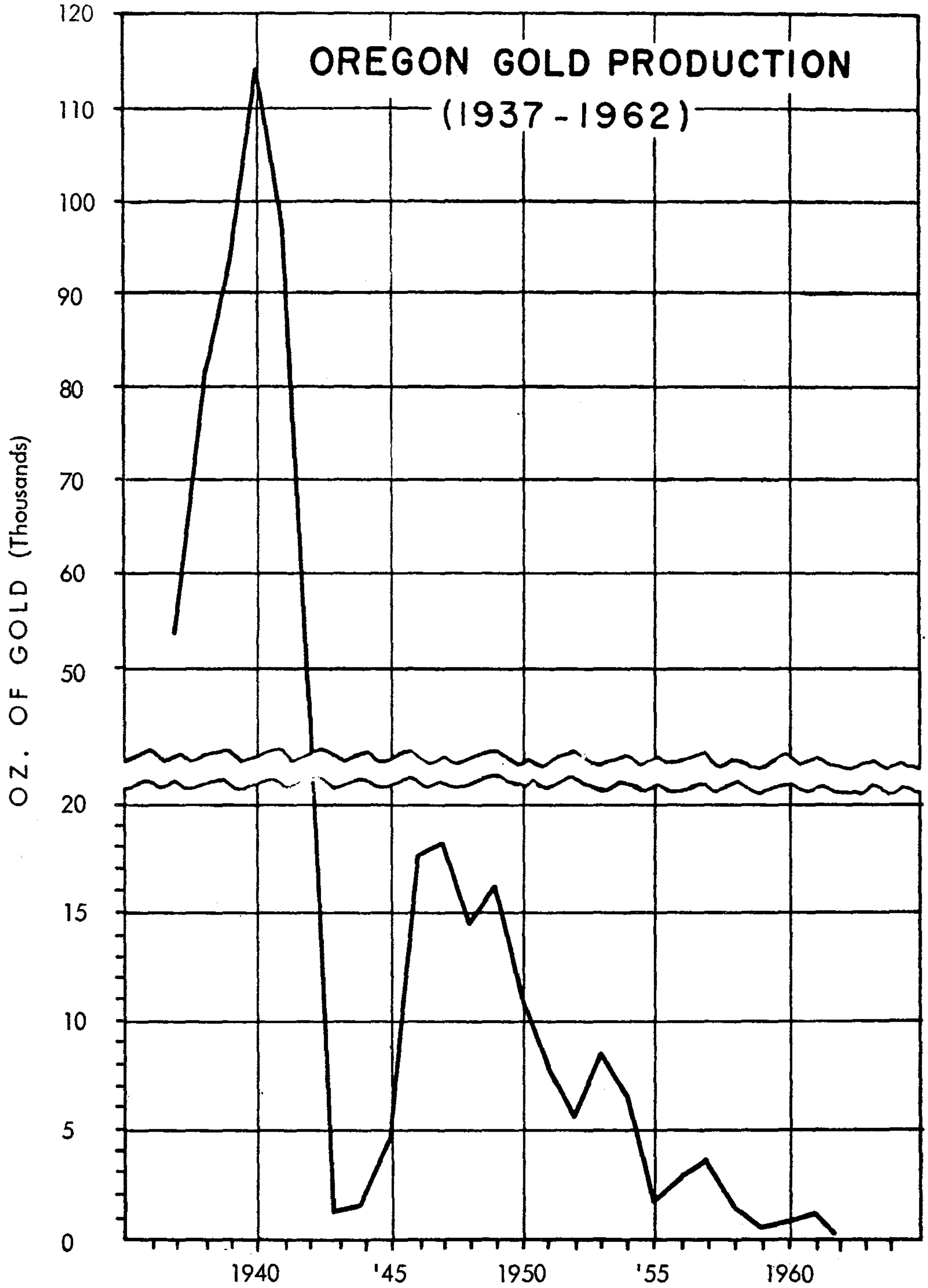
Eight carloads of uranium ore were shipped from the Lucky Lass mine in Lake County by Don Lindsey and associates. The ore came from a development pit being dug to reach some high-grade material located by drilling last year. Shipments went to Vitro Chemical in Salt Lake City. The White King mine, a short distance from the Lucky Lass, was operated by Vance Thornburg, who reopened the old No. 1 shaft and kept the large open pit pumped out. No shipments of ore were made during the year.

Ferruginous bauxite

Exploration of the ferruginous bauxite deposits in northwestern Oregon by a large aluminum company continued during the year. The scale of operations was small, however, and consisted largely of shallow drilling and sampling.

Quicksilver

The only mercury producer in the state was the Angel Peak mine in Lake County, operated by Vance Thornburg, who retorted a few flasks, the second lowest amount produced in the state since 1926. At year's end the department was compiling an extensive report on the state's quicksilver resources. Notice of publication of this bulletin will be announced in The ORE BIN. The Office of Minerals Exploration signed a contract during the year with Pacific Minerals & Chemical Co. to explore the Mother Lode, Cobar, and Lookout Mountain claim groups in Crook County.


OREGON GOLD PRODUCTION
(1937-1962)
OZ. OF GOLD (Thousands)
120
110
100
90
80
70
60
50
20
15
10
5
0
1940
'45
1950
'55
1960

Chromite

The department published an extensive and detailed report, "Chromite in Southwestern Oregon," early in the year. The bulletin contains reports on the numerous mines in this part of the state and discusses the formation of the various types of ore bodies.

Exotic metals

Although constantly changing technologies kept exotic metals producers and fabricators on the jump in 1962, the community of space-age metals specialists continued to develop. In the Albany area, facilities operated by the U.S. Bureau of Mines, Wah Chang Corp., Oregon Metallurgical Corp., and Northwest Industries, Inc., either produced or fabricated a wide range of metals and alloys. Included in the list are molybdenum, tungsten, columbium, tantalum, zirconium, hafnium, and vanadium. In the Beaverton area several research and testing laboratories designed to serve the "new" metals industry have become established recently. It is interesting to note that this entire industry uses not one pound of Oregon-produced ore.

Electroprocess industries

Hanna Nickel Smelting Co. operated its smelter at Riddle continuously throughout the year, treating slightly over one million tons of raw ore from the Hanna Mining Co. openpit mine nearby. The mine and smelter employ 440 men. Total payroll in 1962 was over $3,000,000. In addition, the company purchased nearly $1,300,000 of electrical energy and $1,000,000 worth of local supplies. Hanna's Riddle smelter has the distinction of having the world's largest ferrosilicon furnace. The alloy is used as an intermediate product in the reduction of the nickel ore to ferronickel. The ferronickel contains 53 percent nickel and is sold to some 30 consuming steel companies. Several shipments were made to European customers.

National Metallurgical Corp. continued to produce elemental silicon at its plant at Springfield. High-purity quartz for the process was obtained from Nevada and the Bristol Silica Co. quarry in Jackson County, Oregon. National's parent company, Apex Smelting, merged with American Metals Climax and Kawneer late in the year. Two carbide manufacturers in the Portland area, Electrometallurgical Corp. and Pacific Carbide & Alloys, were in continuous operation during the year. One plant used burnt lime from the Chemical Lime plant near Baker and the other shipped in limestone from Texada Island, British Columbia.

Primary aluminum was produced continuously at the Reynolds Aluminum Co. plant at Troutdale and the Harvey Aluminum plant at The Dalles. Harvey installed automated equipment to handle metal and materials. The plant

Some of Oregon's Minerals at a Glance
Preliminary figures for 1962
(in thousands of dollars)

	1961	1962
Clays	$ 357	$ 315
Gold	37	11
Sand and gravel	13,680	12,318
Stone	21,202	21,000
Misc.*	15,557	16,795
Estimated total	51,730	49,091

*Asbestos, cement, copper, gem stones, lead (1961), iron ore, lime, mercury, nickel, pumice, uranium ore.

produced approximately 80,000 tons of metal during the year.

Industrial Minerals

Pyroprocess Industries

Production of Portland cement continued at the three plants located in the state, but preliminary estimates by the U.S. Bureau of Mines indicate that total volume produced in 1962 will be slightly less than that of the preceding year. First shipment of limestone from Texada Island, B. C., to the Oregon Portland Cement Co. plant at Oswego arrived in a 10,000-ton barge late in the year. Previously OPC used limestone quarried in a company-owned plant located at Lime in Baker County. The new limestone movement will increase Port of Portland's annual tonnage figures by about 500,000 tons. The two barges that will be used are the world's largest deck cargo carriers.

Expanded shale was bloated at both the Smithwick Concrete Products Co. and the Empire Building Materials plants. Both are located in northern Washington County, where large deposits of Keasey shale are readily accessible. Empire supplied expanded shale to Oregon Portland Cement Co. for use as a pozzolan material in the cement for the John Day dam on the Columbia River.

Oregon's oldest manufacturing industry - brick and tile - continued at about the same pace that it has for many years. Twenty plants are operating, most of them in western Oregon.

At its plant in Portland, Supreme Perlite Co. expanded raw perlite imported from out of state. A. M. Matlock opened a perlite deposit 10 miles south of Paisley in Lake County and announced plans to erect a crushing and screening plant at the quarry. The perlite is said to expand to a product weighing less than 6 pounds per cubic foot. Vermiculite-Northwest continued to exfoliate raw material imported from Libby, Montana, at its

Portland plant.

Natural lightweight aggregates

Production of pumice, scoria, and volcanic cinders was at about the same pace as in previous years. Two companies in the Bend area of central Oregon produced carefully sized and blended pumice and cinder aggregate for concrete block and monolithic purposes. Large quantities of cinders and scoria were also used for county and state road construction.

Silica

Two silica producers, Bristol Silica Co. in Jackson County, active for over 25 years, and Silica Product Co. of Roseburg, less than a year old, supplied all of the silica produced in the state in 1962. In addition to metallurgical and petrochemical processing uses, Bristol developed markets for its pure white quartz in ornamental building block, built-up roofs, and similar applications. Silica Product shipped test lots of its Quartz Mountain rock to Hanna Nickel Smelting Co. at Riddle.

Limestone

Big news in limestone circles in Oregon in 1962 came from two sources. Large-scale shipments of stone from Texada Island, British Columbia, to the Oregon Portland Cement plant at Oswego in Clackamas County began in September, apparently ending a trans-state haul by rail from Lime in Baker County which has been going on for many years. Ash Grove Lime & Portland Cement Co. of Kansas City, Missouri, one of the oldest manufacturers of lime in the United States, announced plans to build a multimillion-dollar plant on the outskirts of Portland, construction to start in early 1963. Raw stone for the plant is also to come from Texada. Production of burnt lime by the Chemical Lime Co. of Baker increased over the previous year. Limestone is also burned by Pacific Carbide & Alloys Co. in Portland and by the Amalgamated Sugar Co. at Nyssa in Malheur County.

Building stone

Production of building stone continued in about the same volume and manner as last year. The industry is characterized by numerous small operations and no really large ones. The various volcanic tuffs which abound in many parts of the state form the basis for most of the stone produced.

Sand and gravel

Swings in the general business level of an area are accurately recorded by the cash registers of the state's many sand and gravel producers. No major construction can be accomplished without these products, and the awareness of this fact has resulted in steps being taken by several county planning commissions to protect potentially valuable deposits against inroads of civilization which might render them unusable. In certain communities in the eastern part of the nation a complete program, including identification of deposits, adequate zoning to protect mutually the deposit and the public, programmed exploitation, and eventual conversion to other uses such as parks and housing developments is already in effect.

Asbestos

Coast Asbestos Co. operated a quarry and beneficiation plant a few miles north of Mount Vernon in Grant County. Chrysotile asbestos was rough-finished and shipped to southern California for further processing.

Bentonite

A gray clay from Crook County was mixed with a bright red dye and used to keep northwest forests green during the past year. Central Oregon Bentonite Co. produced bentonitic clay from a quarry in the Camp Creek area which, when mixed with rhodamine dye and added to large quantities of water, produced a slurry used by the Forest Service to "bomb" range and forest fires.

Plans to erect a bentonite processing plant at Bend were announced during the year by Anderson Mining & Development Co., with completion scheduled for the spring of 1963.

Clinoptilolite

A mineral new to industry appeared on the scene during the latter part of the year. Clinoptilolite, a member of the zeolite family occurring in a tuff member in the middle of the John Day Formation, has the ability to capture radioactive Cesium-137 from atomic wastes, but cannot be readily identified, and has no present value or market. A report on clinoptilolite appeared in the December 1962 ORE BIN.

Diatomite

A. M. Matlock of Eugene opened up a large pit of diatomite in Christmas Valley in northern Lake County and will install a processing plant at Silver Lake. Previously the crude ore was trucked to the Willamette Valley for treatment before being sold for poultry litter, sweeping compound, and other uses.

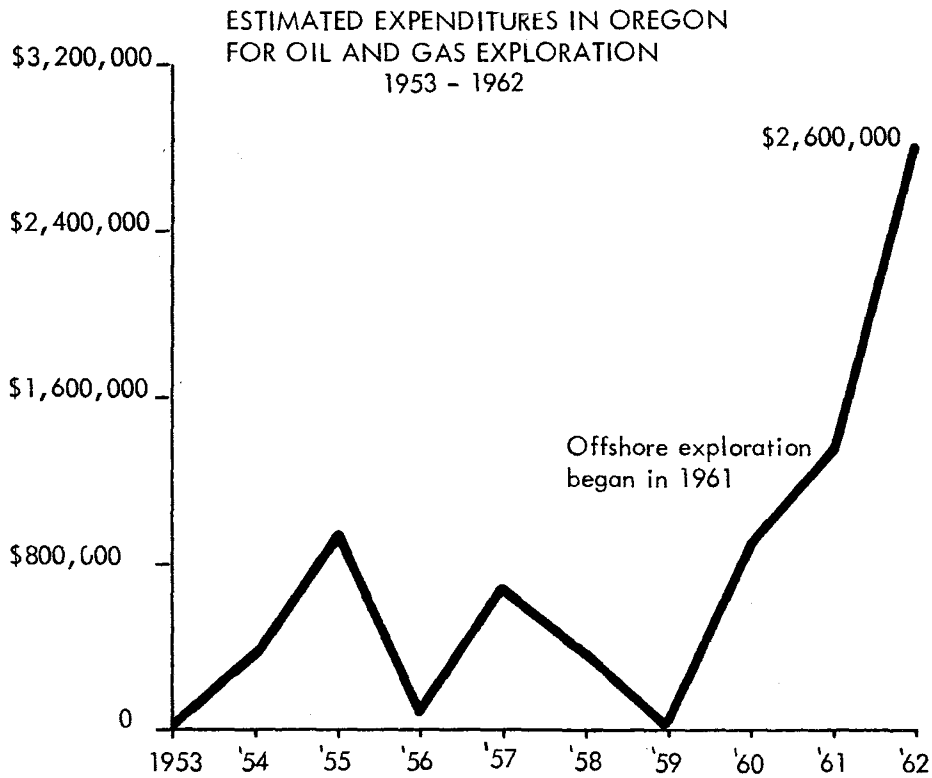
* * * * *

OIL AND GAS EXPLORATION IN 1962

By

Vernon C. Newton, Jr.*

Offshore seismic work and drilling in the Willamette Valley of western Oregon pushed exploration expenditures to nearly $3 million in 1962 (see graph). The department issued six drilling permits for oil and gas tests this year, three to large firms and three to independent "wildcatters." Footage drilled in the 12-month period totalled 23,335 feet.



*Petroleum Engineer, Oregon Dept. Geology & Mineral Industries

The year completed the 60th anniversary of oil exploration in the state. According to the department's records, 168 oil and gas tests have been drilled in Oregon to date, but unfortunately no commercial deposits of petroleum have been found in that time. Small amounts of natural gas, however, were utilized for domestic purposes in various areas of the state in the past, and a few farms still use locally produced gas for heating. Besides the 168 oil and gas drillings made thus far, exploration companies have drilled 46 core holes and several hundred stratigraphic holes for near-surface geologic information.

Willamette Valley

Drilling activity was concentrated in the Willamette Valley during 1962, following 8 months of competitive leasing. The Humble and Gulf Oil companies began leasing in the valley in October 1961. In 1962 several other firms joined the leasing when they realized the play was of some magnitude. Gulf appeared to be concentrating efforts at the southern end of the valley, while Humble assembled leases in the Salem and Silverton areas.

Reserve Oil & Gas Co. of San Francisco was the first organization to drill in the Willamette Valley last year. The company operated on leases held by the Linn County Oil Development Co. under a farmout arrangement. In May, when Reserve began its drilling, an estimated one million acres were under lease by various companies. Operations were halted on the Reserve well in September pending a decision by management to drill ahead or abandon.

In midsummer Humble moved in a massive rig to drill a deep test about 6 miles east of Silverton. After abandoning this hole, the equipment was moved to a location 6 miles north of Albany and a second hole drilled. This also proved to be a dry test. The company was reported to be dropping leases in the area as renewal dates were reached. Gulf did not drill on its acreage in 1962, but apparently was still interested in the valley prospects.

Local interest continued in the vicinity of Ash Creek south of Dallas in Polk County. John Miller & Associates drilled two shallow test holes but failed to find production. Sixteen shallow wells have been drilled in this area in search of oil and gas during the past 40 or 50 years. Gas shows encountered in salt-water sands and films of oil seen on water bailed from a few of the drillings have stirred hope of finding commercial deposits.

Coos County

E. W. McDowell of San Antonio, Texas, assembled a 20,000-acre block of oil and gas leases near Coquille in Coos County during the summer months. McDowell was reported to be representing an independent Texas group. No drilling had been done on the lease block by the end of December 1962.

Some leasing was done in northern Coos County but nothing significant developed. An application by Willard Farnham of Portland for oil leases on 80,000 acres of Elliott State Forest land was approved by the State Land Board in June. The application had been held in abeyance pending revision of the state lease form. Farnham did not complete negotiations for the Elliott Forest lands after the application was approved.

Northwest counties

Superior Oil Co. leased an estimated 60,000 acres in Columbia, Washington, and Yamhill Counties of northwestern Oregon during the year. The company was probably attracted to the area by the recent publishing of the state geologic map of western Oregon and by studies made by Texaco and Richfield Oil Corp. just after World War II. Wells drilled by these two firms encountered porous sands in upper Eocene marine sediments. Tests proved the sands to be wet in the early drillings.

Central and eastern Oregon

No activity occurred in central Oregon this past year. Northwestern Oils, Inc., was reported to be maintaining interest in the vicinity of Hay Creek, southeast of Madras. A well was drilled 20 miles southeast of Prineville in 1958 by Standard and Sunray in a joint venture. The latest drilling in central Oregon was done in 1960 by Humble near Lakeview, where two deep tests were made.

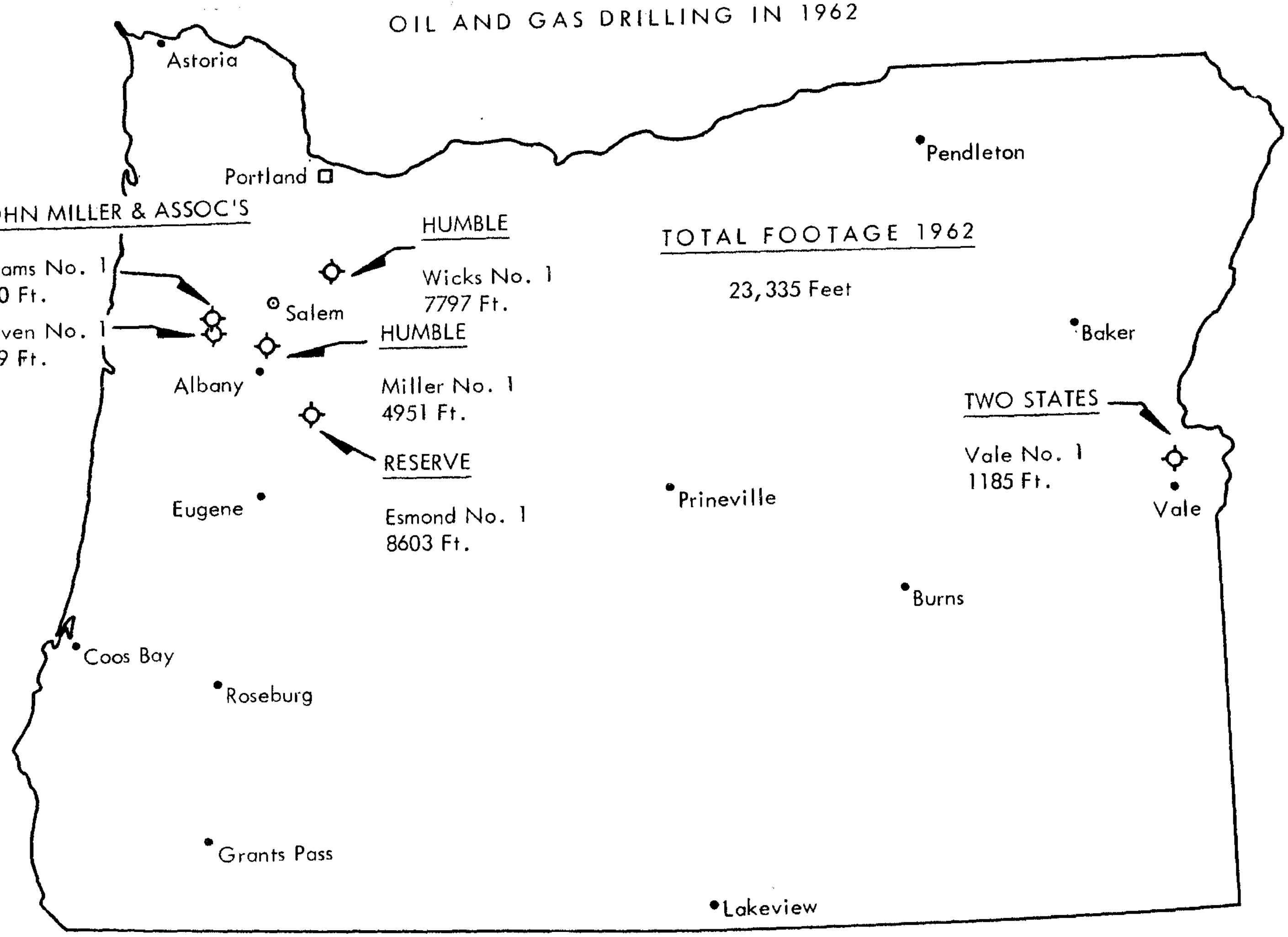
Two-State Oil & Gas Co. of Boise, Idaho, commenced operations in April on a shallow gas test at Vale in Malheur County. The company was reported to hold 50,000 acres of leases around the well site. The hole stopped short of the objective depth because of the company's commitments in Canada.

Offshore exploration

The search for oil structures continued off the Oregon coast in 1962 at a slightly increased pace over the previous year. Seismic, gravity, and magnetic studies were carried on in the coastal region of the state by at least 10 major companies. Expenditures are estimated to have exceeded $\$1\frac{1}{2}$ million.

No leases have been given on offshore state lands since passage of the Oregon submerged lands acts of 1961. Prior to that time one small lease was granted off the coast in Clatsop County in 1957. Donald F. McDonald

OIL AND GAS DRILLING IN 1962



applied for an offshore lease in Coos County in November 1962, but no action had been taken, at the time of this writing. Studies are currently being made by the department to determine leasing procedures used in other shoreline states. Oregon's 1961 law requires that leases on submerged lands be placed for competitive bid with a bonus being the biddable factor.

In October the U.S. Department of Interior sent preliminary lease maps of the Oregon coast to the Land Board and the Department of Geology and Mineral Industries for their inspection. The Federal government uses a 3-by-3-mile map grid on all its outer continental shelf lands for oil and gas leasing. The area covered in the Federal parceling system extends an average of 40 miles seaward from the Oregon coast line. Water depth ranges from 180 feet at the state boundary to 3,000 feet at the edge of the shelf lands.

EXPLORATION OFF THE OREGON COAST

Company	Type survey	Exploration permit No.	Effective date
Shell Oil Co.	Conventional seismic Sparker survey Bottom sampling	SL-2	12-31-62
Union Oil Co.	Gas exploder survey Bottom sampling	SL-3	7- 9-63
*Standard Oil Co.	Gas exploder survey	SL-4	8-31-63
Superior Oil Co.	Gravity survey	SL-5	10-15-63

*Standard Oil Co. was operator for Humble, Pan America, Ohio, Superior, Phillips, and Texaco oil companies under its permit from the State Land Board.

The State of Washington held three lease auctions in 1962 offering submerged state land. Texaco, Union, and Humble took leases on several thousand acres of submerged land in Washington, but the bulk of offshore leases went to the Superior Oil Co. for no more than minimum rental. Union drilled on its leases offshore at Grays Harbor in July and August but failed to reach any of its objectives, due to difficult operating conditions. The drilling was done from a floating barge, and large ground swells prevented the company from finishing any of the 3 holes planned. The third attempt was abandoned when a severe storm threatened loss of the barge. Union will probably resume offshore operations next season, wiser from experience with the not-so-calm Pacific.

Exploration prospects for the Northwest

After drilling 6 holes in Oregon and 10 holes in Washington during the past year, oil prospectors did not discover a single barrel of oil or enough gas to warm a cooling interest. Cost of this year's probing is about $5 million, perhaps more. Further exploration will be done in the Northwest only if an attractive economic climate exists and is accompanied by a valid hope for recovery of losses through discovery of new deposits.

Competition with other countries is forcing rigid economic practices within the domestic oil industry. Ability to obtain vast acreages of prospective land in foreign countries with merely the promise to spend specified sums in exploration is an attraction not found in this country. The risks of dealing with unstable governments are apparently considered worth taking. Oil produced overseas can be piped several hundred miles and then shipped to American ports for less than the cost of developing domestic oil.

During 1961 a total of 300,000 barrels of crude oil per day was imported into the five Far Western States of California, Arizona, Oregon, Washington, and Nevada. Exporters were: Middle East, 53 percent; Canada, 18 percent; South America, 16 percent; and the Far East, 13 percent 1/. Declining production in California, main supplier for the Far Western States, is the reason for the unbalance in supply-demand. California's production dropped 2½ percent in 1962 despite an increase in number of wells drilled 2/. Although there is presently an oversupply of oil on the world market, growth in the Far Eastern markets shows promise of partially relieving the current situation.

The Oregon legislature has attempted to create incentive for exploration by passage of oil and gas laws relieving industry of some burdens. The drilling of expensive, unnecessary wells because of stringent lease contracts is avoided. A race to "outdrill" competitors in order to "capture" oil from beneath adjoining leases is no longer necessary under new laws.

1/ Crude petroleum and petroleum products: U. S. Bur. Mines Annual Petroleum Statement, November 19, 1962.

2/ Preliminary Annual, The Mineral Industry in California in 1962: U.S. Bur. of Mines Area Rept. II-54, December 1962.

DRILLING PERMITS ISSUED IN 1962

Permit No.	Company	Well name	Location	Total Depth	Spud Date	Abandon Date
45	Two-State Oil & Gas Co., Inc.	Vale City No. 1	SW¼ sec. 21, T. 18 S., R. 45 E. Malheur County	1185'	4-13-62	10-24-62
46	Reserve Oil & Gas Co.	Esmond No. 1	SW¼ sec. 7, T. 12 S., R. 1 W. Linn County	8603'	5-25-62	9- 6-62 (suspended)
47	Humble Oil & Refining Co.	Wicks No. 1	NE¼ sec. 11, T. 7 S., R. 1 E. Marion County	7797'	6-18-62	7-31-62
48	Humble Oil & Refining Co.	Miller No. 1	SE¼ sec. 10, T. 10 S., R. 3 W. Linn County	4951'	8- 2-62	8-30-62
49	John T. Miller	Adams No. 1	SW¼ sec. 11 T. 8 S., R. 5 W. Polk County	410'	9-14-62	9-24-62
50	John T. Miller, Ross Mitchell & Associates	Bliven No. 1	SW¼ sec. 11 T. 8 S., R. 5 W. Polk County	389'	9-25-62	10- 2-62

Unit development of oil and gas fields is encouraged by the state so that unnecessary drilling will be eliminated and costs of production equipment shared among participating groups. Larger profits should result from application of these principles for all concerned. Low capital investment per barrel recovered will be the gain for the operator, while royalty holders receive returns over longer periods because fields will be produced longer.

Geologic conditions in several areas of Oregon are favorable for oil and gas accumulation, and if economic incentive remains more drilling will be done. In western Oregon there are at least 14,000 square miles of Tertiary sedimentary basin area, including accessible portions of the continental shelf. In central Oregon, the 6,000 square miles of prospective Mesozoic-Paleozoic marine sediments have been tested at only a few locations. The large, late Tertiary non-marine basins of southeastern Oregon have been tested by only a few deep holes, but several gas shows from relatively shallow horizons indicate that a commercial field may yet be found. Only 40 holes have been drilled deeper than 3,000 feet within the sedimentary basins of the state. Recent drilling has shed some light on geologic conditions of the basin areas, but it has also posed as many more. Further evaluation must be done by the drill.

* * * * *

LAND WITHDRAWALS IN UMATILLA NATIONAL FOREST

According to a January notice from the Bureau of Land Management, the Department of Agriculture has filed application for the withdrawal of lands in the Umatilla National Forest. The total combined area of 828.25 acres, to be withdrawn from location and entry under the mining laws, is desired by the applicant for public outdoor recreation and fish habitat improvement.

* * * * *

DEPARTMENT RELEASES NEW OIL PUBLICATION

A new oil publication entitled "Petroleum Exploration in Oregon" was released by the department this month. Reprints of recent articles from trade magazines and from The ORE BIN have been collected in Miscellaneous Paper 9, describing prospects in the onshore and offshore areas of the state. Price of the new publication was set at $1.00.

* * * * *

GEOLOGY OF THE MITCHELL BUTTE QUADRANGLE PUBLISHED

The second of the department's new Geological Map Series (G.M.S.-2) is now available. It is "Geology of the Mitchell Butte Quadrangle, Oregon" by R. E. Corcoran, R. A. Doak, P. W. Porter, F. I. Pritchett, and N.C. Privrasky. Work was begun in this area in the summer of 1952, when the authors were graduate students at the University of Oregon. Field mapping was completed by the senior author during succeeding seasons from 1953 through 1956 while a member of the State of Oregon Department of Geology and Mineral Industries staff.

The Mitchell Butte quadrangle is named after one of the prominent hills in the east-central portion of the area, which is underlain by massive, cemented sandstones and siltstones of the upper Miocene Deer Butte Formation. The quadrangle encompasses approximately 980 square miles along the northwestern edge of the Snake River Plain in southeastern Oregon. The multicolored map, accompanied by descriptive text, delimits 18 geologic units ranging in age from Miocene to Recent and includes igneous and non-marine sedimentary rocks. It may be purchased from the department's offices in Portland, Grants Pass, and Baker. The price is $1.50.

* * * * *

OREGON ACADEMY OF SCIENCE TO MEET

The 21st annual meeting of the Oregon Academy of Science will be held in Corvallis at Oregon State University on Saturday, February 23, 1963. The Geology-Geography Section, with Raymond Corcoran as chairman, will hold morning and afternoon sessions at 10:15 a.m. and 2:30 p.m. respectively. Twenty-two papers covering a broad range of subjects concerning onshore and offshore geology of Oregon as well as progress reports on geophysical investigations in the state will be presented.

Saturday evening Dr. V. C. McMath, Assistant Professor of Geology at the University of Oregon, will give an illustrated talk on the geology of the Alps. Dr. McMath was a member of the A.G.I. International Field Institute excursion to the Alps during the summer of 1962.

Those interested in obtaining a copy of the titles and abstracts of these papers may do so by writing to Dr. F. A. Gilfillan, Oregon Academy of Science, Oregon State University, Corvallis, Oregon.

* * * * *

The ORE BIN
Volume 25, No. 2
February, 1963

BACKGROUND FOR THE 1963 GOLD AND MONEY SESSION

By Pierre R. Hines*

Economics, especially that which deals with monetary problems, is not an exact science. Some economists have reduced their theories to mathematical formulas which aid in grasping their meaning but which, when applied to the solution of economic problems, do not yield precise answers. The subject raises endless arguments and controversies, the answers to which can, in most cases, be learned only by actual test and experience. The object of this article is to give a brief account of the basic acts and laws governing the monetary policies of the United States for the benefit of those interested in following the discussions in the April 26, 1963 Gold and Money Session of the Pacific Northwest Metals and Minerals Conference.

The results of our monetary policies are readily seen in the collapse of the gold mining industry, as mine after mine shut down until now only a few are operating out of several thousand producers in 1940. These same policies are acting upon the whole economy of the United States, but the corrosive action is slower and not so readily perceived. It is everybody's problem, not just the gold producer's.

The serious outflow of our gold to other countries and our rapidly diminishing gold reserves have called increasing attention to our fiscal policies. Many plans have been proposed to control our debts, stabilize the dollar and the level of prices, and place our finances on a sound basis. The intent here is to explain the situation, not to advocate any particular plan or solution, and to show the relative place of gold in the national monetary objectives.

The Domestic Monetary Policy of the United States

The domestic monetary policy of the United States is administered under Acts of Congress by the U.S. Treasury and the Federal Reserve System and by consultation between them and with other governmental agencies. It is not the purpose of this article to go into all of their operations. Only

---

* Mining engineer, Portland, Oregon.

those policies and powers which apply to money management will be considered.

Federal Reserve System

The Federal Reserve System was established by Congress under the Federal Reserve Act of 1913. Its object was to provide a Central Banking System which could expand or contract the money supply in accordance with the state of business and industry, to provide a central reserve to withstand the shocks to the financial system, and to prevent the recurring panics and hard times. When established, it was authorized to issue Federal Reserve notes secured by 40 percent gold and 60 percent sound commercial paper.

World War I interfered with the primary purpose of the Federal Reserve System and it was used to finance the cost of the war. So it was not until after World War I that it commenced to operate as intended. R.F.Harrod[1/] said, "In 1922 they (Americans) inaugurated what should be called the system of 'managed currency'." The results from certain moves in managing the currency were recognized and furnished an empirical knowledge which was not derived from theory or opinion.

U. S. money was based upon the gold standard until 1932, when the Glass-Steagall Act [2/] was passed by Congress which authorized the use of United States bonds and securities as backing for the Federal Reserve notes. This act was extended many times until 1945, when it was made permanent.

The Reserve Act of January 30, 1934 abolished private ownership of all monetary gold and authorized the President to reduce the weight of gold in the dollar by not less than 40 percent and not more than 50 percent. The President officially reduced the gold content of the dollar and thereby raised the price of a troy ounce of gold from $20.67 to $35. This was the end of the "Gold Standard" and the start of inconvertible paper money.

The power to manage the currency passed from the Federal Reserve System to the U.S. Treasury in 1933 and, except for an interval from 1936 to 1937, remained there until 1941. In 1945 the gold reserve for the Federal Reserve notes was reduced from 40 to 25 percent.

During World War II the Federal Reserve System was used to support the price of U.S. bonds and to keep interest rates low. It was impossible

---

1/ R. F. Harrod, 1958, Policy Against Inflation: St. Martins Press, New York, p. 58.

2/ J. M. Bell and W. E. Spahr, 1960, A Proper Monetary and Banking System for the United States, Ronald Press, New York, p. 161.

for the Federal Reserve System to manage the domestic money supply and at the same time support the U.S. bond market, since they conflicted with each other. The Accord of March 1951 between the U.S. Treasury and the Federal Reserve System released the Federal Reserve from its obligation to support U.S. bond prices and low interest rates and permitted it to return to the free operation of its normal purpose.

The experience accumulated in the past 50 years by the managers of the Federal Reserve System is variously interpreted. Even the economists do not agree on the value and the application of its several powers. Unfortunately, only a few members of Congress are thoroughly acquainted with its workings and purpose and the need to keep it independent of politics, consequently acts are passed which are inimical to its intent.

The Federal Reserve System now has four principal controls:

(1) Regulating the percentage reserves required from the commercial banks which, in turn, determines the amount of their deposits and consequently the amount of the loans and investments they can make. It is used only for long trend regulation.

(2) Regulating the discount rate upon first class commercial paper of short maturity which is accepted from commercial banks as security for loans to them. While this was the original purpose of the Federal Reserve Act, now government securities are usually substituted. At first it was thought a change in the discount rate would exert a powerful influence upon the money market and credit, but it did not work out that way. However, as an indicator of the Federal Reserve's opinion upon the current state of business and industry as well as the probable action the Reserve Board will take in the near future, this control is both heeded and respected.

(3) Control by open market operations which permit the purchase and sale of securities in the open market. The Federal Reserve at the present time confines its operations largely to Treasury bills maturing within 90 days or similar securities. Federal Reserve purchases of government securities increase the reserve balances of member banks and sales reduce them, which controls directly the amount they can loan or invest. Because of the small percentage of their reserves required to be deposited with the Federal Reserve by the member banks, its effect upon them is five or six times the amount of the open market operation.

(4) Regulating the amount of margin customers must put up when purchasing the listed securities.

The relative independence of the Federal Reserve System from political direction, together with its freedom from use for political ends in the management of the currency, is its greatest strength. The Chairman of the Board of Governors in 1957 made the following statement before the

Committee of Finance of the United States Senate[3/]:

"Broadly, the Reserve System may be likened to a trusteeship created by Congress to administer the Nation's credit and monetary affairs - a trusteeship dedicated to helping safeguard the integrity of the currency. Confidence in the value of the dollar is vital to continued economic progress and to the preservation of the social values at the heart of free institutions.

"The Federal Reserve Act is, so to speak, a trust indenture that the Congress can alter or amend as it thinks best. The existing system is by no means perfect, and experience prior to 1914 suggests that either it or something closely approximating it is indispensible."

The United States Treasury

The United States Treasury is one of the administrative branches of the Federal Government. The Secretary of the Treasury is a member of the President's cabinet. He supervises the collections of taxes and revenues of the Federal Government and disburses them according to acts of Congress.

The Secretary's most difficult job is the management of the national debt, which is now 300 billion dollars, and the refunding of these debt obligations when they become due. He also finances the national budget of around 100 billion dollars, borrowing when the receipts do not cover the outgo, as is, unfortunately, most often the case. The large amounts required for the Treasury's financing is a big factor in money management. Much of the effects of this financing depends upon the size of the loan, whether long or short maturity, and where it is borrowed - that is, from the Federal Reserve System, commercial banks, or private investors. The Treasury can increase or decrease a bank's reserves, and consequently the bank's loans and deposits, by the amounts which it keeps with the Federal Reserve banks or other banks.

The Secretary of the Treasury is authorized, under the Gold Reserve Act of 1934, to buy and sell gold at rates that are most advantageous to the public interest. This same act also authorized the President to fix the weight and fineness of the United States gold dollar, which President Roosevelt did at $35 an ounce; but the President's authority to make further change has expired.

3/ The American Assembly, United States Monetary Policy, 1958: Columbia University, New York, p. 44-45.

The United States, under the Bretton Woods Agreement, obligated itself to maintain the weight and fineness of the U.S. gold dollar at $35 an ounce, and promised to make no change except by an act of Congress. The Treasury maintains the gold price at $35 an ounce and buys or sells unlimited amounts to foreign governments and central banks - that is, at a one-quarter percent premium when selling and at a discount of one-quarter percent when buying.

The Treasury has two controls on gold reserves - it can require an export license and it can also "neutralize" a gold purchase by carrying it as a debt on its books, in which case the purchase is financed by tax collections or selling securities rather than the normal way of issuing a "gold certificate" to the Federal Reserve Bank and thus becoming part of the gold reserves.

The Treasury tries to keep the interest rate down on U.S. bonds, Treasury bills, and obligations. During time of war, the Treasury has the enormous task of financing the cost, and uses the Federal Reserve System to support the market on U.S. bonds in order to keep the interest rate down. This wartime policy suspends the "open market" operations of the Federal Reserve for money management purposes. Likewise, in the great depression of the thirties the controls of the Federal Reserve failed to stimulate business and industry and the Treasury had to finance the Administration's "pump priming" policy. An exception to the Treasury's management occurred in the years 1936-37, when the Federal Reserve took over and put on the brakes too hard, thus reversing the slight gains already made.

So both the U.S. Treasury and the Federal Reserve System share responsibility for executing our domestic monetary policies. Neither is perfect and many think that both need overhauling. An effort to solve some of the problems was made by the Commission on Money and Credit. It studied our monetary policies and submitted a report in 1961 for the Board of Trustees of the Commission for Economic Development, New York. Unfortunately, the large number of members (27), selected for their positions in industry, banking, and labor instead of their knowledge of or actual experience in monetary management, prevented their arriving at any noteworthy recommendations or conclusions.

Monetization of the National Debt

Monetization of the debt is a term which should be understood by everyone interested in U. S. monetary policies.

The only limitation now placed upon the issuance of Federal Reserve notes is the requirement that they be backed by 25 percent gold reserves.

The Glass-Steagall Act of 1932 authorized the use of Federal Government securities and obligations for the other 75 percent. Further, it authorized their use for the reserve deposits made by member banks with their reserve banks.

The national debt has grown so large in the past 30 years that the purchase of new and refunding issues has been more than private investors could handle or absorb. Consequently, the Federal Reserve System and commercial banks have had to assist, and now hold about 30 percent of the total debt; private investors, corporations, and insurance companies hold 34 percent; the remainder is held by Federal, state, and other public agencies and miscellaneous investors.

Commercial banks own about 20 percent of the government obligations, but they can expand this into loans, investments, and credits by many times this amount. They can do this because they are required to deposit only a small percentage of their deposits with their Federal Reserve Bank as a reserve. Thus the national debt is the basis for the issuance of both Federal Reserve notes and also for the creation of credit by member banks. This is what is meant by "monetization of the debt." The great danger from it lies in the possibility that the 25 percent gold backing may be reduced further or completely abolished by act of Congress. This would remove all restraints to the unlimited printing of paper money.

The monetary policies responsible for the monetization of the debt were the principal factors which wrecked the gold mining industry in the United States. Until these policies are corrected it will be impossible to restore the gold mining industry to permanent prosperity. While the action is slower, the same thing that happened to gold mining is happening to the thrifty, and those who have savings, pensions, insurance, annuities, and similar holdings.

United States International Monetary Policy

The United States gold dollar is the present international unit of value and standard for exchange of 73 national currencies. The United States agreed at the Bretton Woods Conference in 1944 and in the Act of July 31, 1945 to maintain the par value of the U.S. dollar at the corresponding price of $35 an ounce for gold. It further agreed the par value could be changed only by an act of Congress. Gold coins are not now issued by the U.S. Treasury; the equivalent in gold bars is used to pay international balances and is called the Gold Bullion Standard.

International Monetary Fund

The International Monetary Fund was the outcome of the Bretton Woods Conference in 1944, which was held to arrange ways and means for rebuilding post-war Europe and restoring international trade after World War II. The Allies established both the International Monetary Fund and the International Bank for Reconstruction and Development, as well as cooperating in the formation of the General Agreement on Tariffs and Trade. Of these agencies, the IMF is the most pertinent to this article.

Per Jacobsson, the Managing Director of the Fund, has stated its objectives as follows[4/]:

"Its task is to promote cooperation between the monetary authorities, so that conditions will be established and maintained that are likely to facilitate the expansion of international trade. The Fund's work in fact, combines two main elements; an agreement on foreign exchange policies and a pooling of resources to assist countries to carry out those policies. The Fund Agreement sets as an objective for each country, the establishment and maintenance of a convertible currency at a fixed par value, free of restrictions on current payments and without discrimination in relations with other member countries.

"The Fund has very substantial resources; .... Out of these resources, the Fund will, in cases of need, extend assistance to member countries, for a period usually not exceeding three to five years, to give them time to take such action as is required to correct maladjustments in their balance of payments without resorting to measures destructive of national or international prosperity, such as exchange restrictions or discriminatory currency arrangements. The Fund in fact provides members with a 'second line of reserves' under adequate safeguards....

"Through the application of the principles which have been adopted by the Fund, a measure of monetary discipline is ensured."

U. S. Balance of Payments

Europe had to be rebuilt and international trade restored at the end of World War II. The United States furnished raw materials, finished products, and credit to do this. The U.S. Government gave large amounts in direct aid to the European countries and also spent similar amounts there as military

---

4/ Per Jacobsson, The Market Economy in the World Today, The Jayne Lectures for 1961, The Amer. Philosophical Soc., Philadelphia, p.26/7.

aid. The International Monetary Fund, the International Bank for Reconstruction and Development, the General Agreement on Tariffs and Trade, the Marshall Plan, the European Payments Union Agreement of 1950, and other agencies all contributed to this end.

Immediately following the war, U. S. exports were much greater than U. S. imports, making a large trade balance in favor of the United States as well as creating a scarcity of dollar exchange. This favorable trade balance made it possible for the United States to spend the large amounts abroad in economic and military aid. The outflow of gold from 1949 to 1957, amounting to 1.7 billion, and dropping of the United States gold reserves from 24.6 billion to 22.9 billion, gave no concern.

While the international trade balance by 1957 was still favorable to the United States, it had greatly diminished and was not large enough to support the huge expenditures in economic and military aid to foreign countries. Europe had recovered and its production had reached pre-war levels and was growing vigorously. The European countries were exporting more and importing less. The American economic and military aid to foreign countries continued at the same rate, so gold was required to settle the difference. United States gold reserves were 22.9 billion in 1957, but they lowered to 16 billion in 1962, a drop of 6.9 billion in 5 years. The backing for Federal Reserve notes requires 12 billion in gold, leaving only 4 billion to satisfy foreign claims of three times that amount. This is the "balance of payments problem."

The present balance-of-payments situation and the unending financing of our government deficits by issuing more and more paper affects both the financial standing of the United States and the U. S. dollar. The U. S. gold dollar is the world standard of value and cannot be trifled with. Both of these problems will have to be solved eventually by sound financial management free from political influence.

* * * * *

GOLD AND MONEY SESSION SCHEDULED

The Second Gold and Money Session is a part of the Northwest Metals and Minerals Conference, jointly sponsored by AIME, ASM, NACE, and AWS. The conference will be held April 24-27 at the Multnomah Hotel, Portland. The Gold and Money Session is to be all day April 26 and is open to the public. Registration for the conference is $7.50 or $5 for the Gold and Money Session only. The complete program for the conference will appear in the March ORE BIN.

* * * * *

LAND WITHDRAWALS AND TERMINATIONS

Four land withdrawals totalling 2,403.83 acres were proposed during the month of December. They are as follows:

8.83 acres in Klamath County for the Klamath wildlife administrative site at the request of the U.S. Bureau of Sport Fisheries & Wildlife.

80 acres in Harney County for access to the Chickahominy Reservoir. Withdrawal made by the U.S. Bureau of Sport Fisheries & Wildlife at the request of the Oregon Game Commission.

160 acres in Multnomah County to preserve the historic area of the Columbia River Gorge "for its scenic and recreational values."

A total of 2,155 acres in the Fremont, Wallowa, and Whitman national forests for 23 recreation areas. The withdrawal is being made at the request of the U.S. Forest Service.

A total of 1,062.63 acres was proposed for withdrawal during January and February, as follows:

81.2 acres in Lane County for reservoir and road relocation along Fall Creek by the U.S. Army Corps of Engineers.

981.43 acres in aggregate total are desired for recreation areas and an administrative site by the Department of Agriculture. These areas are in the Rogue River, Willamette, Whitman, and Umatilla National Forests.

Notice has also been received that the proposed withdrawal of two areas totalling 5,610.64 acres in Malheur County has been terminated. Localities involved are the Nigger Rock area in Ts. 21 and 22 S., R. 43 E., and the Disaster Peak area in T. 40 S., R. 40 E. These are the two remaining areas in the original 20,000-acre withdrawal in Malheur County which would have prevented the removal of petrified wood and other semiprecious gem material (see October 1961 ORE BIN). All of these withdrawals have now been terminated.

* * * * *

RARE METALS EXHIBITED

Wah Chang Corp. of Albany has placed on display at the department's museum in Portland a group of rare and exotic metals. Samples on display include small sheets, bars, slabs, and tubing of zirconium, hafnium, tantalum, niobium (columbium), molybdenum, and tungsten. These new metals are new only because they are manufactured to the higher standards of purity which are demanded by today's uses, which require strength at high temperatures, superior corrosion resistance, and nuclear reactor capability.

Each of these metals must be purified in a vacuum arc furnace, or the more complicated electron-beam melting furnace which works like a giant X-ray tube. Later operations, such as making castings, are also done in a vacuum or inert gas atmosphere, so that the hot metal will not pick up impurities such as oxygen, hydrogen, or nitrogen from the atmosphere.

In addition to the Albany Division, the Wah Chang Corp. has plants in Texas, Alabama, and New York. The company is one of the largest processors of tungsten and molybdenum from ores to finished metal products.

* * * * *

BANTA REAPPOINTED TO BOARD

Governor Mark O. Hatfield reappointed Mr. Harold Banta to the Governing Board of the Department of Geology and Mineral Industries February 25, 1963, for a second four-year term. Mr. Banta, senior partner in the law firm of Banta, Silven, Horton, and Young of Baker, Oregon, has a long history of interest in mining and mining law. He has been active in the Western Governors Mining Advisory Committee on matters pertaining to mineral law and public lands; is a member of the Oregon State Bar Committee on Mineral Law, and a member of the Legal Committee of the Interstate Oil Compact Commission.

Other members of the department's Governing Board are Mr. Frank C. McCulloch, Chairman, Portland, and Mr. Fayette I. Bristol, Grants Pass. The Governing Board, by law, is a citizen group, serving without pay, that has direct charge and control of the department.

* * * * *

SPECTROGRAPH GETS SPARK UNIT

During 1962 an additional source unit was added to the spectrograph at the Portland laboratories of the department. This is a high-voltage AC spark unit, which will be used in place of the carbon arc for analysis of high melting point metals and alloys. The AC spark is the preferred source when greater precision rather than extreme sensitivity is desired. For this reason, the spark is generally used to determine the percent of alloying elements in metals. Another advantage of the spark for certain types of analysis is that it is non-destructive, as compared to the carbon arc, in which at least part of the sample must be burned up completely.

* * * * *

LEGISLATION OF INTEREST TO THE MINERAL INDUSTRIES

State

Senate Bill 222: Would abolish the Rogue River Coordination Board.

Senate Bill 259: Strengthens the air and water pollution laws by allowing the State Sanitary Authority to institute a suit at law or in equity to abate or restrain threatened or existing pollution without the necessity of prior administrative procedures or hearing.

House Bill 1233: Would establish a Department of Natural Resources having seven divisions, as follows: Parks and Recreation, Small Boats and Harbors, Mineral Resources, Fish and Game, Forestry, Water Resources, and Agriculture. All divisions would be under a Director appointed by the Governor and the division heads would be appointed by the Director. The department would have a nine-man advisory committee appointed by the Director.

House Bill 1329: Would establish a procedure for purchase of county-owned mineral rights by the owner of the surface rights.

House Bill 1366: Establish a procedure for exploration of ground on which the county owns the mineral rights but the surface rights are owned by someone else.

House Bill 1369: Would limit the size of a mill-site claim to 5 acres of non-mineral land. The location for this claim would be the same as other claims and would require filing within 30 days.

House Bill 1190: Changes the status of the shore (between mean high tide and mean low tide) of the Pacific Ocean from "public highway" to a "state recreation area" and changes the administration from the State Highway Commission to the State Parks System, a division of the State Highway Department.

Federal Legislation on Gold

H.R. 279 - Gold procurement and sales agency: Baring (Nev.) - Committee on Interior and Insular Affairs. Would (1) require the Secretary of the Interior to survey the domestic gold mining industry and determine the price (not to exceed $105 per troy ounce) required to be paid to domestic producers in order to achieve maximum production of gold from domestic mines, and (2) establish in the Interior Department a Gold Procurement and Sales Agency.

Identical bills: H.R. 489, Hagen (Calif.): H.R. 990, Chenoweth (Colo.); H.R. 1095, Johnson (Calif.).

H.R. 281 - Increase depletion rate for domestic gold: Baring (Nev.) - Committee on Ways and Means. Would increase the percentage depletion rate for gold ores from deposits in the United States to 100 percent of the gross income from the property, without any limitation as to the net or taxable income from the property.

H.R. 284 - Free market subsidy for gold: Baring (Nev.) - Committee on Banking and Currency. Would (1) permit the free marketing of gold by any person or Government instrumentality and (2) authorize and direct the Secretary of the Treasury to pay $70 per fine ounce for all gold domestically mined and tendered to the Treasury subsequent to the bill's enactment.

H.R. 286 - Authorize $35 per ounce subsidy for domestically mined gold: Baring (Nev.) - Committee on Banking and Currency. Would (1) establish a free market for gold within the United States and (2) authorize and direct the Secretary of the Treasury to pay an incentive of $35 per fine ounce above the established monetary value for all gold domestically mined and tendered to the Treasury subsequent to the bill's enactment.

Identical bill: H.R. 315, Chenoweth (Colo.)

H.R. 310 - Free market for gold: Chenoweth (Colo.) - Committee on Banking and Currency. Would (1) establish a free market in the United States for gold domestically mined or imported after the bill's enactment, with no restrictions on its exportation, and (2) provide that all gold held or bought by the United States Treasury, mints, or Federal Reserve Banks "shall be construed to be monetary gold and none of said gold may be hereafter sold for commercial use or for the arts."

H.R. 459 - $35 Per ounce gold subsidy: Chenoweth (Colo.) - Committee on Interior and Insular Affairs. In order to encourage the discovery, development, and production of domestic gold, would direct the Secretary of Interior to make incentive payments of $35 an ounce to producers of gold mined in the United States, its territorial possessions, or the Commonwealth of Puerto Rico. Would authorize necessary appropriations.

H.R. 642 - End 25 percent gold backing of currency: Multer (N.Y.) - Committee on Banking and Currency. Would (1) eliminate the requirement that Federal Reserve Banks maintain gold certificate reserves of at least 25 percent against deposit and note liabilities, and (2) permit domestic banks to pay interest on time deposits of foreign governments at rates differing from those applicable to domestic deposits.

S. 158 - Prohibit government sales of gold for commercial use: Allott and Dominick (Colo.) - Committee on Banking and Currency. Would provide "That all gold held or bought by the United States Treasury, or mints, or assay offices, or by the Federal Reserve banks, shall be construed to be monetary gold. Such gold shall not hereafter be sold for commercial use or for the arts, and no gold shall hereafter be sold by the Treasury, or by the Federal Reserve banks, or for the account of the Treasury or of such banks, directly or indirectly, in the United States, its territories or possessions, for the purpose of depressing the market in gold or lessening the price and value of gold."

(American Mining Congress Legislative Bulletin No. 63-1, Feb. 5, 1963)

Note: Other bills of interest now in Congress will be reported on in later issues of The ORE BIN.

* * * * *

EXPANDED AGGREGATE STUDY MADE

"Resources for making expanded aggregate in Western Washington and Oregon," by Henry M. Harris, Karle G. Strandberg, and Hal J. Kelly was recently published as Report of Investigations 6061 by the U. S. Bureau of Mines. Low-carbon shales from 65 deposits and 11 sources of coal-mine waste in western Oregon and Washington were tested in a rotary kiln for their suitability as raw material for expanded aggregate. Shales from 41 sources produced crushed, expanded aggregates weighing less than 65 pounds per cubic foot. These materials are judged according to processing qualities, physical properties, and size and uniformity of the source. Properties of lightweight concretes made from these materials are compared with those of concrete shapes made with commercial aggregates, and with sand and gravel.

Report of Investigations 6061 may be obtained free of charge from the Publications Distribution Section, U. S. Bureau of Mines, 4800 Forbes Ave., Pittsburgh 13, Pa.

* * * * *

FULL CIRCLE - SOON?

Following World War II, Congress decided that never again should the United States become entirely dependent on an overseas supply for the strategic minerals and metals so vital to the conduct of a hot or cold war. This decision was based on the fact that our overseas supply lines had been severed early in the war and a great amount of our war effort had to be diverted to open the sea lanes and thereafter to protect the vulnerable cargo carriers. The decision was strengthened when early in the 1950's Russia, the major source for manganese ore used in the United States, summarily stopped all shipments of this mineral. Before new sources of supply of manganese, which is absolutely necessary for the making of steel, could be established, some steel plants were within just a few weeks of closing for lack of it. Consequently, a mammoth program for the procurement of strategic minerals to be placed in a stockpile was put into high gear.

The result of this stockpile program was the domestic production of tungsten to more than meet the needs of the United States (heretofore Korea and China had been the principal sources of tungsten ore); opening of manganese mines; and production of cobalt, columbium, tantalum, nickel, chrome, and mercury. Of as great a benefit as the actual procuring of a stockpile of ore was the information obtained on our mineral resources (in southwestern Oregon alone, more than 300 chrome deposits were catalogued by this department) and the economic benefit that accrued to the community from payrolls of the mining operations and to the state from taxes.

As the stockpile became filled and metal prices became "normal," most of the domestic strategic metal mines closed because they were not competitive. At the present time, only a token amount of manganese is being produced and but one nickel mine and four mercury mines are operating in all of the western states, and it seems likely that the active mercury mines will be down to two before the year is out. Once again the United States is wholly dependent on overseas sources of supply for the strategic minerals. Unfortunately, these sources become more tenuous all the time. For example, it is well known in mining circles that for some time now a substantial amount of our antimony, part of our tungsten, and possibly some of our mercury has found its way into American markets through devious routes from behind the Iron Curtain. The latest ore to receive publicity as coming from a Russian source is chrome. The E&MJ Metal and Mineral Markets of February 11, 1963 reports as follows:

> G.H. Parkinson, president of the Chamber of Mines of Rhodesia, sharply criticized the U. S. Government for allowing the Soviet Union to ship chrome ore into the U. S. at prices which he said will drive Rhodesian producers out of business.

He said that for the last 3 or 4 years the Russians have been concentrating on the European market and have consistently undersold all competitors. They have now obtained some 70 percent of the European market and are selling at prices which are sub-economic for themselves and completely out of range for economic competition by either Turkey or Rhodesia, hitherto the traditional suppliers to the European market, he said.

The U.S. has long been Rhodesia's main customer, taking 53 percent of total production in 1961....

In the last 4 months, Parkinson said, the Russians have offered two grades of ore to the American market:

1. Hard Lumpy Metallurgical, guaranteed at 56 percent Cr_2O_3 and 4.0:1 Cr:Fe. The price asked for this ore is $34 a long dry ton delivered c.i.f. with no premiums, but a penalty of 70 cents for each unit or part thereof of Cr_2O_3 below 56 percent.

2. Chemical Fines, guaranteed at 53 percent Cr_2O_3 and 3.3:1 Cr:Fe. The price asked for this ore is $15.50 a long dry ton delivered c.i.f. with a premium or penalty of 50 cents per unit of Cr_2O_3 above or below 53 percent....

During the last 3 months, contracts for some 80,000 long tons of Russian ore, mainly Hard Lumpy, have been signed; and three or four 10,000-ton shipments have arrived, Parkinson estimated. Four out of the seven ferroalloy producers have signed contracts; two of these producers have also ordered trial shipments of the Russian fines, Parkinson said. The alloy manufactuers who have signed these contracts claim that European and Japanese producers have been buying cheap Russian ore for some years and then shipping the alloy to America. The only way for American alloy producers to compete is also to use similar Russian cheap and high-grade ore.

It would appear obvious, Parkinson said, that the Russians have carefully priced their two ores, without regard to economic cost, somewhat lower than competitors, with the sole intention of forcing competition into bankruptcy. With the knowledge that the Russian ore is produced deep in the Urals with long rail haulage and lengthy sea freight, it would appear that their prices are sub-economic and set by a Communist-run state with the sole intention of becoming the world's only supplier of chrome ore, he said.

Parkinson said that freight costs in moving chrome ore from a mine in Rhodesia to U. S. ports exceed $14 per ton.

Even at the present time, he said, nearly all Rhodesian chrome producers are producing at a loss in preference to closing down and re-opening later.

"If, however, these types of Russian ore are allowed to enter the American market at the prices quoted, then it appears certain that the majority of Rhodesian chrome mines must close down before the end of 1963," he maintained.

With this groundwork laid, Parkinson accused the U. S. Government of assisting Russia's economy at the expense of her allies. He said this chrome ore marketing is part of Premier Khruschev's policy of economic warfare against the West.

"If the West's major producers of chrome ore are forced to discontinue operations through the loss of their major markets, not only will the economies of those producing countries be adversely affected, but American consumers will be forced to rely on supplies from Russia. The fate of the American ferroalloy producers would then be in the hands of Russia," he said.

This latest development in the chrome market is of particular significance to Oregon, for one of the stockpile procurement depots was located in Grants Pass for purchase of West Coast metallurgical grade chrome. The recent Senate investigation of stockpile purchases brought out that the price paid for the ore was three times the market price. What the investigation did not reveal was that a similar price was paid for foreign ore, largely from Rhodesia.

This department has recently learned* that of the 5.6 million long dry tons of metallurgical-grade chrome in the government stockpile, 4 million tons came from foreign sources, 1.1 million tons from domestic sources, and approximately one-half million tons from "other government agencies," probably the agriculture barter program. Stockpiled metallurgical chrome purchased from foreign sources cost us in excess of $400,000,000. The per-ton cost is $101, which represents the price of the material only and does not include freight and other capitalized costs. Chrome purchased from the West Coast at the Grants Pass depot amounted to 200,000 long dry tons at a per-ton cost of $93. Ore obtained through the Grants Pass stockpile program averaged 46 percent Cr_2O_3 with a 2.7 to 1 chrome-iron ratio. This is good metallurgical-grade chrome, but probably not as high grade as the ore obtained from foreign sources. Experiments run on domestic ore by the U.S. Bureau of Mines indicated that "The energy requirement (for producing ferrochrome) is relatively low...the ferrochromium produced will contain about 60 percent chromium."

Our West Coast chrome mines closed because they were not competitive with Free World chrome - either in grade or price. It appears now that the Free World chrome mines will close for the same reason. At that point the United States will have gone the full circle on this particular strategic mineral - from reliance on a hostile source, to a friendly foreign source, to partial dependence on a domestic source, and back again. And, unfortunately, this is but one of the strategics in which this is taking place.

We now have the stockpile to fall back on, which is something we did not have in 1950 or 1940. But how long we can rely on this is questionable, for plans are under way to dispose of "surplus" amounts. What is surplus and what is a sufficient amount depends on who does the planning. There is little question but that this country faces some real problems in the strategic metals area - problems that would not be as serious if there were a healthy domestic strategic mining industry. It might cost a little more to have this industry than to obtain minerals on the open market, but cost is relative and includes many things. Ask the Rhodesia chrome miners - they can vouch for that.

Hollis M. Dole
Director

---

*Letter from John M. Kelly, Assistant Secretary of the Interior.

The ORE BIN
Volume 25, No. 3
March, 1963

RECENT VOLCANIC LANDFORMS IN CENTRAL OREGON*

By Norman V. Peterson and Edward A. Groh**

Introduction

As the race to be the first mortals on the moon continues, the questions of how the lunar surface features originated and what rock types they contain are still not answered.

Many of the lunar configurations that are telescopically visible certainly resemble volcanoes and features associated with them. Even if only a part of the moon's surface has been formed by volcanic processes, some of the smaller volcanic forms, such as hummocky lava flow surfaces, spatter cones, and lava tubes could be present. If these features exist, they could provide ready-made shelters to protect men and vehicles from the hostile environment of radiation, high temperatures, and meteorite and dust bombardment.

A reconnaissance of the Bend-Fort Rock area in central Oregon shows that it has a wealth and variety of fresh volcanic landforms that should be of interest to the planners of our lunar programs as well as to the students of volcanology or to those curious about the rocks of Oregon.

Recent Volcanic Activity in Oregon

Before discussing central Oregon specifically, it may be well to look at the pattern of Recent volcanic activity in all of Oregon. "Recent" volcanism is that which occurred during the Recent Epoch of the geologic time scale, beginning at the close of the Pleistocene (glacial) Epoch about 11,000 years ago and extending to the present.

As shown in Figure 1, numerous lava flows, domes, and pumice and cinder cones of Recent age are present throughout the High Cascades and their eastern slopes, extending as a belt from Mount Hood to Crater Lake, with the greatest concentration in the Three Sisters area. This belt of

---

* Geologist, State of Oregon Dept. Geology and Mineral Industries.
** Private geologist, Portland, Oregon.

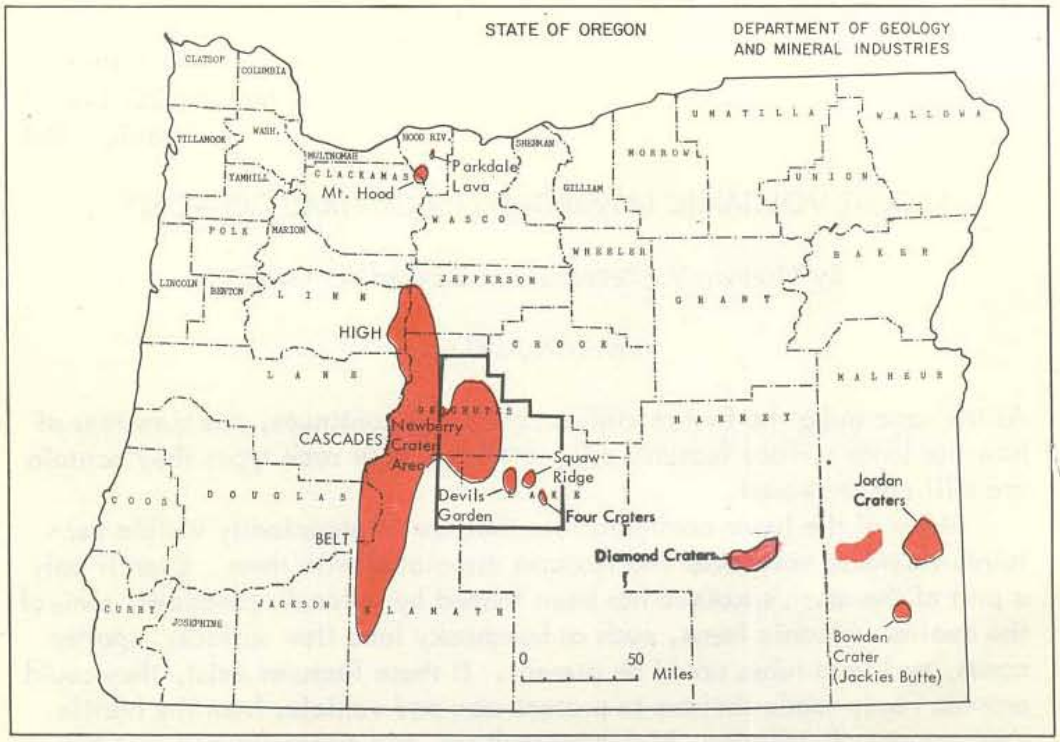


Figure 1. Index map of Oregon showing areas of Recent volcanism.

volcanism contains such well-known features as the Belknap Craters and surrounding lava field, more commonly called the McKenzie Highway lava field; the flow damming Davis Lake; the cones and lava flow damming Clear Lake; cones and flows around the Three Sisters; Lava Butte and its rough lava field; the Lava Cast Forest; and, of course, Crater Lake. A more complete list and description of the numerous Recent volcanic features in this belt, including the Newberry Crater area, can be found in the geologic map by Howel Williams (1957).

Other Recent lava fields and associated cinder cones that are not nearly as well known or described in geologic literature include Devils Garden, Squaw Ridge lava field, and Four Craters lava field. These border the north part of the Fort Rock and Christmas Lake Valleys. Jordan Craters, Bowden Crater, and Diamond Craters are isolated Recent eruptive centers located in southeastern Oregon.

The time of eruption of some of Oregon's volcanoes has been determined quite accurately by radiocarbon dating of carbonaceous material. For example, pumice from the cataclysmic eruptions of Mount Mazama fell about 7,600 years ago. Similarly, a pumice eruption from Newberry Volcano has been dated at about 9,000 years ago and a later one around

2,000 years.

The age of many of the Recent volcanic rocks can be only inferred on the basis of such factors as appearance and geologic relationship. In the estimate of some volcanologists, Lava Butte and the McKenzie Highway lava field are about 1,000 years old. The writers believe the Four Craters cones and lava field to be about this same age. More study and observation of Oregon's Recent lavas may produce carbonaceous materials which will provide accurate determination of their ages by the radiocarbon method.

Of special interest in historic time is the Parkdale lava flow, which issued from a small vent on the northern slope of Mount Hood. The end of this flow is about one mile west from the town of Parkdale in the Hood River valley. Radiocarbon dating of wood carbonized by the heat of this lava flow places its age at about 240 years, therefore setting the eruption in about the year 1720. A thin ash fall around the upper flanks of Mount Hood is believed, from tree-ring dating, to have resulted from a short eruption in the main crater about the year 1800, and may be the last fairly well-substantiated volcanism known in Oregon. Some fumarolic activity still exists on Mount Hood near Crater Rock and at the headwall of Reid Glacier.

In our neighboring state of Washington, report of a short eruption at Mount St. Helens producing an ash fall during November 1843 is well documented. There is evidence that a small, blocky andesite flow may have been extruded on the mountainside around 1838. Also, it has been scientifically demonstrated that an ash eruption may have taken place about 1802. Fumarolic action is still present on this mountain.

To the south in California, Mount Lassesn, the United States' latest active volcano, had its most recent eruptions from 1914 to 1917.

Recent Volcanic Areas in Central Oregon

During the summer of 1962, in cooperation with the Bend Chamber of Commerce, a reconnaissance of the area south and east of Bend, including the northern parts of the Fort Rock and Christmas Lake Valleys, was made to determine the extent and variety of Recent volcanic landforms. It is not the intent to list every feature but to show areas where there are concentrations and to illustrate and describe briefly some of the typical landforms.

Figure 2 shows that most of the recent volcanism is within a broad, northwest-trending zone extending from the Three Sisters area at the crest of the High Cascades southeastward through Newberry Volcano and the Devils Garden area until it terminates in the Four Craters lava field in the north part of the Christmas Lake Valley.

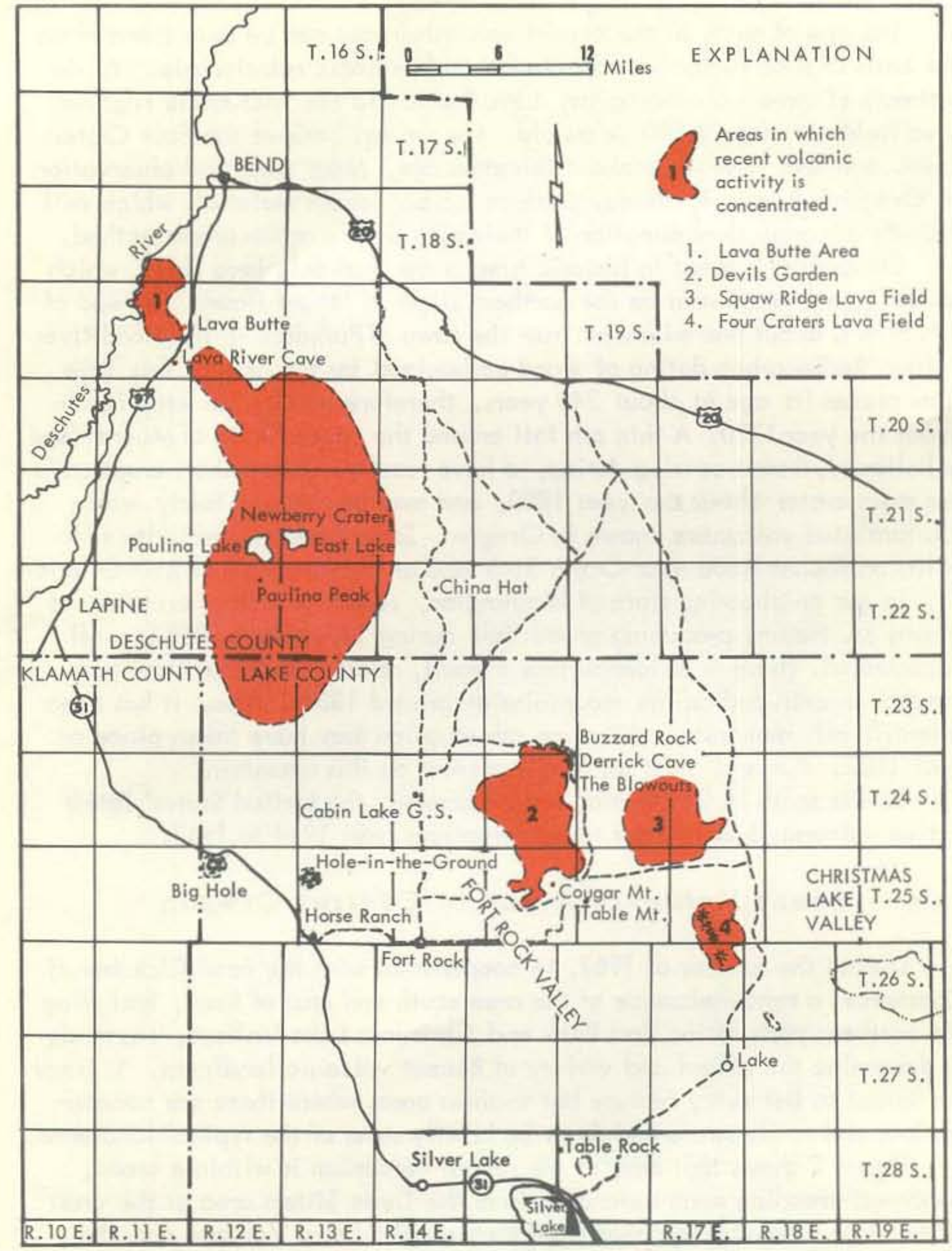


Figure 2. Index map showing areas of Recent volcanic landforms in central Oregon.

Four Craters lava field

This unnamed area, for this report called the Four Craters lava field, is the most remote and farthest southeast area of very recent lava flows and cinder cones. It covers about 12 square miles in Ts. 25 and 26 S., R. 17 E. on the northern edge of the Christmas Lake Valley. This relatively small area is a typical example of the alignment of cinder cones on a strong fissure from which basaltic lavas have been erupted. The four main cratered cinder cones with smaller parasitic scoria mounds are surrounded by clinkery aa flow lavas that came from numerous vents along a fissure that trends about N. 30° W.

Squaw Ridge lava field

A large unnamed basalt cone lies to the south of Squaw Ridge and is called the Squaw Ridge lava field in this report. This broad, shallow cone covers an area 6 to 7 miles in diameter mainly in T. 24 S., Rs. 16 and 17 E. This lava field was not examined in detail because of poor access and difficult terrain; however, both the rough, clinkery aa lava and the smooth-crusted ropy pahoehoe lava were noted at the edge of the flow.

One or more cinder cones top this shield-shaped cone and probably were formed during the last eruptive phases. Two "steptoes" or islands of older rock were seen within the eastern part of the lava field when viewed from the top of the northernmost cinder cone in the Four Craters field.

The Devils Garden

The Devils Garden area covers about 45 square miles of the northern part of the Fort Rock Valley in northern Lake County, mainly in Ts. 24 and 25 S., R. 15 E. Thin flows of black pahoehoe lavas originating from fissures in the north and northeast part spread to the south and southwest. Several rounded hills and higher areas are islands or "steptoes" completely surrounded by the fresh black lavas.

Excellent examples of smooth, ropy pahoehoe lava are common on the upper surfaces of the large slabs formed by collapse when the hot fluid lava of the flows was drained from beneath thin, solidified crusts (Figure 3).

Along the northeast edge of the Devils Garden, there are classic examples of spatter cones, spatter ramparts, and lava tubes. Figure 4 shows one of two especially large spatter cones, locally called "the blowouts," in sec. 12, T. 24 S., R. 15 E. These were built over a fissure from temporary vents by the bubbling up of pasty clots of semi-molten lava. Another group of these spatter cones (Figures 5 and 6) aligned along a fissure are situated about a mile to the north.

Figure 7 shows the collapsed roof near the entrance to a very interesting lava tube that has been named "Derrick Cave." In some places the height to the roof is more than 50 feet, indicating that the formation of all lava tubes is not as simple as presently explained. Certainly the flow, whose top and sides cooled and later drained owing to pressure of the contained hot fluid lava on its snout, was narrow and thick. Numerous flat benches (Figure 8) on the tube walls show that the drainage of the tube was not continuous but stood still or flowed sluggishly at times. Further study of this lava tube, in which so many primary flow features are preserved, could give valuable information about how they are formed.

Lava Butte area

Lava Butte is situated alongside U. S. Highway 97 about 10 miles south of Bend and is a well-known feature to anyone who has travelled by. A road leading from the highway spirals around this classic, basaltic cinder cone to a parking area at the top. A well-formed crater exists at the apex of this cone and the lava field some 500 feet below can be viewed from its rim. Clinkery aa lava (Figure 9) erupted from a vent at the foot of the cone on the southern side and flowed to the west and northward for about 6 miles, blanketing an area of about 12 square miles. As it was extruded, this flow diverted and dammed the Deschutes River. The gutter through which lava flowed may be seen by following a trail of wooden planks, called the Phil Brogan Trail, which proceeds from the road at the bottom of Lava Butte over the rough lava surface to a viewpoint.

Across the highway to the southeast from Lava Butte is a small area of agglutinated spatter features that are aligned along the same fissure which fed the lava to Lava Butte and its lava field. These features were formed by semi-molten clots of lava thrown out by "fire fountaining" to build irregular mounds.

Figure 10 is a photograph of the quarry cut into Finley Butte, which lies some 12 miles south of Lava Butte. The picture shows the typical structure of a cinder cone, with beds of cinders lying at the angle of repose, about 32 to 35 degrees. Lava Butte would also show this same structure if its slopes were quarried.

Newberry Volcano (Paulina Mountains)

Newberry Volcano, with its large caldera, crater lakes, pumice and cinder cones, and domes of obsidian is one of the largest and most spectacular volcanic areas in central Oregon. Howel Williams (1935) has adequately described many of the features of Newberry Mountain. However, there are at least 150 small subsidiary cones on Newberry Volcano and many that have not been described in detail. Further study of these would seem to be warranted, since a large percentage of the cones and several lava fields, including Lava Cast Forest, are undoubtedly of Recent age. Of interest also are the several lava tubes situated about the flanks of Newberry Volcano. Probably many more of these tubes exist and will eventually be discovered.

Hole-in-the-Ground

Southward beyond the edge of the broad shield of Newberry Volcano are two young craters in T. 25 S., Rs. 12 and 13 E. that should be mentioned because of their resemblance to smaller lunar craters. Hole-in-the-Ground and Big Hole are maar-type craters that are believed to be formed by a series of brief, violent eruptions when rising basaltic magma encounters water or water-saturated rocks near the surface. These and other maar-type features have been described by Peterson and Groh (1961).

Is New Volcanism to be Expected?

Observation of the numerous volcanic cones, flows, and other features which have been formed by eruptions within the last 11,000 years, many within the last millenium, and some almost to the present, calls for wonder. The question then comes to mind: Will new eruptions take place in the near future - the far-off future?

Oregon, along with the other Western States, is within the zone of volcanic activity which surrounds the Pacific Ocean. Several hundred volcanoes in various phases of activity occur in this circum-Pacific belt. This "belt of fire" is also noted for its seismic (earthquake) activity, which signifies mobility of the earth's crust along this zone.

Volcanic and seismic processes in different segments of this belt have varied greatly in intensity throughout past geologic time and also in historic time. For the present, Oregon is enjoying a stage when activity within its segment is probably at its least. Therefore, volcanism in Oregon should be considered only as dormant, not extinct.

Renewal of volcanism in Oregon could well begin next month - this year - next year - or thousands of years hence. That is to say, its occurrence is not predictable in the light of our present-day geologic knowledge.

New eruptions, should they begin, probably would occur in the areas of most recent activity. The dominant zone of Recent volcanism trending northwest from the Four Craters area to that of the Three Sisters, as previously mentioned, would seem to be most favorable in this respect. Nevertheless, the older volcanic monarchs of the Cascade Range, such as Mount Hood and Mount Jefferson should not be thought of as dead. History has demonstrated that numerous volcanoes considered extinct by the nearby inhabitants could become reactivated. Even calderas thought by most volcanologists to have expended the energy of their magma chambers have renewed activity. Consequently, Newberry Crater and Crater Lake, Oregon's outstanding examples of calderas, should not be considered extinct.

New volcanism, though, is signaled almost invariably by earth tremors of moderate to great intensity and of increasing frequency days to months ahead. Crustal movements allowing magma to ascend toward the surface and/or pressures generated by the ascending magma are thought to produce these seismic tremors. A network of seismic stations in addition to the two now existing in Oregon would quickly establish the spot from which these tremors were radiating. Thus the surface locality through which an eruption might occur would be defined. Inhabitants within the zone of danger could be warned and measures for their protection taken.

Conclusions

In this report, we have touched upon only a few of the unique or unusual volcanic landforms existing within the area of Recent volcanic rocks in central Oregon. For the geologist and volcanologist, and for students of these sciences, there is a wealth of features to be observed and from which to reconstruct the volcanic processes leading to their formation.

Similarly, researchers in our nation's manned lunar landing program are offered a great variety of forms which may be landscape features of the moon's surface. Various instrumented probes will determine more thoroughly the composition and texture of the moon's surface in the immediate future. If this surface is comparable to recent volcanic terrain on the earth, then this central Oregon region should be of great value to those who are developing the vehicles and training the men who will land and explore the moon.

Selected Bibliography

Bowen, R. G., 1961, Dating Oregon's geologic past: The Ore Bin, v. 23, no. 2, Oregon Dept. Geology and Mineral Industries, p. 13-18.

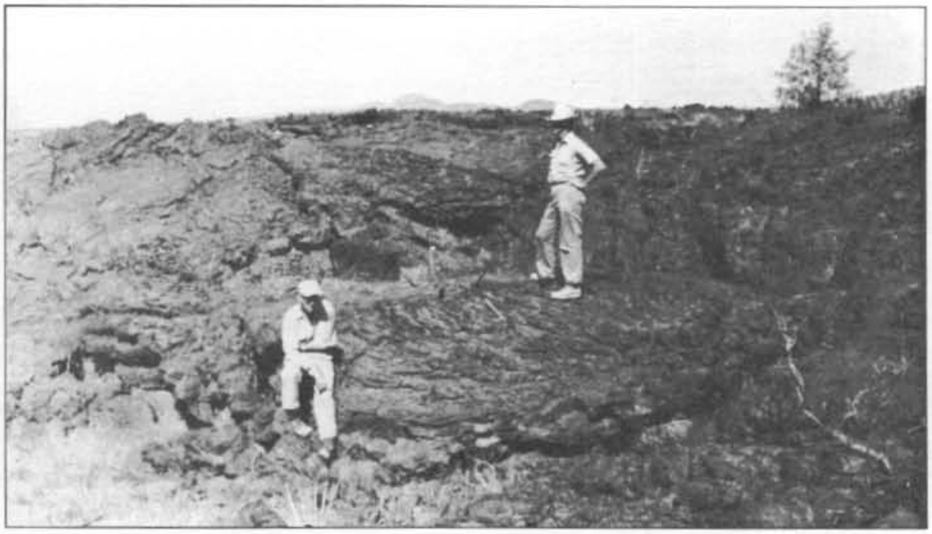


Fig. 3. Typical pahoehoe lava surface on eastern edge of Devils Garden lava field. Hot fluid lava flowed from beneath the cooled crust, causing it to collapse and break into a jumbled mass of slabs.

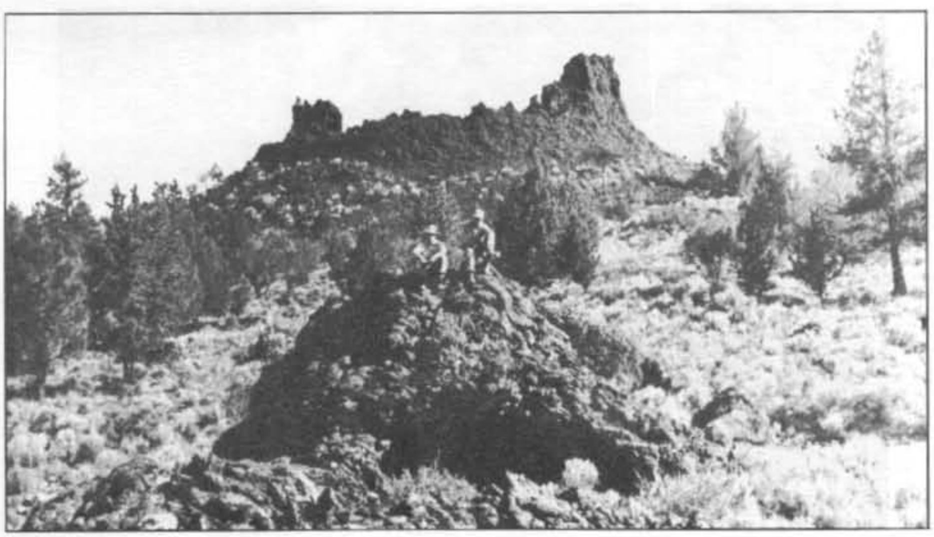


Fig. 4. Small spatter cone is disclosed in foregound. In background is an unusually large spatter cone called a "blowout." Another is hidden behind it.

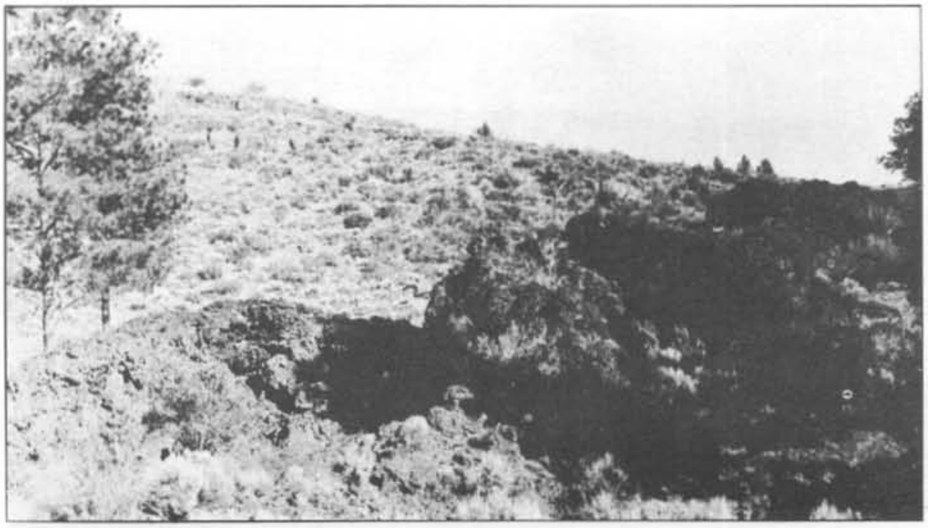


Fig. 5. A row of spatter cones aligned along a westward-trending fissure, which crosses photograph from left to right.

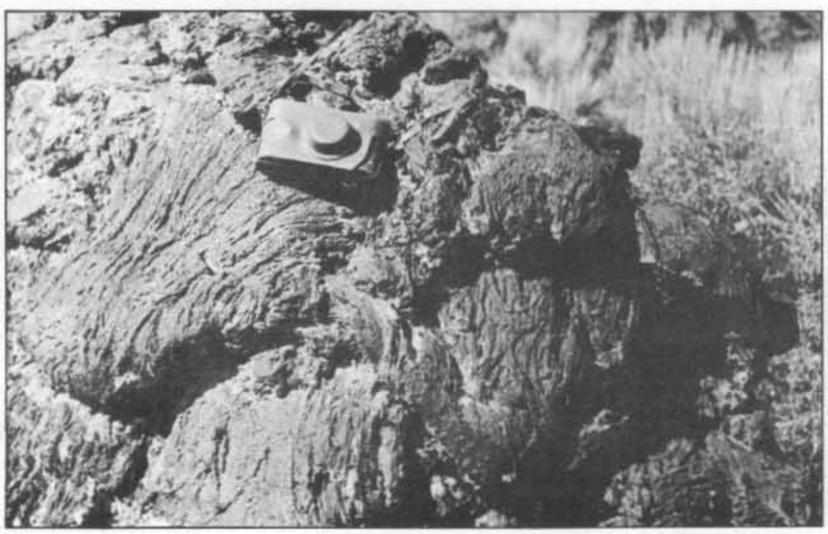


Fig. 6. Detail of flow lines on spatter cone at upper end of row in figure 5. Semi-molten clots of basaltic lava were thrown out and piled on one another to form this feature. Note freshness of lava.

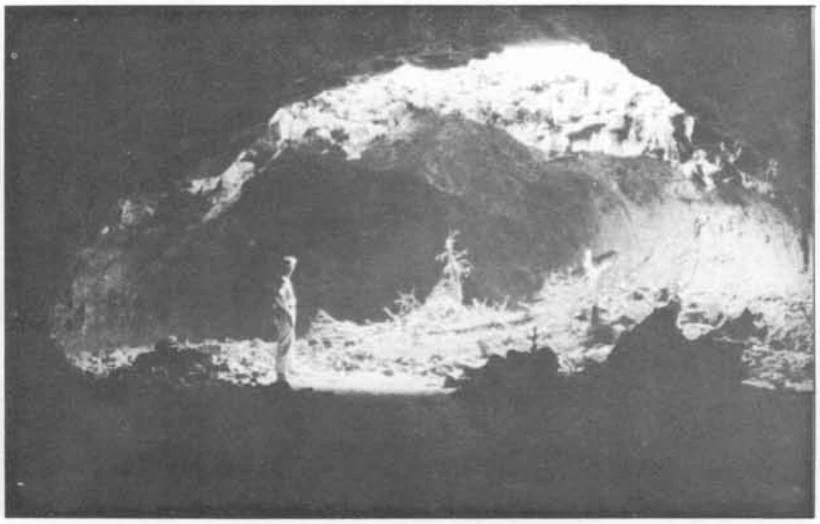


Fig. 7. This photograph was taken a short distance inside entrance of Derrick Cave. The roof has collapsed, allowing light to disclose shape of upper half of this lava tube. Debris from roof fills lower half of cave in foreground.

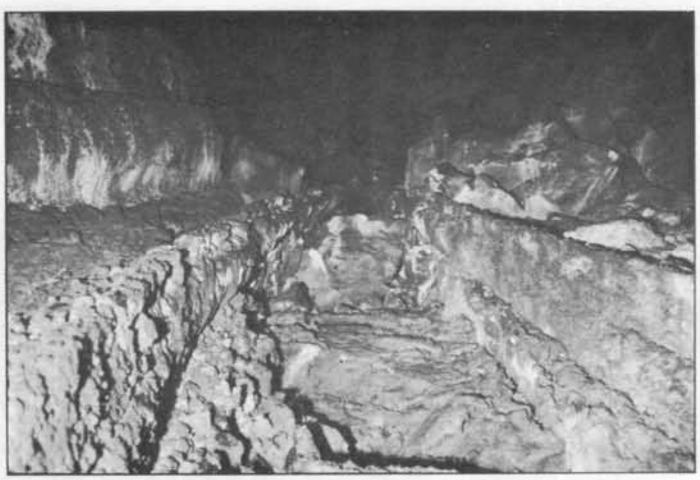


Fig. 8. This photograph taken far back in Derrick Cave displays several benches where lava remained at a temporary level as it flowed from the tube, some of it congealing along the sides. A gutter through last of the lava drained is seen in foreground.

Fig. 9. Clinkery or aa surface of Lava Butte lava field in foregound. Looking eastward, cinder cone of Lava Butte is in background. Lava issued from a vent at right side of base of cone.

Fig. 10. Quarry cut into Finley Butte, picturing bedding of cinders and bombs of a typical basaltic cinder cone. Successive ejections of these pyroclastics produced the beds which lie at angle of repose. Lava Butte has a similar structure.

Bullard, F. M., 1962, Volcanoes in history, in theory, in eruption: University of Texas Press.

Hopson, C. A., 1962, The latest eruptions from Mount Rainier Volcano: Jour. Geology, v. 70, no. 6, p. 635-647.

Lawrence, D. B., 1938, Trees on the march: Mazama, v. 20, no. 12, p. 49-54.

______________, 1941, The "Floating Island" lava flow of Mount St. Helens: Mazama, v. 23, no. 12, p. 56-60.

______________, 1948, Mount Hood's latest eruption and glacier advances: Mazama, v. 30, no. 13, p. 22-29.

Peterson, N. V., and Groh, E. A., 1961, Hole-in-the-Ground: The Ore Bin, v. 23, no. 10, Oregon Dept. Geology and Mineral Industries, p. 95-100.

Williams, Howel, 1935, Newberry Volcano of Central Oregon: Geol. Soc. America Bull. 46, no. 2.

______________, 1953, The ancient volcanoes of Oregon: Condon Lectures, Oregon State System Higher Educ., 2nd ed.

______________, 1957, Geologic map of the Bend quadrangle, Oregon, and a reconnaissance geologic map of the central portion of the High Cascade Mts.: Oregon Dept. Geology and Mineral Industries.

* * * * *

LAND WITHDRAWAL IN MALHEUR COUNTY

Announcement has been received that the Federal Aviation Agency has filed application for the withdrawal of 52.5 acres in T. 34 S., R. 39 E., Malheur County, as an addition to the Rome, Oregon, VORTAC air navigation systems facility.

* * * * *

OIL DRILLING RECORDS RELEASED

The Department of Geology and Mineral Industries released drilling records from its confidential files on Humble Oil & Refining Co. "D. J. Leavitt 1" drilled in Lake County during 1960-61. The well was located approximately 4 miles south of Lakeview and reached a depth of 9,579 feet.

* * * * *

H.R. 61 - Inventory of mining claims on National Forest lands: Kyl (Iowa) - Committee on Interior and Insular Affairs. Would require the Secretary of Agriculture to make a survey of all public lands under his jurisdiction "to establish an inventory of all unpatented mining claims on such lands, determine the current status and validity of such claims, resolve the validity of doubtful claims and of occupancies under alleged mining claims, and to proceed with eviction of all those in unlawful occupancy of unpatented mining claims."

Would require completion of the survey by December 31, 1964 and a report to Congress not later than February 28, 1965, including the Secretary's recommendations relative to the need for further legislation. The Secretary would also be required to advise Congress twice a year thereafter, until all unauthorized occupancies have been eliminated, of the progress being made to eliminate unauthorized occupancies and to resolve doubtful ones.

H.R. 70 - Eliminate duty on limestone spalls, fragments & fines: Pelly (Wash.) - Committee on Ways and Means. Would amend the Tariff Act of 1930 by adding to the free list "Limestone spalls, fragments, and fines (as distinguished from sized rock)."

Related bill: H.R. 1695, by Pelly, which would add to the free list "Limestone, crude, not suitable for use as monumental, paving or building stone; limestone chips and spalls; and limestone, crushed or ground."

H.R. 930 - National Wilderness preservation system: Saylor (Pa.) - Committee on Interior and Insular Affairs. Would establish a National Wilderness Preservation System composed of some 14.6 million acres of national forest areas which are generally open to prospecting and mining under the general mining laws. These areas are now administratively classified as wilderness, wild, primitive or canoe.

Would provide, with limited exceptions, that "there shall be no commercial enterprise within the wilderness system, no permanent road, nor shall there be any use of motor vehicles, motorized equipment, or motorboats, or landing of aircraft nor any other mechanical transport or delivery of persons or supplies, nor any temporary road, nor any structure or installation, in excess of the minimum required for the administration of the area for the purposes of this Act."

Many similar bills, including S. 4 by Anderson (N. M.), which is identical to S. 174 of the last Congress.

H.R. 935 - "Modernize" Mining Laws: Saylor (Pa.) - Committee on Interior and Insular Affairs. Would amend the mining laws to provide that any mining claim hereafter located may not embrace lands of more than four contiguous 10-acre tracts, each of which must be mineral in character, and must be recorded in the appropriate Federal land office by means of a copy of the notice of location to which would be attached a statement listing the minerals for which the claim is located; no rights in an unpatented mining claim "shall be established prior to a discovery of a valuable mineral deposit within the limit of the claim located, and no rights shall be deemed established unless all requirements of this Act are performed within the period of time provided therefor."

Would authorize location of exploration claims embracing contiguous tracts not exceeding 160 acres, with the maximum area in which any one locator could have an interest in any one State limited to 5,120 acres at any one time; exploration claims would have to be described in the location notice as provided with respect to regular mining claims.

Other provisions would (1) give the holder of a valid exploration claim exclusive right to explore for locatable minerals within the exploration claim and exclusive right to locate minerals within the exploration claim under the provisions of the general mining laws; (2) unless sooner terminated, by relinquishment or by location of claims under the general mining laws, terminate all rights in an exploration claim at the expiration of the second exploration year (it would be unlawful for the holder thereof to acquire any further interest in the lands covered by the exploration claim for a period of two years thereafter); (3) require the holder of an exploration claim, upon its termination or expiration, to restore the surface to the condition, so far as it is reasonably possible, in which it was immediately prior to exploration activities; (4) require the holder of any unpatented mining claim located prior to the effective date of the bill to file within two years of that date, in the Federal land office, a copy of the notice of location together with a statement setting forth the minerals for which the claim is valuable (failure to so record a location would constitute an abandonment and forfeiture of the mining claim); (5) with respect to assessment work, require the recorded holder of an exploration claim or an unpatented mining claim to perform at least $10 per acre in assessment work annually and to make a detailed report to the Secretary of the Interior indicating the work done or caused to be done by him during the assessment year (failure of a claimant to report assessment work would be treated as failure to perform the annual assessment work); (6) give the locator or claimant the "right to (A) use so much of the surface as may be reasonably necessary for mining purposes and (B) acquire, through lease, purchase, or permit, the use of surface resources reasonably required for mining purposes"; (7) terminate the rights to mineral deposits in any mining claim hereafter located at the boundaries of the claim; (8) require applications for patent to be filed (a) within 10 years from the effective date of this Act with respect to claims heretofore located, and (b) within 10 years from the date of location with respect to any claim located after the effective date of the bill (failure to make a mineral patent application within the specified time would terminate the rights within the limits of the claim); and (9) specify that patents to mining claims located on and after the effective date of this Act "shall convey to the patent applicant the mineral estate only; subject, however, to the right of the patentee to purchase or lease surface rights, at fair market value as determined by the head of the department or agency having jurisdiction over the lands involved, for use of so much of the surface as may be necessary for mining and milling purposes only: PROVIDED, That in any areas within national forests the patentee may only receive temporary use of the surface, by lease, permit, or otherwise, to the extent required during the mining operations."

H. R. 2460 - Comprehensive program for a healthy mining industry: Baring (Nev.) - Committee on Interior and Insular Affairs. Title I would state that "Congress has determined that it is essential that the United States be as nearly self-sufficient as is reasonably economically possible in all useful minerals and metals as well as those classified by the Government as strategic and critical, since dependence upon foreign sources invites possible national suicide."

Title II would amend the Minerals Exploration Act of 1958 to "include development work as necessary to bring such minerals into production."

Title III would authorize the location of temporary mining claims for geological, geochemical, geophysical and other scientific methods of prospecting for minerals.

Title IV would require the Secretary of the Interior, if he finds "(1) that the domestic production of any metallic or nonmetallic mineral is being or has been reduced because of the importation of competing products or because of economic conditions to a point where the national defense or the national economy is imperiled, or (2) that the maintenance of, or an increase of production in, any portion of the mining industry would benefit the national defense or economy, or both /to/ impose such import quotas, make such incentive payments, and authorize such barter contracts as may be necessary to maintain or increase such production. Incentive payments may, at the option of the Secretary, be made on an individual mine basis, based upon production costs." Would also authorize the Secretary to make loans to operators of unprofitable mines.

Title V would authorize the Secretary of Interior to establish a program to assist mine operators in meeting the cost of pumping and other required maintenance with respect to mines which can not be profitably operated, if the metals and minerals in such mines are necessary to the national defense.

Title VI would authorize necessary appropriations to carry out the bill's provisions.

S. 57 - National policy on utilization of natural resources: McGee (Wyo.) - Committee on Interior and Insular Affairs. Would require the President to transmit annually to Congress a Resources and Conservation Report setting forth "(1) the condition of the soil, water, air, forest, grazing, mineral, wildlife, recreational, and other natural resources with particular reference to attainment of multiple purpose use; (2) current and foreseeable trends in management and utilization of the aforesaid natural resources; (3) the adequacy of available natural resources for fulfilling human and economic requirements of the nation; (4) a review of the conservation programs and activities of the Federal Government, the state and local governments, and nongovernmental entities and individuals with particular reference to their effect on full conservation, development, and utilization of natural resources; (5) a program for carrying out the policy...together with such recommendations for legislation as he may deem necessary or desirable."

Would create in the Executive Office of the President a Resources and Conservation Council composed of three members appointed by the President, with Senate consent, to (1) assist the President in the preparation of his annual Resources and Conservation Report, (2) gather information concerning natural resource and development trends, and (3) recommend to the President national policies to promote conservation, development, and utilization of natural resources.

S. 139 - Federal minerals survey: Metcalf (Mont.) - Committee on Interior and Insular Affairs. Would authorize the Secretary of the Interior to conduct a survey of Federally owned land for the purpose of locating deposits of minerals and mineral fuels necessary to the national security and economic welfare of the United States. The Secretary would submit to Congress, and make public, records which would include (1) the probable location of strategic minerals and approximate grade of ore, and (2) the availability of mineral lands whether under the mining laws or mineral leasing laws. Would authorize appropriations of not to exceed $7 million annually to carry out the purposes of this Act.

(American Mining Congress Legislative Bulletin No. 63-1, Feb. 5, 1963)

* * * * *

TERTIARY DEPOSITIONAL HISTORY PUBLISHED

"Tertiary Geologic History of Western Oregon and Washington," by P. D. Snavely, Jr., and H. C. Wagner, has been published as Report of Investigations No. 22 by the Washington Division of Mines and Geology. In the 25-page booklet the authors recount on a broad regional basis the evolution of the Tertiary geosyncline that occupied western Oregon and Washington and illustrate their concepts by a series of paleogeographic maps. The report, which is of particular interest to those concerned with petroleum exploration, is for sale by the Department of Conservation, Olympia, Washington. The price is 25 cents.

* * * * *

SURVEY ISSUES NEW REPORTS ON OREGON

Four Water-Supply Papers and one Bulletin concerning the geology in certain parts of Oregon were issued recently by the U.S. Geological Survey. All are for sale by the Superintendent of Documents, Government Printing Office, Washington 25, D.C. Prices of some have not been announced.

1. "Ground Water in the Coastal Dune Area near Florence, Oregon," (Water-Supply Paper 1539-K) by E. R. Hampton. Evaluates the ground-water supply in the extensive dune sheet north of Florence, Briefly describes the geology of the area, and includes a geologic map. Price not announced.
2. "Ground-Water Resources of the Coastal Sand-Dune Area North of Coos Bay, Oregon," (Water-Supply Paper 1619-D) by S. G. Brown and R. C. Newcomb. Evaluates the ground-water supply in the dune area north of Coos Bay and summarizes the geology. Price 55 cents.
3. "Ground-Water Resources of Cow Valley, Malheur County, Oregon," (Water-Supply Paper 1619-M) by S. G. Brown and R. C. Newcomb. Explains limitations on ground-water supply for small structural basin in northern Malheur County, describes geology, and includes a geologic map. Price 45 cents.
4. "Problems of Utilizing Ground Water in the West-Side Business District of Portland, Oregon," (Water-Supply Paper 1619-O) by S. G. Brown. Presents geologic and hydrologic data on occurrence and use of ground water and includes a geologic map and cross sections. Price not announced.

5. "Geology of the Anlauf and Drain Quadrangles, Douglas and Lane Counties, Oregon," (Bulletin 1122-D), by Linn Hoover. Part of the Survey's investigation of petroleum possibilities of the Coast Range in Oregon. Shows that area is underlain by approximately 20,000 feet of Eocene sedimentary and volcanic rock, including the Umpqua, Tyee, and Spencer marine formations, and the Fisher Formation of nonmarine pyroclastic and volcanic rocks. Post-Eocene intrusive and extrusive rocks occur locally. Includes a multicolored geologic map. Price not announced.

* * * * *

STOCKPILE CHECKS RED CHINESE CONTROL OF TUNGSTEN

The U.S. tungsten stockpile is now worth something like $440 million less than the U. S. originally paid for it. But this huge stock may be the key to thwarting Red China's attempts to seize control of the Free World industry.

The situation is already serious. So serious that, even as the Congo-Katanga crisis teetered on the edge of success or failure, 28 members of the United Nations held a two-day closed meeting on tungsten. The problem is price. The working paper for the UN delegates called it "depressed." A spokesman for a U.S. company involved in tungsten says, "Never has there been a depression of prices over such a long time." And a spokesman for another company says prices are "badly deteriorated." The UN conference complained of the "paucity of statistical data" with which to get a complete world picture pointing to effective remedial action.

A spot check of U.S. companies doing business in tungsten found none willing to talk for the record. But all agreed that Red China is at the core of the problem. And none held any glimmer of hope that the situation would improve much in the immediate future, despite UN interest.

The situation is this. Red China has by far the largest known deposits of tungsten ore. And it is high quality. Estimates run as high as 70 percent of world reserves. But the exact amount is a matter of conjecture. There is no doubt that China cannot, at this stage of its industrial development, use the vast majority of the tungsten it is producing. One U.S. tungsten man estimates Chinese output at about 20,000 short ton units of tungsten trioxide (WO_3) He figures they can use only about 1000 tons. And the rest is being dumped directly and indirectly on Free World markets at substantially below the going market. Estimates run as much as 20 percent below.

Tungsten is the metal with the highest melting point and is being used increasingly in space and military applications. But this is not the major consideration of the Chinese. The feeling is that China needs foreign exchange to buy industrial equipment. Its surplus tungsten provides an excellent opportunity to get what is needed. But as China drives the Free World price lower, the return from the tungsten also goes lower: the Chinese must discount to sell. The next logical step, say Free World commentators, would be to make a concerted attempt to drive Free World mines to the wall. When mines were forced out of business, the consumers would be dependent on Chinese ore. China could then put the price at any level. And once a mine is closed it is expensive and time-consuming to open it again. But, as long as the U.S. has large stocks to offset any bad sag in supply, the consensus is the Chinese are stymied - and know it. (F.J. Starin in The IRON AGE for Feb. 28, 1953.)

* * * * *

METALS AND MINERALS CONFERENCE APRIL 24-27

Four full days of activities have been scheduled for the Pacific Northwest Metals and Minerals Conference to be held at the Multnomah Hotel, Portland, April 24-27. More than 600 miners, metallurgists, space-age specialists, bankers, geologists, and students are expected to attend the 18 technical sessions on the 25th and 26th. Field trips to exotic metals plants, space-age testing facilities, and specialty steel plants will be conducted on the 24th and 27th. Social activities on Wednesday, Thursday, and Friday nights will round out the full schedule for the conference.

The Second Gold and Money Session has attracted from South Africa, New York, and California speakers who are recognized internationally as experts on gold in international finance. Problems of the domestic mining industry will be discussed by a panel of speakers headed by S.H. Williston of Cordero Mining Co. Stockpiling policies of the federal government currently receiving much publicity will be discussed along with the problems of the small miner, the effect of public lands administration, and other subjects of interest to the domestic minerals producer.

The growing impact of electric furnace operations in the area is reflected in the all-day session devoted to that subject with 10 top metallurgists from all parts of the country listed as speakers. Corrosion in the pulp and paper industry, fabrication of missiles, space-age materials, semi- and super-conductors, foundry sand and mold materials, and both astro and submarine geology are subjects to be discussed in other technical sessions.

* * * * *

The ORE BIN
Volume 25, No. 4
April, 1963

INVESTIGATIONS OF THE EARTHQUAKE OF NOVEMBER 5, 1962, NORTH OF PORTLAND

By
P. Dehlinger[1], R. G. Bowen[2], E. F. Chiburis[1], and W. H. Westphal[3]

Introduction

Earthquakes are one of the most destructive of the earth's natural phenomena. The larger earthquakes provide the bulk of our information about the interior of the earth, smaller quakes much of the information on nearby crustal and subcrustal structures. Seismograms (recordings) of the November 5, 1962, Portland earthquake and later shocks in the Northwest written at different seismic stations are being analyzed to provide information on these earthquakes and on the local crustal structures in the Northwest. These analyses concern locating earthquake epicenters and determination of their origin times, depths of foci, mechanisms of faulting at the source, and the nature and configuration of the crust and subcrustal material.

The Portland earthquake was the largest shock to occur in Oregon since the recent installations of the several new seismic stations in the Pacific Northwest. Although damage resulting from this shock was minor, as indicated in a preliminary report (Dehlinger and Berg, 1962), the shock is of considerable seismological importance. Because it was large enough to be recorded at the newly installed as well as at many of the older seismic stations, and because its epicentral location was known approximately from the felt area and from on-site recordings of aftershocks, this earthquake has provided the first significant data to be used for constructing travel-time curves for Oregon. The seismograms also provided data for a better understanding of the source mechanism associated with the Portland shock.

Sufficient energy was propagated from the focus to trip the U. S. Coast and Geodetic Survey strong-motion seismographs located in Portland, such

[1] Geophysics Research Group, Department of Oceanography, Oregon State University, Corvallis.
[2] State of Oregon, Department of Geology & Mineral Industries, Portland.
[3] Stanford Research Institute, Palo Alto, California.

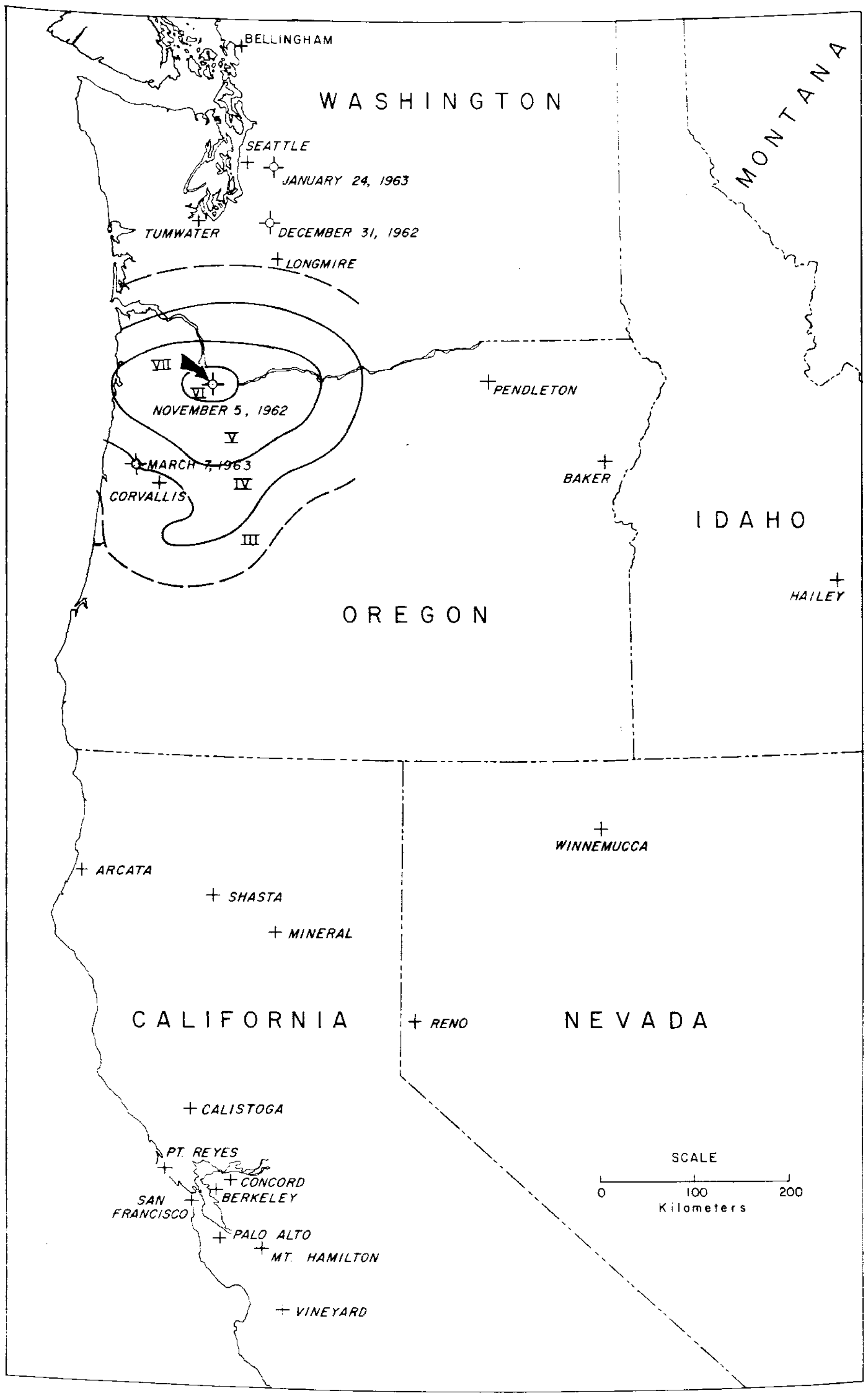


Figure 1. Location and isoseismal map, showing (1) epicenters of the November 5 (Portland), December 31, January 24, and March 7 shocks; (2) locations of seismic stations; (3) isoseismal lines of felt area for the Portland shock (isoseismal map reproduced from Dehlinger and Berg, 1962).

that measurements of ground acceleration were obtained. Conventional seismographs at most of the stations in Oregon, Washington, and Idaho went so far off scale with the first arriving waves that arrivals of very few of the later waves could be measured. At the more distant stations in California and Nevada, later arrivals were measured.

Aftershocks nearly always occur subsequent to an earthquake. Numerous aftershocks followed the Portland temblor, about 50 of which were recorded over a period of 18 days by three portable seismic stations in the Portland area.

Seismology

Recording stations

Seismograms were analyzed from more than 26 stations (Fig. 1) recording this shock. Eight of these stations are in Oregon, Washington, and Idaho. Because of their relative proximity to the source or their higher instrumental magnifications, these stations provided most of the data used in determining the epicentral location. The stations are located at:

Corvallis, Oregon (lat. 44°35.1'N, long. 123°18.2'W).
Baker, Oregon (lat. 44°50.9'N, long. 117°18.3'W).
Pendleton, Oregon (lat. 45°36.7'N, long. 118°53.0'W).
Seattle, Washington (lat. 47°39.3'N, long. 122°18.5'W).
Longmire, Washington (lat. 46°45.0'N, long. 121°48.6'W).
Tumwater, Washington (lat. 47°05'N, long. 122°56'W).
Bellingham, Washington (lat. 48°44.2'N, long. 122°29.0'W).
Hailey, Idaho (lat. 43°38.9'N, long. 114°16.0'W).

Sixteen of the stations are in central and northern California and two in western Nevada. All but one of these 18 stations are part of the University of California network of seismic stations for detecting and locating earthquakes in California, one of the outstanding such networks in the world.

Five of the eight stations in Oregon, Washington, and Idaho have new instruments that were installed during the past year. The stations at Corvallis* and at Longmire, the latter operated by the University of Washington,

* The Corvallis station was set up in 1950 by the University of California and operated by the Oregon State University Department of Physics as part of the University of California network of stations. In 1962 the instruments were replaced with the new standardized units. The station is no longer part of the University of California network; it is now operated by the Geophysics Research Group, Department of Oceanography, Oregon State University.

are part of the world-wide network of Standard Stations equipped with uniformly calibrated sets of short- and long-period seismographs, provided and installed by the U.S. Coast and Geodetic Survey as part of the VELA UNIFORM* program. The Blue Mountain Seismological Observatory at Baker, Oregon, is one of the most sensitive seismic stations in existence. It contains 21 seismometers, 10 of which are part of special arrays which provide for recordings at exceptionally high signal-to-noise ratios. This observatory is one of five similar ones established in the United States as part of the VELA UNIFORM program. The Pendleton and Hailey stations are semipermanent stations, operated by the Geotechnical Corp. of Dallas, Texas, as part of the VELA UNIFORM program. These stations have very sensitive short- and long-period seismographs. Except for the Corvallis station, which operated with the old instruments, the only stations operating in western Oregon and Washington prior to 1961 were the University of Washington stations at Seattle and Tumwater.

In addition to the permanent and semipermanent stations, three portable stations were set up in the vicinity of Portland to record aftershocks. These were operated by the Stanford Research Institute for 18 days, beginning three days after the main shock. Each portable station consisted of an array of exploration-type seismometers.

Travel-time curves

Accurate travel-time curves are of great value in locating earthquake epicenters. Prior to the Portland shock, travel-time curves applicable to California had been used in Oregon, since there were too few seismic stations in and around Oregon to develop such curves. However, crustal thicknesses and crustal and subcrustal velocities are not likely to be the same in the two areas. The earthquake in Portland and three later quakes in western Washington and Oregon (December 31, 1962, lat. 47°02'N, long. 121°58'W; January 24, 1963, lat. 47°28'N, long. 121°57'W; March 7, 1963, lat. 44°46'N, long. 123°37'W) recorded at seismic stations in the Northwest provided materials for construction of preliminary travel-time curves for Oregon and vicinity.

Although these travel-time curves will not be complete until either many more local shocks are recorded at the present stations, or a larger number of stations are established to record future local shocks, they have

---

* A large-scale program sponsored by the U.S. Department of Defense for detecting and for developing methods of detecting the detonation of large underground nuclear explosions, and for developing methods of differentiating recordings of explosions from those of earthquakes.

been significant in investigating the shock north of Portland. The preliminary curves do indicate that either (1) the subcrustal compressional (Pn) and shear (Sn) wave velocities are somewhat lower in western Washington, Oregon, and northern California than are the comparable velocities in a southeasterly direction east of the Cascade Mountains, or (2) the crust of the earth (that is, material above the Mohorovicic discontinuity*) thins in an easterly direction across eastern Oregon. The latter is not considered as likely. Recordings in Oregon and Washington of shocks originating in Idaho or Utah must be awaited, however, to establish whether present velocity determinations across eastern Oregon are correct. Recordings of numerous local shocks in western Oregon and Washington will also be required before travel-time curves can be established for different compressional (P) and shear (S) waves traveling within the crust.

Main earthquake

The epicenter and origin time of a shock indicate the location on the surface and the time of occurrence of the initial source motion. Directions of ground displacements at the receiving stations resulting from the incident compressional wave are determined by the initial source motion. The source is considered to be a fault in which the rupture progresses along the fault surface for the duration of the shock. This duration is usually short. From seismograms of the Portland shock, it was estimated that the source motion lasted no more than a few seconds.

Epicenter and origin time: With the new travel-time curves, the earthquake epicenter was placed at latitude 45°36'N, 122°40'W, which is north of Portland and near Vancouver, Washington. The origin time was set at 7 hr 36 min 43.0 sec PM, PST, November 5 (3 hr 36 min 43.0 sec, GCT, November 6). These values provided smooth plots on the travel-time curve for the P_n waves at all stations in Oregon, Washington, and Idaho, except at Tumwater, which exhibited early arrival times. They also provided for satisfactory plots at most of the stations in California and Nevada.

Magnitude and intensity: The magnitude of the shock is placed at 5

* Seismic discontinuity about 35 km below the continents and about 10 km below the oceans which separates the earth's crust and mantle.

on the Richter scale*. Magnitudes of 4 3/4 were obtained from seismograms recorded at Corvallis (only an approximation because amplitudes were offscale during much of the recording), and 5 1/4 to 5 1/2 from those at Palisades, New York, and 4 3/4 from those at Berkeley, California.

The maximum intensity was VII on the Modified Mercali Scale, 1956 version (based on a maximum of XII; see Richter, 1958, p. 137 for complete scale). This was observed in north Portland, where a ceiling light fixture fell to the floor in a city library; in other parts of Portland masonry was cracked and some chimneys were toppled. This intensity is also consistent, according to Richter's findings (Richter, 1958, p. 140) in California, with accelerations recorded by the U.S. Coast and Geodetic Survey strong-motion seismographs in Portland. These instruments recorded a maximum ground acceleration of 0.16 g (vertical component of 0.076 g and two horizontal components of 0.103 g and 0.096 g). The decrease in intensity away from the epicenter is illustrated by the isoseismal lines in Figure 1; these lines are reproduced from Dehlinger and Berg, 1962.

Depth of focus: The focal depth could not be determined accurately because all seismic stations were too far away. A best depth estimate is 15 to 20 km**. Depth calculations were based on epicentral distances and travel times to the Corvallis, Longmire, and Seattle seismic stations, using the standard equation

$$h = \sqrt{(TV_p)^2 - \Delta^2}$$

where T is the travel time, V_p the velocity of propagation from focus to station, and Δ the epicentral distance. Values of V_p were estimated since they have not yet been established for the Oregon-Washington area. The h is quite sensitive to small variations in velocity. A V_p of 6.1 km/sec to Corvallis gives a depth of 16 km; a V_p of 6.2 km/sec gives a depth of 28 km. An average velocity of 6.0 to 6.1 km/sec is consistent with the Corvallis arrival on the travel-time curves. Similarly, using a V_p of 6.4 km/sec to Longmire and 6.5 km/sec to Seattle, both sets of values being consistent with travel times and epicentral distances at these two stations, a focal depth of 15-20 km is obtained. Depth estimates could not be made from the arrival at Tumwater without resorting to excessive velocities; either

---

* Magnitudes according to this scale are based on ground amplitudes recorded at seismic stations. The scale ranges from 0, the smallest recorded shocks, to 8 3/4, the world's largest and most destructive earthquakes. For descriptions of the magnitude scale, see Richter, 1958, p. 340.

** 1 Kilometer equals approximately 0.621 mile.

the arrival time at Tumwater was in error or waves arrived early because of anomalous conditions in the vicinity of the station.

Very small increases in the assumed average velocities result in a substantial increase in calculated depth; conversely for small decreases in the velocities. Clearly, the depth estimates also depend on the accuracy of the epicentral and origin-time determinations.

The best depth determinations are obtained at stations near the source. The Stanford Research Institute portable stations in the Portland area were well situated for aftershock depth determinations, but these calculations will not be completed for some time. The focal depths of aftershocks need not, however, be the same as that of the main shock, although experience in California has demonstrated that the average depth of aftershocks is usually about that of the main shock.

Source motion: The direction of displacement at the source was investigated from initial ground displacements recorded at the stations. For the eight stations in the Northwest, these initial displacements were:

Corvallis - north, with small down and east motions.
Baker - up, south, and west.
Pendleton - up (other two directions not determined).
Seattle - down, with small south and east motions.
Longmire - down, with small south and west motions.
Tumwater - down and south, with small east motions.
Bellingham - down, south, and east.
Hailey - up (other two directions not determined).

The displacements are plotted in Figure 2 at the respective station locations. This figure also indicates the quadrants with respect to an assumed northwesterly trending strike-slip fault in which initial ground motions of the direct and refracted compressional waves should be compressions or dilatations (Gutenberg, 1941, Figs. 1 and 2). As the observed initial ground motions were dilatations at Corvallis, Longmire, Tumwater, and were compressions at Pendleton, Baker, and Hailey, the source motion could have been along a northwesterly trending strike-slip fault with a right-handed displacement (as illustrated in Fig. 2), which is of the same sense as the San Andreas fault. The first-motion observations fit equally well a northeasterly trending strike-slip fault with a left-handed movement, of the same sense as the Garlock fault of California. The data are not consistent with a predominantly vertical fault motion; hence, the faulting would not be normal or reverse. However, some vertical component of motion may have

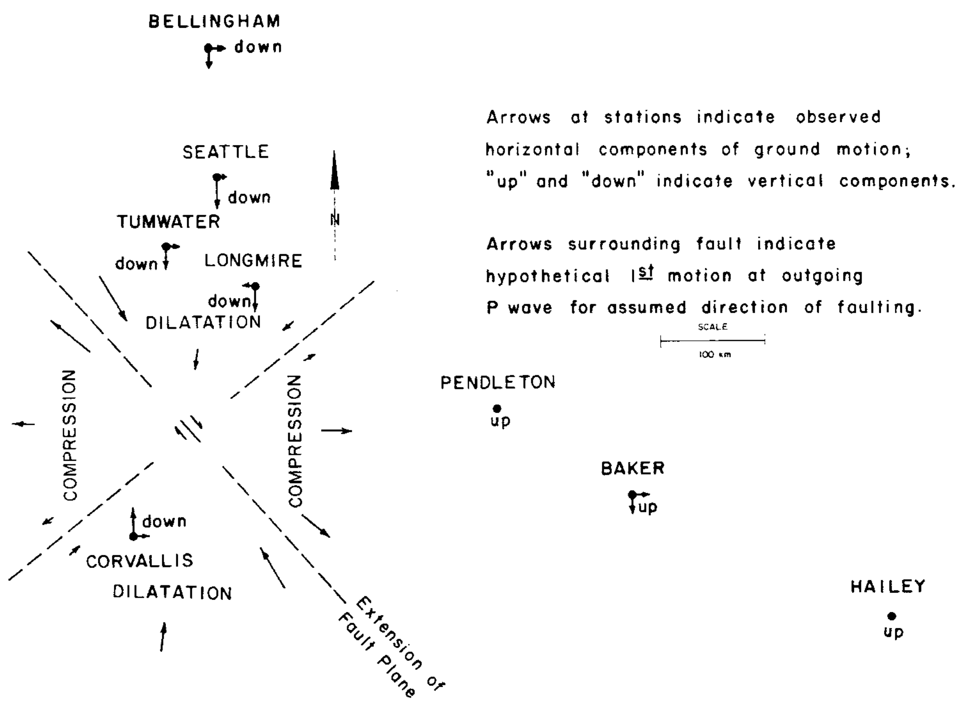


Figure 2. Components of first motions in the initial compressional wave recorded at the different stations; hypothetical dilatational and compressional first motions radiated from a northwesterly trending right-handed strike-slip fault.

accompanied the strike-slip motion.

If strike-slip faulting was the source motion, it then appears that the stress distribution acting in the Portland area has a maximum principal stress in approximately a north-south direction, with a minimum principal stress in the vertical direction.

Aftershocks

Numerous aftershocks were recorded subsequent to the main shock. Apparently none of these were large enough to have been felt in the Portland area. Several of these were sufficiently large to have been recorded at Corvallis and at Longmire. Corvallis reported aftershocks until November 15. Several later shocks were recorded from the Portland area which were larger than the earlier aftershocks, occurring on December 18, 1962; February 26, 1963; and March 2, 1963. These later three are probably separate shocks, however.

Aftershock measurements were made with three portable seismic stations operated by the Stanford Research Institute in the Portland area between

November 9 and 26. The three stations recorded a total of 50 aftershocks during this time, one on the 9th, one on the 26th, and the others between the 10th and 23rd (Westphal, 1962).

The three stations were located at distances of 18 to 35 km from the epicenter (stations A, B, and C, Fig. 3); the high seismic noise level in the city necessitated station sites out of town. Sites of the initial stations were based on preliminary epicentral locations; they were found to be too far south. Hence, two of the stations were moved; Station A_1 was moved to A_2 (Fig. 3) and Station C_1 to C_2. Station B was not moved. Each station consisted of six 4 1/2 cps seismometers arranged in L-shaped arrays to permit azimuthal determinations of incoming waves.

At a later time the Stanford Research Institute plans to make directionality and depth-of-focus computations of recordings at each portable station. These results will be made available when calculations are completed. The largest number of aftershocks, especially during the latter part of the recording time, were recorded at Station C_2 (Westphal, 1962), which is the station nearest to the epicenter of the main quake. The proposed epicentral location of the main shock is thus consistent with the present aftershock results.

Geology

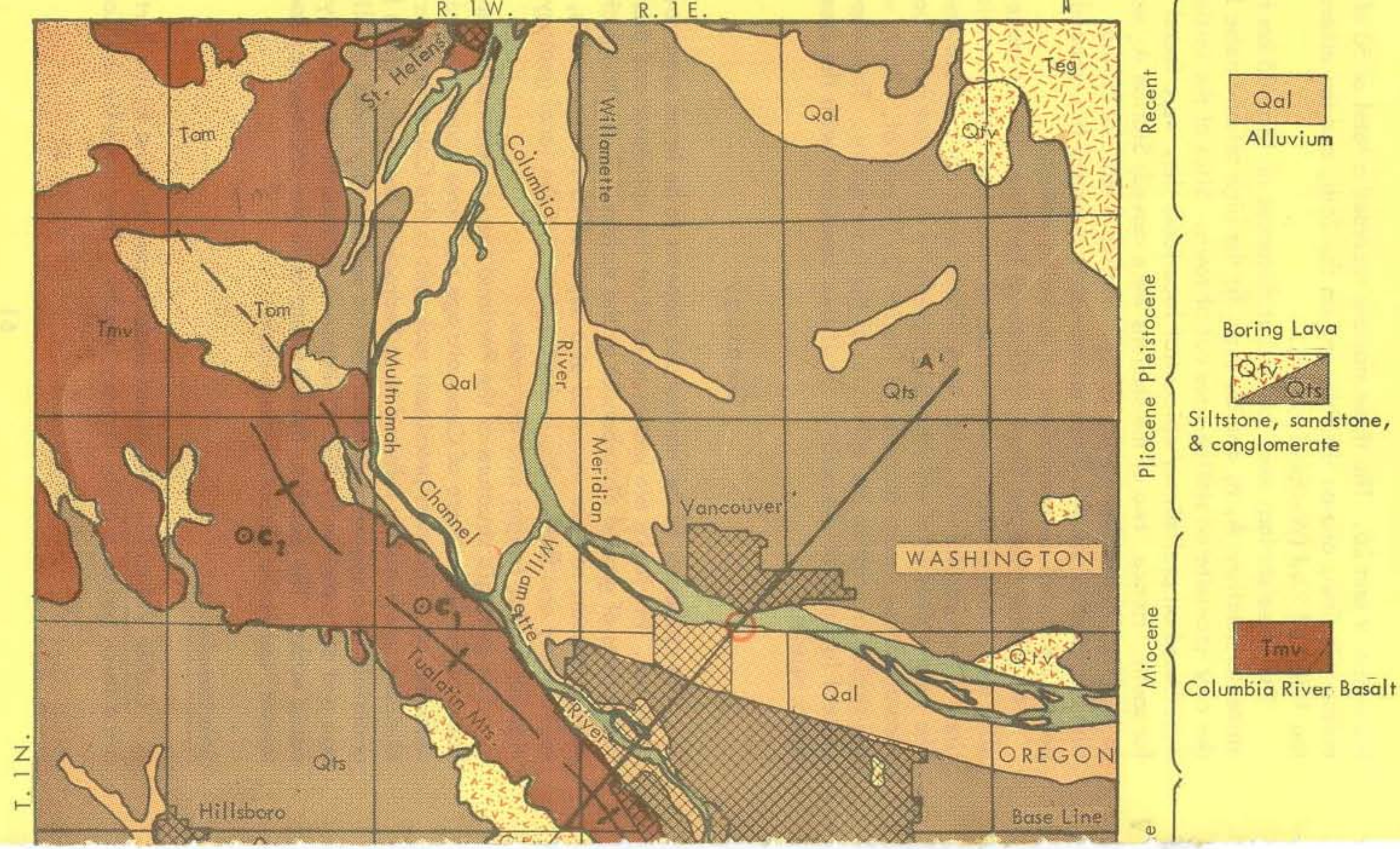
The epicenter of the earthquake appears to be in an area covered by alluvium. No faults are known to exist at the epicenter and there were no indications of ground disturbances at the surface. Even though the source motion appears to have occurred at a depth of 15-20 km, that is, below the sedimentary and flow rocks, a short summary of the local geology will provide for further insight into the quake.

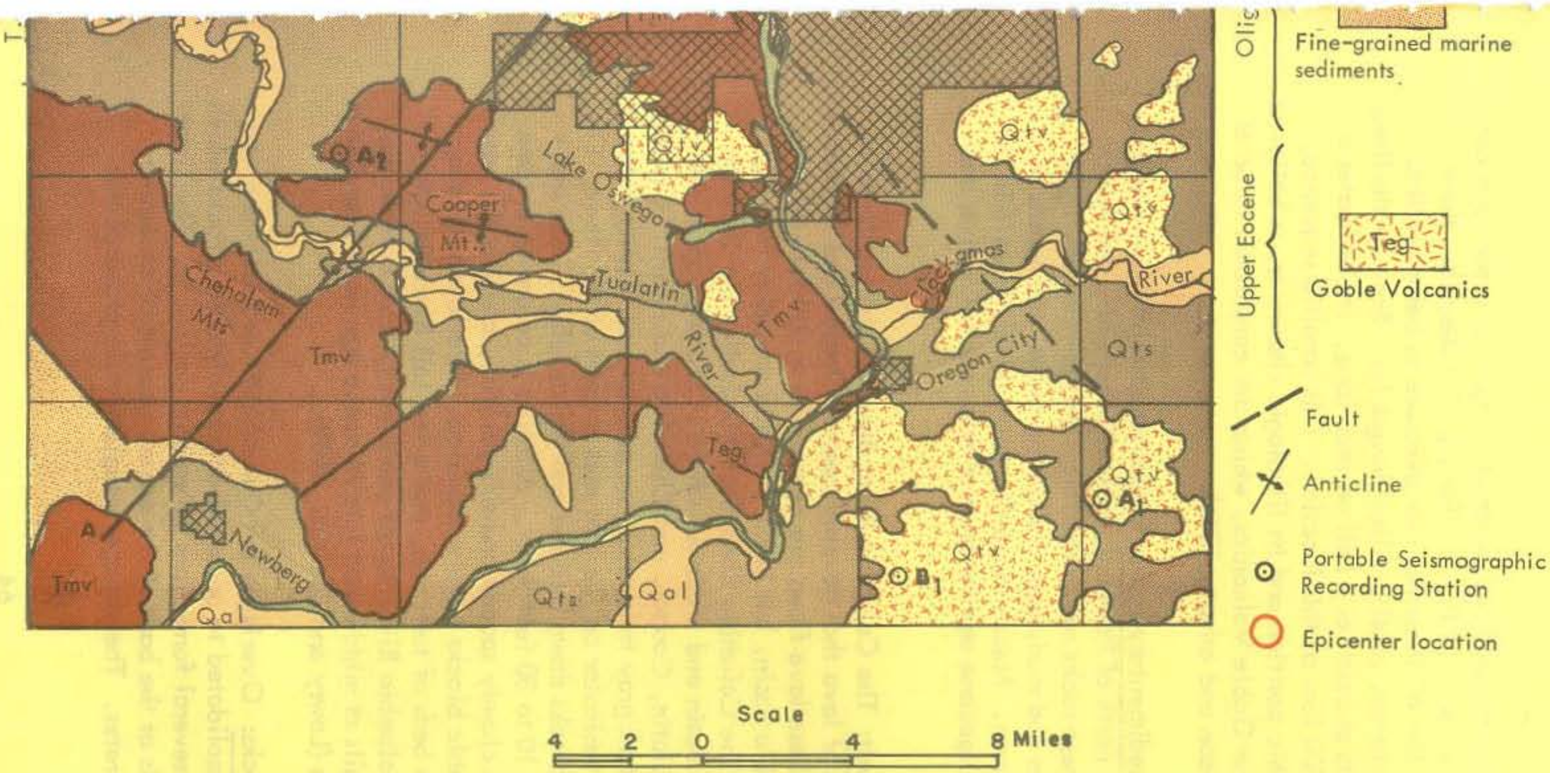
The geologic structure of the Portland area is relatively simple (Fig.3). Rocks at the surface are of Cenozoic age and have undergone only small deformation. The most prominent rock unit is the Columbia River Basalt of Miocene age, usually referred to as bedrock in the area. These basalts are underlain by a sequence of older marine sedimentary rocks of Oligocene age and are overlain by Plio-Pleistocene continental sedimentary and volcanic rocks. The depth to the basement or to pre-sedimentary rocks is not known, nor is the nature of these rocks.

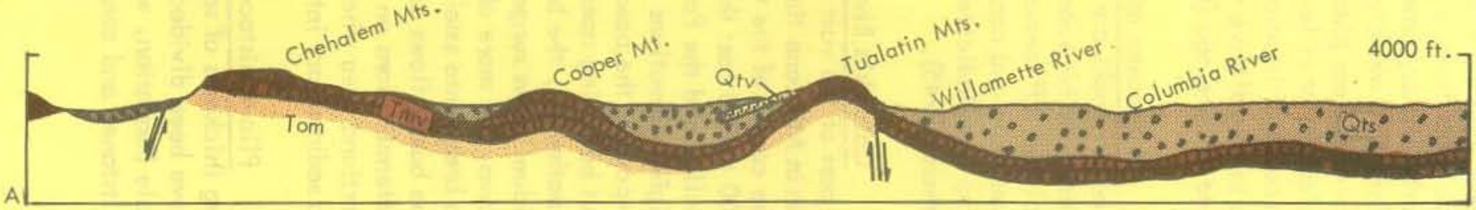
Stratigraphy

Goble Volcanics: The oldest rocks known to exist in the Portland area are a thick series of early Tertiary basalts. They underlie the Columbia

Figure 3. Geologic map of the Portland area, Oregon: A_1, B_1, C_1 are initial portable station locations used for aftershock measurements; A_2, C_2 are the locations to which A_1 and C_1 were moved on the basis of initial aftershock recordings.




Olig
Fine-grained marine sediments
Upper Eocene
Teg
Goble Volcanics
Fault
Anticline
Portable Seismographic Recording Station
Epicenter location
Lake Oswego
Cooper Mt.
Chehalem Mts
Tualatin
River
Clackamas
River
Oregon City
Newberg
Tmv
Teg
Qtv
Qts
Qal
A
Scale
4 2 0 4 8 Miles


Chehalem Mts.
Cooper Mt.
Qtv
Tualatin Mts.
Willamette River
Columbia River
4000 ft.
Tom
Tmv
Qts
A
A'

River Basalt along the Willamette River south of Oregon City and crop out again northeast of Vancouver. Schlicker (1954, p. 27) describes these early Tertiary basalts in the Willamette River exposure as being mottled black and white with numerous zeolite-filled amygdules. Some of the flows have feldspar phenocrysts as much as a half an inch long. He estimates a thickness of at least 1,500 feet at this location. This basaltic sequence, because of its stratigraphic position and its lithologic character, is believed to be correlative with the Goble Volcanics, which are considered to be of late Eocene age (Wilkinson and others, 1946).

Oligocene marine sedimentary rocks: Extensive areas of marine sedimentary rocks are found north of Portland, around Scappoose, and to the west near Newberg. These rocks are predominantly fine-grained, light-colored tuffaceous shales and mudstones containing occasional lenses of limestone and conglomerate. Fossils found at various localities within the map area indicate an Oligocene age for most of these rocks (Warren and others, 1945).

Columbia River Basalt: The Columbia River Basalt in the map area is a part of the vast floods of lava that covered central Oregon and Washington in Miocene time. These lava flows are as much as 6,000 feet thick in the center of the Columbia Basin, but in the Portland area they are only 600 to 800 feet thick. The Columbia River Basalt underlies the Tualatin Valley and the Portland Basin and crops out where it is bowed up at the higher elevations on Tualatin, Cooper, and Chehalem Mountains. On fresh exposures the basalt is dark gray to black, fine grained and usually dense but becoming open and vesicular on the tops and bottoms of the flows. On weathering, the basalt breaks down into red and yellow clays. The individual flows range from 10 to 30 feet thick. Jointing is columnar in some flows, but more often is closely spaced and sub-parallel, causing the basalt to break into small rhombic blocks upon weathering. Interlayered among the basalt flows are thin beds of tuff, ash, and a few soil horizons. Age determinations on the Columbia River Basalt come mostly from outside the Portland area where fossils of middle and late Miocene age have been found in sedimentary interbeds (Lowry and Baldwin, 1952).

Plio-Pleistocene rocks: Overlying the Columbia River Basalt is a varying thickness of semiconsolidated to unconsolidated sedimentary rocks which have been divided into several formations by various geologists. The Troutdale Formation, which is at the base of the series, consists of sandstone, siltstone, and conglomerates. The younger conglomeratic phase of this formation is frequently quite distinctive, since it contains light-colored, well-rounded quartzite pebbles unlike any bedrock in the area. The lower part, encountered largely in wells, is bedded sandstone and siltstone.

The Boring Lava stratigraphically overlies the Troutdale Formation. East of the Willamette River it forms several small volcanic cones and necks including Mount Tabor, Kelley Butte, and Mount Scott. On the west side of Tualatin Mountain, the Boring Lava occurs mainly as thin intracanyon flows. These flows differ mineralogically from the Columbia River Basalt in that they contain a great amount of olivine and have an expanded open texture. The Boring Lava is similar in appearance and age to the Cascade Andesite, the rock that makes up the bulk of the High Cascade flows. The Boring Lava is late Pliocene to early Pleistocene in age (Treasher, 1942).

Mantling Tualatin Mountain and many of the higher areas is a cover of silt ranging from light to dark brown in color. Lowry and Baldwin (1952) named this unit the Portland Hills Silt and pointed out features that made them believe it was deposited by the ancestral Columbia River during Pliocene time when relief was much less than at present. Other workers, including Trimble (1957) believed the silt to be of loessal origin; that is, to have been deposited by the wind in late Pleistocene time.

Unconsolidated gravels, sands, and silts underlie a major part of the area, including most of east and north Portland. These deposits, as much as 500 feet thick (Baldwin, 1959), were deposited during a time when either the Columbia River's flow was dammed northwest of the Portland area or sea level was higher than now. The effect was to create a large lake or sound into which alluvium washing through the Columbia River Gorge was deposited into quieter waters fanning out to fill the basin, leaving the coarser deposits at the mouth near Camas and Troutdale and grading finer to the west. The surface was veneered with coarser gravels and boulders by the Missoula Flood (Baldwin, 1957).

Recent alluvium: The present flood plain areas of the Columbia, Willamette, and smaller rivers are covered with deposits of Recent alluvium. These deposits, in most cases less than 50 feet thick, consist predominantly of fine-grained sediments derived from the upstream drainage areas.

Structure

Tualatin Mountain, running diagonally through the area, is the most prominent structural feature on the map. This is an anticline that has been faulted on its northeast flank.

In the Tualatin Valley the rocks are folded down to form an elongate synclinal basin. There the surface of the Columbia River Basalt, which is nearly 1,000 feet above sea level on Tualatin Mountain, drops to about 1,200 feet below sea level beneath Hillsboro and then rises again at Chehalem Mountain. Cooper Mountain is a small anticlinal fold on the southwest side of the Tualatin Valley. Chehalem Mountain forms the west edge of the basin; here the rocks have been uplifted, then faulted on the west side, leaving several hundred feet of Columbia River Basalt and underlying marine sedimentary rocks exposed in the escarpment.

On the east side of Tualatin Mountain, the surface of the Columbia River Basalt forms another alluvial-filled basin that reaches depths of at least 1,500 feet below sea level. To the east the basalt comes to the surface in the Columbia River Gorge about 20 miles away, while to the north and northeast it pinches out or is faulted out against older Eocene volcanics and sedimentary rocks that crop out around the margins of the basin.

Early geologists (Diller, 1915) believed the east-facing front of Tualatin Mountain to be the result of faulting. The theory was based on the unusually straight alignment of the east base of the hills, the general absence of surface exposures of the Columbia River Basalt, and the presence of the falls at Oregon City. Later, Treasher (1942) pointed out the lack of direct evidence for faulting and that the variations in the elevation of the basalt, as determined from water wells, could be accounted for by folding rather than faulting. Most of the recent publications dealing with the geology of the Portland area have ascribed to this later view. The presence of the Columbia River Basalt under younger sediments in west Portland at depths ranging from 125 to 500 feet precludes a fault of large vertical displacement along the front of Tualatin Mountain. The evidence that some displacement has taken place in the past, however, is very strong. The interpretation that fits the existing geologic conditions best is a normal fault with a vertical displacement of less than the thickness of the Columbia River Basalt, which is about 700 feet in this area. This would explain the horizontal flows just above the foot of the escarpment and account for the relatively low dips of the lava under the west side business district of Portland.

Other faults have been mapped along the surface to the west and southeast of Portland, some striking northwest and some northeast. It is believed that the earthquake occurred along one of these other faults, which would be buried beneath alluvium, or along a deeper fault that may not even extend into the sedimentary layer. The seismic evidence indicates that the movement was along a strike-slip fault, with a right-handed displacement if trending northwesterly, as illustrated in Figure 2, and a left-handed displacement if trending northeasterly. The fault was not believed to be either a north-south or east-west trending strike-slip type nor a reverse or normal type.

Recommendations

The new seismic stations and instruments in the Northwest have resulted in substantially more reliable determinations of local epicenters and are providing valuable data for determination of regional crustal structures. Much will be learned from data yet to be recorded by these stations. However, many more stations, with a variation in types of instruments, are needed. Two of the stations currently operating in Oregon and Idaho are mobile stations, operated to fill the needs of Project VELA UNIFORM; these cannot be considered as part of the permanent set of stations in the Northwest.

It is recommended that vertical seismometers be installed near Portland, the Oregon coast, and central and southeastern Oregon. Oregon State University is planning to install a station at Klamath Falls. Some stations, as at Portland, should have both high and low magnification units. At least one station should have Wood-Anderson torsion seismometers to provide for rapid and reliable magnitude determinations. A larger number of stations throughout Oregon would provide for better epicentral location of shocks; magnitude determinations; focal depth determinations; aftershock recordings; and data pertinent to the crustal and subcrustal structures and variations of these features in Oregon. Oregon is particularly well situated for such investigations.

Acknowledgments

The following people are gratefully acknowledged for providing seismograms and arrival times used in this investigation: Mr. N. Rasmussen and Dr. K. E. Kaarsberg of the University of Washington; Dr. Don Tocher of the University of California (Berkeley); Dr. R. A. Christman of Western Washington State College; Mr. J. M. Whalen of the Geotechnical Corp. (Dallas, Texas); Mr. Ray Reakes of the Blue Mountain Seismological Observatory. Professor Frank Neumann of the University of Washington kindly made available a copy of curves he constructed and uses at Washington for determining epicentral distances, origin times, and focal depths. Discussions with him and Mr. N. Rasmussen on earthquakes in the Northwest have been most helpful. The aftershock study by the Stanford Research Institute was wholly supported by the Air Force Technical Applications Center under Contract No. AF49 (638)-1205. A portion of the study at Oregon State University was supported by the Office of Naval Research under Contract No. Nonr 1286(02), Project NR 083-102.

Dr. Joseph W. Berg, Jr., of Oregon State University critically reviewed a portion of the manuscript and contributed in the form of discussions and in the initial evaluation of the shock. Appreciate is also expressed to the many others who aided in this investigation, including those at Oregon State University who helped in the initial seismogram evaluation or participated in a field trip to the epicentral region, those at the Stanford Research Institute who helped in obtaining field data, and those at the Oregon State Department of Geology and Mineral Industries who aided in the geologic analyses.

References

Berg, J. W., Jr., and C. D. Baker, 1963, Oregon Earthquakes, 1814 through 1958: Seismol. Soc. Am. Bull., v. 53, p. 95-108. (Condensation in The Ore Bin, v. 24, no. 9, p. 143-149, 1962.)

Condon, Thomas, 1871, The Willamette Sound: Overland Monthly, v. 7, p. 468-743.

Dehlinger, P. and J.W. Berg, Jr., 1962, The Portland Earthquake of November 5, 1962: The Ore Bin, v. 24, no. 11 p. 185-188.

Diller, J.S., 1896, Geological Reconnaissance in Northwestern Oregon: U.S. Geol. Survey 17th Ann. Rept., p. 1-80.

Diller, J.S., and others, 1915, Guidebook of the Western United States, Part D: U.S. Geol. Survey Bull. 614, p. 32-34.

Gutenberg, B., 1941, Mechanism of Faulting in Southern California Indicated by Seismograms: Seismol. Soc. Am. Bull., v. 31, p. 263-302.

Hodge, E. T., 1938, Geology of the Lower Columbia River: Geol. Soc. America Bull., v. 49, p. 831-930.

Lowry, W. D., and E. M. Baldwin, 1952, Late Cenozoic Geology of the Lower Columbia River Valley, Oregon and Washington: Geol. Soc. America Bull., v. 63, p. 1-24.

Richter, C. F., 1958, Elementary Seismology: W. H. Freeman & Co., San Francisco, 768 p.

Schlicker, H. G., 1954, Columbia River Basalt in Relation to the Stratigraphy of Northwestern Oregon: master's thesis, Oregon State College, Corvallis.

Treasher, R. C., 1942, Geologic History and Map of the Portland Area: Oregon Dept. Geology and Mineral Industries Short Paper 7.

Trimble, D. E., 1957, Geology of the Portland Quadrangle, Oregon-Washington: U.S. Geol. Survey Geol. Quad. Map GQ 104.

U.S. Coast and Geodetic Survey, 1962, Preliminary Determination of Epicenters: Card No. 92-62, Dec. 3.

Warren, W. C., Hans Norbisrath and R. M. Grivetti, 1945, Geology of Northwestern Oregon West of the Willamette River and North of Latitude 45°15': U.S. Geol. Survey Oil and Gas Inv. (Prelim.) Map 42.

Westphal, W. H., 1962, Seismic Aftershock Investigations--Project Vela, Portland, Oregon, Earthquake of November 6, 1962: Tech. Rep. No. 1, Stanford Res. Inst., 11 p., Dec.

Wilkinson, W. D., W. D. Lowry, and E. M. Baldwin, 1946, Geology of the St. Helens Quadrangle, Oregon: Oregon Dept. Geology and Mineral Industries Bull 31, 39 p.

* * * * *

NEW PROCESS TESTED ON OREGON LATERITES

The standard method for extracting alumina from aluminous-bearing rocks is the Bayer process. This process uses caustic soda solution to dissolve the alumina (Al_2O_3) in the ore, leaving a residue high in iron, titanium, and silica to be discarded as waste. The dissolved alumina is then precipitated, calcined, and shipped to electrolytic reduction plants like those here in the Northwest for final production of aluminum metal. The principal disadvantage of the Bayer process is that it works well only on ores which contain less than 10 percent of silica. These high-alumina, low-silica deposits are called aluminous laterites or bauxites. Research chemists have, therefore, spent many years trying to develop a process capable of treating the more extensive higher-silica deposits that occur in many parts of the world. Several such processes have been invented, but so far none have been shown to be economically competitive with the Bayer process.

A recent method using sulphuric acid as the dissolving reagent has been developed in Melbourne, Australia, by Dr. T. R. Scott of the Commonwealth Scientific and Industrial Research Organization. The principal advantage of the Scott method is that it can handle ores much higher in silica content than is feasible for the Bayer process. Because there are large deposits of relatively high-silica laterite in Oregon, a composite sample containing approximately 15 percent silica and 35 percent alumina was sent to Dr. Scott, who kindly consented to test the sample to determine its ease of treatment by the sulphuric acid method. At the same time, another sample from Cowlitz County, southern Washington, was sent to Dr. Scott as an additional check.

Dr. Scott recently visited the department, while returning from a trip to South America, to explain his process in greater detail and to report on the results of his tests on the Oregon-Washington samples. Both were found to be amenable to treatment on a laboratory scale by the sulphuric acid process with very high-grade alumina being produced. The only difficulty experienced was that it was found necessary to calcine the Oregon sample to approximately 700°+ C prior to digestion in acid in order to lower contamination of the alumina by iron.

The question, whether the sulphuric acid method can treat Northwest laterites at a price competitive with higher quality ores using the Bayer process, cannot be answered until large-scale pilot plant tests are made on these deposits.

Unfortunately, there is no such pilot plant in operation at the present time. The U.S. Bureau of Mines at Albany has been studying various processes for producing alumina from Northwest laterites for several years.

Their work so far has also been on only a laboratory scale, but their future plans are to build a pilot plant if one of these processes shows economic promise and sufficient funds become available. Perhaps within the next few years the demand for domestic sources of medium-grade aluminum ore will result in a new mining operation for Oregon. The state will then have a completely integrated aluminum industry from the raw material to the finished product.

* * * * *

WILDERNESS BILL PASSED BY SENATE

Once again the Senate has overwhelmingly passed and sent to the House a bill (S.4) to establish a National Wilderness Preservation System in which mining and other commercial activity would be virtually banned. The vote was 73 to 12, not much changed from the 78-to-8 vote by which the Senate passed a similar measure in 1961.

The wilderness system would be composed initially of about 13.5 million acres of national forest areas now designated as wilderness, wild or primitive, and a roadless canoe area in northern Minnesota. At the present, the mining laws apply in general to all of these except the canoe area.

As in 1961, Senator Frank Church (Idaho) led the floor fight for enactment. The minority was spearheaded by Senator Peter H. Dominick (Colo.), who substituted for Senator Gordon Allott (Colo.), absent for much of the debate because of a death in his family. (American Mining Congress News Bulletin, April 12, 1963.)

* * * * *

GRUENING BILL DESIGNED TO AID MINING INDUSTRY

Senator Ernest Gruening (Alaska) has introduced legislation designed to "aid our ailing mining industry." Speaking on the Senate floor, Gruening said, "It would help the operator who is confronted with a fixed price for his product and a continually increasing cost of production. The miner today has to find higher grade ore. He must also find a means to reduce his cost. The Federal government can help lick its growing dependence upon foreign sources for its metals and minerals by sharing the risk and cost, thereby stimulating exploration and, hopefully, increasing production."

The bill (S. 1279) would amend Public Law 85-701, which established the Office of Minerals Exploration. (American Mining Congress News Bulletin, April 12, 1963)

* * * * *

HAZARD HUNTING IN THE HILLS

By breaking a few simple rules practically anybody taking a vacation in the mountains can have a really dangerous, if not fatal, experience at very little effort or expense. The list of hazards which can be encountered ranges from simple drowning or asphyxiation to being crushed by falling rock. Abandoned mines offer excellent opportunities, and hardly a year elapses without reports of accidents in them. Old mine timbers may look sound and sturdy, but don't kick them as a test. All too often they collapse and bring down tons of rock. Large mines often have pockets of air deficient in oxygen. Unless a light with an open flame is carried, this deadly condition cannot be detected and asphyxiation may result. Underground winzes and shafts sunk below the tunnel level often have rotten timbers hiding their presence. Persons crashing through these openings feel lucky if they merely fall into water, since the bottom of the hole may be a hundred feet or more below. Many mines have interesting mineral specimens sticking to the walls and roof and incautious picking and prying may bring down not only the specimen but part of the roof as well. To make disaster doubly sure, always test doubtful timbers and pick at the roof while standing on the side away from the entrace. This insures secure entombment. To further perfect the hazard don't tell anybody where you are going, go alone, and don't leave a note at the mine entrance. With luck you won't be found for months.

One of the big thrills for the hazard seeker comes with the sudden and unexpected discovery of an open shaft on a hillside covered with underbrush. The first step down is a big one, several hundred feet perhaps, but after that there will be little if any walking to do. Animal lovers have a special thrill in store for them in some old tunnels. These abandoned man-made openings often become the home of porcupines, snakes, bobcats, skunks, and even cougars. An orderly retreat is suggested -- if the animal is discovered on your way into the mine. Meeting one of these animals on the way out presents an entirely new and interesting situation.

In summary, here are the ways to have a hazardous vacation in the hills: (1) enter all the old mine workings you can but don't tell anybody about it; (2) use a flashlight, which doesn't need oxygen; (3) pick and pry at rocks and timbers overhead; (4) tramp nonchalantly over planks on the tunnel floor without testing them; (5) climb up and down all the ladders in the shafts but don't bother to keep track of the number you have climbed -- you may get lost; (6) don't worry about old mine shafts half hidden in underbrush, they can take care of themselves; (7) ignore the fact that to many animals an old mine tunnel is home and that they intend to defend it; and

(8) forget that nitroglycerine is practically indestructible, that is, until you bumped that old dynamite box you found way back in the mine.

One last little thought. Leave your keys in the car, so the next of kin can drive it away. Those towing charges will only decrease your estate listed in the will you forgot to have drawn up.

R.S.M.

* * * * *

GOVERNOR HATFIELD BACKS MINING

Mark O. Hatfield, Governor of Oregon, called a meeting of Oregon's hard-rock mining people April 11 to obtain views on how Oregon's mining industry could be bolstered. In his opening remarks to the 35 prospectors, mine owners, and government officials gathered in his offices in the Capitol, Governor Hatfield stressed the need for broadening Oregon's economic base and stated that mining had not received the attention in Oregon which he thought it deserved. He cited the economic pressures the Iron Curtain countries were exerting on certain strategic minerals and oil and called for an increase in mineral exploration so that America can remain strong. Noting that metal mining had been on a downward trend in Oregon and in the West for many years, Governor Hatfield asked the group for suggestions on how best he and the State Executive departments concerned with mining could help reverse the trend. The conclusions coming from the meeting were:

(1) Utilization of Federal lands for prospecting and mining should be according to Federal law and not restrictive administrative regulation.

(2) Federal legislation should be proposed to shorten the period of time now taken by the Administrative Procedures Act on determinations concerning mining claims, be they for patent proceedings or for determinations under Public Law 167 (examinations of claims to determine if the claim holder or the Federal Government has management of surface rights).

(3) Commendation was given to the U.S. Forest Service for its new policy of assigning mining engineers to those forests having a high incidence of mining claims within the forests, and a recommendation was made that the U.S. Forest Service go one step farther by establishing a staff mining engineer at the Washington level to determine policies for the local engineers.

(4) The state should embark upon research programs through the Department of Geology and Mineral Industries in the field of geophysics, and assistance should be given by the Department of Planning and Development through market research.

* * * * *

The ORE BIN
Volume 25, No. 5
May, 1963

MAARS OF SOUTH-CENTRAL OREGON

By

N. V. Peterson* and E. A. Groh**

Introduction

If we could go back in time some 5 to 10 million years to the Pliocene Epoch and recreate the landscape of south-central Oregon, here are some of the things we would probably see:

From a plain originally of slight relief, faulting has already delineated broad basins containing large, shallow lakes. To the west, the High Cascade volcanoes are beginning to erupt on a grand scale. In and around the basins, volcanic vents, aligned along northwest-trending fissures, spew out fire fountains to form reddish-black scoria cones. These break through, spreading thin sheets of basaltic lava to fill depressions and further disrupt the existing drainage. When the basaltic magma rises beneath the lakes or near their borders, tremendous steam pressures are generated that trigger catastrophic initial explosions. Ash, lapilli, and large blocks of all the rocks involved are thrown high into the air in successive explosive eruptions to settle and to build raised rims of ejecta around the funnel-shaped craters. In some, the explosive phase dies quickly and fluid magma rises to fill the craters with a lava lake. In others the magma solidifies at depth, or withdraws, and water enters to form crater lakes. In still others, the same vents or ones nearby again explode violently to modify the original simple features.

Returning to the present, we see only the eroded and buried remnants of these peculiar volcanic features; our colorful reconstruction of the past had to be based on imagination and the little geologic evidence that remains.

---

* Geologist, State of Oregon Dept. of Geology & Mineral Industries.
** Private Geologist, Portland, Oregon.

Distribution of Basaltic Tuff Landforms

During the summer of 1962, we made a broad reconnaissance of northern Klamath County and north-central Lake County to determine the distribution of the landforms described above to see if they form a pattern that would help to explain the special conditions necessary for their formation; we also looked for criteria that would make them easy to recognize.

The index map (pages 82 and 83) shows the distribution of basaltic tuff landforms that have been definitely recognized in the field during this study and also during other assignments in Klamath and Lake Counties in 1959, 1960, and 1961.

There are concentrations in two broad northwest-trending zones, one in the Fort Rock-Christmas Lake valleys in northern Lake County and the other in the Yonna and Sprague River valleys of central Klamath County. Individual occurrences and small groups of occurrences have also been identified adjacent to the Klamath River west of Keno and in the southern Fremont Mountains north and west of Lakeview, Oregon.

Future study will be extended to the south and east to cover the area bounded by Summer, Abert, and Alkali Lakes, and more detailed studies will be made of the individual landforms already recognized, to determine their original structures and origins.

Definition of terms

Maar, dry maar, ubehebe, tuff cone, tuff ring, and diatreme have all been used by various authors to describe relatively large, shallow, flat-floored craters that resulted from short-lived volcanic explosions.

Maar: As defined in the American Geological Institute glossary, a maar is "a relatively shallow flat-floored explosion crater, the walls of which consist largely or entirely of loose fragments of the country rock and only partly of essential, magmatic ejecta. Maars are apparently the result of a single violent volcanic explosion, probably of phreatic origin. Where they intersect the water table, they are usually filled with water and form natural lakes. The term was originally applied to craters of this nature in the Eifel district of Germany."

Dry maar or ubehebe: These terms have been used by Cotton (1941) to describe two small craters in Death Valley, California. These craters have raised rims built of layers of rock fragments derived from the immediately underlying terrain.

Tuff cone or tuff ring: These are synonymous terms for volcanic cones built primarily of consolidated ash and generally shaped something like a saucer, with a rim in the form of a wide circle and a broad central depression often nearly at the same elevation as the surrounding country. They usually show maximum growth on the leeward side. Individual tuff beds forming the cone dip both inward and outward, those in the high part of the rim approaching the angle of repose. Tuff cones are believed to be the result of hydroexplosions caused when lava erupts under water or water-saturated rocks close to the surface. In form tuff cones, or tuff rings, bear a general resemblance to maars.

Diatreme: A general term given to funnel-shaped or pipelike volcanic vents that are filled with angular fragments of many sizes of the rock types through which the pipe passes. In some there is no trace of magmatic material, but in others basaltic tuffs are present. An explosion crater is the surface expression of a diatreme. The term should probably be restricted to eroded features where only the pipe or the pipe-filling breccia remains.

The term maar is becoming more popular and is being used increasingly to describe these explosion craters with rims built of volcanic tuffs and breccias, even though no lakes were present. The term is also utilized for the volcanic processes that form this type of crater.

Tuff cone (or tuff ring) seems to be a more descriptive term, however, and is probably more nearly correct for describing the south-central Oregon structures where high rims of layered tuffs and breccias are present. These two terms, then, maar and tuff ring will be used interchangeably for the features in south-central Oregon.

Maar or Tuff Ring Field Identification

General types

Most of the central Oregon maar/tuff-ring features are similar and probably resulted from almost identical volcanic explosive processes. On the basis of the ones examined so far, there are enough differences in individual occurrences so they can be classified into three general types:

1. Simple maars: Circular or roughly circular craters surrounded by rims made up of steeply dipping, thin to thick layers of pyroclastic rocks. Excellent examples of this type are Hole-in-the-Ground and Big Hole,

shown in figure 1. As this type becomes more dissected and its original crater obliterated, the layers of tuff are usually exposed as low, curving hogback ridges that show their original ring shape, or as bold cliffs with a roughly circular shape, such as Fort Rock, shown in figure 2.

2. Simple maars modified by later lava: In this type, the conditions necessary for violent explosive activity ceased after a time, and the craters were filled by quiet extrusion with basaltic lava, which in some cases overflowed the rims and poured down the sides. Erosion of this type results in a lava-capped hill or butte surrounded by inward-dipping layers of explosion tuffs. Typical of maars of this type in the Fort Rock valley are Flat Top, shown in figure 3, and Table Mountain, in figure 4.

3. Complex maars: Where individual explosive vents were closely aligned or spaced, the tuff layers from separate explosions are superimposed on one another. Erosion of these complexes results in oval to elongate ridges of the layered tuffs with anomalous attitudes. A good example of this type can be seen in the large mass which makes up Table Rock near Silver Lake. This massive ridge is about 5 miles long and $3\frac{1}{2}$ miles wide and covers about 15 square miles with bold erosional outcrops of layered basaltic explosion tuffs.

Surface expression

The landforms that still retain crater depressions are the easiest to recognize, and so far two have been found in the Fort Rock-Christmas Lake valley. Hole-in-the-Ground has a crater almost a mile in diameter and Big Hole, $1\frac{1}{2}$ miles in diameter. Williams (1935) has reported three tuff rings within the Newberry caldera, one of which still has a saucer-shaped crater. The surface expression of eroded outcrops of the others examined indicates that this size is probably about the minimum, and where they occur in clusters they formed much larger masses.

Thickness of the layered tuffs

The layered tuffs and breccias at the rim crest of Hole-in-the-Ground are only about 150 feet thick, and they thin rapidly in all directions away from the crater. At Fort Rock (figure 2) the eroded cliffs show at least 300 feet of the thinly layered tuffs, indicating that either it was originally much larger than Hole-in-the-Ground, or that it had higher rims. At Table Rock near Silver Lake, the explosion tuffs make up most of the highest point, which is more than 1,000 feet above the surrounding plain.

(a)

(b)

Figure 1. Examples of typical simple maars. (a) Aerial view of Hole-in-the-Ground, showing truncated edges of the older rocks through which the vent was drilled. A small lake probably once filled the crater. (b) Aerial view of Big Hole. Walls and rim are composed entirely of thin layers of basaltic lapilli tuffs and breccias. Crater depression is broad and shallow.

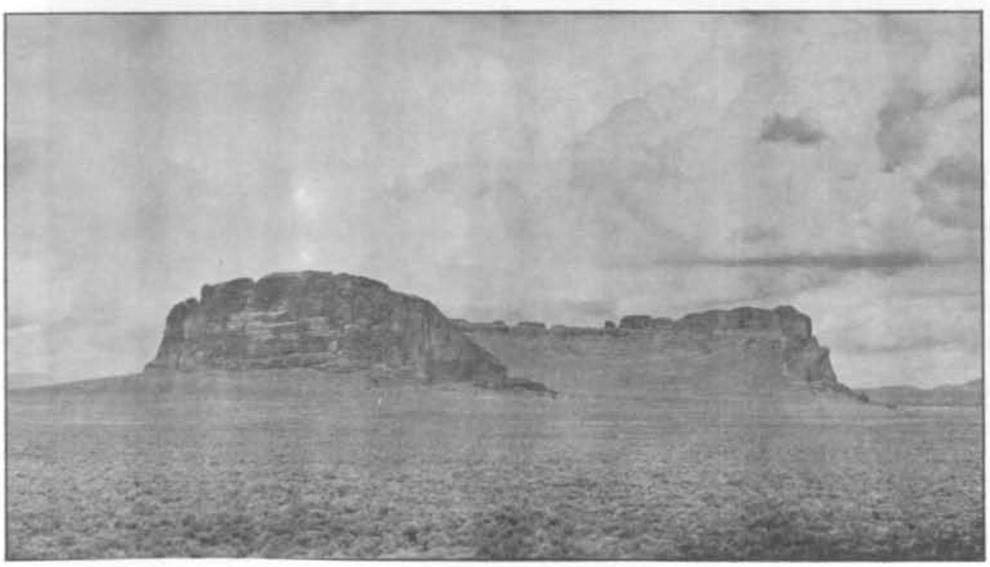


Figure 2. Fort Rock, an eroded remnant of a once much larger maar. The steep cliffs expose hundreds of thin layers of typical basaltic explosion tuffs. Well developed wave-cut terraces were formed by Pleistocene lake.

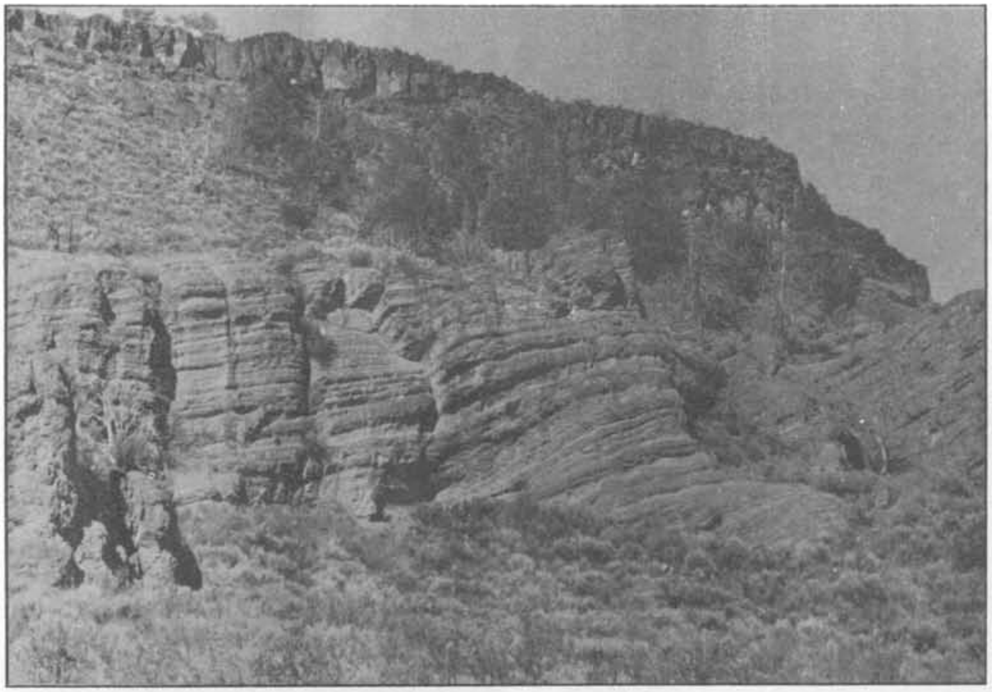


Figure 3. Flat Top, a remnant of a modified, simple maar. Layers of tawny basaltic tuffs dip beneath a basalt capping that originally filled the crater.

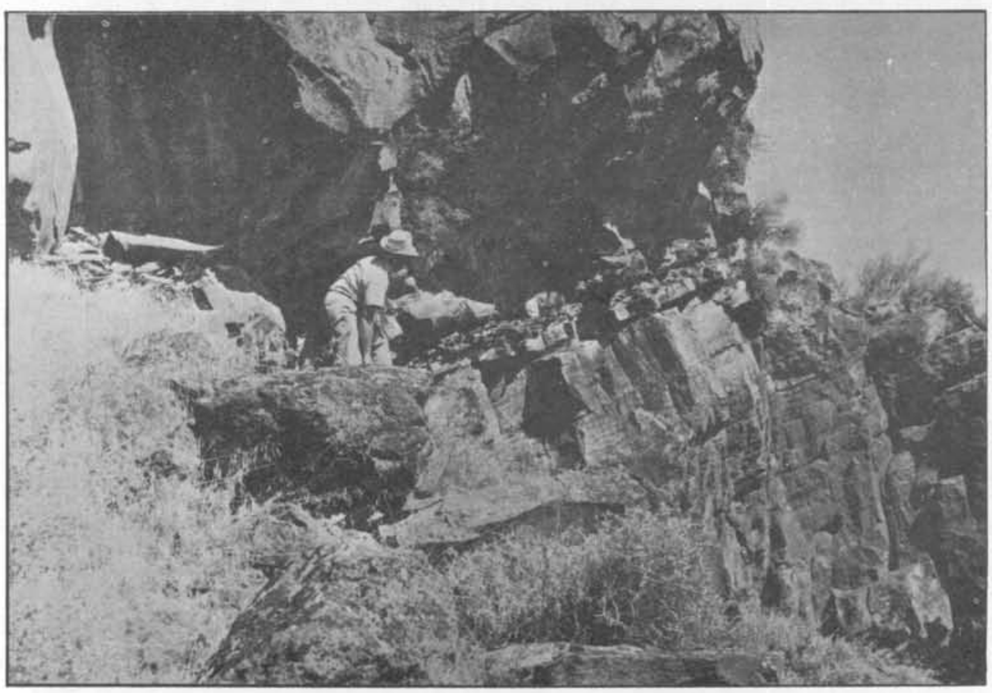


Figure 4. Table Mountain, illustrating a closer view of the contact of crater-filling lava with slightly baked, undisturbed tuffs which dip inward toward the crater.

Composition and structure of the tuffs

Thin layers of vitric lithic tuffs are present in all the maar/tuff-ring features and are perhaps the best criteria for their identification. Colors range from gray to drab yellows and browns, but are usually tawny. Tuffs of this type are composed of a variety of angular volcanic rock fragments in a matrix of fine, frothy basaltic glass. The fragments vary in size from microscopic shards to large blocks as much as 10 feet in diameter (figures 5 and 6), with lapilli sizes most abundant. The glassy nature of the groundmass in most of the explosion tuffs is easily recognized with a hand lens.

The tuffs and breccias almost always show a thin layering even though the rock fragments are large. This layering results from powerful sporadic showers of ejected material that drop directly into place. Cross bedding, channeling, and other sedimentary features resembling those of waterlaid deposits are locally present. Some layers are deformed by the larger fragments and blocks that have fallen directly on them.

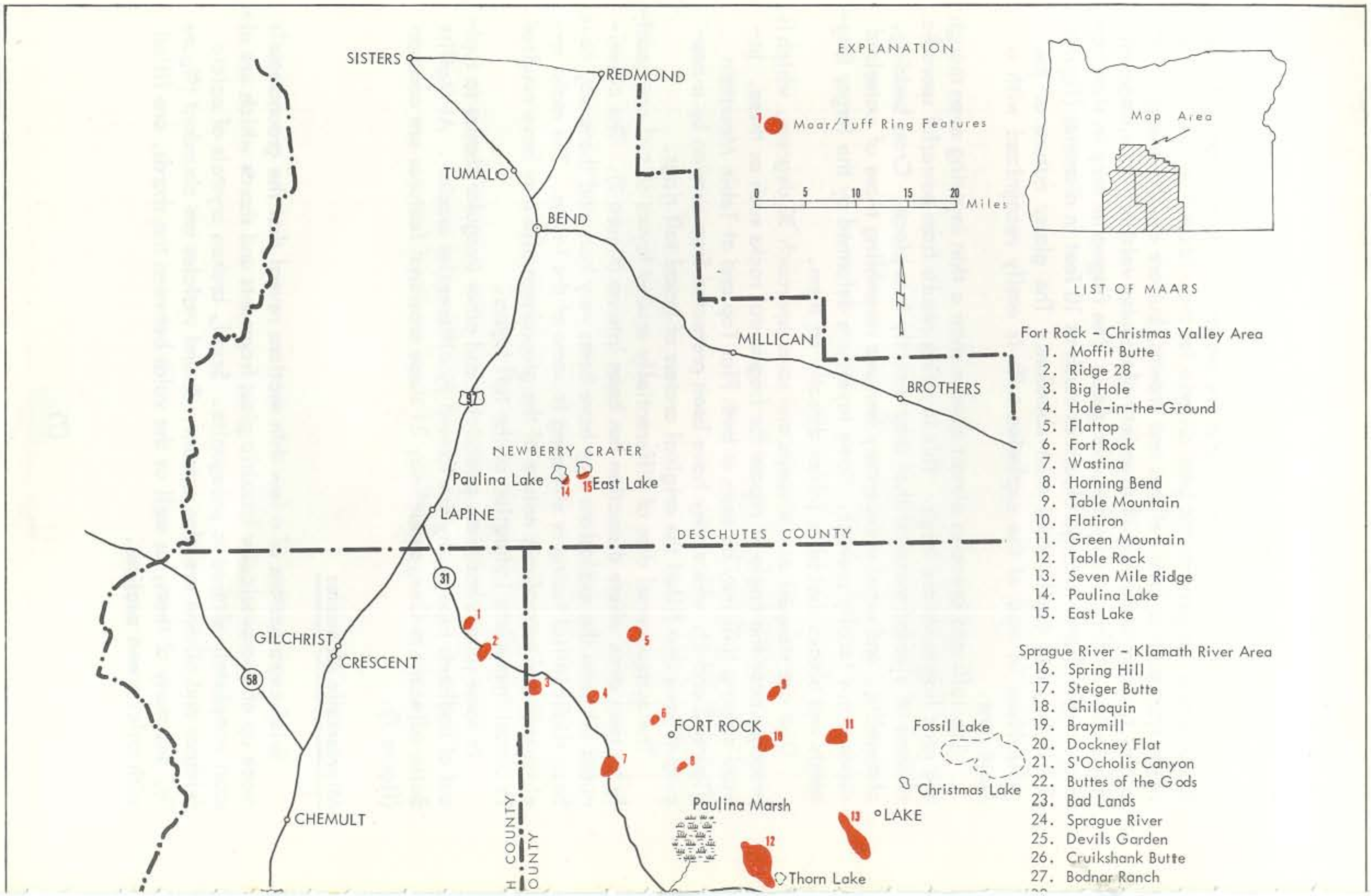
Dips are steepest at rim crests and some approach 30 degrees, which is probably near the angle of repose for fragmental rocks such as these. Inward dipping tuffs may be seen at both Flat Top and at Table Mountain (figures 3 and 4), where they have been protected from erosion by a capping of lava that filled the original craters of broad tuff rings.

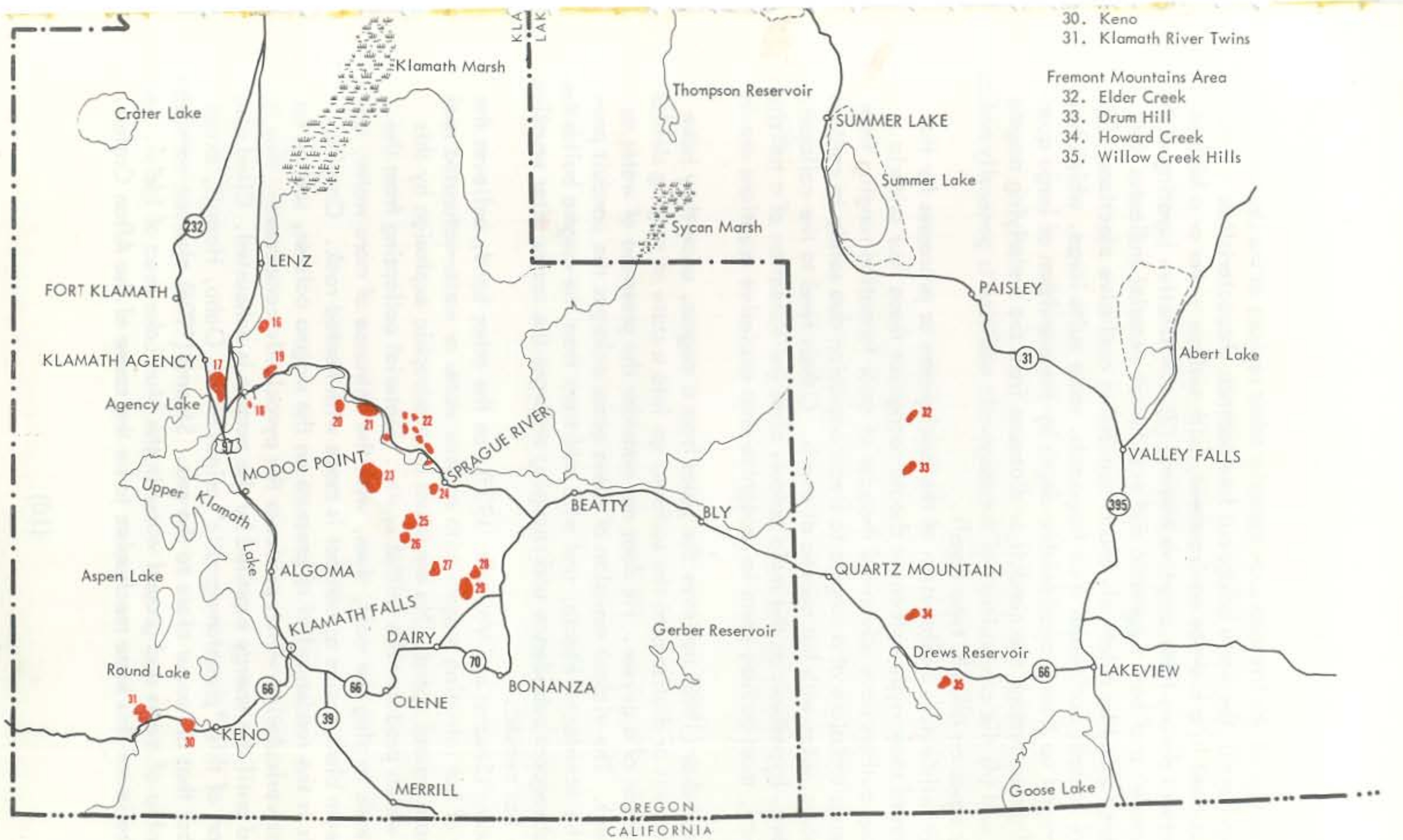
The quaquaversal dips of differentially eroded layers of tuff can usually be seen even where dissection has been intense (figure 2). The comminuted ash from the explosions may have been very hot, and there may have been slight initial fusing or sintering in some of the layers. The moist environment and pozzolanic nature of the groundmass also may have resulted in almost immediate induration of the tuff layers.

In some places hoodoos, pedestals, and other irregular shapes so typical of badlands topography are formed by differential erosion. At Moffitt Butte adjacent to Oregon highway 31 these erosional features are common (figure 7).

Microscopic character

Brief examinations of a few thin sections reveal that the groundmass is made up of microvesicular basaltic glass fragments and shards which are almost completely altered to palagonite. Small, broken crystals of calcic feldspar and olivine are also present. Round vesicles are abundant (figure 8), and many of them, as well as the voids between the shards, are filled with calcite and zeolites.


EXPLANATION
Moar/Tuff Ring Features
0 5 10 15 20 Miles
Map Area
LIST OF MAARS
Fort Rock - Christmas Valley Area
1. Moffit Butte
2. Ridge 28
3. Big Hole
4. Hole-in-the-Ground
5. Flattop
6. Fort Rock
7. Wastina
8. Horning Bend
9. Table Mountain
10. Flatiron
11. Green Mountain
12. Table Rock
13. Seven Mile Ridge
14. Paulina Lake
15. East Lake
Sprague River - Klamath River Area
16. Spring Hill
17. Steiger Butte
18. Chiloquin
19. Braymill
20. Dockney Flat
21. S'Ocholis Canyon
22. Buttes of the Gods
23. Bad Lands
24. Sprague River
25. Devils Garden
26. Cruikshank Butte
27. Bodnar Ranch
SISTERS
REDMOND
TUMALO
BEND
MILLICAN
BROTHERS
97
NEWBERRY CRATER
Paulina Lake
East Lake
LAPINE
DESCHUTES COUNTY
31
GILCHRIST
CRESCENT
58
FORT ROCK
Fossil Lake
Christmas Lake
Paulina Marsh
LAKE
Thorn Lake
CHEMULT



DISTRIBUTION OF MAARS IN SOUTH-CENTRAL OREGON

Volcanic Processes in Maar Formation

A review of the literature on maars in other regions of the United States and elsewhere in the world brings out four common characteristics: (1) maars have occurred in a hydrous environment, with surface water or a high water table present during their eruptive history; (2) a distinctive layering of the ejecta made up of both magmatic and accidental material indicates that they were formed by relatively short, successive explosive ejections; (3) there are present accidental rock fragments, some quite large, which have been brought up from a considerable depth by the expulsion of large quantities of gases through the conduit or diatreme from the underlying magma source; and (4) the composition of the magmatic addition is generally mafic, in many cases an alkalic type basalt.

Any satisfactory explanation of the mechanisms or processes for the formation of maar-type volcanoes should recognize these four criteria. Numerous authors have advanced theories of maar formation ranging from the gaseous emissions of a magma to steam explosion due solely to contact of meteoric water with hot magma at depth. Others tend to the collapse, or caldera, hypothesis as the main process after the formation of a tuff ring. In general, most authors seem to recognize that explosive eruptions are involved.

Shoemaker (1962) believes the gases from a magma, once they have drilled a vent or diatreme to the surface, go into a state of surging similar to the action of a geyser. He does not consider the presence of water as significant. The violent emission of these gases enlarges the conduit providing the accidental ejecta, and with additions from the magma builds the maar; subsequent subsidence and slumping enlarges the crater after eruptive activity has ceased.

Stearns (Stearns and Vaksvik, 1935), on the other hand, believes the contact of hot intruding magma with surface water or water-saturated rock is the main causal agent. He envisions a catastrophic explosion by this method which produces the initial crater. Material collapsing from the crater tends to plug the vent, then, with the entrance of more water, another steam blast occurs as contact is made with heated rock. Coupled with this is the sudden relief of pressure on the magma column, setting up a violent vesiculation which produces the pyroclastic component. This is repeated until the energy supplied by the magma is exhausted. Cited also in support of this "phreatomagmatic" origin of the Oahu, Hawaii, maars is the fact that all occur close to the sea. Stearns (1926) also has noted the relationship of maars and ground water in the Mud Lake area of Idaho. Lee (1907) believed this same mechanism to be the cause of the Afton Craters,

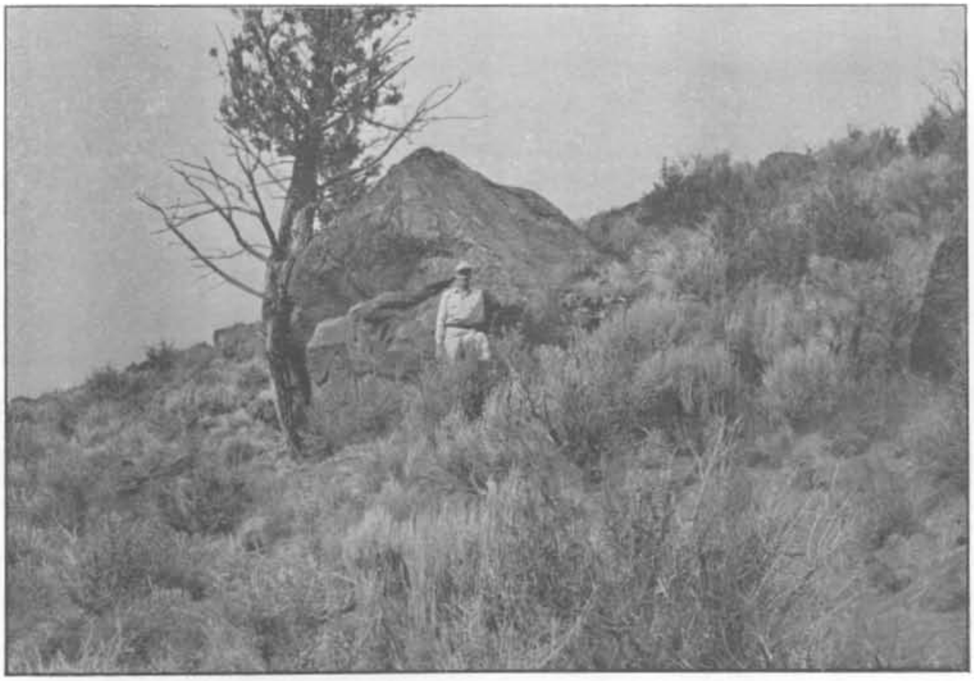


Figure 5. Enormous accidental block of porphyritic basalt lying near the crest of the east rim of Hole-in-the-Ground.

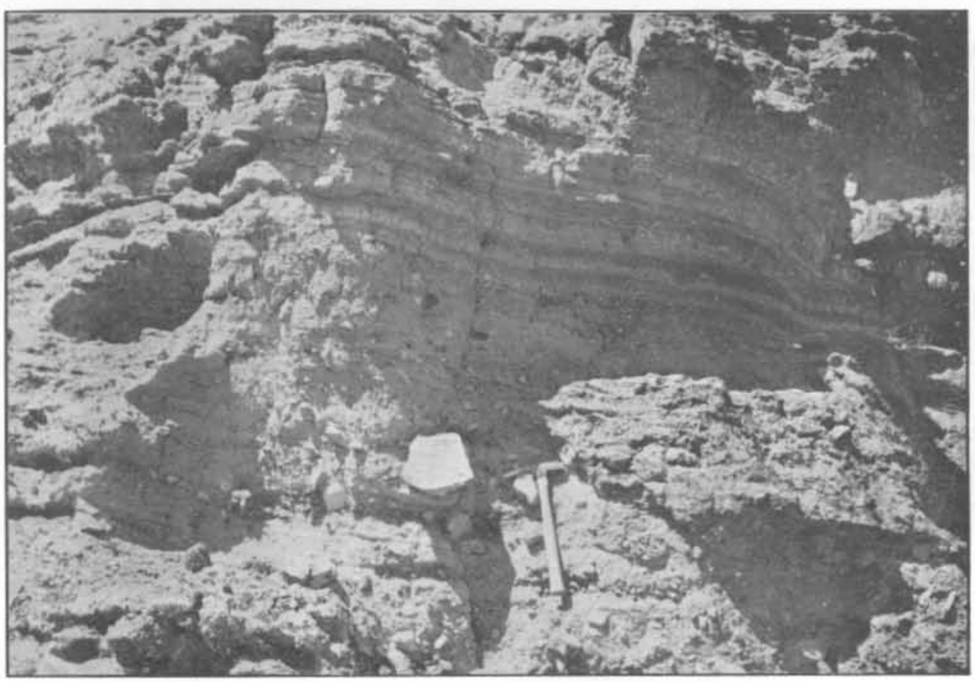


Figure 6. Closeup of Horning Bend showing thin layers and intimate mixing of angular rock fragments. The tuffs at this location contain a high percentage of accidental glassy rhyolite.

Figure 7. Hoodoo and badlands type of erosional landforms at Moffitt Butte. These and other differential weathering features are characteristic.

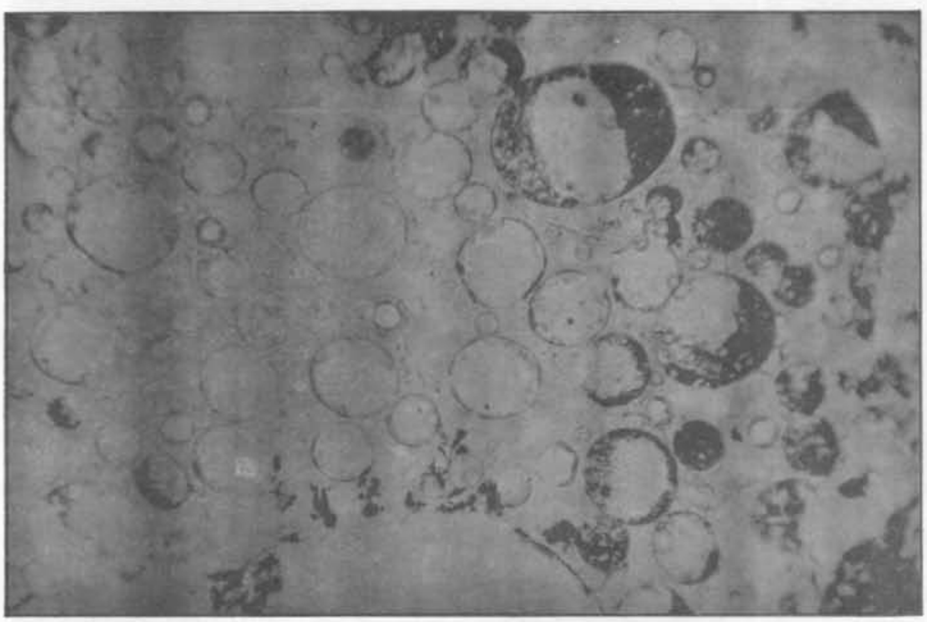


Figure 8. Micro-photograph of basaltic (palagonite) tuff showing the microvesicular nature of the groundmass, which is composed of fragments and shards of yellow-brown basaltic glass.

New Mexico. In his study of the Hopi Buttes area diatremes, and remnant maars, Hack (1942) has postulated the "phreatomagmatic" origin of these features which are closely associated with the Pliocene sedimentation of that region.

Jahns (1959), in his study of the Pinacate Craters in Sonora, Mexico, postulates the formation of a large tuff breccia cone by explosive action of a vesiculating magma on a catastrophic scale. When this magmatic energy is expended, collapse and foundering into the partially evacuated magma chamber results in the formation of a caldera. Since the Pinacate Craters belt is confined to only a part of a large volcanic field containing hundreds of cinder cones. Jahns also cites Stearns' (Stearns and Vaksvik, 1935) theory as a possible alternate explanation.

A different view of the formation of a maar is offered by Mueller and Veyl (1957) by their observations of the eruption of a new maar called Nilahue Maar, in Chile. It is their contention that the pyroclastics making up the maar cone were formed from fusion of the rock originally contained in the crater by the enormous quantity of hot gases expelled and that no addition of magmatic material took place. Added to this was also unfused accidental ejecta of the rocks penetrated by the vent. Theorizing on the origin of the maar, they believe gases which accumulate at the top of an intruding magma erupt through the overlying rock and continue their spasmodic expulsions until exhausted. Surface water, and presumably ground water (although they do not specifically mention ground water), breaching the weak ash barrier and flowing into the vent help to keep it open by secondary steam blasts. Otherwise, in the absence of water, they believe a regular pyroclastic cone would be built which would place a damping effect on the gases escaping, this in turn allowing the cone to grow by keeping the ejecta close to the vent.

All of these hypotheses attempt to explain the causes for the characteristic features of maars, but there are still many questions which are not completely answered. The one point that most authors do agree on is that violent expulsion of gases is an important requirement in maar volcanism.

The writers' studies and field work on the maars discovered to date in south-central Oregon strongly point to a hydrous environment existing at the time of their formation. Many probably erupted into the shallow lakes present throughout this region during the Pliocene and Pleistocene epochs. Others were formed in the areas where the water table was near the surface around the lakes and in the drainage system of the region. In such an environment it can well be expected that magma and/or the volatiles heating fractured and porous water-bearing rock would produce a phreatic or steam explosion, throwing out this rock and forming a funnel-shaped crater, as advocated by Stearns (Stearns and Vaksvik, 1935). Corwin and Foster (1959) describe an explosive eruption on Iwo Jima which occurred in such a manner.

The numerous beds of crudely sorted ejecta which make up a maar or tuff ring indicate a similar number of ejecta falls, each expelled essentially as a unit. Each bed apparently was explosively ejected in a short interval of time with a relatively quiescent period between successive eruptions. The observations of Mueller and Veyl (1957) confirm this evidence. Yet these short, violent eruptions, of perhaps 20 or 30 minutes duration, do not seem to be satisfactorily explained solely by ground or surface water contacting heated rock, the magma, or its volatiles. After the initial phreatic explosion, the major share of energy must be derived from the magma, mainly its hot gases. Some mechanism that causes a plugging or stoppage between successive eruptions seems to be a necessary requirement. A point that has not been previously emphasized in the maar volcanic process is possibly the influence of the wide crater, a feature common to all maars. After phreatic eruption forms the initial crater, part of the fallback would tend to plug the vent until increased gas pressure could blow this material out again. As the crater widens with repeated new eruptions, a greater portion of the fallback is collected and funneled into the vent. Thus a temporary plugging by a load of loose material falling back into a wide crater may be of major importance in maar volcanism. Stearns (Stearns and Vaksvik, 1935) advocates a similar process of plugging by fallback, but does not consider the importance of a wide crater in relation to this action. The infiltration of surface and ground water into the lower and hotter portion of the vent may help to produce steam blasts causing further fragmentation of the rock and adding some energy during eruptions. Crater diameter enlarges to a size which is related to the maximum energy expended in the eruptive process.

With each eruption, tremendous volumes of gases must be generated by an explosive frothing of the magma. A fluid, mafic magma carrying volatiles would permit this action more readily than a viscous one. This would account for the glassy, vesicular ash of basaltic composition typically present as the magmatic addition in the maars of south-central Oregon. Expulsion of a large volume of gases also can be expected to provide a high velocity streaming through the conduit. This streaming of gases carries rock broken from the walls up the conduit. Some quite large blocks are brought from considerable depths in this manner. Fragments of rock transported from depths of several thousand feet have been reported in studies of maars and diatremes of other localities (Hack, 1942, and Shoemaker, 1956). The fragments are probably brought to the surface during one single eruption, although some may fall back and require two or more eruptive episodes. As previously mentioned, the writers' study of Hole-in-the-Ground has pointed out that some enormous blocks have been carried up from depths of at least several hundred feet (fig. 5).

After all volcanism ceases, the diameter of the crater is further increased by subsidence and compaction of the material in the vent, slump of the crater walls, and normal erosion.

Conclusions

A wide distribution of maars/tuff rings occurs throughout south-central Oregon, and the evidence shows an association with a hydrous setting at the time of their formation. Studies of the Pliocene-Pleistocene rocks of areas not as yet examined in this region will no doubt expose many more of these features. At present, these peculiar volcanic structures show a pattern along two rather broad, northwest-trending zones which is also, as expected, the major direction for the faults of this region. As additional maars are discovered, some modification of this pattern may be noted.

Since accidental fragments in the tuff-breccia beds of these maars have been expelled from a conduit or diatreme, they provide a rough sample of a section of the underlying rocks. Petrographic study of these fragments, some of which may have been brought up from depths of several thousand feet, can confirm whether a certain known rock formation exists below. This may aid the geologist, for instance, in solving a structural problem when mapping a particular area in the vicinity of a maar.

Many hypotheses for the volcanic processes of maar formation have been offered by various writers from their observations of these features. Generally, all who have studied maars or tuff rings agree that explosive eruptions are necessary to their production. The almost universal association of maars with a water-bearing environment seems also to be an essential factor. Relating this factor to the explosive volcanic process which forms a maar leaves many questions unsatisfactorily answered. The maars of south-central Oregon, ranging from those little eroded to those completely dissected, present an unusual opportunity for study.

References

Corwin, G., and Foster, H. L., 1959, The 1957 explosive eruption on Iwo Jima, Volcano Islands: Am. Jour. Sci., v. 257, p. 161-171.

Cotton, C. A., 1952, Volcanoes as Landscape Forms: J. Wiley & Sons, Inc., 1st ed., rev. 1952.

Hack, J. T., 1942, Sedimentation and volcanism in the Hopi Buttes, Arizona: Geol. Soc. America Bull., v. 53, p. 335-372.

Howell, J. V., 1957, Glossary of geology and related sciences: The American Geological Institute.

Jahns, R. H., 1959, Collapse depressions of the Pinacate volcanic field, Sonora, Mexico: Arizona Geol. Soc., Southern Arizona Guidebook 2, p. 165-184.

Lee, W. T., 1907, Afton Craters of southern New Mexico: Geol. Soc. America Bull., v. 18, p. 211-220.

Mueller, G., and Veyl, G., 1957, The birth of Nilahue, a new maar type volcano of Rininahue, Chile: Internat. Geol. Congress 20th, Mexico City, 1956, Rept. sec. 1, 375-395.

Peterson, N. V., and Groh, E. A., 1961, Hole-in-the-Ground: The ORE BIN, v. 23, no. 10, Oregon Dept. Geology and Mineral Industries, p. 95-100.

Shoemaker, E. C., 1956, Occurrence of uranium in diatremes on the Navajo and Hopi reservations, Arizona, New Mexico, and Utah: U. S. Geol. Survey Prof. Paper 300, p. 179-185.

_______________, 1962, Interpretation of lunar craters, in Physics and Astronomy of the Moon: Zdenek Kopal, ed., Academic Press, p. 283-351.

Stearns, H. T., 1926, Volcanism in the Mud Lake area, Idaho: Am. Jour. Sci., v. 12, 5th series, no. 64, p. 353-363.

____________, and Vaksvik, K. N., 1935, Geology and ground water resources of the Island of Oahu, Hawaii: Hawaii Div. of Hydrography Bull. No. 1.

Williams H., 1935, Newberry volcano of central Oregon: Geol. Soc. America Bull., v. 46, no. 2, p. 253-304.

* * * * *

Reprinted from The ORE BIN, Volume 25, No. 5, May, 1963, pages 73-88. State of Oregon Department of Geology and Mineral Industries, 1069 State Office Building, Portland, Oregon 97201.

* * * * *

The ORE BIN
Volume 25, No. 6
June, 1963

LEST WE FORGET

By F. W. Libbey*

Introduction

Gold mining was originally the mainstay of the economy of southern Oregon. It started settlements, built roads and schools, promoted local government, and established law and order. It was about the only source of new wealth and was a common means of earning a livelihood. It is now at best only a token of its past. Not only is gold mining as an industry dead, but its history and the knowledge of its individual mines, which formerly represented a large part of the area's payrolls, are fading into the hazy past. The critical point in its downfall was World War II's Administrative Order L-208, which was designed to stop the mining of gold, thus forcing gold miners to seek employment in base-metal mines, especially copper, in which there was supposed to be a shortage of miners. The order failed essentially to accomplish its objective, but the final result was to deal a crushing blow to gold mining. Shutdowns, always a serious operating matter in an underground mine because of the maintenance problem, compounded the gold miners' difficulties. After the war and the termination of L-208, costs of labor and supplies had multiplied but the price of gold remained the same. Thus gold mining was effectively killed.

The following outline of events in the rise and fall of gold mining in southwestern Oregon is here recorded - almost as an obituary - so that Oregonians may not entirely forget how important this industry was in building up this part of the state.

History

California gold rush

In 1848-49 a large number of Oregonians went south to the Sacramento Valley in the great California gold rush. As has been told many times, so great was the exodus that fully two-thirds of the inhabitants of the Willamette Valley joined the stampede, paralyzing business and industry in this newly settled

---

* Mining Engineer, Portland, Oregon

region. One party of south-bound fortune-hunters found gold in the sands of a Rogue River crossing (Scott, 1917, p. 150) but they were not diverted by the find from their main objective.

As the miners moved from one camp to another in central California, attracted by word-of-mouth reports of rich "strikes" made on another stream, a small reverse flow of prospectors set in. This began as a few groups started probing into northern California, especially along the Klamath River. Thus, while the great influx of people continued into California, a part of the current - a small eddy - changed from southbound to northbound, and inevitably drew gold seekers into southern Oregon.

The migration of fortune-hunters was generally overland, but one historic trip was made by a party who sailed north from San Francisco to the mouth of the Umpqua River in 1850. This expedition had, as principals, Herman Winchester, Dr. Henry Payne, Jesse Applegate, Levi Scott, and Joseph Sloan. It resulted in the founding of Umpqua City (at the mouth of the river), Gardiner, Scottsburg (at the head of tidewater), Elkton, and Winchester, and this string of settlements became a main supply route for the mining camps.

Placer mining in southern Oregon

Stream placers: In 1850 a party of prospectors from California investigated streams near the California-Oregon border, found pay gravels on Josephine Creek, and began to work them near its junction with the Illinois River. This may have been the first gold mining in the state (Spreen, 1939, p. 5).

The discovery that made the real gold boom in Oregon, however, was on Jackson Creek, near what is now the town of Jacksonville. In December 1851 two packers from Scottsburg on their way to the mines of northern California found a small gold nugget in the gravels of Jackson Creek. Later they told freighters Jim Cluggage and J. R. Poole of the find, and, in January 1852, Cluggage and Poole camped at the spot. They found rich gravels in the creek at what was named Rich Gulch and the rush to Jacksonville began as the news spread rapidly. People came from all directions--from the Willamette Valley, from the California gold camps, and from the Eastern States. Jackson County soon became the most populous county in Oregon. Gold production increased and the producing area spread into Josephine and Douglas Counties (see figure 1).

After Jacksonville came Sailors Diggings* (Waldo, near the headwaters

* Named because a party of sailors deserted ship at Crescent City when they heard of the rich strikes at Jacksonville. They journeyed across the Siskiyous and camped on the upper Illinois River, where they found rich gravels, and the boom camp of Sailors Diggings was born. A single nugget was found weighing 15 pounds and valued at $3,100, as reported by Spreen. He also states that the largest nugget ever found in southwestern Oregon was that discovered by Mattie Collins on the East Fork of Althouse Creek in 1859. It weighed 204 ounces (17 pounds troy) and was valued at $3,500.

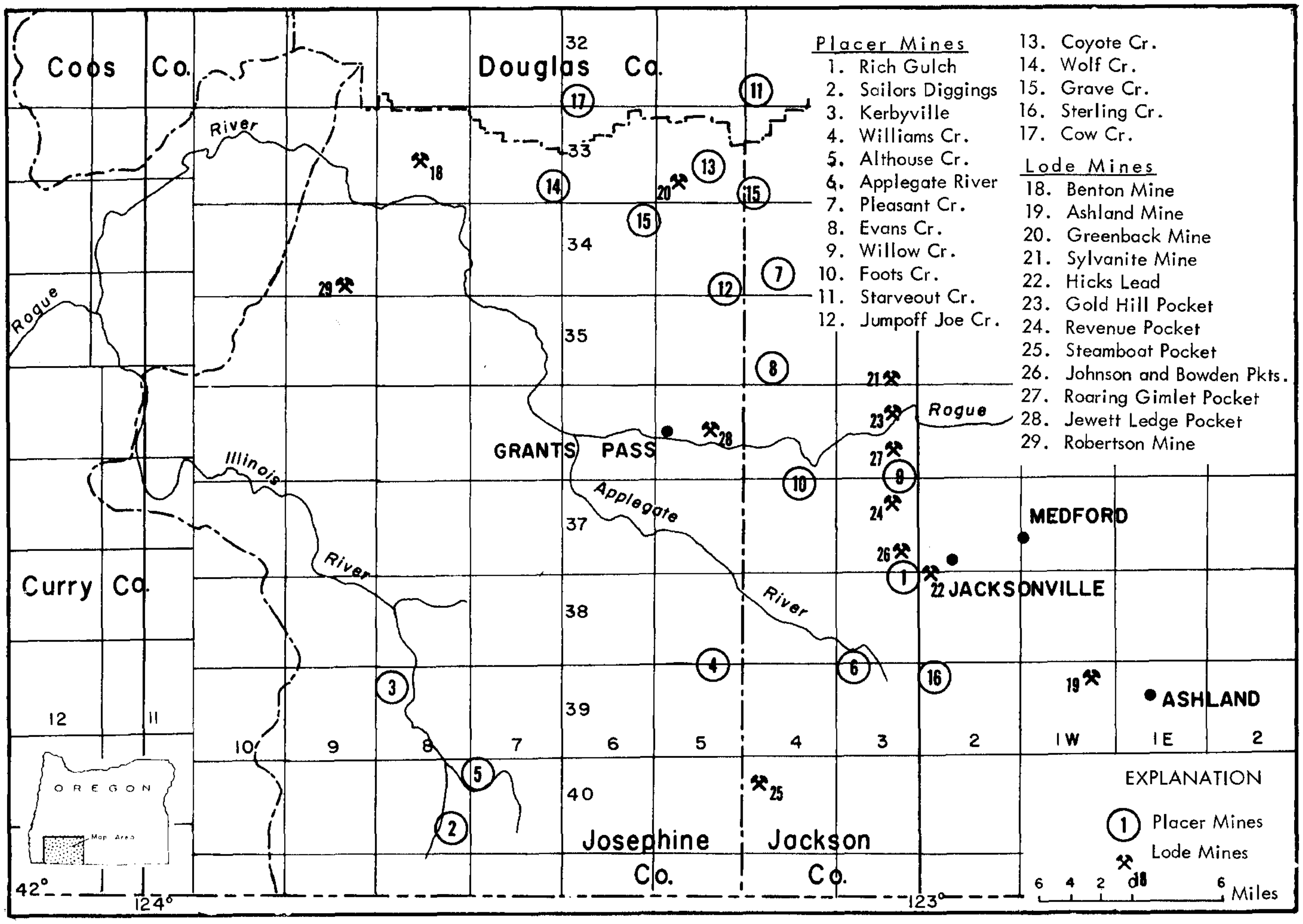


Figure 1. Index map showing locations of stream placer and lode gold mines in southern Oregon.

of the Illinois River), Kerbyville, Williams Creek, Althouse Creek, Applegate River, and numerous tributaries of the Rogue System on which such camps as Buncom became good producers. Farther up the Rogue, camps sprang up on Pleasant Creek, Evans Creek, Willow Creek, and Foots Creek. Numerous other creeks of the Rogue system were found to be productive, notably Starveout, Jumpoff Joe, Coyote, Wolf. Probably the most important of all was Grave Creek and its tributary, Tom East Creek. Some of the other stream valleys were later dredged, notably Foots Creek, Evans Creek, Pleasant Creek, and members of the Applegate system. Practically all important tributaries of the lower Rogue were hydraulicked at one time or another, and, although decreasing greatly in recent years, family operations and a very few partnerships are continuing for a few months a year. The Sterling was one of the largest of the hydraulic mines, continuing over many years. It worked the gravels on Sterling Creek for 4 of the 7 miles of its length above Buncom at the junction with the Little Applegate River. Total production was valued at $3,000,000 in 1916 (Oregon Dept. of Geology, 1943, p. 190). No production records are available for later years.

Cow Creek in Douglas County had some prolific placers in the early days. Starveout Creek, a tributary of Cow Creek, was said to have had very rich gravels when first worked.

Beach placers: Gold prospecting on the inland streams spilled over onto the ocean beaches as prospectors fanned out. "Colors" were easily found by panning the beach sands almost anywhere on the southern coast. Horner (1918) writes that the first beach mining on the Pacific Coast was at Gold Bluff, Humboldt County, California. Spreen (1939, p. 11) reports that gold was found in the beach sands of Curry and Coos Counties at Gold Beach, Pistol River, Ophir, Port Orford, Cape Blanco, Bandon, Old Randolph, and South Slough (see Figure 2). Exact dates of each discovery are not available, but they probably were from 1852 to 1854. It is recorded that the earliest beach mining in Oregon was at Whiskey Run, about 10 miles north of Bandon, in 1852. Here the boom town of Randolph was born and flourished for awhile, then suffered a decline. There is no record of production for the pioneer period. It may have been substantial, amounting to many thousands of dollars, since reports of good returns were current. The discoverers, reportedly halfbreed Indians, worked their ground for two summers without news of their find getting abroad. After word got out, the rush started and they sold out to McNamara Brothers for $20,000. Spreen's (p. 11) report contains an estimate "that during the fifties and sixties more than one hundred thousand dollars were taken from this one claim." It is stated that pans of black sand from this claim yielded from 8 to 10 dollars each. Pardee (1934, p. 26) groups Whiskey Run with other beaches in his statement that "they are popularly reported to have yielded a large amount of gold."

The mining history of the various other southern Oregon beaches was similar to that of Whiskey Run. First was the discovery, next the boom period when flush production was obtained, and then came the decline--sometimes rather quickly when workers encountered concentrations of heavy black sand* which resulted in high mechanical losses of gold and in discouragement.

Since the boom period of the past century, sporadic attempts to work the black sand deposits for gold and platinum have been made in both Coos and Curry Counties, and on both the present beaches and the ancient elevated terraces. A typical operation on a present beach, as at Cape Blanco, is described as follows by J. E. Morrison (Oregon Dept. Geology & Mineral Ind., 1940, p. 81):

"The beach sands just south of Cape Blanco have been worked off and on for almost a century. For five years prior to March 29, 1938, the property had been operated by Carl Hopping....It is said that Hopping was very successful, but most of his records as to production were lost in the Bandon fire. However, he did have records covering the period from January 4 to July 8, 1937, during which time he ran approximately 700 yards of sand. His mint receipts amounted to $1,650.32. Platinum and osmium amounted to $1,133.93. The gold averaged about 860 in fineness."

Offshore beds: A characteristic of the present beaches in relation to their economic importance is that they are transitory, and may vary in volume and distribution with the seasons and weather. A heavy storm may pile up sand from offshore beds on the beach, and another storm under different conditions may return the sand to the ocean. Thus the difficulty of estimating the volume and mineral content of sand on beaches is evident. Whether or not a feasible plan to recover economic minerals from offshore beds may be developed is problematical. If all the economic minerals could be recovered and sold, such a project could have future commercial possibilities.

---

* The principal original source of the heavy minerals such as gold, platinum, chromite, magnetite, ilmenite, olivine, garnet, and zircon found in southern Oregon beaches, was the Klamath Mountains. Gold occurs in veins in the rocks, and chromite, platinum, olivine, and other common heavy minerals are genetically related to the large bodies of peridotite and serpentine in the Klamath Mountains. Erosion breaks down these rocks, and the streams transport the resulting sands and gravels toward the ocean. Finally they become beach sands, where the heavy minerals collect in beds called "black sand" because they are predominantly black in color. It is not difficult for the placer miner to detect gold and platinum in a gold pan; the problem is to separate them from the other heavy minerals by methods available to small-scale miners. Losses of the metallics in tailings may be so large that profits disappear. Placer operations that succeeded in early days did so because the sands were so rich that, even though the losses were heavy, a profitable quantity of gold was recovered.

Distribution of black sand beds has been greatly influenced by changes in ocean level throughout geologic time, evidence of which is given by ancient shore terraces at several elevations. Black sand layers in these old terraces have been of considerable economic interest in recent times because of their chromite content.

Ancient terraces: Ancient elevated beach terraces contain black sand beds and, in places, gold and platinum metals. Before World War II, many attempts were made to work these deposits commercially. The remnants of these old mines may be found along the coast ranging from South Slough in Coos County to Gold Beach and beyond in Curry County (Figure 2). Many of them had interesting histories. One of the best known and typical of attempts to recover the precious metals from old beach terraces was the Pioneer mine on Cut Creek, about 5 miles north of Bandon in Coos County. It adjoins the Eagle mine on the south and since they were both on the same bed similar methods were used in treatment. Following is a description by Pardee (1934, p. 38) of one of several attempts to mine the deposit.

"The pay streak is a layer of black sand 3 feet or more thick, the richer part of which was mined through drifts said to have been made more than 60 years ago. Some of the mining timbers as well as an occasional huge log of drift wood are exposed by the present workings. Samples of the black sand remaining averaged about 3 percent of magnetite and 55 percent of chromite and ilmenite together. Gold and platinum alloy were being recovered by sluicing. A sample of the platinum alloy as determined by a spectrographic examination by George Steiger in the laboratory of the United States Geological Survey is composed of a relatively very large amount of platinum and smaller amounts of iridium and ruthenium. It contains in addition a possible trace of rhodium but no osmium or palladium....A sample from a hole 3 feet deep at one place contained 4 percent of magnetite and 60 percent of chromite and ilmenite. It is said that the tailings in the Lagoons contain unrecovered gold and platinum..." The thick overburden of barren gray sand (thicker than indicated by Pardee) was a great drawback, also the quantity of minable reserve was limited. The tailings flowed down Cut Creek and were impounded in a basin called the Lagoons, from which they were mined for their chromite content during World War II.

Some of the other early-day black sand mines on elevated terraces, named from north to south, were the Chickamin, Rose, Eagle, Iowa, Geiger, Butler, Madden, and Peck.

Lode mining in southern Oregon

Earliest mining in California and Oregon meant placer mining. First there were the high-grade stream gravels, which gave rich returns and generated an influx of miners. The best gravels were exploited relatively soon. Some of the miners moved on to other camps. Others, especially those with families, stayed on to build communities and become permanent residents. They also began to search for the lodes or veins which, in the process of weathering and erosion, formed the placer deposits.

Southwestern Oregon had some fame among prospectors and miners as a "pocket" country, that is, a region where rich concentrations of lode gold were sometimes found, usually as near-surface deposits. Many of these were discovered in Jackson and Josephine Counties down through the years. A class of prospectors known as "pocket hunters" became adept at finding and following traces which might lead to a pocket of gold. Most pockets were small - worth only a few hundred or, rarely, a few thousand dollars, but always the incentive was sufficient to keep them searching. Naturally the locations of most of the smaller ones were never reported and remained nameless. However, some exceptionally large and rich pockets were discovered and became famous. In the aggregate even the smaller pockets created a great deal of wealth in periods of the state's history when even a thousand dollars meant wealth to a settler or, in later years, to a family out of work. This was especially true during the early 1930's, when there was much unemployment. Pocket hunting became popular and, along with small-scale placer mining, helped the free-enterprise people of southern Oregon through a difficult period.

The discovery and development of lodes is generally more complicated and costly than the same undertaking for placers. Excavations in the form of cuts, tunnels, shafts, and various other underground workings in rock must be opened, involving much labor and the expenditure of time and money, hence the term "hard-rock miners."

Over the years many gold lodes were discovered in southwestern Oregon - too many to list here. Most of these were closed because of economic conditions or because of government restrictions. A few of those representative of gold mining (see Figure 1) are briefly described below.

Benton Mine: The mine, owned by the Lewis Investment Co., Portland, is on Drain Creek about 21 miles southwest of Glendale in secs. 22, 23, 26, and 27, T. 33 S., R. 8 W., Josephine County. Eight patented and 16 unpatented claims are included in the Benton Group. Joe Ramsey made the discovery in 1893. Mr. J. C. Lewis acquired the property in 1894 and developed it until 1905, completing approximately 5,000 feet of development work, at which time the mine was shut down. When the price of gold was increased in 1934, the mine was reopened and development work was resumed. A cyanide plant was installed and production maintained until April 15, 1942, when government regulations forced the closing down of mining and milling operations. Between 1935 and 1942, including time spent on exploration and construction, ore mined and milled totaled 64,282 tons averaging $8.55 for a gross value of $549,414.00. All development rock high enough in value to pay milling cost was sent to the mill rather than to the waste dump. About 10,000 lineal feet of work was done in the Benton mine proper, and about 1,150 feet on adjacent claims.

Ore bodies were formed in quartz veins by replacement in a quartz diorite or granodiorite stock which is in contact with metavolcanics and greenstone on the east. Eight veins have been found on the property. The main Benton vein has been explored and mined through the Kansas adit for an over-all strike length of 2,000 feet trending N. 20° to 40° E., and for 600 feet in depth. The main ore shoots were formed within a network of intersecting veins related to premineral faulting, and their emplacement was governed by structural control. The ore bodies have a pronounced rake (inclination in the plane of the vein) to the south. Minor postmineral faulting has been encountered but nothing that presented a serious problem.

On the bottom level (1,020) development revealed ore of better grade than the average value of ore mined in upper levels. A drift on the Louisiana No. 1 vein, 200 feet long, with a strike N. 80° E. and dip of 55° N.W., to its junction with the Benton Vein showed ore which averaged $25 a ton for widths of from $2\frac{1}{2}$ to 3 feet, with the face still in ore when work stopped. A winze on the 1,020 level sunk on the Benton vein from a point 50 feet south of the Kansas crosscut to a depth of 64 feet was channel sampled at about 5-foot intervals in both compartments of the winze. The north compartment samples averaged about $40 a ton for $4\frac{1}{2}$ feet average; the samples from the north compartment averaged about $18 a ton for approximately 5 feet average width*.

The cyanide plant of 40 tons capacity was completed in 1937 and enlarged to 60 tons capacity in 1940. It incorporated a counter-current system using Dorr thickeners, Dorr agitators, an Oliver continuous filter, together with Merrill-Crowe precipitation equipment. Reportedly mill recovery was about 85 percent, which could be increased to 90 percent if changes indicated by the operating experience were made. An adequate water supply was obtained from Drain Creek. Diesel power was used.*

It may be noted that in 1941 the Benton Mine had the largest individual payroll in the county.

<u>Ashland Mine:</u> Owners are Fred and Dewey Van Curler, Ashland, Oregon. The mine area comprises 276 acres of patented ground situated about 3 miles northwest of the City of Ashland in the $E\frac{1}{2}$ sec. 12, T. 39 S., R. 1 W., Jackson County, at an approximate elevation of 3,500 feet.

The mine was located in 1886 by William Patton (Burch, 1942, p. 105-128) and was active almost continuously until 1902 when the shaft reached a depth of 900 feet. It was closed down because of litigation with owners of adjoining claims and was not reopened until about 1932 when P. B. Wickham became manager. A 10-stamp mill operated by electric power was installed.

Total development is approximately 11,000 lineal feet and includes two shafts, an adit, raises and drifts. A depth of 1,200 feet on the dip of about 45° was reached. Reportedly (Oregon Dept. Geology & Mineral Ind., 1943,

---

* Elton A. Youngberg, written communication, 1963.

p. 24) several veins have been found but only two have been explored. The one on which most of the work has been done represents a fissure filling of quartz and brecciated granodiorite country rock. Two principal ore shoots have been mined. They show metallization of pyrite and metallic gold with occasional galena. Originally ore was graded as "shipping," which averaged about $100 a ton (gold at $20 an ounce), and "milling," which averaged about $13 a ton. Mill concentrates assayed about $75 a ton, although concentrate values of $150 to $350 have been reported. Value of ore and size of ore shoots are said to increase with depth. Up to 1933 total value of production was reported as $1,300,000. From 1933 to 1939 production was reported to be steady but "modest," all from milling operations (Oregon Dept. Geol. & Mineral Ind., (1943), p. 25).

The 10-stamp mill had the usual amalgamation plates, a concentration table, and cyanide tanks. Most of the gold recovery was from amalgamation, with a small percentage from concentration. Total recovery was reported to be 90 percent. Cyanidation proved to be of little assistance.

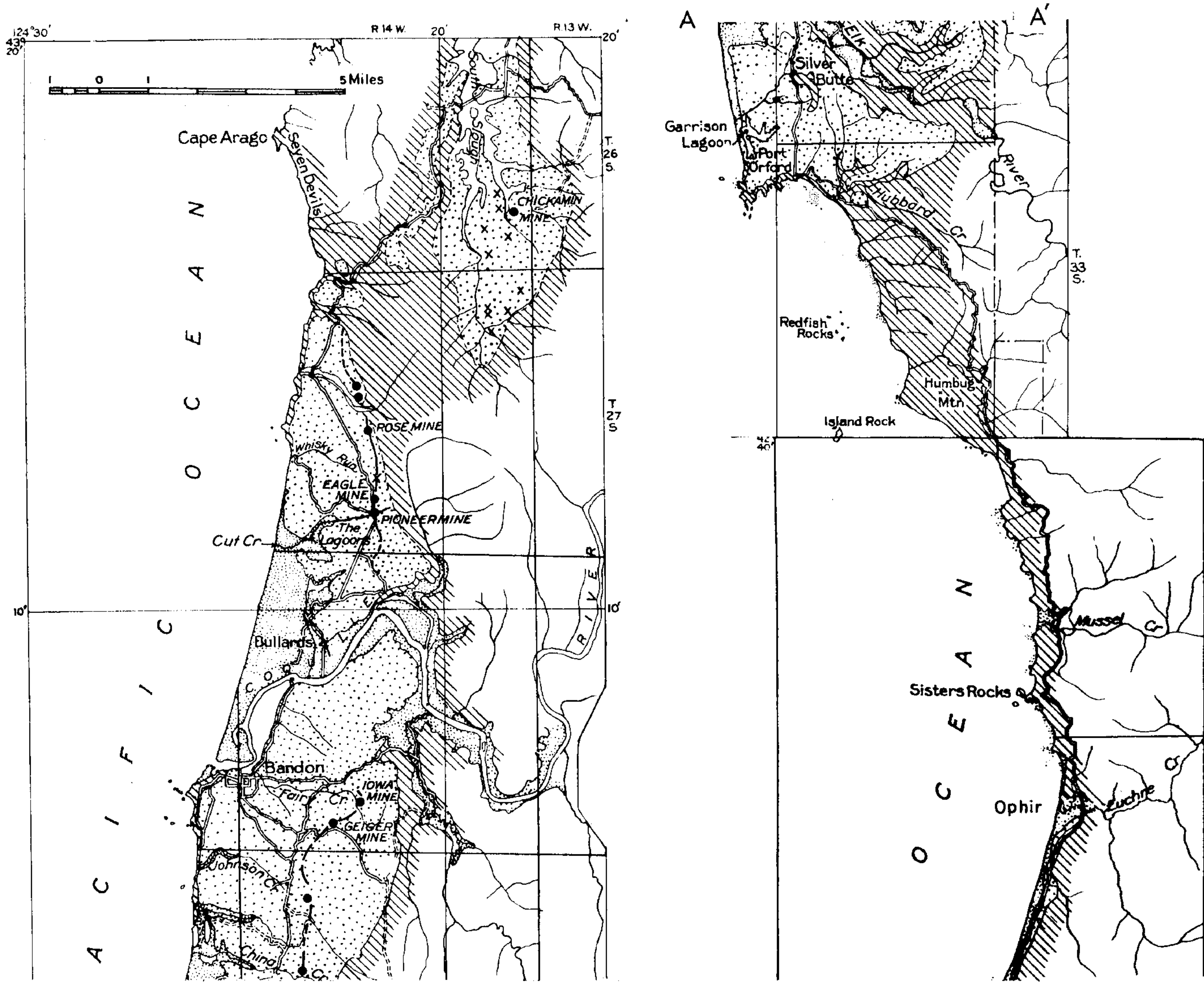
The owners used the mill for concentrating chrome ore during World War II.

Greenback Mine: The location is on Tom East Creek about 1.5 miles north of the old settlement of Placer and about 5 miles east of U.S. Highway 99 at the Grave Creek bridge. The property includes 243 acres of patented ground and 76 acres held by location. Legal description is secs. 32 and 33, T. 33 S., R. 5 W., and sec. 4, T. 34 S., R. 5 W., Josephine County.

Parks and Swartley (1916, p. 112-114) reported that the property was owned and operated by a New York group. In 1924 it was acquired by L. E. Clump, who held the mine until 1954. During part of that time the mine was operated by the following lessees: Finley and McNeil of San Francisco in 1937; P. B. Wickham in 1939; and in 1941 Anderson and Wimer, who discontinued work in 1942. The mine was purchased from Clump in 1954 by Wesley Pieren, Grants Pass, the present owner, who is carrying on some exploration.

The early history began with a rich surface discovery in 1897. The ore was first worked in an arrastra and later, after mine development work, a 40-stamp mill was installed, together with concentration tables and cyanide tanks. Capacity was rated at 100 tons per day. Electric power was brought in from the Savage Rapids Dam on the Rogue River.

Total underground development work aggregated about 7,000 lineal feet on 12 levels to a depth of 1,000 feet on the dip of the vein, which strikes about east and dips about 45° N. to the ninth level and 55° to 60° below the ninth. The country rock is greenstone and the quartz vein was productive for about 600 feet in length along the strike. Thickness averaged about 3 feet. Value was reported to average somewhat more than $8 a ton (gold at $20 an ounce). The vein was cut off by a fault on the west and by serpentine on the east. Commercial values were principally gold partly recovered by amalgamation.


A
A'
124°30'
43°
20'
R 14 W.
20'
R 13 W.
20'
1 0 1 5 Miles
Cape Arago
Seven Devils
T. 26 S.
CHICKAMIN MINE
P A C I F I C
O C E A N
T 27 S
ROSE MINE
Whisky Run
EAGLE MINE
PIONEER MINE
The Lagoons
Cut Cr.
10'
10'
RIVER
Bullards
Bandon
IOWA MINE
Fair Cr.
GEIGER MINE
Johnson Cr.
China Cr.
Silver Butte
Garrison Lagoon
Port Orford
Elk
River
Hubbard Cr.
T. 33 S.
Redfish Rocks
Humbug Mtn.
Island Rock
40'
O C E A N
T. 34 S.
Mussel Cr.
Sisters Rocks
Ophir
Euchre Cr.
T. 35 S.

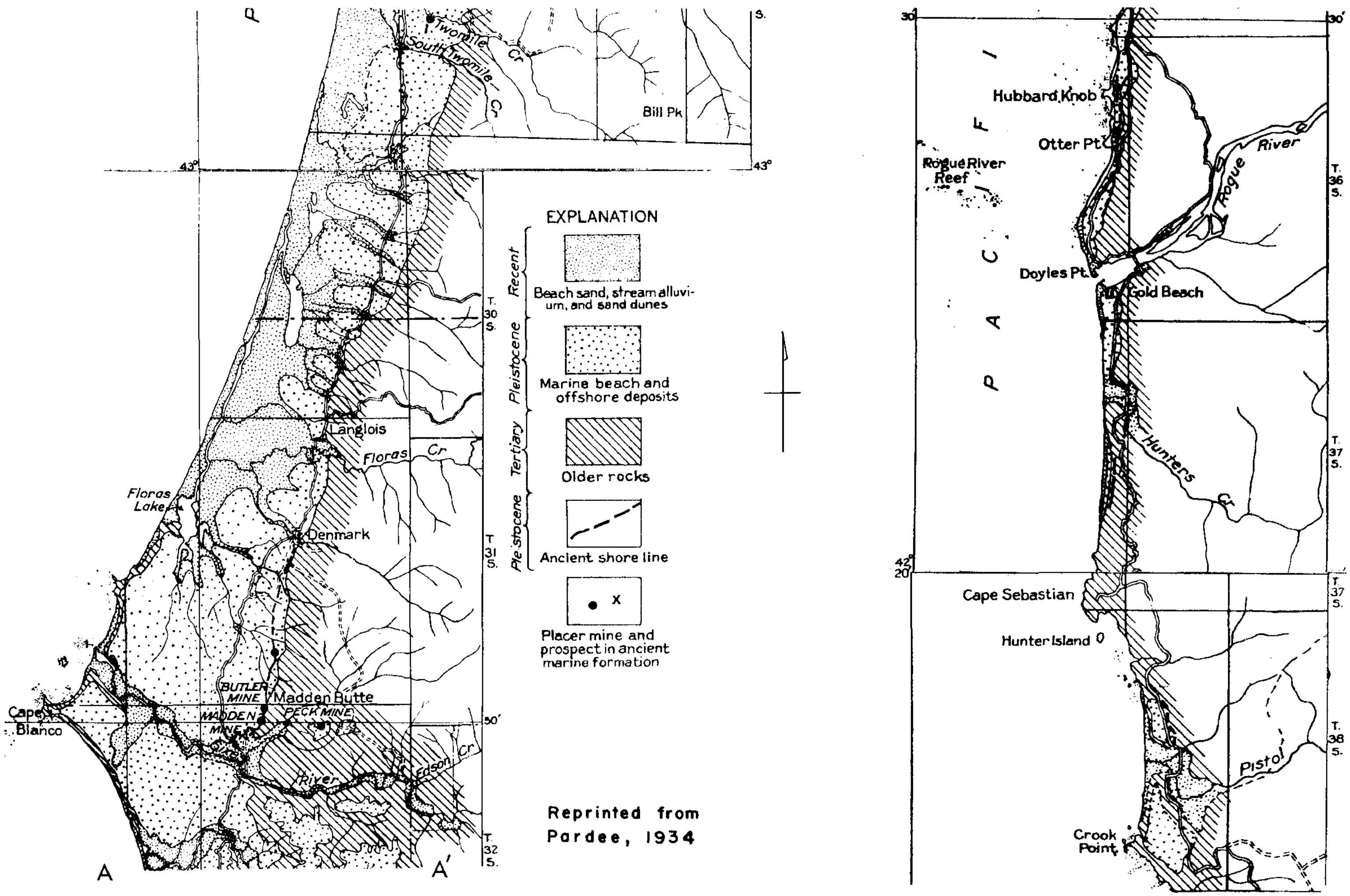


Figure 2. Beach placers of the southern Oregon coast.

Concentrates made up of chalcopyrite, pyrite, and some arsenopyrite averaged about $75 a ton (gold at $20 an ounce).

According to Mr. Wickham, production amounted to $3\frac{1}{2}$ million dollars. Mr. Pieren reports that about $100,000 was produced during L.E. Clump's ownership and that the average mill ore was $13.70 a ton.

One of the largest placer deposits in the state was formed on Tom East Creek below the outcrop of the Greenback Mine. It operated as Columbia Placers for many years.

Sylvanite Mine: The property is in sec. 2, T. 36 S., R. 3 W., about 3 miles northeast of Gold Hill in Jackson County, and comprises 132 acres of patented ground which, the record shows, includes four full mining claims and two fractional claims. The owner of record in 1951 was George Tulare, Route 2, Box 371, Gold Hill.

The discovery and early history of the mine are not of public record. Various published reports show that, beginning in 1916, owners and operators were, successively, E. T. Simons, with Stone and Avena, Denver, Colorado, lessees who found scheelite (tungsten ore) associated with the gold ore; Oregon-Pittsburg Co. in 1928; Discon Mining Co., A. D. Coulter, Manager, discoverer of the high-grade ore shoot along the Cox Lyman vein in 1930; Western United Gold Properties; Sylvanite Mining Co.; and finally Imperial Gold Mines, Inc., in 1939. This last company built a concentrating mill of 140 tons daily capacity and cleaned out underground workings to expose the openings where the rich ore shoot had been found.

The Sylvanite vein or shear zone occurs between meta-igneous and meta-sedimentary (largely argillite) rocks. It shows intense shearing and alteration and is intruded in places by basic igneous dikes. It trends just east of north and dips southeasterly at about 45°. The Cox-Lyman shear zone strikes at right angles to the Sylvanite vein and stands nearly vertical. No certain sequence of faulting in the two shear zones has been established. Ore shoots are said to be from 5 to 12 feet thick and have averaged from $5 to $15 a ton. They have a gangue of quartz and calcite and carry galena, chalcopyrite, and pyrite. A fracture zone roughly parallel to the Sylvanite vein cuts the Cox-Lyman vein and at the intersection a rich ore shoot was found on the hanging wall, producing $1,000 per lineal foot of winze in sinking 600 feet. Discontinuous pockets of ore were found in the hanging wall of the shoot for 200 additional feet of depth. The winze reached 900 feet below the surface. This ore shoot was reported to have yielded about $700,000.

A total of more than 2,560 lineal feet of underground development work has been done. In addition, numerous surface pits and cuts, now caved, have been dug by pocket hunters.

Seemingly little effort has been made to explore the scheelite possibilities, although it is known that the Imperial Gold Mines Co. had such plans. They ran into difficulties underground because of caving ground, and presumably war-time conditions finally forced them to close down.

Hicks Lead: The first gold "pocket," also the first gold lode, discovered in Oregon was the so-called Hicks Lead found on the left fork of Jackson Creek above Farmers Flat in Jackson County. Sonora Hicks, the discoverer, working with his brother, took out $1,000 in two hours, according to the Jacksonville Sentinel of that time. Walling (1884, p. 328) relates that Hicks sold his claim to Maury, Davis, and Taylor, owners of the adjoining claim, who then built the first arrastra in Oregon in order to treat the Hicks ore. The yield from the Hicks claim was $2,000.

Gold Hill Pocket: The most famous of all was the astonishing Gold Hill Pocket, discovered in January, 1857 by Emigrant Graham and partners near the top of the hill 2 miles northeast of the town of Gold Hill in SW$\frac{1}{4}$NE$\frac{1}{4}$ sec. 14, T. 36 S., R. 3 W., Jackson County, at about 2,000 feet elevation. According to available records (Oregon Dept. Geology & Mineral Ind., 1943, p. 70), the outcropping rock was so full of gold that it could scarcely be broken by sledging. The crystallized quartz associated with the gold was not honeycombed as it generally is where sulfides have leached out of the rock, leaving sprays of gold in the cavity. The gold in this pocket went down only 15 feet and occurred in a fissure vein striking about N. 20° W., dipping about 80° E., with a vertical gash vein cutting the fissure nearly due east. The fissure vein averages 5 feet between walls with 1 to 2 feet of gouge on the footwall, which contains calcite and quartz mixed with a little pyrite, in spots containing free gold. A mass of granite, about 5 feet wide by 200 feet long, crops out in the footwall side of the fissure. The country rock is pyroxenite. It is said that this pocket produced at least $700,000.

Revenue Pocket: Another large "pocket" was named the Revenue. It was found and mined out (date unknown) by the Rhotan brothers 5 miles south of Gold Hill on Kane Creek in sec. 11, T. 37 S., R. 3 W., Jackson County, at an elevation of about 2,570 feet. Reportedly it produced $100,000 (Parks and Swartley, 1916, p. 193) and was one of the larger pockets discovered by Rhotan brothers, who evidently were well-known pocket hunters.

Steamboat Pocket: This important enrichment in a network of quartz veins in andesite was found in the Steamboat mine about 1860. The location is on Brush Creek, a tributary of Carberry Creek, 2 miles west of Steamboat and 42 miles by road west of Medford. It is in sec. 20, T. 40 S., R. 4 W., Jackson County. The property has had several names and once was known as the Fowler mine, derived from the name of one of the owners of the Fowler and Keeler Trading Post on the Applegate River, 17 miles distant, and under this name was a litigant in long and costly law suits over title. The yield from the pocket (Parks and Swartley, 1916, p. 212) is reported to have been $350,000.

Johnson and Bowden Pockets: Two pockets in the Jacksonville locality are described under the name of Town Mine by Parks and Swartley (1916, p. 136). Date of discovery and extraction is not recorded. The deposits were discovered at points about 600 feet apart, approximately 2 miles west of the reservoir on Jackson Creek in sec. 25, T. 37 S., R. 3 W., Jackson County. The Johnson deposit yielded $30,000 and the Bowden $60,000.

Roaring Gimlet Pocket: Diller (1914, p. 46) described a rich deposit known as the Roaring Gimlet pocket, discovered in 1893. It was found at the mouth of China Gulch, Jackson County, about 2½ miles south of the Gold Hill pocket. The high-grade ore was apparently liberated from oxidized sulfides, leaving very little quartz, and formed an enriched gouge seam from a quarter of an inch to 6 inches thick between a porphyry footwall and a slate hanging wall. At a depth of 40 feet the vein continued down between dioritic walls and contained some small kidneys of calcite and quartz with pyrite - a gangue looking very much like that of the Gold Hill pocket. Several small pockets were extracted just east of the large Gimlet pocket. The combined yield is said to have been $40,000.

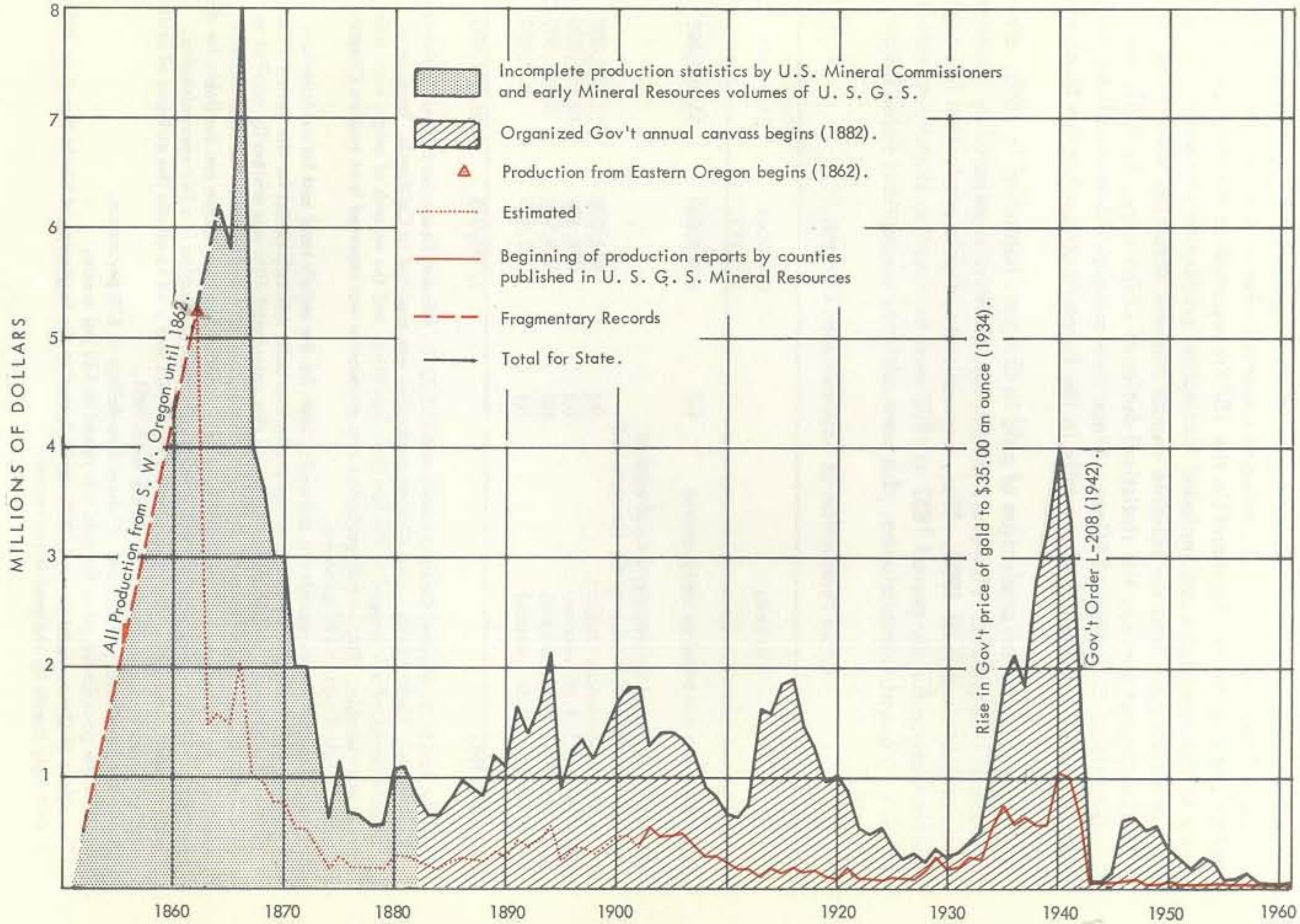
Jewett Ledge Pocket: Known as the Jewett Ledge, this pocket was found in 1860 by the Jewett brothers on the south side of the Rogue River in sec. 27, 28, 33, and 34, T. 36 S., R. 5 W., Josephine County. As reported by Walling (1884, p. 330), the Jewetts were "signally successful" and took out $40,000. It is said that they exhausted the deposit and ceased work. In later years considerable work was done on the property and seven claims were patented.

Robertson Mine: In more recent times an underground high-grade lens of gold ore was found at the Robertson (or Bunker Hill) mine in March, 1940, somewhat different in character from the surficial deposits previously described. The mine owners, William Robertson and Virgil E. Hull, struck an enrichment in their quartz vein, and took out 640 ounces of gold valued at about $20,480 in four days of mining. The mine is west of Galice in sec. 2, T. 35 S., R. 9 W., Josephine County, at an elevation of 4,500 feet. A specimen of this high-grade ore is on display in the Portland museum of the Oregon Department of Geology and Mineral Industries.

Production

Early-day statistics of gold production in Oregon were meager and, for the most part, based on records of agencies such as Wells Fargo, banks, and

OREGON GOLD PRODUCTION



post offices which handled gold shipments to the San Francisco Mint. An organized canvass of mineral production in Western States by the Government began about 1880, although U.S. Mineral Commissioners J. Ross Browne (in the 1860's) and Rossiter W. Raymond (in the 1870's) reported on the mineral industry in Western States and included incomplete production statistics. These pioneer efforts grew into the reliable annual Mineral Resources volumes of the U.S. Geological Survey, the statistical duties of which were, in 1933, assigned to the U.S. Bureau of Mines. Since then mineral industry statistics have been assembled and published annually in the Bureau's comprehensive Minerals Yearbook.

Figures for annual production of gold in Oregon, beginning in 1881, are believed to be reliable. However, production statistics segregated by counties were not published until 1902. Thus, any estimate of gold production for southwestern Oregon for the period 1852 to 1902 must be based on sketchy reports of the U.S. Mineral Commissioners, plus some arbitrary assumptions noted below.

Gold Production of Southwestern Oregon

Periods		Ounces (Troy)	Dollars
1852-1862 (estimate based on early reports)	(a)	1,560,000	31,200,000
1863-1901 (estimated by assuming a fixed ratio of production between the total for the state and that of southwestern Oregon)	(b)	943,000	18,800,000
1902-1933 (U.S.B.M. records)	(c)	495,590	12,670,000
1934-1942 (U.S.B.M. records)	(d)	183,900	6,436,000
1943-1961 (U.S.B.M. records)	(e)	12,520	438,000
Total 1852-1961		3,195,010	69,544,000

(a) Mostly from U.S. Mineral Commissioner's and U.S.G.S. Mineral Resources reports, which are fragmentary. Undoubtedly, some Oregon production was credited to California, because all the gold produced was shipped to the San Francisco Mint, and the records of origin were some times questionable. This period was before any production was reported from eastern Oregon. Value is calculated at $20 an ounce.

(b) After 1901, production records are authentic, both for the state's total and for southwestern Oregon. An over-all ratio for these two production units was calculated for the period 1902 to 1942 (Order L-208 closed gold mines), and this calculated ratio was arbitrarily applied to production for the period 1863-1901 in order to translate it into production for southwestern Oregon. As has been stated, no reliable records for southwestern Oregon are available for this period, but the corresponding figure for the state's total production is a fair approximation, and accurate after 1880. The ratio was 4.2:1 and 4:1 was used to obtain the estimate of southwestern Oregon production for the period 1863-1901.

(c) Authentic records from U.S.B.M. Ounces into dollars at $20 per ounce.

(d) In 1934 the government price for gold was raised to $35 per ounce.

(e) The effect of Government Order L-208, promulgated at the beginning of World War II in 1942, is strikingly shown by the production record.

As gold was not discovered in eastern Oregon until 1862, the reports of production in the state from 1852 to 1862 represent production from southwestern Oregon, except a very small amount from camps in the Western Cascades. This early 10-year period, of course, included the large flush production which may have been as much as two-thirds of the total for the 50-year period, 1852-1902. Gold production in southwestern Oregon from 1852-1961 is summarized in the accompanying table and graph.

Outlook

What is the outlook for gold mining in Oregon? Prospects for any change in economic conditions that would narrow the gap between high operating costs in gold mining on the one hand and the fixed government price on the other look rather bleak. No matter what else may happen other than a deep depression, high costs, the principal element of which is labor, are here to stay. Then how about a rise in the price of gold? Economists do not agree on the effects of such a change, and as a matter of policy, official Washington must oppose it very definitely.

An uncertain element in this murky situation is the effect of our continuing loss of gold because of the unfavorable balance of payments in our international trade. But one thing is certain. There is a limit below which our gold stock may not go without destroying confidence in the dollar. What is that limit? Probably no one knows, and Washington doesn't like to talk about disagreeable subjects.

Selected Bibliography

Burch, Albert, 1942: Oregon Hist. Quarterly, vol. 43, no. 2, p. 105-128.

Diller, J.S., 1914, Mineral resources of southwestern Oregon: U.S. Geol. Survey Bull. 546.

Hornor, R. R., 1918, Notes on the black-sand deposits of southern Oregon and northern California: U.S. Bur. Mines Tech. Paper 196.

Oregon Dept. Geology and Mineral Ind., 1940, Bull. 14-C, vol. 1, Coos, Curry, and Douglas Counties.

__________________, 1943, Bull. 14-C, vol. II, sec. 2, Jackson County.

Pardee, J.T., 1934, Beach placers of the Oregon Coast: U.S. Geol. Survey Circ. 8.

Parks, H.M., and Swartley, A.M., 1916, Handbook of the Mining Industry of Oregon: Oregon Bureau of Mines and Geology.

Scott, Leslie M., 1917, Pioneer stimulus of gold: Oregon Hist. Quarterly, v.18.

Spreen, C.A., 1939, A history of gold mining in Oregon, 1850-1870: University of Oregon master's thesis.

Walling, A. C., 1884, History of southern Oregon: Portland, Oregon.

Youngberg, E.A., 1947, Mines and prospects of the Mt. Reuben Mining Dist. Josephine County, Oreg.: Oreg. Dept. Geology & Mineral Ind. Bull. 34.

* * * * *

STOCKPILE POLICY THREATENS MERCURY INDUSTRY

The Atomic Energy Commission has recently declared some 50,000 flasks of mercury excess to its requirements and turned this material over to the General Services Administration for disposal. This is a part of the AEC stocks of mercury which it has collected over the last 9 years.

While in 1953 the stockpile authorities professed there was no need of additional mercury for defense purposes, in 1954 the AEC requested that GSA acquire 170,000 flasks of mercury at the earliest possible moment. It is understood that AEC removed from the Strategic Defense Stockpile approximately half of the total mercury in the stockpile. In addition, it contracted through barter for additional amounts of metal from foreign sources (Spain and Italy). Domestic producers were not even given a chance to bid on these requirements.

Industry estimates of total mercury in the hands of AEC would indicate that it had at least 225,000 flasks. How much of this material has been lost in processing is unknown but, if it follows general industry practice, an estimate of 25,000 flasks might be an educated guess. Thus, the AEC should still have at least 100,000, and possibly 150,000, flasks in its possession.

The 50,000 flasks declared excess represents almost a normal year's U. S. consumption. It represents $2\frac{1}{2}$ years or more of current U. S. production. Total AEC stocks of 200,000 flasks is close to annual world consumption.

In 1958, according to the U.S. Tariff Commission, 11 domestic mines supplied 90 percent of U.S. production. Today three mines represent over 95 percent of U.S. production, and eight other mines have closed because of steadily declining prices and steadily increasing costs. In the last 4 years domestic production has dropped 50 percent.

An estimated 90 percent or more of the AEC mercury stock is of foreign origin and came into the U. S. without payment of duty. If any appreciable part of this 50,000 flasks is placed on the domestic market, it can only result in declining price and very possibly the forced closure of all domestic mines. Even if it is not placed on the market, the mere fact that it overhangs the market will almost certainly result in a reduction of domestic production by 25 percent, or possibly more. In any event, the net result of this surplus disposal will mean an abandonment of almost all exploration and development programs were such programs even being considered.

It is ironic to note that the government is financing one of its largest mercury exploration programs in Alaska at the present time; one branch of the government endeavoring to increase production of mercury while another branch of the government, in effect, may well destroy the whole industry.

California has been for almost 100 years the principal producer of mercury in the U.S. Nevada, Alaska, Oregon, Idaho, and Texas have been important producers, and Arizona, Arkansas, and Washington have made some contribution to domestic production.

While disposal of strategic metal stockpiles and Defense Production Act stockpile requires Congressional approval, surpluses of material in excess of requirements already in the hands of other government agencies can be disposed of under ordinary surplus property laws and regulations. Thus, if this material is not put back in the strategic stockpile by the AEC it will hang over the market and could be declared surplus and dumped on 24 hours' notice. Manifestly, no industry can continue under such conditions. The American Quicksilver Institute estimates that probably not more than one mine could last as long as a year, and even this is somewhat problematical.

During the last several months the mercury market has been weakened by the threat of Russian and Chinese mercury shipments. The domestic industry, facing labor costs five times as high as 20 years ago and prices which increased only two and a quarter times in that same period, has found it extremely difficult to continue under normal circumstances. This government action in regard to mercury would seem almost inevitably to mean the end of the mercury industry.

* * * * *

RE-ENTRY PERMIT ISSUED

The Department of Geology and Mineral Industries issued a permit to Marvin C. Lewis of Salem, Oregon, on June 5, 1963 authorizing re-entry of an oil test hole which was drilled by the Reserve Oil & Gas Co. of San Francisco, California, in 1960. "Roy-L&G-Bruer 1" was drilled to a depth of 5,549 feet by Reserve and then abandoned. Cement plugs will be drilled out in order to test zones which Lewis and associates believe to be productive. The well is located in sec. 31, T. 6 S., R. 4 W., Polk County.

* * * * *

GEOCHEMICAL SAMPLING PROGRAM TO BEGIN

The Board of Governors of the Oregon Department of Geology and Mineral Industries has approved a long-range plan for the Department to begin a statewide geochemical sampling program. The plan is to sample sediments of the streams for trace amounts of minerals that in turn may indicate the presence of ore deposits. This information will be plotted on maps for ready reference by interested persons. The program would start in a modest way by sampling in the areas that are most likely to have mineralization, and then over a period of years be extended throughout the entire state. Testing will be for three metals, copper, zinc, and molybdenum. These three metals were chosen because they occur either as ore or as indicators of the main types of deposits that might be expected. Copper and molybdenum would indicate porphyry type deposits; copper and zinc would indicate epithermal gold, silver, and base-metal deposits; and molybdenum would point to pegmatite deposits containing tungsten and molybdenum.

The project will be carried on mainly by student labor, supervised by R.G. Bowen, Economic Geologist on the department staff. Initial sampling will be done by following roads and taking samples at stream crossings. Analysis of the samples will be made in the Portland office of the department, again by students, using standard rapid chemical analytical procedures. When anomalous concentrations of metal are found, they will be checked by department geologists to see if the source of the metal can be ascertained. Publication of the data will be in the form of maps with symbols to indicate sample location and amount of elements present.

Geochemical testing can do no more than indicate areas where ore deposits may exist. The object of the program is to target areas for further exploration by individuals or companies looking for mineral deposits.

Large-scale geochemical sampling programs are being conducted in Russia in conjunction with all of its geologic mapping. Most other countries do not have such ambitious programs. In Canada, Nova Scotia has conducted a large-scale stream-sediment sampling project similar to the one planned in Oregon. In the United States, most of the geochemical prospecting is being carried out by mining companies. The U.S. Geological Survey is doing research in developing new prospecting methods and is sampling in selected districts.

* * * * *

STATE GEOLOGISTS TAKE STAND ON WILDERNESS BILL

At a meeting May 7th in Morgantown, West Virginia, the following resolution was adopted by the members of the Association of American State Geologists:

> Whereas, it is recognized that there exists a present and future need for the public preservation of open space, including natural areas, for the enjoyment and benefit of present and future generations; and
>
> Whereas, the Wilderness Bill (S 4) as passed by the Senate would greatly hinder -- if not virtually negate -- the beneficial development of our Nation's mineral resources;
>
> Now, therefore, the Association of American State Geologists, in annual meeting assembled, respectfully urges that favorable consideration be given to revising this Senate Bill, before its final enactment, along the lines of HR 776 (1962).

* * * * *

The ORE BIN
Volume 25, No. 7
July, 1963

THE RELOCATION OF GEOLOGIC LOCALES IN ASTORIA, OREGON*

By Betty Rae Dodds

The growth of the City of Astoria during the past 100 years has had a serious effect on the study of the geological type section of the Miocene upon which Astoria is built and which it therefore partially conceals.

The first visit to Astoria by a geologist was in 1841 when James Dana, who accompanied the Charles Wilkes Expedition which was formed to estimate the capacities of the Oregon Country, collected the first Miocene fossils found on the west coast of North America from the "beach near Astoria" (Dana, 1849). J. K. Townsend obtained fossils from the same area in 1842. The published description of the rocks and the associated fossils in these collections caused Astoria to become a type section for the marine Miocene of the West Coast. Throughout the intervening 120 years, geologists have correlated Tertiary stratigraphic sections from other locations on the Pacific Coast with the section exposed at Astoria.

The circumstance that a populous town has developed exactly upon the site of a geological type section has advantages, but these are interwoven with frustrating difficulties. The frequent exposure of fresh rock in road cuts and in the excavations required for building has offered periodic opportunities for the study of previously covered sections. However, the rapid masking of described exposures and the frequent removal of seemingly stable reference points has caused confusion. Present day investigators find it difficult to locate themselves according to past authors. When they finally believe themselves properly situated, they may in fact be many blocks from their desired position. During the history of the city, the street names and numbers have been changed, shuffled, and removed. The two Spruce Streets of the 1880's, one running north-south and the other east-west, disappeared in 1899. Before 1899, Astor Street was the present Exchange Street. The present Astor Street lies four blocks north. Obviously, it is necessary to know whether or not an Astor Street collecting locale, for instance, was described before or after 1899. Such dating is vital.

It is the purpose of this paper, through a brief review of the history of Astoria, to construct a framework of the physical history of the city, to place each published geologist in his correct historical setting within the city, and to reestablish his

---

→ Mrs. Dodds is a native Astorian, a graduate of the University of Oregon, and wife of Kenneth Dodds, geologist, whose thesis area was the Svensen quadrangle just east of Astoria. His attempt to find the old fossil sites in Astoria, some of which were geologically famous long before that point of land became a town, was the inspiration for Mrs. Dodd's interesting and valuable piece of research.

*Paper presented at the 1960 Oregon Academy of Science meeting in Eugene.

locales so as to be presently useful.

The practical history of Astoria begins with the 1805-06 Lewis and Clark Expedition, which wintered not far from the present location of the town. It was largely its accounting which convinced John Jacob Astor that a fur-trading fort on the Astoria peninsula would be a worthwhile venture. This was accomplished in 1811 with the building of Fort Astor. The men who lived in the fort were such a long distance from ordered civilization that, when the English appeared during the War of 1812 and suggested that they surrender, they complied immediately. So, in 1813, American Fort Astor became English Fort George. However, the fact that the American flag had flown first over this western-most establishment became an important and winning argument in the ensuing battle over territorial rights between the United States and England. By 1818, Fort George was the establishment of Astoria but there were neither Englishmen nor Americans on the site. It had been completely abandoned.

In 1825-26, a young man named John McLaughlin was sent by the Hudson's Bay Co. to establish a fur-trading post and fort on the Astoria peninsula. After a brief reconnaissance, he concluded that Astoria was too far from the center of the territory, and he moved up-river where he built Fort Vancouver. He left one man in Astoria to gather the furs as they were brought to him by the Indians and to send these furs to Vancouver. Astoria, after the initial excitement of Lewis and Clark, the English and Americans, and finally, Dr. McLaughlin, returned to its original calm. It was during this low period that one boat of the Charles Wilkes Expedition ran aground on the sandbar off Astoria.

James Dwight Dana was the geologist who accompanied the expedition to the Pacific Northwest. The name of James Dana is well known and greatly respected by geologists, not only for his personal skill in the field but for his system of minerology. He was a young man when he stepped from an Indian canoe which came to rescue the beached members of the Wilkes Expedition. It was 1841. At that time Astoria was described as:

> "... a miserable squatter's place, invested by the rival American and English factions with the pompous name of Fort George and Town of Astoria, the fort being represented by a bald spot, from which all vestige of buildings had long since disappeared, and the town by a cabin and a shed." (Lockley, 1928, p. 226).

The white population numbered one. He was the Hudson's Bay lookout and trader who lived in the company cabin on the site of the old fort near the present St. Mary's Hospital. This area, at what is now 15th and Exchange, was in 1841 on a slight promontory with a sea cliff to the north and small bays on either side (see figure 1). The "cabin and a shed" were also on this high ground and it was from here that James Dana walked the beaches east towards Tongue Point and west towards Smith Point, to study the exposed rocks.

They were difficult hikes. There were rock-strewn beaches up-river towards Tongue Point, some of them exposed only at low tide. The deep forest in many places extended to the water's edge and the tangled underbrush discouraged its penetration. Down river were a series of small bays with rock and sand beaches and a high, forest-covered sea cliff, which plunged into deep water at its base and which had to be sailed around to reach the narrow beach which ended eventually at Smith Point. From here, one can see the ocean and the waves breaking on the treacherous sandbars at the mouth of the Columbia. In spite of the remoteness of the country and the difficulties involved in traversing it, Dana collected some representative fossils and thoroughly described the rock exposures he examined along the river. He was able to preserve the Astoria collection during the rest of the long journey, and later published the description of the exposures in which he found them (Dana, 1849). So began Astoria's geological interest.

In 1844 James Shively took up residence on his Donation Land Claim on the ground surrounding the Hudson's Bay property. Within a year, there arrived Colonel John McClure, who settled down river to the west, and Colonel John Adair, who made his claim up river to the east of Shively. Each of these proud and independent gentlemen platted a portion of his land for a future town. Each was planned and filed separately. The streets were not arranged to join what would be the same street in the next claim, nor were the names co-ordinated to be consistent from one claim to the other. Neither was street-name duplication avoided; there were two Spruce Streets, two Cedar Streets.

There is a special breed of man who will take a plot of land in the wilderness and confidently proceed to plan a city designed to grow upon his property. Mr. Shively and Colonels Adair and McClure were of this breed. Independently, each had his own idea of a claim-sized town in this remote spot - a dream of considerable proportion. Each was far-sighted, but not one of the three could foresee that the plans would be incorporated into one another and extended. The peculiar appearance of parts of the city map is due, not to landsliding as has been suspected, but to the laying of the streets as originally platted using whatever jogs or omissions were necessary to join the streets in approximate regularity. Because Shively had platted his blocks larger than either McClure or Adair, there is no room for Harrison Avenue between 13th and 23rd Streets (see maps, pages 122 and 123). Shively and McClure regarded one another with some contempt. However, they did agree on one point, which was that there would be an uninhabited wild area between their claims. This area corresponds to what should be 13th Street in the present city, and the elusive, irregular character of 13th Street has caused the city planners a number of headaches. The jumble of street names persisted until 1899 and until that time it was important to have explicit directions. The terms "Shively's Astoria," "McClure's Astoria," and "Adair's Astoria" were commonly used to denote addresses and buildings. These terms persisted into the 1920's and they are still used infrequently.

By the year 1850 the population had grown, as it had in much of the West, and the inhabitants of Astoria were separated into two small communities. One group lived on Adair's claim, called either Upper Town or, derisively, "Adairsville" by the other group which lived on McClure's claim, called Lower Town. There was great rivalry between the two settlements. Upper Town fought for and won the first Customs House, while Lower Town managed to gain the Post Office. Each of these government offices was the first of its kind to be established west of the Rocky Mountains.

The city was incorporated in 1856 and the limits set. The city included all of Shively's claim and the eastern part of McClure's claim. A fossil collected by John Evans, United States Geological Survey geologist, and described by B. F. Shumard (1858), was said to have come from "the shores of the Columbia a short distance above Astoria, Oregon." The date of Dr. Evans' visit was 1851 and the described location was probably up-river from the present 19th Street.

Until about 1860 the population remained small. Lower Town was separated from Upper Town not only by the bay which necessitated the use of a rowboat to go from one area to the other, but by the aforementioned rivalry which prevented any accord. Each group had wonderful paper plans involving tree-shaded avenues and beautiful public buildings for its own part of the peninsula. The people seemed blind to the fact that Upper Town consisted of a few rough plank buildings at the edge of the water, and Lower Town of an army barracks and some small houses (see figure 2). At the same time, neither group was yet able to foresee that the peninsula was to become one town incorporating both areas. However, by 1870 the population had grown a great deal. There were many landowners to take advantage of the sale of waterfront property. The sale occurred in 1872 when the State of Oregon, which until this time owned all the land between high and low water marks, offered to sell it to the landowners who owned the waterfront property. Immediately, wharves and buildings on pilings were erected, and this spurred a prosperity which in turn encouraged a rapid growth of population. Because of a lack of level land, most of the business district began to be built on pilings over the water.

In 1876 the Astoria city limits were expanded to include all of the Shively and McClure claims, extending from the summit of the hill to the Columbia River, in addition to the corresponding area on the south side of the hill facing Young's Bay. The metropolitan district continued its growth on the river side of the hill. In 1878 the first road was built connecting the Upper and Lower Astorias.

Thomas Condon, Oregon's first State Geologist, came to Astoria during these early years. His collection of fossils is preserved at the University of Oregon in Eugene and they are labeled, unfortunately for our purposes, "In loose concretions near the water level at Astoria, Oregon." The water level in 1878 was at the original waterfront, but it was greatly altered even then by the constructions which had taken place on the shore and over the water (see figure 3). The city limits extended from the present 2nd to 32nd Streets and the original beach and river cliffs beyond these boundaries were certainly exposed. The Smith Point area at the westernmost end of the peninsula was unaltered, as were the "Aturia beds" in whatever area they may finally be located. We have no direct indications as to the specific water level areas in which Dr. Condon found fossils, but they were very likely east of 32nd Street, west of 2nd Street, and very probably in the bay area between 19th and 23rd Streets.

In 1883 Astoria suffered a large downtown fire, but this was a prosperous era and the town was quickly rebuilt. The use of waterfront fills dates from this time. However, without modern equipment, only a few central beach areas were covered with sand filling and the whole downtown area was rebuilt as it had been before - on pilings above the water (see figure 4). In 1890 when W. H. Dall, geologist with the United States Geological Survey, came to Astoria, the so-called "Aturia beds" were inaccessible. These beds had provided a few samples of a lovely, distinctive, Eocene-Oligocene cephalopod which every geologist-vistor to Astoria since 1878 has wanted to find. Dall believed the Aturia beds to be at the water level in the vicinity of the filled-in area that is now Gyro field, between 19th and 23rd Streets, but he was unable to find them. He was able to investigate the strata on Smith Point, which for many years now has been covered.

A burst of civic confidence in 1891 resulted in the extension of the city limits to include a great area. The city was bounded by the Columbia River, John Day River, Young's Bay and River, and a line connecting the John Day and Young's Rivers (far outside the area of the map). These boundaries were in force when U.S.G.S. Geologist Joseph Silas Diller arrived in Astoria in 1894. He, his aid, and a cook had mules fitted out in Forest Grove and made the arduous trip over the Coast Range by the old Military Trail. In the report of his reconnaissance of the geology of Northwestern Oregon (1896), he includes Plate IX opposite page 470 which is described as "From a photograph taken near the High School building in Astoria." During its history, Astoria has built three high schools. A present reference to the high school refers to the school built in 1957 on West Marine Drive near Young's Bay, while the "old high school" is located at 16th and Jerome and at present houses the Community College. In the 1920's, this was "the high school" while "the old high school" was the McClure School, located in the block bounded by the present 7th and 8th Streets and by Grand and Franklin Avenues. At present the block is a playground. The exposure in the photograph was not located, but was very likely one block south (up the hill) on Harrison Avenue, where there is a fairly high bluff.

In 1899 the city limits were changed again. They have remained stable since that time. That was also the year which saw a partial solution of the confusion caused by the unrelated street names in the three original town plats. The streets in the main part of town were alphabetically named from east to west - A for Astor Street at the Columbia River to N for Niagara at the summit of the hill. The north-south streets were numbered from 1st Street, immediately west of McClure's claim, to 40th Street, some 15 blocks within the eastern city limits. Notably, the numbering system omitted 13th Street, which is at the point where the claims of McClure and Shively meet. The lot-numbering system provided for 50 numbers to a block, that is: block One had numbers 1 to 49, block Two, 50 to 99, and so forth. Therefore, across town, there were two blocks with numbers in the five hundreds, two blocks with numbers in the six hundreds, etc. However, it must be remembered that there was no 13th Street, so from 11th to 12th Streets was the 500 to 549 block and from 12th to 14th Streets was regarded as a single block with numbers 550 to 599. The reason for listing all of these numbers becomes obvious when one is attempting to find a locale described as "opposite 1774 Franklin Street," especially because this numbering system ended in 1955, and so 1774 Franklin is now 3658 Franklin. Today "opposite 1774 Franklin" is 19 blocks away from the true, intended location!

The general street plan as sketched above was in effect when Chester Washburne studied the Astoria area several times between 1900 and 1905, and again in 1910. The locales listed by Washburne (1914) are still valid where they are indicated by Street and Avenue, such as "5314, Tenth and Harrison Streets," or "5322, Irving Avenue and 34th Streets." But, because of the change effected in 1955 of numbering each block by hundreds and this time including a 13th Street, many of the locales need to be relocated. Too, some of the reference points used in the work have disappeared and an attempt must be made to replace these references with present-day landmarks.

The accompanying list of Astoria locales includes those in Washburne's paper and gives, wherever possible, an indication of the present availability of exposures.

Washburne, in the body of his Astoria description, uses a brick kiln as a reference point for a number of locations. For instance, "three blocks east of the brick kiln" and "two blocks east of the last location." Unfortunately, the brick kiln and all vestiges of it have completely disappeared, no doubt because, as Mr. Washburne remarked, the quality of the bricks was so terrible. Through discussions with an elderly woman of the area, the writer has tentatively placed the brick kiln between Birch and Ash Streets near 45th Street in the eastern part of town. It must be mentioned too, that the main road from 45th Street to the town gates was along Birch Street through a section of town known locally as Alderbrook, and was not one block south on the present U.S. Highway 30. Therefore, the exposures which Washburne saw were ones existing some 50 years ago at the base of the cliff on which U.S. Highway 30 is built, and not exposures along the present main highway. Some of the present cuts offer very good exposures. Another reference point used by Washburne and by subsequent authors is the Hammond Lumber Mill, which was a mammoth building erected on pilings over the water at 53rd Street near the city limits. It burned long ago, but one may still see the remains of it at low tide when hundreds of pilings are exposed.

In the years 1900 to 1910 the Smith Point waterlevel exposure was covered with basalt talus and Washburne could not find any good fossils such as Dall had found in 1890. Nor could he find the Aturia zone, but he believed such beds would be found between 30th and 40th Streets, whereas Dall would have expected them between 19th and 23rd.

Arnold and Hannibal (1913) list four locales in Astoria. These four are also included on the accompanying list, together with comments upon the availability of present exposure.

H. V. Howe worked the Astoria area during the summer of 1921 and published parts of this work in 1926. He often uses street names and numbers as references, such as "Bond and Hume" or "19th and Grand" and these remain true indicators of location. Some of his other reference points, such as the Hammond Mill, are no longer adequate. One of his locales "outside the city limits, and about one and one-half blocks south of the Hammond Lumber Mill" refers to an exposure outside the eastern city limits along the former U.S. Highway 30, which now leads into the Tongue Point area. It is not known why he correlates these beds with the ones pictured by Diller (1896) on Plate IX. The High School in 1894 was far from the eastern city limits and it is definitely the High School to which Diller links his plate. It is easily possible to find the areas in Howe's work. It is far more difficult to find an exposure in these places. He discusses the original beach at Smith Point, now no longer available; he meticulously describes a band of green sand at 14th and Irving, now covered by a large concrete bulkhead; land slumping has disguised the described slopes at both 5th and Commercial Streets and 5th and Duane.

Figure 1. Astoria in the 1840's. Tongue Point is in the middle left. The large house is the Hudson's Bay building on the site of the present St. Mary's Hospital. Notice particularly the bay in the right foreground. (Courtesy, Oregon Historical Society)

Figure 2. Astoria in 1856. The building marked 4 is the Hudson's Bay Commissary, as on Figure 1. House No. 7 is Shively's home. The other buildings are shops, army buildings, private homes, and a church. (Courtesy, Oregon Historical Society)

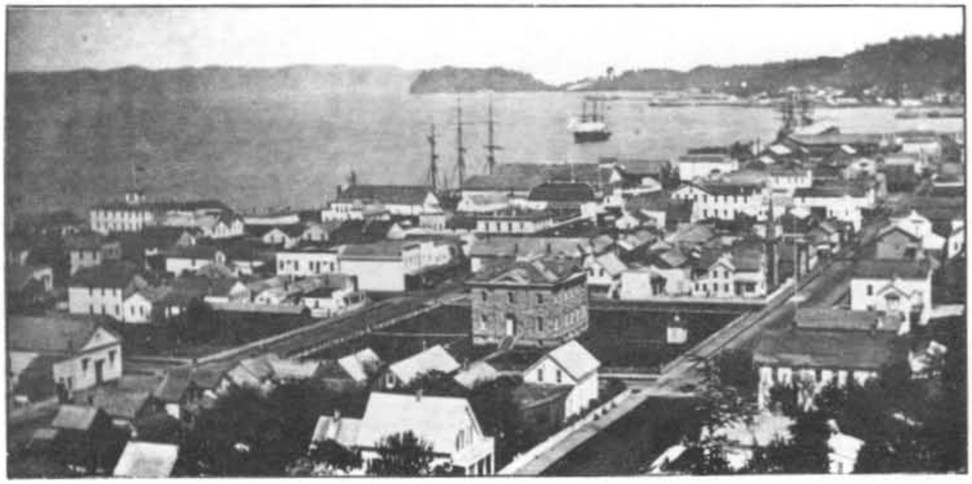


Figure 3. Astoria about 1881. Before the fire of 1883. The gray stone building in the foreground is the Post Office. The streets are wooden planks built on pilings. At upper right is the bay as in figures 1 and 2, and is still open water. (Courtesy, Oregon Historical Society)

Figure 4. Astoria as rebuilt after the fire of 1883. The gray stone building in the foreground is the Post Office. The bay area as on figures 1, 2, and 3 is bridged over. The arrow marks the site of the Hudson's Bay - St. Mary's Hospital block. Shively's house is to the right and uphill from here. The blocks of buildings are built on pilings over the water between the Post Office and St. Mary's, which are on solid land. (Photo by Snodgrass, courtesy, Oregon Historical Society)

On a December morning of 1922, a raging fire broke out in downtown Astoria. The flames licked around the pilings, roared along the wooden streets, and toppled frame buildings into the hissing water. Amid cries of dismay and screams of terror, the famous hotels, shops, and landmarks of "Old Astoria" twisted into blackened ruins. When the flames died and the embers cooled, it was found that nearly 40 acres of the business district was completely destroyed (see figure 5). It was then that the extensive filling began which has completely buried the original shoreline. The watery areas between 8th and 23rd Streets and from the present waterfront as far back as Franklin Avenue, as in the Gyro field-19th to 23rd Streets section, were buried under many feet of dredgings. This was an extensive reclamation project which provided a great level area for the construction of the modern business district (see figure 6). At the same time, the filling has forever ruined the chances of the geological investigation of the original waterfront as James Dana described it in 1841.

The significant change effected by the city planners in 1955 when the blocks were re-numbered by hundreds, was accompanied by certain street name changes. In the western end of town, Taylor Avenue which circumscribed Smith Point was changed to West Marine Drive. At 1st Street, West Marine becomes Marine Drive and changes finally at 32nd Street into Lief Erickson Drive. The change has eliminated not only Taylor Avenue but portions of Astor, Bond, Commercial Streets, Franklin Avenue, and again Commercial Street in a west to east traverse along the Columbia River.

In 1945, Dr. E. M. Baldwin of the University of Oregon and R. E. Stewart of the State of Oregon Department of Geology and Mineral Industries collected foraminiferal samples from "about 100 feet east of 37th and Commercial Streets." According to the present arrangement, the exposure referred to is the large road cut at 38th and Lief Erickson Drive.

There are a number of other Astoria locales mentioned in already published works, and there are sure to be many more locales found in the type section of the Miocene at Astoria, Oregon. With the aid of the information included here and with the assistance of the maps, it is hoped that those who are interested in the area will be able to find locales which have been published to this time.

The geologist of today must be aware of the significant changes which human habitation, in just a few years, can work on described sections. He must also be aware that, although humans can change the landscape rapidly, their cultural edifices are fragile things and to use them as permanent reference points is precarious.

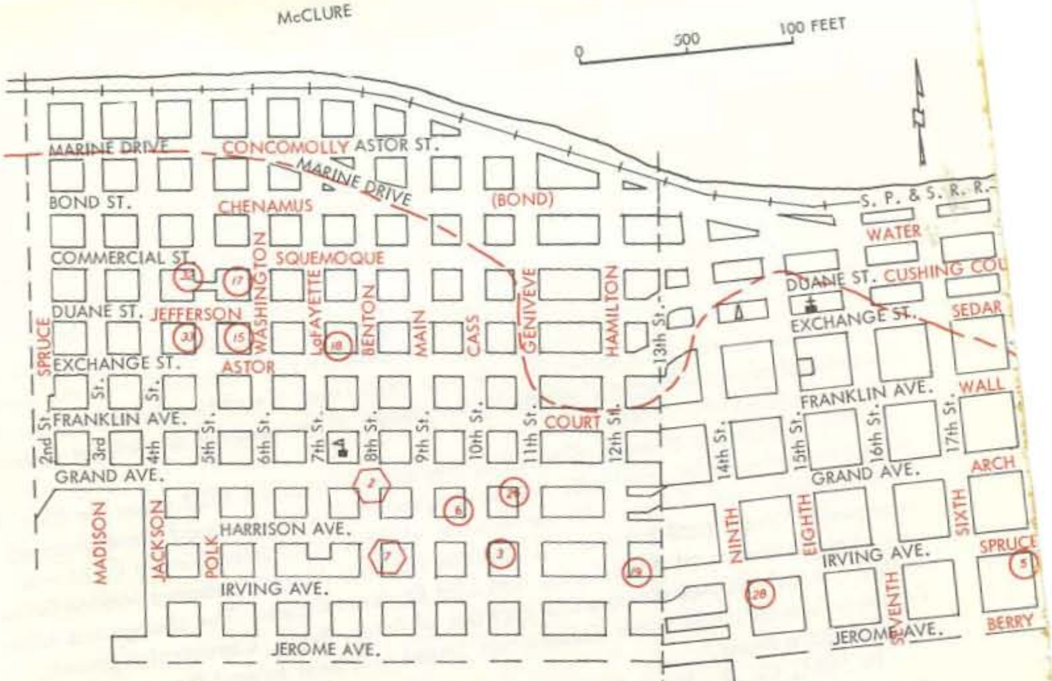
References

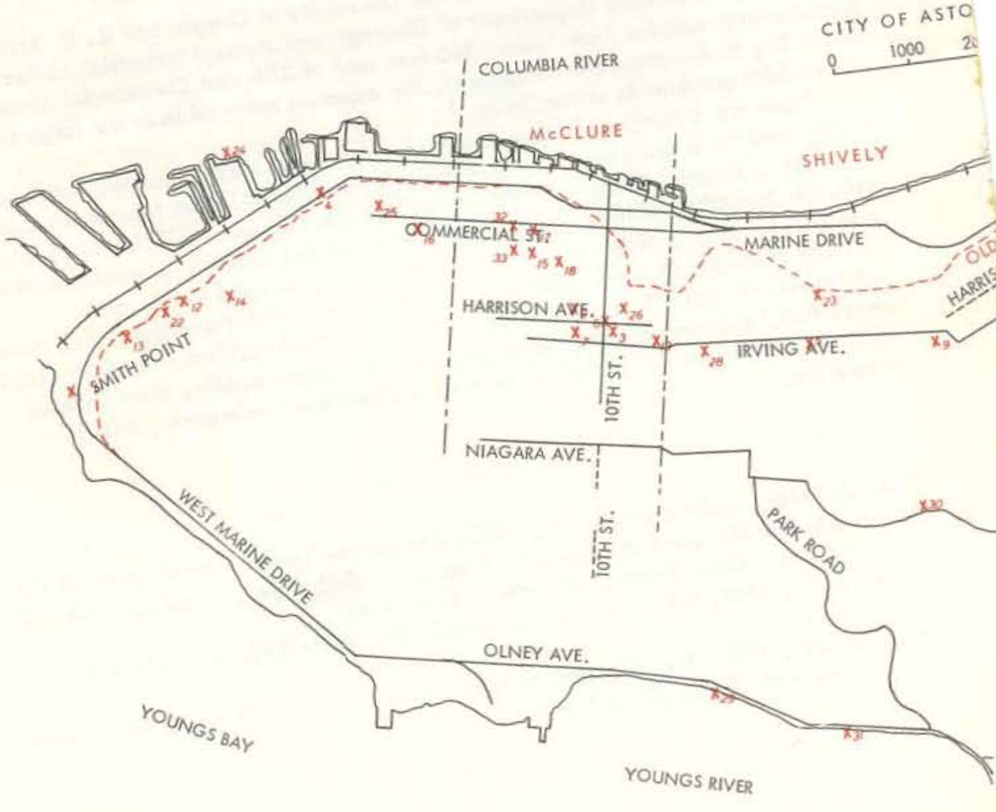
Arnold, Ralph, and Hannibal, H., 1913, The marine Tertiary stratigraphy of the North Pacific Coast of America: Proc. Am. Phil. Soc., v. 52, p. 559-605.

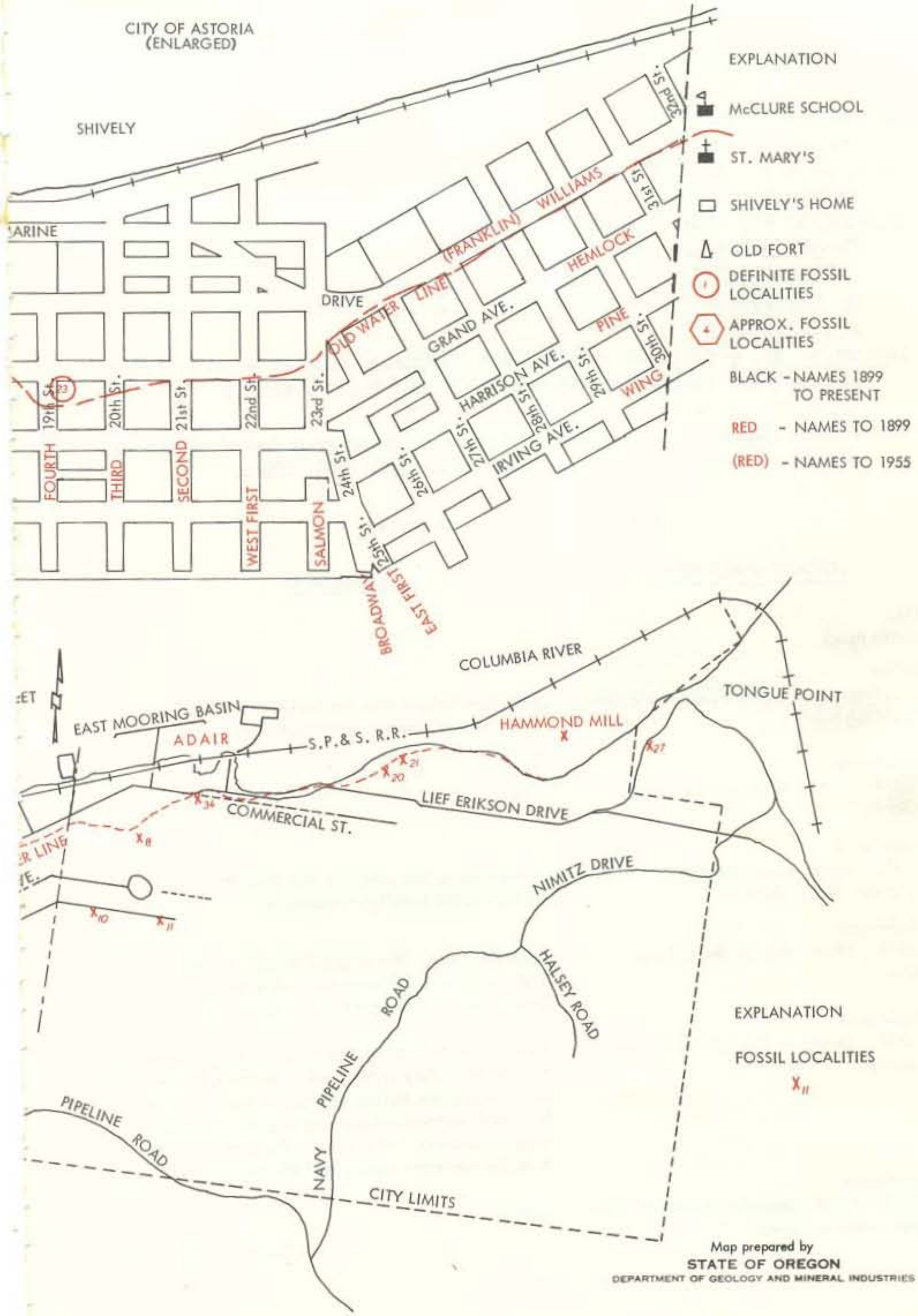
Clatsop County Court House, Oregon, Plat Book No. 1.

Dana, J.D., 1849, Wilkes exploring expedition, 1838-1842: v. 10 (Geol.), p. 653.

Dall, W. H., 1909, The Miocene of Astoria and Coos Bay, Oregon: U.S. Geol. Survey Prof. Paper 59, 278 p.


McCLURE
0
500
100 FEET
MARINE DRIVE
CONCOMOLLY
ASTOR ST.
MARINE DRIVE
BOND ST.
CHENAMUS
(BOND)
S. P. & S. R. R.
WATER
COMMERCIAL ST.
SQUEMOQUE
WASHINGTON
DUANE ST.
CUSHING
DUANE ST.
JEFFERSON
LaFAYETTE
BENTON
MAIN
CASS
GENIVEVE
HAMILTON
13th St.
EXCHANGE ST.
SEDAR
SPRUCE
EXCHANGE ST.
ASTOR
FRANKLIN AVE.
WALL
FRANKLIN AVE.
COURT
2nd St.
3rd St.
4th St.
5th St.
6th St.
7th St.
8th St.
9th St.
10th St.
11th St.
12th St.
14th St.
15th St.
16th St.
17th St.
GRAND AVE.
GRAND AVE.
ARCH
MADISON
JACKSON
POLK
HARRISON AVE.
NINTH
EIGHTH
SIXTH
IRVING AVE.
SPRUCE
IRVING AVE.
SEVENTH
JEROME AVE.
BERRY
JEROME AVE.


CITY OF ASTO
0
1000
COLUMBIA RIVER
McCLURE
SHIVELY
COMMERCIAL ST.
MARINE DRIVE
OLD
HARRISON
HARRISON AVE.
IRVING AVE.
SMITH POINT
10TH ST.
NIAGARA AVE.
PARK ROAD
WEST MARINE DRIVE
10TH ST.
OLNEY AVE.
YOUNGS BAY
YOUNGS RIVER



CITY OF ASTORIA
(ENLARGED)
SHIVELY
EXPLANATION
McCLURE SCHOOL
ST. MARY'S
SHIVELY'S HOME
OLD FORT
DEFINITE FOSSIL LOCALITIES
APPROX. FOSSIL LOCALITIES
BLACK - NAMES 1899 TO PRESENT
RED - NAMES TO 1899
(RED) - NAMES TO 1955
32nd St.
31st St.
30th St.
29th St.
28th St.
27th St.
26th St.
25th St.
24th St.
23rd St.
22nd St.
21st St.
20th St.
19th St.
WILLIAMS
(FRANKLIN)
HEMLOCK
PINE
WING
OLD WATER LINE
DRIVE
GRAND AVE.
HARRISON AVE.
IRVING AVE.
FOURTH
THIRD
SECOND
WEST FIRST
SALMON
BROADWAY
EAST FIRST
COLUMBIA RIVER
TONGUE POINT
EAST MOORING BASIN
ADAIR
S.P.& S. R.R.
HAMMOND MILL
COMMERCIAL ST.
LIEF ERIKSON DRIVE
NIMITZ DRIVE
HALSEY ROAD
PIPELINE ROAD
NAVY PIPELINE ROAD
CITY LIMITS
EXPLANATION
FOSSIL LOCALITIES
Map prepared by
STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

Diller, J.S., 1896, A geological reconnaissance in northwestern Oregon: U.S. Geol. Survey 17th Ann. Rept., pt. I, p. 441-520.
Howe, H. V., 1926, Astoria: mid-Tertic type of Pacific coast: Pan. Am. Geol., v. 45, p. 295-306.
Lockley, Fred, 1928, History of the Columbia River valley from The Dalles to the sea, v. 1, S. J. Clarke Pub. Co.
Seitz, James F., 1948, An investigation of the type locality of the Astoria Formation: Univ. Washington master's thesis, unpub.
Shumard, B. F., 1858, Description of new fossils from the Tertiary formation of Oregon and Washington Territories and the Cretaceous of Vancouver Island, collected by Dr. John Evans, United States geologist, under instructions from the Department of the Interior: Trans. Acad. Sci. St. Louis, v. 1, no. 2, p. 120-123.
Stewart, R. E., and Stewart, K. C., 1951, Oligocene shale in Astoria, Oregon: Oregon Dept. Geology and Mineral Industries, The ORE BIN, v. 13, no. 11, p. 74.
Washburne, Chester W., 1914, Reconnaissance of the geology and oil prospects of northwestern Oregon: U.S. Geol. Survey Bull. 590, 108 p.

Astoria Fossil Locales

LOCALE or REFERENCE	COMMENT	MAP NO.
Dall Smith Point		1
Diller "...from a photograph taken near the High School."	The High School was the McClure School, since burned down. The block is now a playground.	2
Washburne "5314. Tenth and Harrison Streets, Astoria."	Same	3
Washburne "5315. Loose concretions on river bank in lower part of Astoria."	Too general, but refers to the area west of 1st Street called locally, Uniontown.	4
Washburne "5316. North side of Smith Point, Astoria."	General area. The original beach is filled in and the bank is extensively overgrown with brush and is bulkheaded below most homes.	--
Washburne "5317. Opposite 766 Irving Avenue, Astoria."	Now opposite 1762 Irving Avenue at the corner of 18th St. Very little bank is exposed because of a large stone bulkhead erected here. There is a small outcrop which may require some digging to uncover. It is rich in Foraminifera and is at the southern corner of 18th and Irving.	5
Washburne "5318. N.W. corner of 10th and Harrison Avenue, Astoria."	Same.	6

Continued on page 126

Figure 5. Astoria looking west, after the fire of 1922. To the extreme upper left is the old St. Mary's building. In front of the building notice the broken wooden street and the burned piles on which it was built. In the middle distance is the Court House, which appears in figure 6. (Photo by Frank Woodfield, courtesy, Oregon Historical Society)

Figure 6. Astoria in 1947. The arrow marks the modern St. Mary's building on the site of the original Hudson's Bay property. The two buildings in the foreground are the Court House with the cupola (now removed) and the Post Office, on the site of the gray stone building as in figures 3 and 4. Notice that the former bay in front of St. Mary's has a number of larger buildings situated upon fill, among which is the John Jacob Astor Hotel. The whole visible area, except those in the distance having docks built on pilings, is constructed on fill. (Photo by the Oregon Journal, courtesy, Oregon Historical Society)

Washburne "5319. One block ( ) of old high school on Harrison at the N.W. corner of 8th Street, Astoria."	The McClure School, formerly in the block bounded by 7th and 8th Streets, and Grand and Franklin Avenue. There is no exposure on the N.W. corner of 8th and Harrison, but there is a large weathered bank at the southeast corner.	7
Washburne "5320. Opposite 1774 Franklin Street, Astoria."	Now opposite 3658 Franklin Avenue, one block east of the John Jacob Astor School, which is between 35th and 36th Streets. The whole hill is badly weathered.	8
Washburne "Irving Avenue, in hill above sawmill, Astoria."	The sawmill is replaced by the Astoria Plywood mill and the station referred to is probably an exposure at 23rd and Irving Avenue, on the south side of the street.	9
Washburne "5322. Irving Avenue and 34th Street, Astoria."	Same. No visible exposure.	10
Washburne "5323. Irving Avenue near 37th Street, Astoria."	Same. Poor exposure.	11
Washburne "5339. Smith Point, Astoria, bank 50 feet above Columbia River, SW$\frac{1}{4}$ sec. 7, T. 5 N., R. 9 W."	Unlocated, but might have been near Port Way Street, which is the entrance to the Port Docks.	12
Washburne "5340. Smith Point on road to Young's River; SW$\frac{1}{4}$ sec. 7, T. 8 N., R. 9 W."	Possibly near Hamburg Avenue.	13
Washburne "5378. Opposite 383 Alameda Avenue, Astoria: SW$\frac{1}{4}$ sec. 7, T. 8 N., R. 9 W.	Same. No visible exposure.	14
Washburne "5379. Sixth and Duane Streets, Astoria, in rear of Southwest corner house; altitude, 40 feet."	Same. Walk up a little private road.	15
Washburne "5390. Commercial Street, Astoria, road cut 2,650 feet west of Sixth Street in dark gray shale."	Probably the best available exposure in this area is higher on the hill at 1st and Duane. The 1st and Commercial area slid some 400 feet downhill in 1951.	16
Washburne "5403. Commercial Street, at the southwest corner of Sixth Street, Astoria; Miocene."	Same. No exposure.	17
Washburne "5404. Southwest corner of Seventh and Exchange Streets, Astoria."	Same. Badly weathered.	18

Washburne "5405. Irving Avenue west of Thirteenth Street, Astoria; Oligocene?"	Same but badly weathered, overgrown, and bulkheaded.	19
Washburne Brick kiln	Probably between Birch and Ash Streets near 45th Street.	20
Arnold and Hannibal "loc. 46: ashy shales with limestone nodules, beach at foot of 46th Street, Astoria, Oregon."	Same location, eastern part of town. Not checked.	21
Arnold and Hannibal "loc. 47: ashy shales with limestone nodules beach between foot of Hull Street and Smith Point."	Between Hull Street and Smith Point, fill material has covered the original beach since 1940.	22
Arnold and Hannibal "loc. 273: ashy shale, bluff back of town between 1st and 13th Street."	A wide area to include in one locale. It must be assumed that the authors had no exact information on the areas from which their fossils came.	--
Arnold and Hannibal "loc. 45: basal sandstone, beach at foot of 19th Street."	The foot of 19th Street is completely buried under fill.	23
Howe "Smith's Point to the west of the old settlement of Astoria, especially in the vicinity of the present port docks."	Same. All fill.	24
Howe "...Hume Avenue and Bond Street."	Same.	25
Howe "...foot of Nineteenth Street."	Same. All fill.	23
Howe "...Eleventh and Grand."	Same.	26
Howe "...deep cut on the Columbia highway, immediately outside the city limits, and about one and one half blocks south of the Hammond lumber mill."	On the FORMER Columbia highway. Now this road leads into Tongue Point.	27
Howe "...Irving and Fourteenth in the center of the city."	Same, but bulkheaded.	28
Howe "...Tenth and Harrison."	Same.	3
Howe "...along both the Olney and waterworks roads."	Along the Olney road. Along the Waterworks road.	29 30

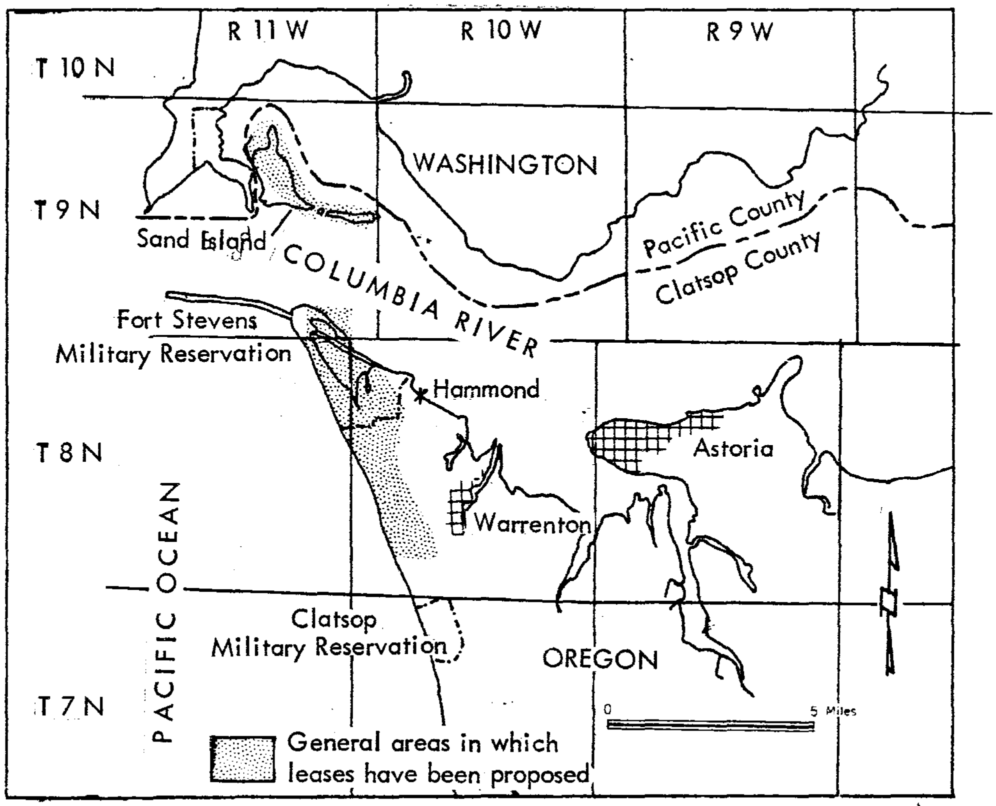
Howe "...in the neighborhood of Williamsport."	Same.	31
Howe "...Fifth and Commercial Streets."	Same, but there is no good exposure.	32
Howe "...corner of Fifth and Duane Streets."	Same, but no exposure.	33
Stewart and Baldwin "...about 100 feet east of 37th and Commercial Streets."	Now at 38th and Lief Erickson Drive.	34

* * * * *

BEACH SANDS ATTRACT BUNKER HILL

The Bunker Hill Co., Kellogg, Idaho, has recently filed applications for mining leases with the Clatsop County Court and the State Land Board covering approximately 3,000 acres of iron-bearing sands in the Clatsop Spit area in Clatsop County. In its application Bunker, one of the largest mining and smelting companies in the country, indicated that extensive exploration would necessarily precede any mining or plant construction. The company also stated that new metallurgical methods might be employed to recover the very low percentages of iron-bearing minerals from the sands.

Bunker Hill became interested recently in the Clatsop Spit sands after Pacific Power & Light Co. brought the deposit to its attention. The black sands of the Oregon beaches and the estuary of the lower Columbia River have been the subject of numerous investigations and reports over the years. In 1941 the department drilled 13 holes near Hammond, about 10 miles northwest of Astoria. A deposit of black sand measuring approximately 500 by 800 feet and at least 3 feet deep was sampled. The deposit contained about 40 percent magnetite, an iron oxide mineral which has the unusual property of being magnetic. Results of the department's work are published in Bulletin 14-D, "Oregon Metal Mines Handbook." In 1944 the U.S. Bureau of Mines also drilled the Hammond property and reported its findings in its Report of Investigations 4011, "Columbia River magnetite sands, Clatsop County, Oregon, and Pacific County, Washington, Hammond and McGowan deposits," 1947, by J.V. Kelly. In addition to the magnetite, the bureau reported the following concentrations of minerals: hornblende 16 percent, ilmenite 19 percent, quartz-feldspar 15 percent, garnet 7 percent, zircon, rutile, biotite, and olivine 3 percent. The department also made a comprehensive study, "Mineralogical and physical composition of the sands of the Oregon coast from Coos Bay to the mouth of the Columbia River," which was published as Bulletin 30 in 1946. The report concerned itself not only with the mineralogical character of the sands but with the natural forces involved in their removal, transportation, and deposition by ocean currents, large rivers, and winds. The effects of these agencies are of great importance to harbor, river, and highway construction, to land owners



INDEX MAP OF CLATSOP SPIT AREA, CLATSOP COUNTY, OREGON.

located on or near beach areas, and to tourist-oriented activities.

The areas which the Bunker Hill Co. is desirous of leasing are shown on the above map. Because of a multiplicity of ownerships, only the outlines of the general areas are indicated. The Clatsop County Court has indicated that it is willing to issue a permit to the company, which would permit prospecting on county lands on a temporary basis pending negotiation of mining leases. No action has been taken by the State Land Board, which not only must refer the proposed lease to other state agencies concerned with the area but must unravel a complicated skein of ownerships of both surface and mineral rights both above and below the ordinary high tide line. Typical of the problems involved is the identification of the various parcels of submerged land which cannot be conveniently or accurately defined by the usual section, township, and range methods commonly used on dry land. A system of coordinates based on the Lambert Azimuthal Projection has been adopted by the board to cover these areas.

The scope of the proposed project can be gauged by the recent announcement in the press that Bunker anticipates that it will erect a $12,000,000 plant if preliminary testing, which will probably require several years, indicates ore in sufficient quantity and of high enough grade. The company is applying for an initial lease period of 25 years from the state. The dune sands and those lying below water will probably be mined by a connected bucket dredge or similar equipment capable of handling large volumes of unconsolidated sand. The company has announced that a dike will be erected around the area to be mined and that this will reduce any pollution and disturbance of the estuarine waters to an absolute minimum. Because of the unconsolidated nature of the sands and the dredging method which will be employed, the mined areas will be restored promptly to their original appearance. The action of the ever-present winds and waves will also aid in erasing rapidly any evidences of mining activity.

Whether the recovered minerals would be treated further locally is unknown at the present time. Possible steps which might be taken include the production of either sponge iron or pig iron by one of the relatively new direct-reduction processes which do not require the very heavy capital expenditures necessary for the erection of a standard blast furnace. Briquetting of the concentrated material to make it acceptable to some of the steel mills which cannot handle the loose sand is also a possibility.

The feasibility of beneficiating Oregon coast sands has already been demonstrated. From 1954 to 1956, a plant located just north of Coquille in Coos County beneficiated some rough, black sand concentrates prepared under a World War II contract and produced salable concentrates of chromite, garnet, ilmenite, magnetite, and zircon. The plant used electrostatic and electromagnetic equipment. The original concentration was accomplished with the aid of Humphrey spirals located in a small plant near Bullards north of Bandon. Interest in the black sands actually dates back more than 100 years, however. The early discovery of placer gold in the Coos County beach sands and in the elevated beach terraces several miles distant from the coast resulted in considerable mining activity which lasted for many years.

The economic impact of the proposed Bunker Hill operation will be great. Once actual mining and processing are under way, the activity will be continuous, day in and day out, for a long period of time. It will not be subject to seasonal variations, closed seasons, or any of the normal factors which adversely affect the economy of this part of the state.

* * * * *

MINING NEWS

Gold

Hydraulic "giant" and sluice operations at the Parkerville placers near the head of the North Fork of Burnt River west of Whitney in Baker County have been maintained at full capacity this spring. While water was plentiful during spring runoff, a giant with a 5-inch nozzle was employed around the clock. Reserves from two storage ponds are now rapidly being depleted and a smaller giant with 3-inch nozzle is being used a few hours a day. Operation of the giant is expected to cease about August 1. The property has been owned and operated on a limited basis since 1932 by Tony Brandenthaler of Baker. This is the first year the placers have been worked on such a scale. At the height of operation, 8 men were employed under the management of Scotty Hay.

Perry Hobson and two employees are operating a washing plant on the North Fork of Burnt River immediately below the mouth of Geiser Creek and about three miles below Parkerville. The washing plant and 3/4-yard dragline have a capacity of 50 to 60 yards of gravel an hour.

Standard Industries, Inc., a construction company from Tulsa, Oklahoma, has leased the Mormon Basin placers which are owned or controlled by Calvin Suksdorf of Baker. Operations were begun about June 20. Equipment includes a $1\frac{1}{2}$-yard dragline and a 150-yards-per-hour washing plant with bowl-type concentrators. At the present time they are working on Emigrant Creek, Malheur County.

Prior to World War II, placer gold was recovered from bedrock and near bedrock horizons on the Steinmetz claim on Pine Creek, Baker County, a few miles above Carson in the Cornucopia district, by means of shafts and short drifts. Shaft depth was in the neighborhood of 50 feet and timbering, pumping, and running sand constituted serious mining problems, but gold values of compensating worth were reportedly encountered and mined. Attempts are now being made by the H & H Mining Co. to test this ground by drilling. The ground is generally comprised of nested granite boulders, with the pay streak reportedly limited to near-bedrock.

Copper

An 18-ton shipment of sorted chalcopyrite-gold ore has been recovered from an exploration tunnel on the Standard mine claims, Dixie Creek, Grant County, and delivered to the American Smelting & Refining Co. smelter at Tacoma, Wash., by Jim Kinsella of John Day. The Standard was a substantial producer of copper ore during the opening decade of 1900, and it is particularly noted for associated cobalt-gold mineralization. Available records show that several shipments of the cobalt were made to Thomas Edison and to consumers in Germany at that time. The source of the present shipment of copper ore is a new tunnel located high on the hill above and beyond the area occupied by the old workings, but in line with the projected course of the old vein system.

Mercury

A new cinnabar prospect was recently discovered in Grant County by veteran prospector L. H. Roba of Canyon City, Oregon. The prospect is located on ranch land owned by L. H. Williams in the Little Canyon Creek watershed. This area is known to contain a number of hot springs and hot water seepages along fault zones cutting Triassic sediments. The Triassic sediments are capped locally by Tertiary lavas. According to reports, enough exploration work has been done to indicate that the discovery merits additional attention, and a project for continued exploratory development is being currently drafted.

Uranium

Five carloads of uranium ore from the Lucky Lass mine near Lakeview, Lake County, have been shipped to Vitro Chemical Products of Salt Lake City for reduction to uranium oxide. About six more carloads are reported in the present stockpile. The ore was taken from the bottom of the pit which was dug on the property last year. The owners are seeking advice from Vitro on future mining methods, according to an article in the Lake County Examiner, June 27.

* * * * *

GAS LINE EXTENSION GRANTED

Permission to expand natural gas service into southwestern Oregon has been granted the El Paso (Texas) Natural Gas Co. by the Federal Power Commission. El Paso will build 6 miles of 16-inch pipeline and 121.6 miles of 10 3/4-inch line from Eugene to a new terminus near Grants Pass at an estimated cost of almost $7.7 million. California-Pacific Utilities Co., San Francisco, will then extend its main line from Grants Pass to Ashland at a probable cost of $5.27 million. On completion of the projects, 16 southwest Oregon communities will receive natural gas for the first time. These would be Ashland, Canyonville, Central Point, Gold Hill, Grants Pass, Jacksonville, Medford, Myrtle Creek, Oakland, Phoenix, Riddle, Rogue River, Roseburg, Sutherlin, Talent, and Winston-Dillard.

* * * * *

DOMESTIC MINES CLOSED - PLANTS THREATENED

An investigation of imports of manganese and chromium ferroalloys, and of electrolytic manganese and chromium has been ordered by the Office of Emergency Planning. In announcing the planned investigation, Edward A. McDermott, Director of OEP, cited section 232 of the Trade Expansion Act as his authority to investigate imports which may appear to threaten or impair the national security.

Application for the investigation was made by the Manufacturing Chemists Association on behalf of 11 companies. The application contends that imports of manganese and chromium ferroalloys have increased to such an extent that the domestic ferroalloy industry is in serious jeopardy, and that unrestrained growth of lower priced imports will cause a shut-down of domestic plants that will render the United States incapable of supplying its needs in time of national emergency.

McDermott said that he will seek the views of other Federal departments and agencies having an interest in the problem. (American Mining Congress Bulletin, June 19, 1963)

* * * * *

DOMESTIC AGRICULTURAL GOODS FOR FOREIGN MINERALS

How can the Federal Government ease the United States' continuing balance-of-payments deficit? The Administration believes that a major tool is utilization of the U.S. barter program under which surplus U.S. farm commodities are bartered for defense and foreign aid goods instead of paying cash, thus reducing the outflow of U.S. dollars overseas.

Evidence of the increased use of barter was provided by a recent Department of Agriculture announcement of a barter project designed to furnish Brazil with 200,000 tons of wheat in exchange for Brazilian metallurgical-grade manganese ore, ferromanganese produced in this country from Brazilian manganese ore, and muscovite block mica and beryl ore. (American Mining Congress Bulletin, June 19, 1963)

* * * * *

The ORE BIN
Volume 25, No. 8
August, 1963

GROUND WATER IN THE ORCHARD SYNCLINE, WASCO COUNTY, OREGON*

By R. C. Newcomb

Abstract

Rocky Prairie anticline impedes the movement of ground water northward through the Columbia River Basalt from the large Ortley anticline. The damming of ground water causes artesian-pressure levels 400 feet higher in the Orchard syncline than in the down-gradient Mosier syncline. Under these conditions the water is a potential economical source for irrigation.

The importance of geologic structure in the occurrence of ground water, particularly for irrigation or other large-quantity uses, was brought out during field mapping of a type area of the Columbia River Basalt. The map of this area shows geologic structures that produce favorable situations for the economic use of ground water.

The Tertiary rocks consist of accordantly layered Columbia River Basalt, about 3,000 feet thick, and several hundred feet of sedimentary tuffaceous andesitic agglomerate, tuff, sandstone, and siltstone of the Dalles Formation which overlies the basalt in a nearly conformable manner (see geologic map, pages 140 and 141). Quaternary alluvial, colluvial, and glaciofluvial deposits and intracanyon lavas unconformably overlie the older rocks in places. One deposit of water-laid silt and fine sand, lakebeds in the valley of Mosier Creek, forms especially good orchard soil. The basalt affords 300 to 800 gpm (gallons per minute) of water to properly constructed wells (Newcomb, 1959), but the Dalles Formation in general transmits and yields little water.

The Rocky Prairie anticline and the parallel Orchard syncline are

→ Mr. Newcomb is Research Geologist, U.S. Geological Survey, Ground Water Branch, Portland, Oregon.
* Publication authorized by the Director of the U.S. Geological Survey.

subordinate folds in the Tertiary rocks along an overstressed segment of the large Mosier syncline, which is one of the broad northeastward-trending folds along the east side of the Cascade Range. Rocky Prairie anticline is only about a quarter of a mile wide, and the 40° to 60° dips near its axial plane are marked by local shearing and interflow gliding. This zone of sheared basalt curves across the lowest part of the Mosier Creek basin and terminates against higher parts of the monoclinal slopes of the basalt on the sides of the creek basin (see geologic map).

The mechanical destruction of the water-transmitting capacity of the basalt within this sharply folded anticline has created a partial barrier to ground water moving northwest, downdip from the large Ortley anticline. Such structural barriers influence ground-water movement in accordance with principles previously described (Newcomb, 1961, p. 5). Though the levels of ground water in the basalt north of the Rocky Prairie anticline are near the 72-foot altitude of the river, and though the anticlinal axis is notched to an altitude of about 270 feet by Mosier Creek gorge, ground water in the top several hundred feet of the basalt within the Orchard syncline rises in wells to an altitude of about 500 feet.

Some representative data from four irrigation wells tapping ground water in the basalt in the Orchard syncline are listed below.

Map No.	Owner	Altitude (feet)	Total depth (feet)	Basalt penetration (feet)	Yield (gpm) / Drawdown (feet)	Static water level (altitude, in feet, by barometer)
E1	D. Evans	455	620	470	350f / 25	480
B1	C. Root	675	431	160	180 / 2	520(?)
H2	A. Francois	685	401	180	200 / "no"	490
Q1	A. Beach	410	88	80	500f / 85	495

Yield:

gpm, gallons per minute.

f, flow when well first drilled.

Static water level: That recorded when well was drilled.

Assuming a basalt penetration of about 220 feet, the average for the wells listed above, additional wells that are similarly constructed and properly spaced should yield at least 200 gpm, with 50 feet of drawdown. This yield is near the average for similar wells in the basalt of other parts of the region (Newcomb, 1959, p. 14).

About 3,000 acre-feet of water is desired annually to irrigate 1,500 acres distributed in many plots on the low plateaus and terraces overlying the Orchard syncline in secs. 6, 7, 8, 17, and 18 of T. 2 N., R. 12 E., and secs. 1, 12, and 13 of T. 2 N., R. 11 E. The present wells would each supply about 100 acre-feet of water if pumped half time during the 200-day irrigation season. Thus, assuming that additional wells could each yield similar quantities of water, about 25 or 26 more wells would be needed to provide the required amount of water.

It is estimated that wells of 500-foot average depth and 12- to 8-inch diameter cased to basalt would cost about $7,000 each if constructed as a group. Pumps would cost about $3,000 each installed, and the total capital outlay for such a ground-water development would be about $300,000, or about $200 per acre. Also, other arrangements--such as a smaller number of wells, each of which would have greater capacity--could be used, and wells could be constructed and pumps installed to fit the needs of the individual farm units.

The probable longtime dependability of the ground water to sustain a withdrawal of as much as 3,000 acre-feet of water per year can be evaluated by induction from general information on two hydrologic factors: (1) the water-carrying capacity of the basalt and (2) the average annual recharge to the ground water.

The transmissibility of the basalt varies considerably from place to place, but the average, from recent tests on 400- to 600-foot-thick sections of the rock, may be at least 100,000 gallons per day per foot at a hydraulic gradient of 1 on 1. For this value of the coefficient of transmissibility and an estimated natural gradient of 5 feet per mile across a 4-mile arc around the south, southeast, and southwest hydraulic approaches to the Orchard syncline, about 2,100 acre-feet of water would pass into the pumping area each year. If it is assumed that increased pumping could steepen the hydraulic gradient to 20 feet per mile, nearly 9,000 acre-feet per year would be transmitted through such a basalt section along the 4-mile arc. Under these conditions the water-carrying capacity of the basalt section would be adequate to transmit the additional water required.

Because of the low permeability of the overlying Dalles Formation, natural recharge to the ground water in the basalt probably occurs largely where the porous layers of the basalt are at or near the surface on the slopes of the Ortley anticline and where they crop out in Mosier Creek valley south of the Orchard syncline. The characteristics of natural recharge on the slopes of the Ortley anticline are now unknown. If increased ground-water pumpage in the Orchard syncline lowered ground-water levels where the aquifers crop out in Mosier Creek, additional recharge would be induced from the creek. If natural or induced recharge were deficient in the future, artificial recharge could be accomplished by injecting clean surface water into wells along Mosier Creek.

Besides the ground water directly below the lands to be irrigated, other sources of ground water occur in Mosier Creek valley upstream from the Orchard syncline. Fault displacements, such as those which follow the south side of the basalt exposed in the Ortley anticline and in a small anticline farther west, ordinarily form a barrier to the movement of ground water in the basalt. Such a barrier would result in ground water being reservoired with a relatively high water level on the downthrown side of the fault beneath Mosier Creek valley in about sec. 1, T. 1 N., R. 11 E. During the dry periods of the year, ground water adds about 1 cubic foot per second to the flow in this segment of Mosier Creek. Exploration may establish the availability of ground water in this area, from which it could be transported down Mosier Creek and diverted to these orchard tracts. Thus, geologic mapping indicates that additional water may be available in subsurface reservoirs farther upvalley as well as directly beneath the orchard tracts.

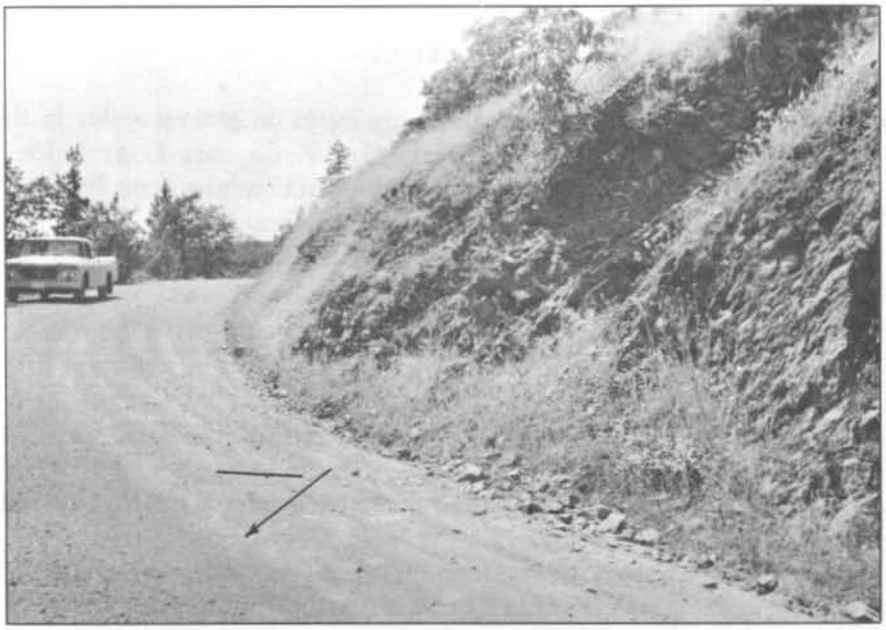
Conclusions

The barrier effect of the Rocky Prairie anticline provides a ground-water reservoir in the Columbia River Basalt in which the water level is about 400 feet higher than that in the downgradient Mosier syncline. Detection of this type of secondary tectonic structure is a good example of the immediate economic applicability of geologic mapping.

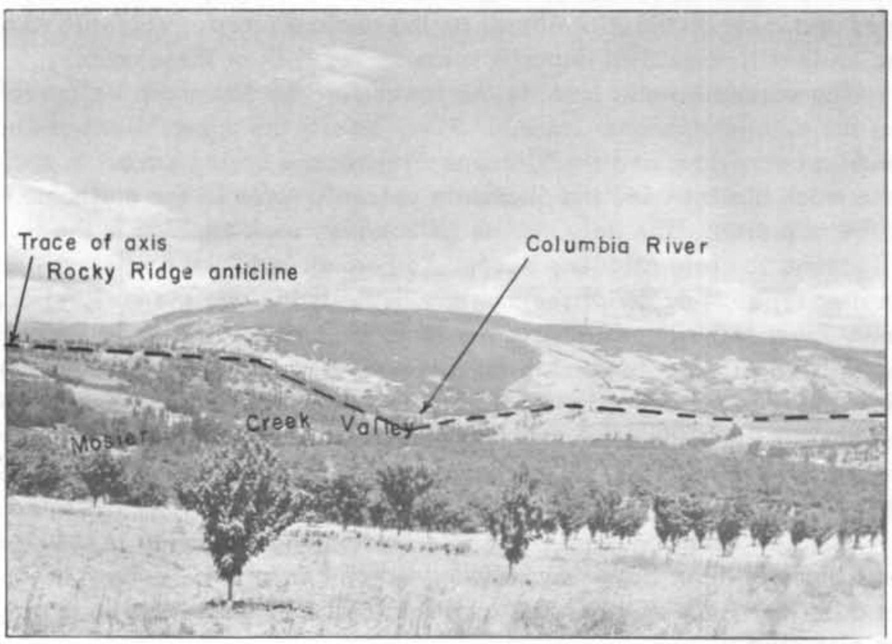
Ground-water characteristics of the basalt, as observed here and inferred from similar areas elsewhere, suggest the reservoir could provide the 3,000 acre-feet of applied irrigation water that would be needed annually on 1,500 acres of orchard and farm land situated over the Orchard syncline.

Alternate sources may occur in at least one other fault-impounded ground-water reservoir upstream from the Orchard syncline and may be usable by stream transport and rediversion.

[Note: The two photographs on the opposite page were added to Mr. Newcomb's paper by the State of Oregon Department of Geology and Mineral Industries.]



Southward (40°) inclined flows of the Columbia River Basalt exposed in bank of the Mosier-Rocky Prairie road just south of the anticlinal axis.



View north down lower part of valley of Mosier Creek, showing the trace of the Rocky Prairie anticline and many of the orchards that need irrigation.

References

Newcomb, R.C., 1959, Some preliminary notes on ground water in the Columbia River Basalt: Northwest Sci., v. 33, no. 1, p. 1-18.

______ 1961, Storage of ground water behind subsurface dams in the Columbia River Basalt, Washington, Oregon, and Idaho: U.S. Geol. Survey Prof. Paper 383-A, 15 p.

* * * * *

GEOLOGY OF PORTLAND REGION PUBLISHED

The long-anticipated work of Donald E. Trimble on the geology of the Portland region has been issued by the U.S. Geological Survey. This is Bulletin 1119, "Geology of Portland, Oregon, and adjacent areas," an 119-page report and geologic map presenting basic data applicable to many fields. The bulletin is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price to be announced.

The report covers five 15-minute quadrangles (Hillsboro, Portland, Camas, Oregon City, and Boring). About 20 stratigraphic units are defined and their distribution shown on the geologic map. Volcanic rocks and basin-fill terrestrial deposits make up the bulk of these units.

The volcanic rocks include the lower Tertiary Skamania Volcanic Series; the middle Miocene Columbia River Basalt; the upper Miocene Rhododendron Formation; and the Pliocene-Pleistocene Boring Lava. A granodiorite stock has intruded the Skamania volcanic rocks in the northeast part of the map area. The only marine sedimentary rock exposed is the late Oligocene to early Miocene Scappoose Formation in the northwest part of the map area. Terrestrial sedimentary deposits include the early Pliocene Sandy River Mudstone (formerly the lower part of the Troutdale Formation); the Pliocene Troutdale Formation; a sequence of Pleistocene fluvial, lacustrine, and loessal deposits, some of which have been given formal names; and Recent landslide products, bog deposits, and alluvium. Fully treated are the cause and effect in the Portland area of the tremendous volume of flood waters from Lake Missoula in late Pleistocene time.

Special attention is given to laterization and formation of bauxite on the Columbia River Basalt and Rhododendron Formation. Economic resources are described, and engineering construction problems related to geology are discussed.

* * * * *

GOLD AND SILVER ASSAY OF A MANGANESE NODULE

By William E. Caldwell
Department of Chemistry, Oregon State University

The miner of gold from quartz-bearing veins knows that his gold assay is apt to be higher if manganese oxide minerals are also present. This association of gold and manganese minerals led to the thought that gold might be present in the manganese-containing nodules that are present on the floors of some seas. Articles disproving the earlier reported high values of gold in sea water are also in mind (Caldwell and McLeod, 1938; Jaenicke, 1935).

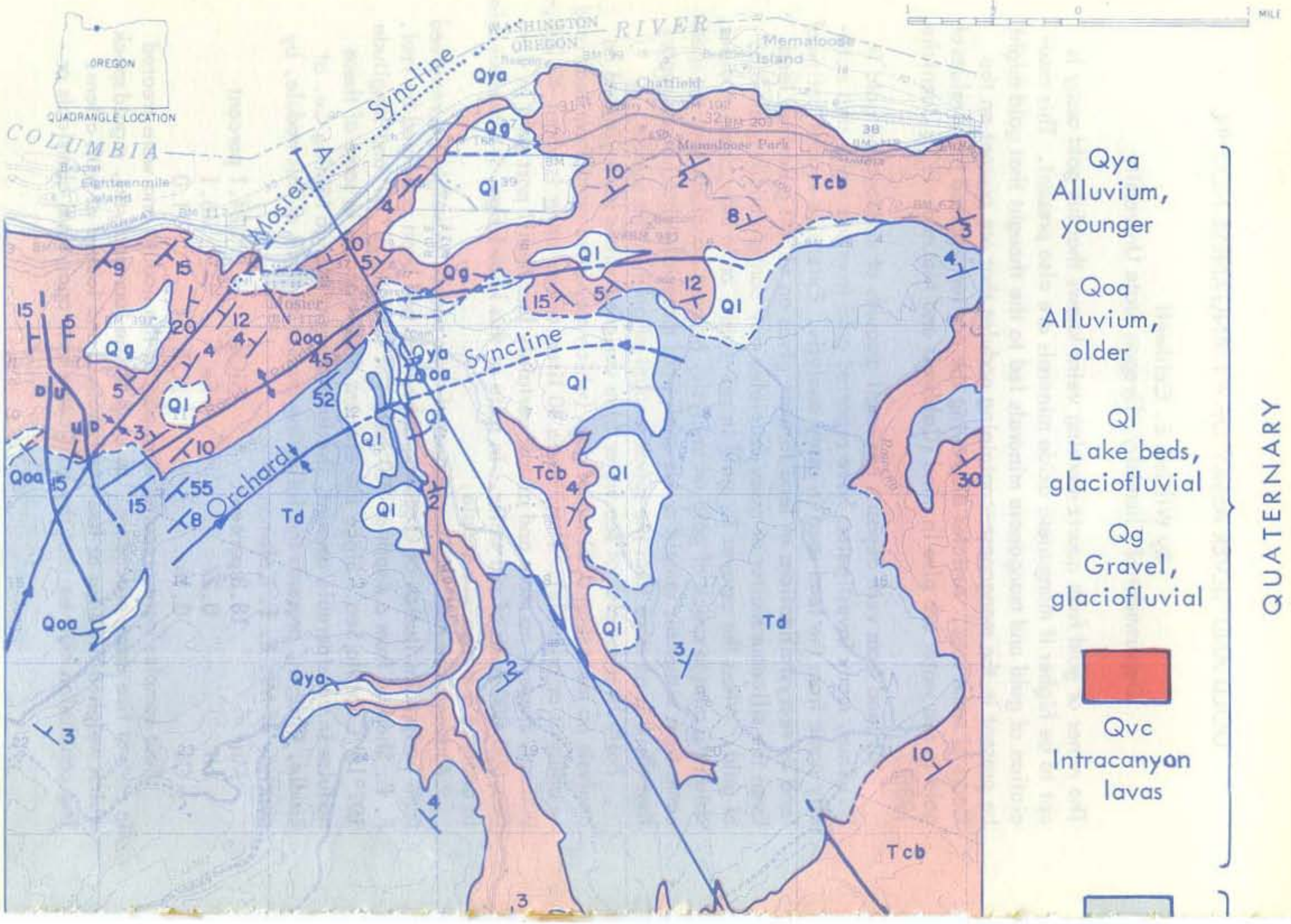
All lead from vein deposits has small amounts of codeposited gold in it. Thus, many investigators have reported gold from sea water that actually came from the lead used in assay analysis. Extensive repurification of lead by recrystallizations of lead tartrate gives an almost gold-free lead. Even the siliceous matter of assay crucibles may contain micro quantities of gold. When the assayer for gold in sea water, or in manganese nodules, obtains a minute speck of gold on analysis, he must conclude that the speck came from either his sample or his analytical materials--but he can report that there is no more than the speck amount of gold in the sample.

Forty liter samples of sea water from various sources have yielded an analysis no more than 0.01 mg of gold (which may have come from lead used in analysis or crucible). Thus, since 40 liters of sea water is about 40,000,000 mg, there is no more and almost certainly less than 1 part gold in 4,000,000,000 parts of sea water. In spite of this knowledge, it was desirable to analyze a manganese nodule.

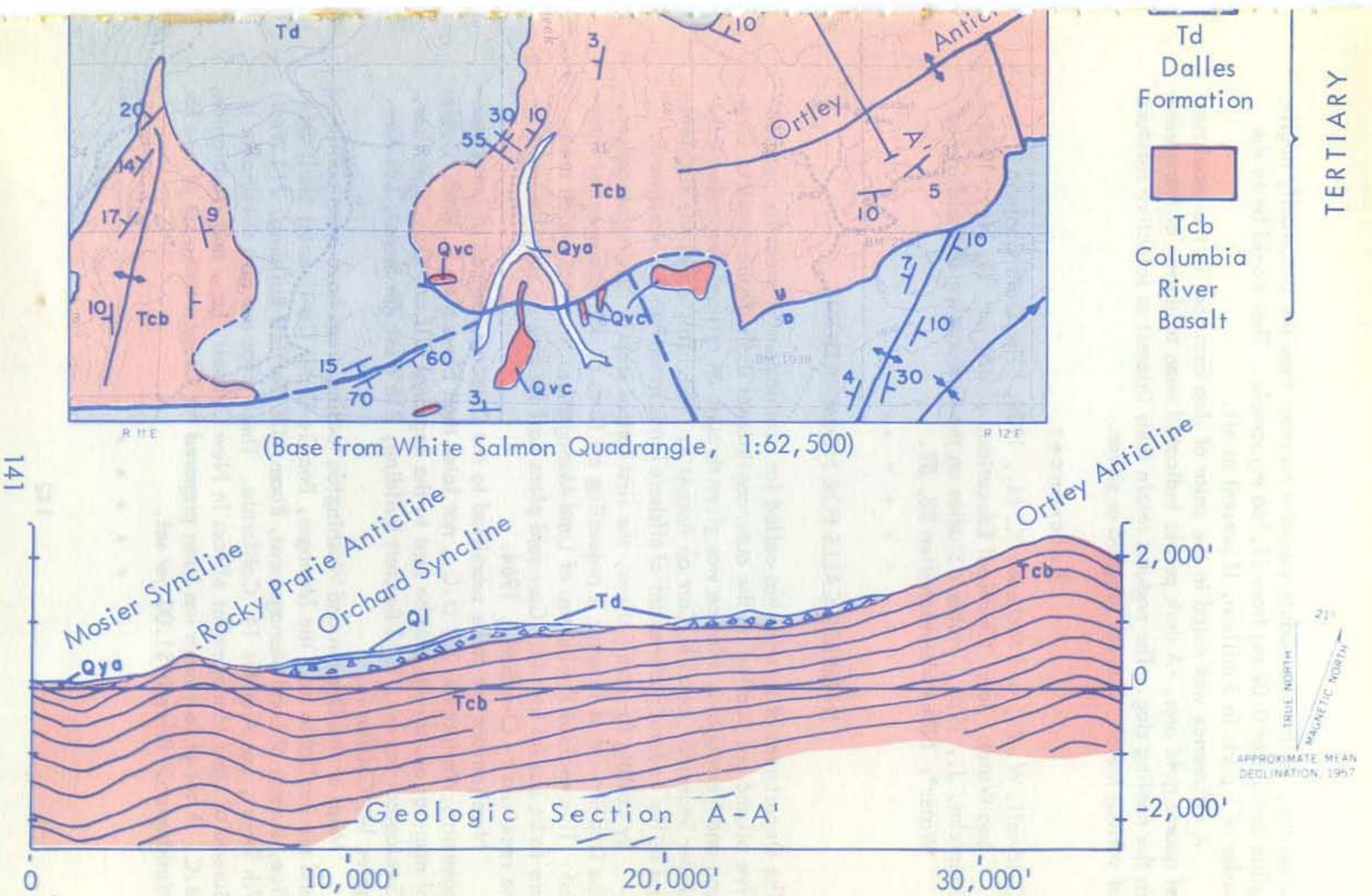
A manganese nodule of approximately two pounds in weight was received from Scripps Institution of Oceanography, and had been collected by Prof. F. P. Shepard from a depth of 800 meters at latitude 22° 50' and longitude 109°15' Cabrilla Sea. Since the element nickel occurs in some of these nodules in considerable amount, the laboratory of Hanna Mining Co. at Riddle, Oregon, presents the following partial analysis of this nodule, by courtesy of Mr. E. E. Coleman.

Mn	18.8 percent	SiO_2	24.1 percent
Ni	0.27	Fe	16.1
Co	0.16	LOI	11.0

Four samples were prepared from part of the nodule and were treated in normal fire assay procedure. In each of the four analyses, a gold speck which weighed 0.02 mg or less was obtained and looked at with a lens. The conclusion must be that the gold came from analytical chemicals or



OREGON
QUADRANGLE LOCATION
COLUMBIA
RIVER
WASHINGTON
OREGON
Memaloose Island
Chatfield
Memaloose Park
Eighteenmile Island
Mosier
Mosier A Syncline
Syncline
Orchard
Qya
Qoa
Qg
Ql
Tcb
Td
T 2 N.
MILE
Qya
Alluvium, younger
Qoa
Alluvium, older
Ql
Lake beds, glaciofluvial
Qg
Gravel, glaciofluvial
Qvc
Intracanyon lavas
QUATERNARY



Geologic map and section of the lower part of the Mosier Creek valley, Wasco County, Oregon crucibles, or that the nodule contains no more than the practically negligible amount of 0.02 mg from 29,166 mg sample. That would be in the order of 2 parts in 3 million, if present at all.

A difference was noted in the color of slag from that in the usual run of quartz gold ores. A dark purple indicated some oxidation of manganese in the cooling slag. The nodules retain their interest as selective residues of various metals, but not for gold or silver.

References

Caldwell, W. E., and McLeod, K. N., 1938, "The Gold Content in Sea Water: Jour. Chemical Education, v. 15, no. 11, Nov. 1938.

Jaenicke, J., 1935, "Haber's Studies on the Occurrence of Gold in Sea Water": Naturwissenschaften 23, 57.

* * * * *

INTERIOR CALLS FOR NOMINATIONS

The Department of Interior has called for nominations of areas for prospective oil and gas leasing on the outer continental shelf off the coasts of Oregon and Washington. Notice was given through an official news release by Under Secretary James K. Carr on August 9, 1963. This marks the first leasing by the Federal government of offshore lands in the Pacific Northwest.

By calling for nominations, the first formal step in leasing procedure, the Department of Interior is requesting oil firms to indicate areas of interest. This enables the Bureau of Land Management to select which areas are to be put up for bid. Carr said plans call for bids on specific tracts to be received by October 1, 1964.

Nominations are to be submitted to the Director, Bureau of Land Management, Washington 25, D.C., not later than November 1, 1963. Copies of nominations should also be sent to the Regional Oil and Gas Supervisor, Geological Survey, 1012 Bartlett Building, 215 West 7th Street, Los Angeles 14, California.

Maps of the Oregon and Washington leasing areas have been published and are available from the Manager, Pacific Outer Continental Shelf Office, Bureau of Land Management, Room 1130 Bartlett Building, 215 West 7th Street, Los Angeles 14, California. These maps are also obtainable at Bureau of Land Management offices in New Orleans, La., and Washington, D.C. A set of four maps has been prepared for Oregon and a set of two for Washington. Price is $1.00 per set.

* * * * *

OREGON MINERAL INDUSTRY HOLDS PRICE LINE

By Ralph S. Mason*

Despite steadily mounting prices in nearly every segment of the nation's economy, prices of minerals produced in Oregon during 1962 remained nearly constant, and even dropped a little in the case of stone and sand and gravel. The value of minerals produced in the state declined slightly from the figure for 1961, with a total of $52.5 million being reported by the U. S. Bureau of Mines (see Table 1). The number of workers employed in the state's mineral industries (mining, stone, clay and glass products, primary metals, industrial chemicals, and petroleum refining and related industries) increased fractionally and averaged 10,267 in 1962. More than 1,200 men were employed in mining activity during the year. Impact of the mineral industry on Oregon labor is shown clearly in Table 2.

The broad geographic base occupied by the state's mineral industry is indicated on the accompanying map, which lists individual county mineral production figures. All 36 of the state's counties reported mineral production, and 14 of them had greater income in 1962 than in the previous year. Mineral production is not only an excellent indicator of the economic well-being of a community but in itself provides a much needed bolster against seasonal dips in other aspects of the local economy.

Although not reflected in the value of minerals produced within the state, the economy benefited considerably from the exploration activities of minor and major petroleum companies. Both upland and offshore tests were conducted.

Skyrocketing silver prices on world markets spurred interest in an old silver producer, the Oregon King Mine near Ashwood in Jefferson County. Idle for a number of years, the Oregon King was reopened and an exploration program was undertaken. Interest in gold, on the other hand, remained quiet, with only 822 fine troy ounces of gold, the second lowest total in the history of the state, being produced. If melted and poured into a mold, the gold would make a 4-1/3-inch cube. It would be worth almost $29,000, however. A lower level cross-cut at the Buffalo Mine in eastern Grant County and a 1,660 foot exploration tunnel in the Bohemia

* Mining Engineer, Oregon State Dept. of Geology & Mineral Industries.

TABLE 1. Mineral Production in Oregon, 1961 - 1962 1/

Mineral		1961 Short tons (unless otherwise stated)	1961 Value (thousands)	1962 Short tons (unless otherwise stated)	1962 Value (thousands)
Clays	thousand short tons	294	$ 357	249	$ 305
Copper (recoverable content of ores, etc.)	short tons	2/	2/	2/	2/
Diatomite	short tons	2/	2/	50	2
Gold (recoverable content of ores, etc.)	troy ounces	1,054	37	822	29
Iron ore (pigment material)	long tons	829	2/	2/	2/
Lime	thousand short tons	82	1,702	78	1,514
Mercury	76-pound flasks	138	27	2/	2/
Nickel (content of ore and concentrate)	short tons	12,860	2/	13,110	2/
Perlite	short tons	- -	- -	3	3/
Pumice and volcanic cinder	thousand short tons	203	461	2/	2/
Sand and gravel	thousand short tons	12,299	13,680	14,869	14,556
Silver (recoverable content of ores, etc.)	troy ounces	2,022	2	6,047	7
Stone	thousand short tons	4/17,455	4/21,202	18,258	20,977
Uranium ore	short tons	2,160	66	2,722	112
Zinc (recoverable content of ores, etc.)	short tons	3	1	- -	- -
Value of items that cannot be disclosed: Asbestos, cement, gem stones, lead, and values indicated by footnote 2/			15,557		14,956
Total			4/$53,092		$52,458

Note

1/ Production as measured by mine shipments, sales, or marketable production (including consumption by producers.)

2/ Figure withheld to avoid disclosing individual company confidential data.

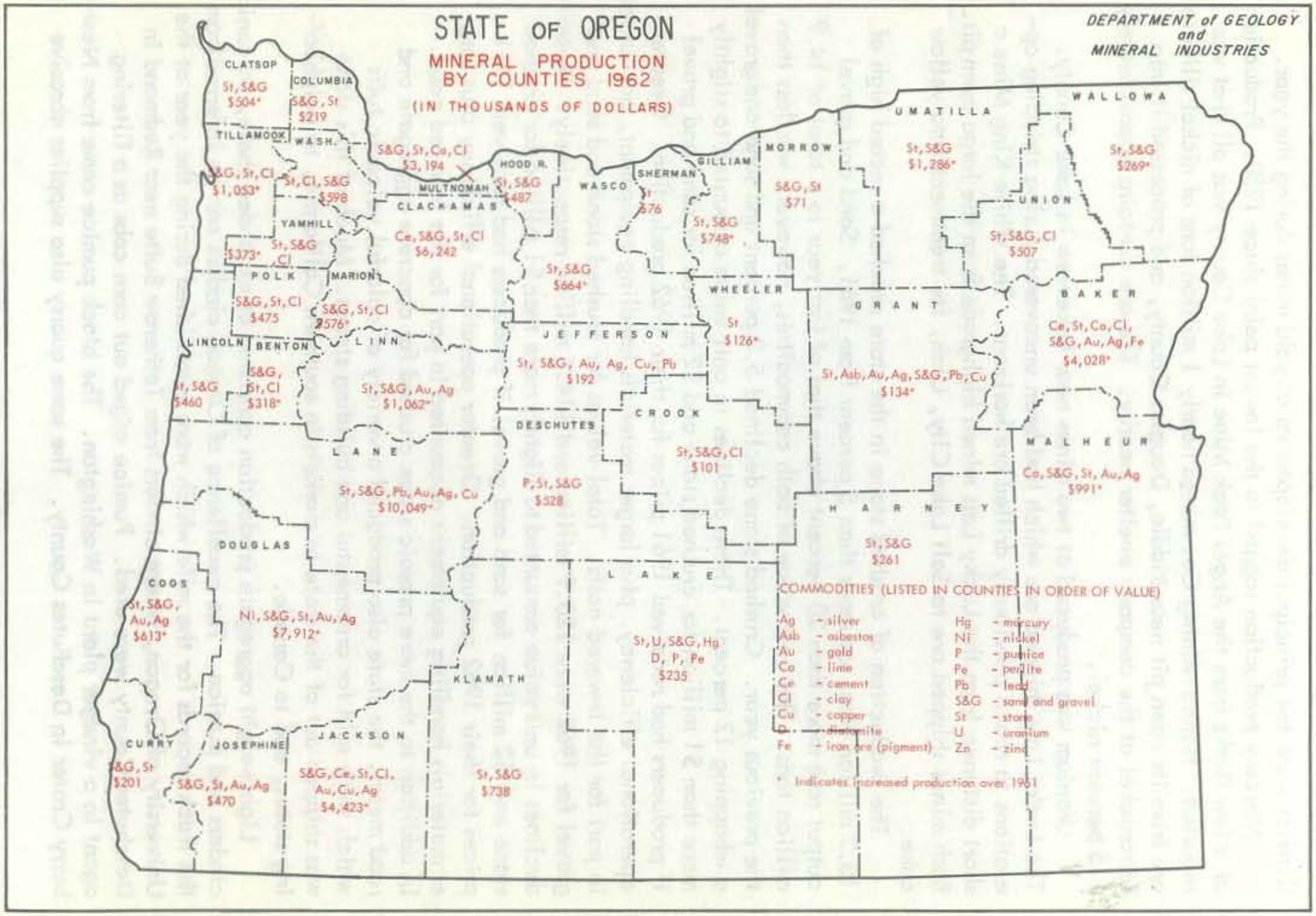
3/ Less than $500.

4/ Revised figure.

TABLE 2. Oregon Mineral Industry Employment and Payrolls*

	1961 Employment	1961 Payrolls	1962 Employment	1962 Payrolls
1. Mining	1,112	$6,558,000	1,263	$7,272,000
2. Mineral manufacturing	2,674	16,216,000	2,820	17,589,000
3. Primary metals	5,532	36,662,000	5,405	36,521,000
4. Miscellaneous	821	5,274,000	779	5,153,000
	10,139	$64,710,000	10,267	$66,535,000

*Oregon State Employment Department figures.


STATE OF OREGON
MINERAL PRODUCTION BY COUNTIES 1962
(IN THOUSANDS OF DOLLARS)
DEPARTMENT of GEOLOGY and MINERAL INDUSTRIES
CLATSOP
St, S&G
$504*
COLUMBIA
S&G, St
$219
TILLAMOOK
WASH.
S&G, St, Ca, Cl
$3,194
HOOD R.
MULTNOMAH
St, S&G
$487
St, Cl, S&G
$598
CLACKAMAS
YAMHILL
St, S&G
Cl
$373*
Ce, S&G, St, Cl
$6,242
POLK
MARION
S&G, St, Cl
$475
S&G, St, Cl
$576*
LINCOLN
BENTON
LINN
S&G,
St, Cl
$318*
St, S&G, Au, Ag
$1,062*
LANE
St, S&G, Pb, Au, Ag, Cu
$10,049*
DOUGLAS
Ni, S&G, St, Au, Ag
$7,912*
COOS
CURRY
JOSEPHINE
S&G, St, Au, Ag
$470
JACKSON
S&G, Ce, St, Cl,
Au, Cu, Ag
$4,423*
KLAMATH
St, S&G
$738
WASCO
St, S&G
$664*
SHERMAN
St
$76
GILLIAM
St, S&G
$748*
MORROW
S&G, St
$71
UMATILLA
St, S&G
$1,286*
WALLOWA
St, S&G
$269*
UNION
St, S&G, Cl
$507
BAKER
Ce, St, Ca, Cl,
S&G, Au, Ag, Fe
$4,028*
WHEELER
St
$126*
GRANT
St, Asb, Au, Ag, S&G, Pb, Cu
$134*
JEFFERSON
St, S&G, Au, Ag, Cu, Pb
$192
DESCHUTES
P, St, S&G
$528
CROOK
St, S&G, Cl
$101
MALHEUR
Ca, S&G, St, Au, Ag
$991*
HARNEY
St, S&G
$261
LAKE
St, U, S&G, Hg
D, P, Pe
$235
COMMODITIES (LISTED IN COUNTIES IN ORDER OF VALUE)
Ag - silver
Asb - asbestos
Au - gold
Ca - lime
Ce - cement
Cl - clay
Cu - copper
D - diatomite
Fe - iron ore (pigment)
Hg - mercury
Ni - nickel
P - pumice
Pe - perlite
Pb - lead
S&G - sand and gravel
St - stone
U - uranium
Zn - zinc
* Indicates increased production over 1961

District were the principal developments at gold mines during the year.

Mercury production sagged to the lowest point since 1950. Production of a few flasks from the Angel Peak Mine in Lake County was all that was reported. Hanna Mining Co. mined nearly 1 million tons of nickel silicate ore from its open pit near Riddle, Douglas County, and processed it into ferronickel at the company smelter nearby. The ore contains approximately 1.5 percent nickel.

Uranium was produced at two mines near Lakeview in Lake County. The Lucky Lass shipped ore which had been uncovered during stripping operations to reach previously drilled ore horizons. The White King Mine a short distance from the Lucky Lass mined highgrade from the large open pit. Both mines shipped ore to Salt Lake City, Utah, for treatment into yellow cake.

The production of crushed stone in the state reached a record high of 18.2 million tons, up more than 5 percent from 1961. Sand and gravel output rose more than 20 percent above that of last year to a total of 14.9 million tons. The unit value of both commodities, however, was less than the previous year. Crushed stone declined 5.3 percent and sand and gravel a whopping 12 percent. These declines in unit value amounted to slightly more than $1 million for crushed stone and $2 million for sand and gravel if producers had received 1961 prices for their 1962 production. Greater operational efficiency, plus larger materials handling equipment, accounted in part for the lowered costs. Total values for crushed stone and sand and gravel for 1962 were $20.9 million and $14.5 million respectively. These declines in unit value amounted to slightly more than $1 million for crushed stone and $2 million for sand and gravel if producers had received 1961 prices for their 1962 production. Greater operational efficiency plus larger materials handling equipment accounted in part for the lowered costs. In addition to the more prosaic stone crushed for concrete aggregate and road metal, the state also produced a variety of colorful volcanic tuffs which were sold for ornamental and building stones. Much of this stone was shipped out of the state to markets in southern California, to neighboring states, and to Canada.

Lightweight aggregate production consisted of expanded shale, volcanic cinders and pumice. The excellence of Oregon cinders can be inferred from the track records for the mile which were established during the year at the University of Oregon, where cinders from Tetherow Butte near Redmond in Deschutes County were used. Pumice edged out corn cobs as a filtering agent in a vinegar plant in Washington. The block pumice came from Newberry Crater in Deschutes County. The same quarry also supplies abrasive grade lumps and large blocks for landscape architecture. Volcanic cinders and scoria found increased use as an aggregate in unit concrete masonry and lightweight monolithic concretes. Large quantities were also used in highway construction throughout central Oregon. Expanded shale, produced by two plants in Washington County, supplied aggregate for lightweight concretes and one producer furnished aggregate which was then ground to minus 325 mesh for a pozzolan replacement for portland cement used in the huge John Day Dam on the Columbia River.

Chrysotile asbestos was mined and processed near Mt. Vernon, Grant County, and shipped to southern California for finishing and marketing. The property has been worked intermittently for nearly 50 years.

The volume and value of semi-precious gems produced in Oregon appears to be growing steadily, although solid data is impossible to obtain. Quartz-family minerals occur widely across the state and are avidly sought by both amateur and professional collectors. Several communities have recognized the need for collecting areas and information about local gemstone deposits and have taken steps not only to provide maps and brochures but to make available collecting areas. Numerous private digging grounds have also been established and opened to the collectors.

* * * * *

NICKEL LATERITE REPORT AVAILABLE

The U. S. Bureau of Mines has issued Report of Investigations 6206, "Pine Flat and Diamond Flat Nickel-Bearing Laterite Deposits, Del Norte County, California," by W.T.Benson. The investigation, done in cooperation with the California-Oregon Power Co. (now Pacific Power & Light Co.), was prompted by the building of the nickel smelter at Riddle, Oregon, to treat ores on nearby Nickel Mountain. Report of Investigations 6206 points to the existence of a number of other deposits of nickel laterite that have developed on peridotite rock in the Klamath Mountains of Oregon and California. The Pine Flat and Diamond Flat deposits lie just south of the Oregon boundary. Sampling indicated that the deposits are comparatively small and of marginal or submarginal grade. Metallurgical tests conducted by the Bureau of Mines laboratory at Albany, Oregon, showed that the ore could be upgraded by reduction roasting and magnetic separation.

The report may be obtained free of charge from the Publications Distribution Section of the U. S. Bureau of Mines, 4800 Forbes Ave., Pittsburgh 13, Pa.

* * * * *

1963

PACIFIC NORTHWEST
METALS & MINERALS CONFERENCE

Portland, Oregon - April 24, 25, 26, 1963

U. S. GOLD STOCK

Proceedings of the:

SECOND GOLD AND MONEY SESSION

Available from the State of Oregon Department of Geology & Mineral Industries, 1069 State Office Building, Portland 1, Oregon.

Please make checks payable to H. M. Dole, Chairman, Second Gold and Money Session.

Price $1.50 postpaid.

Contents

The ORE BIN
Volume 25, No. 9
September, 1963

GEOMORPHOLOGY OF THE OREGON CONTINENTAL TERRACE SOUTH OF COOS BAY

By John V. Byrne
Department of Oceanography
Oregon State University, Corvallis, Oregon

Introduction

The continental terrace consists of the continental shelf, extending from the shoreline to the first major increase of slope to greater depths, and the continental slope, extending from the outer edge of the continental shelf to the decrease of slope angle which marks the edge of the abyssal plain. Off the coast of Oregon the continental terrace varies in width from 35 nautical miles* off Cape Blanco to approximately 60 miles off Astoria. Variations in the width of the continental shelf and continental slope can be seen in Figure 1. The boundary between the shelf and the slope generally occurs in water 80 to 100 fathoms** deep; the edge of the abyssal plain, in water 1,500 to 1,700 fathoms deep. Characteristically, the continental shelf off the Oregon coast is narrower, has its outer edge in deeper water, and has a steeper angle of slope than the continental shelf in most parts of the world. The continental slope off Oregon is not as steep as the continental slope in most other parts of the world.

Three bathymetric charts of the continental shelf and slope off the Oregon coast have been prepared from unpublished soundings of the U.S. Coast and Geodetic Survey and from depth records of the Department of Oceanography, Oregon State University. The first of the charts, for the area off the central coast of Oregon (43°30'N. to 45°00'N.), was published and described in The ORE BIN for May 1962 (Byrne, 1962). A chart for the area south of Coos Bay (43°30'N.) to the Oregon-California border (42°00'N.) is presented in this article, along with a discussion of

---

* One nautical mile equals approximately one minute of arc of a great circle: 6,076.115 feet, officially. Throughout this report distances are expressed in nautical miles.
** One fathom equals 6 feet.

some of the geomorphic features indicated. The third chart, for the area off northern Oregon, will be presented in a future issue of The ORE BIN.

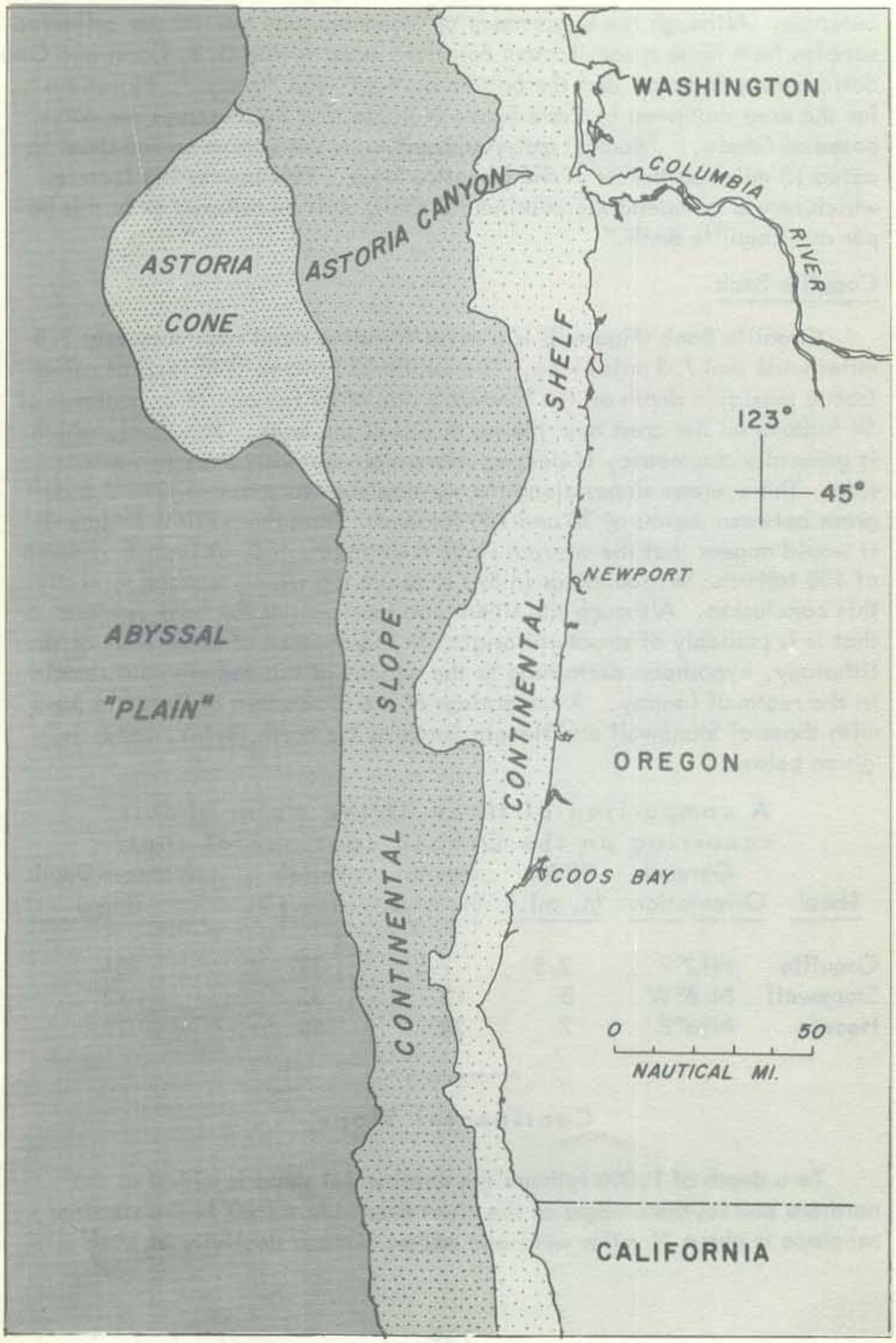
The bathymetric chart (Plate 1) was prepared from the soundings of 22 separate surveys of the U.S. Coast and Geodetic Survey. North of 42°40'N. the chart extends approximately to the 1,000-fathom contour; south of that latitude deeper soundings permitted charting of the lower portion of the continental slope and part of the abyssal plain. Because of differences in sounding densities, it was necessary to use three contour intervals. The sounding density for the continental shelf varies from eight to 40 soundings per square mile, and permits a contour interval of 10 fathoms to be used to depths of 100 fathoms. For the upper part of the continental slope, 100 to 1,000 fathoms, the sounding density is 1.5 to 2.0 soundings per square mile, and a contour interval of 50 fathoms is used. Below 1,000 fathoms the sounding density is less than 1.5 soundings per square mile, and a 100-fathom contour interval is used.

Continental Shelf

The width and slope of the continental shelf is determined by the position and depth of the shelf break (or the point at which the bottom slope increases notably toward deeper water). In the chart area, the shelf break generally occurs at depths of 90 to 100 fathoms, but in several places, such as off Cape Blanco and off the mouth of the Rogue River, the exact position of the slope increase is not easily determined. Off Cape Blanco the bottom slope increases uniformly to 200 fathoms from a depth of about 10 fathoms, and in places near the Rogue River the edge of the shelf can be picked at 60, 70, 80, or 90 fathoms. South of Cape Sebastian and north of Cape Blanco, two areas where the shelf is best developed, the shelf break occurs at approximately 100 fathoms. Using the 100-fathom contour as the average position of the shelf break, it can be seen that the continental shelf off southern Oregon varies in width from about 9 to 17 miles. The shelf is generally widest south of Cape Ferrelo and north of Cape Arago. However, if the shoal southwest of the mouth of the Coquille River is considered to be part of the continental shelf, the maximum width, 17 miles, occurs at this position. Thus, the continental shelf in this area is much narrower than the world average of 36.5 nautical miles (42 statute miles according to Shepard, 1948). The slope of the shelf along the profiles of Figure 2 ranges from 0°18' to 0°40', much greater than the world average of 0°07' (Shepard, 1948).

The irregularities of the shelf surface southwest of Cape Arago and in the area between Cape Blanco and Crook Point are undoubtedly due to rock

Figure 1. Index map of the submarine geomorphic features off Oregon.



outcrops. Although the Department of Oceanography has not yet collected samples from these areas, bottom notations made by the U.S. Coast and Geodetic Survey indicate that the bottom is "hard" and "rocky." Notations for the area southwest of Cape Arago indicate that the outcrops are composed of "shale." "Rocky" material constitutes the bottom on the shoal located 18 miles southwest of the Coquille River. This interesting feature, which serves to extend the continental shelf, will be referred to in this paper as "Coquille Bank."

Coquille Bank

Coquille Bank (Figure 3) is a north-trending shoal approximately 2.5 miles wide and 7.5 miles long. It exhibits 33 fathoms (198 feet) of relief from a maximum depth on the landward side of 87 fathoms to a minimum of 54 fathoms on the crest near the north end of the bank. The shoal, which is generally assymetric, is steepest along the relatively straight western side. The average slopes along the western side vary from 3.5 to 7.5 degrees between depths of 70 and 150 fathoms. From the profiles (Figure 3) it would appear that the western slope is uninterrupted, at least to a depth of 100 fathoms; but soundings in this area are too widely spaced to verify this conclusion. Although the linear configuration of the bank suggests that it is probably of structural origin, in the absence of knowledge of its lithology, hypotheses pertaining to the genesis of this feature must remain in the realm of fantasy. A comparison of the dimensions of Coquille Bank with those of Stonewall and Heceta Banks to the north (Byrne, 1962) is given below.

A comparison of three of the major shoals occurring on the Oregon continental shelf

Shoal	General Orientation	Width (n. mi.)	Length (n. mi.)	Relief (fms.)	Minimum Depth (fms.)
Coquille	N12°E	2.5	7.5	33	54
Stonewall	N 8°W	8	12	35	13
Heceta	N16°E	7	22	40	25

Continental Slope

To a depth of 1,000 fathoms the continental slope is widest at the northern and southern edges of the chart area. At 43°30' N the continental slope is about 31 miles wide and has an average declivity of 1°48'.

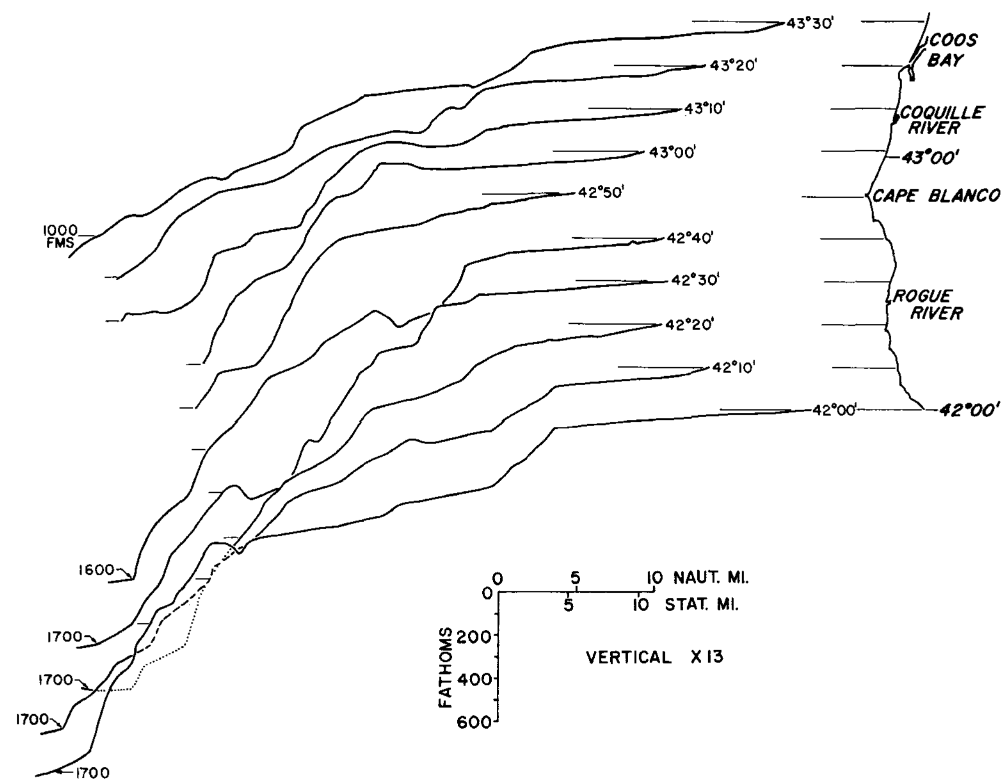


Figure 2. Profiles of the continental terrace from 42°00'N. to 43°30'N.

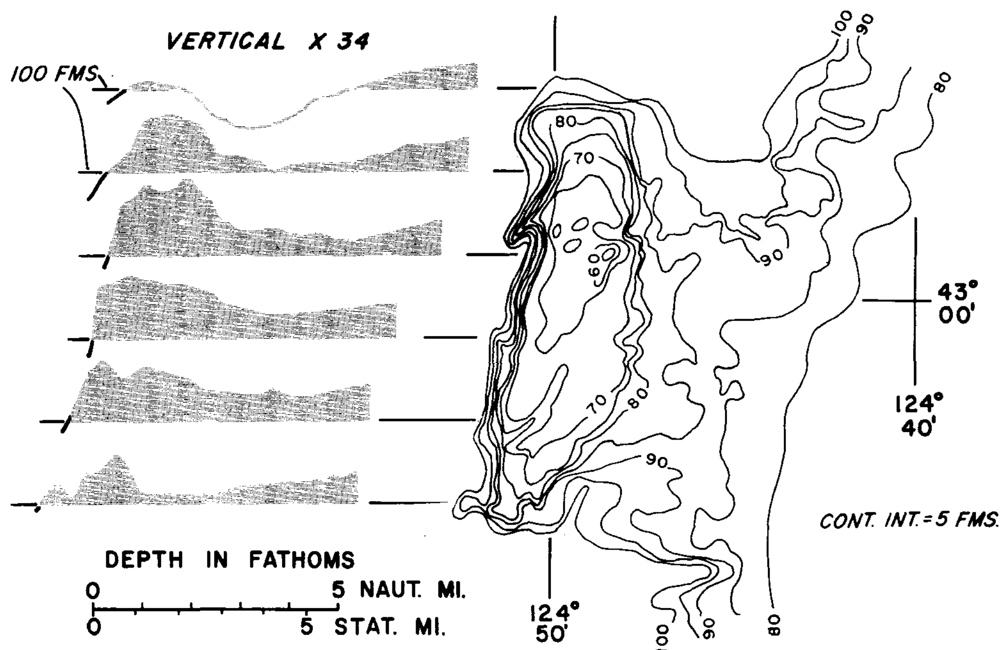


Figure 3. Coquille Bank: Bathymetry and profiles.

Off the Oregon-California boundary (42°00'N) the slope is 25 miles wide to the 1,000-fathom depth, but the overall width from shelf edge to abyssal plain is about 29 miles. In this southern area, the average slope angle to a depth of 1,000 fathoms is 2°01', but when measured to the abyssal plain at 1,600 fathoms, the average slope is 2°56'. Above 1,000 fathoms, the narrowest portion of the continental slope, 10.5 miles, lies opposite Coquille Bank. Here, the bottom declivity is 4°54'. Off the Rogue River the upper slope is also exceptionally narrow (13.3 miles) and steep (3°57'). Along the profiles of Figure 2 the average slope for the upper part of the continental slope (100 to 1,000 fathoms) is about 2°50', with the steepest slopes occurring between Cape Sebastian and the Coquille River.

Where data are available for the portion of the continental slope deeper than 1,000 fathoms, it is evident that the angle of slope is much greater, ranging from 4°18' to 8°55'. Such a steepening at the base of the continental slope has been noted in many places off California and is referred to as a marginal escarpment. This particular escarpment can be traced southward almost 100 miles to the west-trending Mendocino Escarpment (Shepard and Emery, 1941).

Submarine valleys

The most striking features of the continental slope in the chart area are the submarine valleys offshore from Cape Blanco to Cape Sebastian and the numerous benches or terraces to the north and south of the submarine valley area. The valleys, most noticeable southwest of Cape Blanco and northwest of the Rogue River, appear to represent a "submarine drainage system" consisting of two or three major valleys with several tributary valleys. The largest and most distinct valley is the "Rogue Submarine Valley" which heads in about 70 fathoms of water 12 miles northwest of the mouth of the Rogue River. This valley has an axial slope of 2°48', and can be traced for about 10 miles to a depth of 565 fathoms. Where it crosses the edge of the shelf, it is approximately one mile wide and has 76 fathoms (456 feet) of relief. Examination of the original survey data reveals that in its upper reaches the valley is steeper on the south side than it is on the north side; the south side slopes 13 to 17 degrees, the north side slopes only 6 to 8 degrees. Compared to Astoria Canyon off the mouth of the Columbia River (Figure 1), the Rogue Submarine Valley is small. At the shelf edge, Astoria Canyon is about four miles wide and has relief of 355 fathoms.

Benches

The benches, or terraces, are most evident north and south of the area of submarine valley development. This may imply that the benches antedate the formation of the valleys and were destroyed by erosion during the formation of the valleys. The benches are shown on the chart of Plate 1 by a spreading of contour lines, but are more evident on the profiles (Figure 2) as more or less horizontal steps on the otherwise steep slopes. They do not occur everywhere at similar depths, nor are they of equal width, but they do appear to occur within definite depth zones. On the basis of a measurement of total bench widths, it appears that the benches are best developed at depths of 150 to 200, 300, 550 to 600, and 1,000 fathoms. Below 1,000 fathoms the benches are less evident than in shallower water.

The widest benches appear to be located in the southern part of the area, and are best demonstrated on the 42°00'N. profile. Along this line, two fairly wide terraces are obvious from 350 to 450 fathoms and from 500 to 650 fathoms (Figure 2). Narrower benches may exist at depths from 900 to 950 fathoms and from 1,200 to 1,300 fathoms. The wider benches at 350 to 450 and 500 to 650 fathoms are about six and 10 miles wide, respectively, with slopes of 0°56' and 0°47'.

Benches also appear to be prominent along profiles 42°10'N. at 300 to 350 and 550 to 600 fathoms; 42°50'N. at 150 to 200 and 800 to 850 fathoms; and 43°10'N. at 150 to 200, 550 to 600, and 650 to 700 fathoms. The benches or terraces appearing on the upper slope of profile 42°30'N. are not real, but are due to the coincidence of the profile with the side of the Rogue Submarine Valley.

Whether these benches owe their origin to structural processes or to wave processes during a lower stand of the sea must be conjectural until more is known of the lithology and of the details of the physiography of the continental slope in this region.

Acknowledgment: This study was carried out under contract with the Office of Naval Research, Nonr 1286(02) Project.

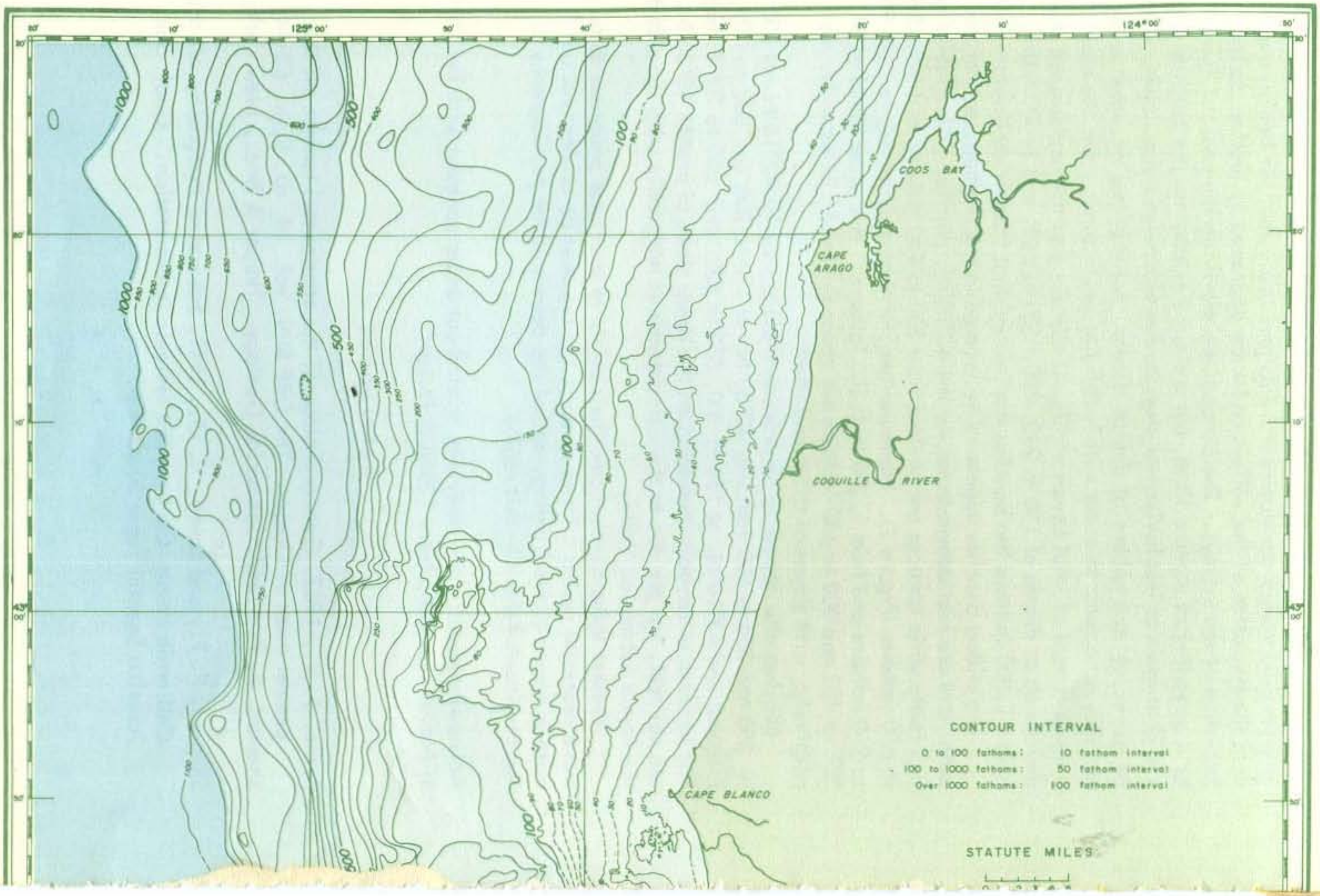
References

Byrne, J. V., 1962, Geomorphology of the continental terrace off the central coast of Oregon: The ORE BIN, vol. 24, no. 5, p. 65-74.

Shepard, F. P., 1948, Submarine Geology. Harper & Bros., New York, 348p.

Shepard, F. P., and Emery, K. O., 1941, Submarine topography off the California coast: Canyons and tectonic interpretation. Geol. Soc. America Special Paper 31, 171 p.

* * * * *



COOS BAY
CAPE ARAGO
COQUILLE RIVER
CAPE BLANCO
CONTOUR INTERVAL
0 to 100 fathoms: 10 fathom interval
100 to 1000 fathoms: 50 fathom interval
Over 1000 fathoms: 100 fathom interval
STATUTE MILES
125° 00'
124° 00'
43° 00'
1000
500
100

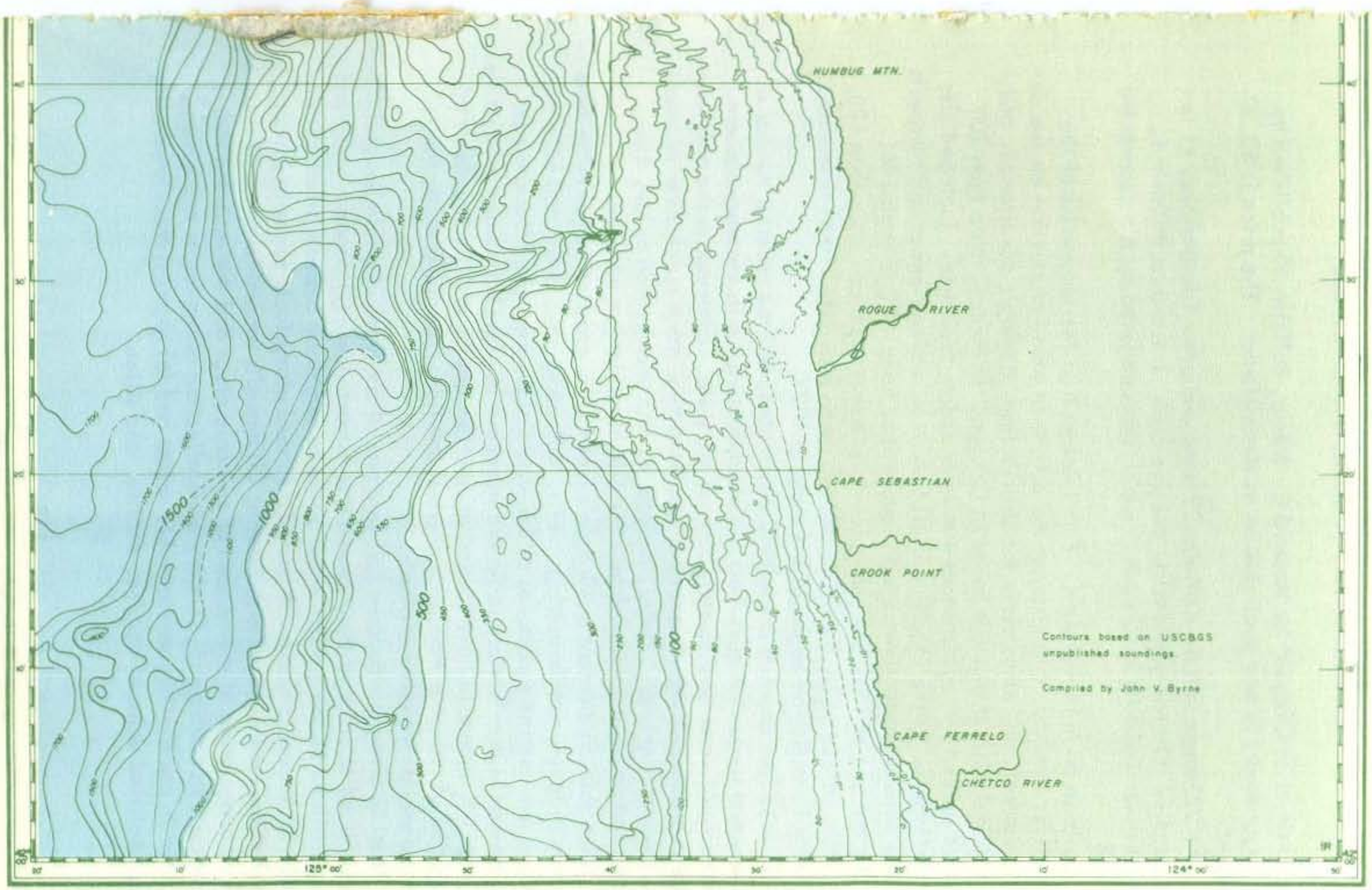


Plate 1. Bathymetric Chart of the Oregon Continental Terrace South of Coos Bay, 42°00'N. to 43°30'N

NEW QUICKSILVER BULLETIN AVAILABLE

"Quicksilver in Oregon" by Howard C. Brooks, Bulletin 55 published by this department, is now available at its three offices. The price is $3.50 postpaid.

The 223-page volume contains 79 maps and other illustrations, 11 tables, and 84 references to earlier publications. It replaces Bulletin 4, "Quicksilver Deposits in Oregon," which was published by the department in 1938.

Bulletin 55 is in two parts. Part I delves into the economics of the quicksilver industry, emphasizing the effects of world production on the domestic market, and summarizes the distribution, geologic occurrence, and types of quicksilver deposits found in Oregon. In Part II, more than 200 separate quicksilver occurrences are described or tabulated. Included also are plates showing the location of all known quicksilver mines and prospects and the annual production of individual mines from 1882 through 1961.

To the end of 1961 Oregon quicksilver mines produced more than 103,000 flasks valued at 14.5 million dollars, more than 100,000 of them since continuous production began in the state in 1927.

Quicksilver deposits are widely distributed, but the greatest number of deposits and those that have been most productive lie in the southwestern, north-central, and southeastern parts of the state. Cinnabar is the only mineral of commercial significance, although several other quicksilver minerals have been recognized. Pyrite, marcasite, and various iron oxide, clay, silica, and carbonate minerals are the prevalent gangue minerals.

More than 99 percent of Oregon's quicksilver production has come from deposits in lavas, volcanic plugs, tuffs, tuffaceous lake beds, and both marine and non-marine sandstones of Eocene, Oligocene, and Miocene age; occurrences in pre-Tertiary rocks are numerous but few have been productive. The deposits appear to have formed at shallow depths and are the result of deposition of cinnabar from hydrothermal solutions ascending along faults, shear zones, or intrusive contacts.

Most of Oregon's deposits fall into one of six types of geologic environments, listed in order of their productive importance: (1) deposits localized along inclined bedding plane shear zones in sandstone beneath strata of relatively impermeable shale; (2) deposits formed along fault zones in lavas, pyroclastics, and tuffaceous sediments; (3) deposits formed in zones of shearing and brecciation at the borders of volcanic plugs and the intruded rocks; (4) deposits in opalite; (5) Tertiary mineralization along faults and minor fractures in pre-Tertiary metamorphic rocks; and (6) deposits associated with large crustified veins of calcite, zeolite, and silica.

OREGON GETS STATE GEOLOGIST

"State Geologist" is now the title of Hollis M. Dole, Director of the State of Oregon Department of Geology and Mineral Industries. The change in the name of the position from director to state geologist, effective September 1, 1963, was made by the legislature to conform to the long-established usage among most of the state geological surveys in the Nation. Duties of the position remain the same.

The last time Oregon had a state geologist was 'way back in the 1870's when the title was applied to Dr. Thomas Condon, first professor of geology at the University of Oregon. This was long before a state geological survey or bureau of mines was created, however. As the following brief history will indicate, a permanent state department designed to study Oregon's mineral resources and disseminate information about them for the purpose of helping to develop the state's economy was a long time in coming. In 1911 the need for such an agency was finally recognized and the legislature established the Bureau of Mines of Oregon, with headquarters in the Department of Mines of the Oregon State Agricultural College (now Oregon State University) at Corvallis. Henry M. Parks, Professor of Mining Engineering, was named director.

Two years later, in 1913, the Bureau of Mines of Oregon was replaced through legislative action by the Oregon Bureau of Mines and Geology. Professor Parks was retained as director with his office in Corvallis. This new bureau was governed by an advisory council, called the commission, which was composed of seven members and included the presidents of both the University of Oregon and Oregon State Agricultural College and five men engaged in the mineral industry. The office of the commission was in Portland, first in the Yeon Building and later in the Oregon Building. During its first year the bureau had eight members on its technical staff in addition to the director, but in later years this number dwindled to only two or three. One of the most important contributions made by the bureau was the publication of a series of investigations called "The Mineral Resources of Oregon," which assembled much valuable information that is still used.

In 1923, the Oregon Bureau of Mines and Geology was terminated as the result of various administrative malfunctions. In subsequent years bills were introduced into the legislature in an effort to reestablish a department of mining and geology with adequate funds to operate, but most of these efforts failed. During this period, the numerous inquiries by the public for information on geology and mining were necessarily handled by the college and university, entailing considerable expense and interference with the teaching programs.

In 1937 the legislature created the existing agency - the State (of Oregon) Department of Geology and Mineral Industries - having a governing board composed of three members and a director appointed by the board. Earl K. Nixon was selected as the first director. His technical staff numbered six, but within a few years it more than doubled. The main office of the department was located in Portland in the Lewis Building, and field offices were established at Baker and Grants Pass. In 1940 the Portland office moved to the Woodlark Building at Southwest Alder and 9th, where it remained for a decade.

F. W. Libbey, staff mining engineer, was appointed director in 1944 to succeed Mr. Nixon, who resigned to accept a position with the Freeport Sulphur Co. In 1951 the State Office Building at 1400 S. W. 5th Ave. was completed and the department moved to its present location on the tenth floor. Upon the retirement of Mr. Libbey in 1955, Hollis M. Dole, assistant director and former geologist on the staff, was appointed director. A bill to change the title of this position was introduced by the Interim Committee on Natural Resources in 1961 and was passed by the legislature in 1963.

Thus, after an interval of some 80 years, Oregon now joins other states in the Union in having an official state geologist.

* * * * *

ROSTER OF U. S. LAKES PUBLISHED

All of the principal lakes in the United States of 10 square miles or more are listed and described in a circular recently published by the U.S. Geological Survey. Information is given on some 250 fresh-water lakes, 27 saline lakes, and 39 artificial reservoirs. Circular 476, entitled "Principal Lakes of the United States" and compiled by Conrad D. Bue of the Survey's Water Resources Division, may be obtained free from the Geological Survey, Department of the Interior, Washington 25, D. C.

* * * * *

NEW LIST OF AVAILABLE WELL RECORDS.

Miscellaneous Paper 8, "Available well records of oil and gas exploration in Oregon," published by the department, has been revised to include new data received since the paper was first issued in 1960. Listed in the publication are lithologic records, borehole surveys, and drill samples which are contained in the files at the Portland office. Sales price is 50 cents.

* * * * *

AMERICAN MINING CONGRESS RESOLUTIONS

At its annual meeting in Los Angeles in September, the American Mining Congress passed a series of resolutions on policy statements, setting forth the mining fraternity's views on problems affecting it. Below are three important ones.

Preamble

From the dawn of recorded history the progress of man has been associated with his initiative and intelligence in the use of his mineral resources. Tribal societies, nations, and even empires have grown great or passed into oblivion caused in large part by their success or failure in the development of mineral deposits and the production of ever better metals. Under the free enterprise system for a hundred years the mining industry of the United States has effectively and efficiently supplied the minerals and metals without which this nation might have long since receded to a second-rate power.

A strong mining industry essential to maintain the future security and economic stability of our country will continue to exist only if it can do so at a profit. We believe the competitive system under which America rose to greatness is threatened by the perils of socialistic experiments, excessive taxation, a managed currency, continued attempts at a managed economy, continued growth of union monopoly power, unwarranted federal intervention in the field of employer-employee relations and an ever increasing horde of minor public officials imposing bureaucratic mandates.

We urge our citizens to insist upon more restraints being placed upon government and also awake to the urgency of a reaffirmation of the sound constitutional principles upon which our Republic was founded.

Public Lands

This nation's future strength, prosperity and security depend upon assured sources of minerals for military and industrial needs. For such assurances there must be an active, healthy domestic mining industry. This requires free access to and full utilization of our public lands and development of their productivity through private enterprise.

We support the principle that the public domain should be put to as many compatible uses as its resources permit.

We oppose any law, regulation, decision or order prohibiting or limiting access to or utilization of any public land for the purpose of prospecting for and mining natural resources unless it is clearly established by examination and appraisal that such action will far better serve the national welfare. Future withdrawals should be kept to a minimum. Orders withdrawing public land from mineral entry should be reviewed periodically with the purpose of eliminating areas found to be in excess of need and opening them to mineral entry.

The concept of "discovery" as developed by judicial decisions should be adhered to by all departments of the Executive Branch of our Government. Government agencies should follow the decisions of our courts and should not impose their own definitions. We condemn the decisions of the Interior Department and its Bureau of Land Management and examiners which distort and disregard long-standing precedents.

Where a person of reasonable prudence is willing to do substantial work and expend substantial sums in exploration of a mineral deposit, or in the development of the means or processes to put the deposit to use, any holding that the deposit is not a "valuable mineral deposit" or that it has no "economic value" is not in accord with the mining laws. Value lies in potential as well as in present use, and this fact should be recognized by administrative agencies.

We urge upon the Department of Agriculture and its Forest Service, and upon the Department of the Interior and its Bureau of Land Management and all other governmental agencies dealing with public lands, that their regulations be administered fairly and uniformly and that their policies be formulated and carried out in a manner which will encourage, and not discourage, the development of our mineral resources.

Future exploration must, for the most part, be directed to the discovery of non-outcropping and often deeply buried mineral deposits. Hence, appropriate supplementary legislation, in keeping with the basic concepts and intent of our present mining laws, is required to afford reasonable prediscovery protection to one who is in good faith engaged in seeking a discovery of mineral. Such protection is needed to encourage the expenditures of vast sums necessary to carry forward mineral exploration.

We endorse the enactment of legislation which will provide for a study by a committee composed of Members of Congress of existing laws and procedures relating to the administration and disposal of public lands of the United States. Such legislation should recognize as the policy of Congress that the public lands be retained, managed and disposed of in a manner consistent with the principles of multiple use and of the general mining laws.

Gold, Silver and Monetary Policy

Monetary policy

With the continued deficit in international payments resulting in further decline in the nation's gold reserves and increases in dollars held abroad, the difficulties inherent in our current monetary policies are daily becoming more acute. The conflict between a domestic dollar that is not redeemable in gold and dollars in the hands of foreign central banks that are convertible into gold at the pre-war rate cannot be ignored much longer without serious danger of being forced to drastic corrections under circumstances beyond our control.

The need for monetary reforms and changes in practices that result in extreme strains on the monetary system is urgent. Steps taken or proposed by our governmental agencies to date have in general been in the right direction but far from adequate to meet the situation or to do more than delay the ultimate crisis.

Gold

Revaluation of the major currencies in terms of gold pursuant to international agreement would be merely a recognition of the inflation that has already taken place since the price of gold in dollars was fixed in 1934. To provide adequate international liquidity and to reestablish the gold standard on a basis that could be maintained, a substantially higher price is called for.

The gold mining industry under these conditions would, of course, benefit. Plants would be expanded, the life of existing mines would be prolonged and new discoveries could be expected from the stimulation that prospecting would receive. With continuation of present policies, however, domestic gold mining will soon be extinguished unless special aid of some sort is provided.

We oppose the removal or suspension of the legal requirement of gold backing of 25% of Federal Reserve notes and deposits. An approach toward this limit of our gold reserves should force corrective action while it could still be accomplished with some measure of order and control. We recommend:

1. Removal of restrictions on ownership, purchase, or sale of gold by American citizens.

2. Termination of sale of gold by the Treasury for industrial uses, thus ending the subsidy the users of gold now enjoy at the expense of the miners..

3. Provision, as an interim measure, of some aid through a premium price, subsidy or tax relief, to preserve the few existing gold mines until the industry is revived through realistic revaluation of gold.

Silver

We commend Congress for adopting legislation providing for the discontinuance of sales of Treasury silver at less than its monetary value and for the repeal of other restrictions on the purchase and sale of silver. We note that this legislation resulted from the exhaustion of Treasury stocks of free silver available for sale to industry. We anticipate a continued demand for silver for industrial and other uses in excess of supplies available from new production and other sources, and note that this will inevitably result in further depletion of the remaining Treasury stocks of silver as silver certificates are presented for redemption. This will in time confront the Treasury with the intensely practical problem of maintaining adequate stocks of silver both to serve as a strategic reserve of this essential defense metal (no Government stocks of which are maintained outside the Treasury), and for use in subsidiary coinage. We deem it essential that the use of silver in our subsidiary coinage be continued so as to maintain a coinage of substantial intrinsic value.

The impending problems resulting from the growing shortages of both gold and silver for monetary and industrial use must be faced. Under the Constitution, the Congress of the United States is charged with the responsibility "to coin money" and to "regulate the value thereof." Therefore, we further recommend the creation by Congress of a Joint Committee on Monetary Policy to inquire into the problems caused by the shortages of gold and silver, and to recommend measures to insure adequate supplies.

Other resolutions set forth policy statements on: antidumping; Government agencies, U.S. Geological Survey and Bureau of Mines; Government expenditures; import controls; labor relations; mine financing; mine safety; solid fossil fuels; stockpiling; taxation; uranium; and water and air pollution.

* * * * *

PORTLAND CHOSEN AS SITE FOR AMC MEETING

Portland, Oregon was selected as the convention site for 1964 at the business session of the American Mining Congress recently held in Los Angeles. The time chosen is September 13 to 16. Earl S. Mollard (Western States Representative, The Hanna Mining Co., Myrtle Creek) was elected Chairman of the Western Division of the American Mining Congress, and Fayette I. Bristol (President, Bristol Silica Co., Rogue River), Veryl Hoover (Vice President, Pacific Power & Light Co., Portland), and Frank E. McCaslin (President, Oregon Portland Cement Co., Portland) were elected to the Board of Governors for the State of Oregon.

The convention in Los Angeles had more than 2,500 people in attendance. Besides a full program of topics of interest to the mining industry, the American Mining Congress adopted its policy for the coming year.

The American Mining Congress was founded in 1898 and is the one national organization representing all branches of the mining and minerals industry. With headquarters in Washington, D.C., it serves as a clearing house for the minerals industry in the Nation's capital, keeping the industry informed as to matters pending in Congress and in the numerous government agencies, and working for constructive action which will adequately recognize mining's special problems. It serves as spokesman for the industry on a wide range of matters involving Congressional and government policies. Through the American Mining Congress the thinking and efforts of all branches of mineral production are correlated for the advancement of the entire industry. Headquarters for the Congress are in the Ring Building, Washington, D.C. Its president is Herbert C. Jackson (Pickands Mather & Co., Cleveland) and its executive vice president is J. Allen Overton, Jr.

* * * * *

WESTERN GOVERNORS MINING ADVISORY COUNCIL

At the American Mining Congress meeting in Los Angeles on September 17, the Western Governors Mining Advisory Council elected DeWitt Nelson (Director, California Department of Conservation, Sacramento) as chairman; Fayette I. Bristol (President, Bristol Silica Co., Rogue River, Oregon), vice chairman; and Kenneth C. Keller (Chief Counsel, Homestake Mining Co., Lead, South Dakota), secretary-treasurer. It was decided at the meeting that the council would meet in Denver in February for the formulation of its policy statements for presentation to the Western Governors.

* * * * *

The ORE BIN
Volume 25, No. 10
October, 1963

STRATEGIC MINERALS

By Hollis M. Dole, State Geologist
State of Oregon Dept. of Geology & Mineral Industries

The term "strategic minerals," like many terms used today, means different things to different people at different times.

One of its first uses can be found in Public Law 117 of the 76th Congress (1939), where it was stated that strategic and critical materials were those which were "essential to the needs of industry for the manufacture of supplies for the armed forces and the civilian population in time of a national emergency." The 79th Congress in 1946 used similar language when, in Public Law 520, it referred to strategic and critical materials as those which are "deficient or insufficiently developed to supply the industrial, military, and naval needs of the country for common defense." The term took on legal status in tax legislation during the early days of World War II. Those metals which were not produced in the continental United States in amounts necessary to meet military requirements were deemed strategic.

It can readily be seen that advancements in technology, commercial uses for elements generally considered as having scientific interest only, changing political alignments of nations, larger domestic consumption by countries which were major suppliers of raw materials to the more industrialized countries, new military weapons, and new methods of conducting warfare all contribute to a continuing expansion and reduction of those minerals which could be considered "strategic." Therefore, the "strategic minerals" which I shall review are necessarily chosen arbitrarily and most likely will not be or will not include the minerals and metals which others would consider "strategic."

My choice is going to be based on nostalgia. I shall hark back to the "good old days"--those days when the term "stockpile" was not a nasty word; when wild and wilderness regions were widé open to mineral exploration

---

* A speech delivered before the 1963 American Mining Congress convention in Los Angeles, Calif., September 16 as part of the "State of the Mining Industries" session.

without censor; and when the requirements for being a successful prospector were skill, luck, and the willingness to work hard (as opposed to the present-day need for ready access to a highly competent legal staff and immortality to carry a case through the hearing procedures and the courts).

The minerals I am going to discuss, or probably more accurately, exhume, are antimony, chrome, cobalt, columbium-tantalum, manganese, mercury, thorium (including monazite and the rare earths), and tungsten. My statistics are taken from two worthy but somewhat conflicting Government documents, namely: "Federal Stockpile Inventories, May 1963, Additional Report of the Joint Committee on Reduction of Nonessential Federal Expenditures" (Senate Committee Print No. 42); and "Stockpile Report to the Congress, Statistical Supplement, July-December 1962," prepared by the General Services Administration.

Antimony

The domestic production of antimony provides only a small proportion (approximately 5 percent in recent years) of our domestic requirements. Under present circumstances and with the bulk of antimony imports (in the form of ores and concentrates) coming in duty free, an expansion of domestic antimony production does not appear possible.

In 1962, the United States imported 15,800 tons of antimony. This was nearly 20 percent more than in 1961. Approximately 28 percent of all primary antimony imported came from Mexico, 23 percent from the Republic of South Africa, 14 percent each from Belgium-Luxembourg and the United Kingdom, 8 percent from Yugoslavia, 7 percent from Bolivia, and the remaining 6 percent from seven other countries. The metal from Belgium-Luxembourg probably originated in Red China which, then, would make a total of 21 percent of our imported supply from communist-dominated sources.

Federal Stockpile Inventories reports 50,688 short tons, of which 30,301 are in the national stockpile and 20,387 are in the supplemental (barter) stockpile. Its value is listed as $32,263,508. The Stockpile Report to Congress reports that only 9,394 short tons in the national stockpile are domestic material (see Table 1).

Chrome

Domestic chrome mining died on October 3, 1961, with the closure of the American Chrome operation in Montana. Oregon-California-Alaska chrome mining had passed away two years earlier. All this mining was in response to the Federal stockpiling program of the 1950's. The result of this program was the production of 400,000 long tons of chrome ore, a pilot plant operation showing the feasibility of converting the ore into acceptable

TABLE 1. Strategic Minerals in the National Stockpile*

Mineral	Percent Foreign Materials Quantity	Material Purchase Cost Total Value	Foreign Materials
Antimony Metal	55.5%	$ 14,000,039	$ 7,895,894
Chromite (all grades, & ferro)	90.8%	240,703,351	200,377,773
Cobalt	93.1%	146,242,631	136,266,378
Columbite	94.9%	24,516,573	23,290,987
Tantalite	85.1%	5,752,354	5,021,516
Manganese (all grades, & syn.)	87.2%	194,449,393	142,447,287
Mercury	100.0%	9,650,382	9,650,382
Rare Earths	35.6%	6,160,519	3,015,461
Tungsten	92.8%	280,931,073	266,460,125
	Average 81.7%	Total $922,406,315	Total $794,425,803

* Includes only minerals discussed in this report and purchased with Public Law 520 funds through December 31, 1962, as recorded in "Stockpile Report to the Congress, Statistical Supplement, July-December 1962."

ferrochrome, and the discovery and cataloguing of more than 400 domestic deposits. Any likelihood of resurrecting chrome mining was effectively stopped by the Senate committee investigating stockpiling when it accused the industry of exerting political influence and receiving prices far above world markets.

During 1963 Russian chrome was taking over the domestic markets through imports of below-market-priced ferrochrome**. Some domestic ferrochrome producers were negotiating with Russia for ore. Because of prodding by Rhodesia and Turkey, the State Department has under consideration further subsidization of these producers. Ironically, the Russian ore was putting the Free World producers out of business for the same reason the domestic producers had to close, that is, higher-grade ore offered at a lower cost.

**Engineering & Mining Journal <u>Metal and Mineral Markets</u>, Feb.11, 1963.

There are 8,810,012 short tons of chrome of all grades in the stockpile. Of this amount the national stockpile lists 330,803 short tons of ore, 6,369 short tons of high-carbon ferro, and 18,741 short tons of low-carbon ferro from domestic sources. Value of chrome in the national stockpile is given as $240 million, of which $40 million was for domestic ore and $200 million for foreign ore.

Cobalt

The situation in regard to cobalt can be summarized in one brief sentence: The price for cobalt in 1940 was $1.50 per pound -- the current price for cobalt is $1.50 per pound. No domestic cobalt mine can operate under these conditions.

The principal production of cobalt comes from Africa, where it is produced in Katanga, Northern Rhodesia, Morocco, and Uganda. The security of these sources of supply needs no comment. Another potential source is Cuba.

In North America, production is coming from the Sherritt Gordon operation at Lynn Lake, Manitoba. There is also some production as a by-product from smelters. In the United States proper the only source for cobalt seems to be the Blackbird District in Idaho which, for some time, produced the metal but was forced to close operations because of the low price. Cobalt-bearing lead ores near Fredericktown, Missouri, and cobalt-bearing iron-ore deposits at Cornwall, Pennsylvania are theoretically potential sources, but no practical production from them has been demonstrated.

There are 103,018,126 pounds of cobalt in the stockpile inventories. Of the 76.8 million pounds in the national stockpile, about half a million pounds have come from domestic sources. This compares with one million pounds in the barter stockpile.

Columbium-tantalum

The western states have the only significant reserves of tantalum in the North American continent, and the only significant potential producer of columbium in the United States, at Bear Valley, Idaho. However, the domestic production of these elements is controlled by imports of both columbium-tantalum ores and heavy rare-earth metal source materials. The result -- all United States mines are at a standstill.

The Federal Stockpile Inventories records a total of 16,099,060 pounds of columbium in the stockpile. Of the 8.4 million pounds in the national stockpile, less than half a million pounds have been produced domestically. This is about the same amount that has been obtained through barter of surplus agricultural goods.

For tantalum, the statistics are 4,959,880 pounds in the stockpile, with 75,588 pounds from domestic mines.

Manganese

From any realistic viewpoint, there is no domestic manganese mining left in the United States. Most of the operating mines closed with the termination of the last of the Government Manganese Purchase Programs in August, 1959. The last special contract with an individual producer ended in 1961 and the plant in Nevada has been dismantled. At the present time, only the mines at Philipsburg, Montana, remain open and their production is primarily for dry-cell battery and chemical use. Anaconda has produced nodules intermittently from stockpiled ore, and Manganese Chemicals Corp. is producing synthetic manganese from manganiferous iron ores and tailings in Minnesota.

Table 2 shows the relation between domestic and foreign production of manganese and illustrates the decline in domestic production since 1958.

TABLE 2. Manganese Production in Short Tons
(From USBM Minerals Yearbook - 1961)

Year	Domestic	Foreign
1952-56 average	222,207	2,530,447
1957	366,334	3,105,172
1958	327,309	2,452,578
1959	229,199	2,397,804
1960	80,021	2,543,841
1961	46,088	2,098,438
1962 (estimated)	20,000	2,200,000

In 1954, there were 367 manganese "establishments" engaged in producing manganese ore in the United States. In 1958 there were 186; in 1961 about half a dozen; and in 1962, four.

The number of employees in the manganese mining and milling industry averaged 2,604 in 1954 and 2,099 in 1958, and wages paid to production and related workers in each of these years amounted to more than $7,000,000. In 1961, there were 222 workers with total wages of about $1,000,000, and in 1962 the figures could well have been reduced by 50 percent of the 1961 figure.

There are 12,327,663 short tons of metallurgical grade manganese in the stockpile, of which 3.4 million have been obtained through barter. Less than 0.4 million short tons of the total is domestic material.

Mercury

In 1958 mercury production in the United States came from 12 major producers. In 1961 the number had dropped to five. At the present time there are only two. Although the United States consumption is probably at, or close to, an all-time high, domestic production continues to fall because of generally increasing domestic labor costs and declining prices. World-wide over-capacity, as the result of United States Government requirements and programs during and after the Korean War, is now having its inevitable effect.

Within the last few months governmental policies came extremely close to destroying entirely the domestic industry and severely crippling the whole Free World's mercury industry. The story is this:

During the middle 1950's the Atomic Energy Commission obtained very large supplies of mercury for its isotope separation facilities, from both the federal stockpile and foreign suppliers. When the program was approaching completion, the AEC declared 50,000 flasks of this material excess to its requirements. This material was turned over to the General Services Administration for disposal under the Surplus Property Act. Fifty thousand flasks is the equivalent of more than three years' domestic production, and almost the equivalent of one year's United States consumption.

The total amount of mercury in the hands of the AEC is probably greater than the total Free World's annual production capacity and could have easily followed the same route.

Although much of this material had been in the United States stockpile, where it could have been disposed of only with Congressional approval, by its transfer to the AEC for essential defense use and then, when that defense use was no longer required, its transference to "excess" and then presumably to "surplus," it was available for public disposal.

As a result of protests by western mining states' Senators, and by vigorous action of Congressman Aspinall and Congressman Baring, the excess mercury was transferred back to the Strategic Stockpile. For a time at least, the domestic industry has been given a reprieve. Congressman Aspinall has also introduced legislation (H. R. 8248) to plug the loophole whereby national stockpile material can reach the market place without Congressional approval through agency transfer. This bill deserves strong support.

(Continued on Page 178)

COAST ASBESTOS CO. OPERATIONS
GRANT COUNTY, OREGON

By N. S. Wagner*

Milling operations in Grant County, Oregon, by the Coast Asbestos Co., Los Angeles**, constitute the only recorded attempt to evaluate an Oregon chrysotile occurrence by actual production under field conditions on a pilot plant scale (figure 1). Approximately 525 short tons of marketable fiber have resulted from this test to date. Thus this production rates as an historical "first" in this area of mineral output in Oregon.

The occurrence on which this test is being made is located on Beech Creek, a few miles northeast of Mount Vernon, Grant County. This locality is indicated in figure 2, along with certain of the other known chrysotile occurrences in eastern Oregon. It is shown in greater detail in figure 3, which features the serpentine body in which the chrysotile occurs and other of the principal bedrock types exposed in the immediate area.

Most of the eastern Oregon chrysotile occurrences have, over the years, received some measure of prospect attention and certain of the more promising localities have been mapped in considerable detail, surveyed with a magnetometer, and even core-drilled to a limited extent. The occurrence on Beech Creek is probably the most publicized of the group as a result of an examination made by the Asbestos Corp., Ltd., Thetford Mines, Quebec, during the field seasons of 1949 and 1950. Geologists of the Johns-Manville Co. also examined the property during the early 1950's but conducted no exploration work.

Operations by the Coast Asbestos Co. began in 1959, were dormant during 1960, and then were pursued actively throughout the field seasons of 1961 and 1962. During this period the original mill was rebuilt several times, and its flow sheet was altered and expanded each time in accordance with the experience obtained from a succession of test runs.

Figure 1 pictures the mill as it appeared in November, 1962, its capacity rated at an estimated 5,000 pounds of recovered fiber per 8-hour shift. Fiber quality as recovered to date is reported to include group 5, 6, and low 7 material as classified by Canadian standards. Under the present set-up, however, the product from the test mill contains approximately 80

---

* Geologist, State of Oregon Dept. of Geology & Mineral Industries.
** The company is an Oregon corporation; the Los Angeles address is that of the Western Chemical & Manufacturing Co., where the accounts are kept.

Figure 1. Coast Asbestos Co.'s pilot mill in Grant County, Oregon, 1962. Primary crushing and drying facilities are housed in large building on left side of picture and the storage shed for sacked fiber is on the extreme right. Supplemental processing and sacking facilities occupy intermediate building space. A portion of one of the pits from which ore is taken is shown in rear.

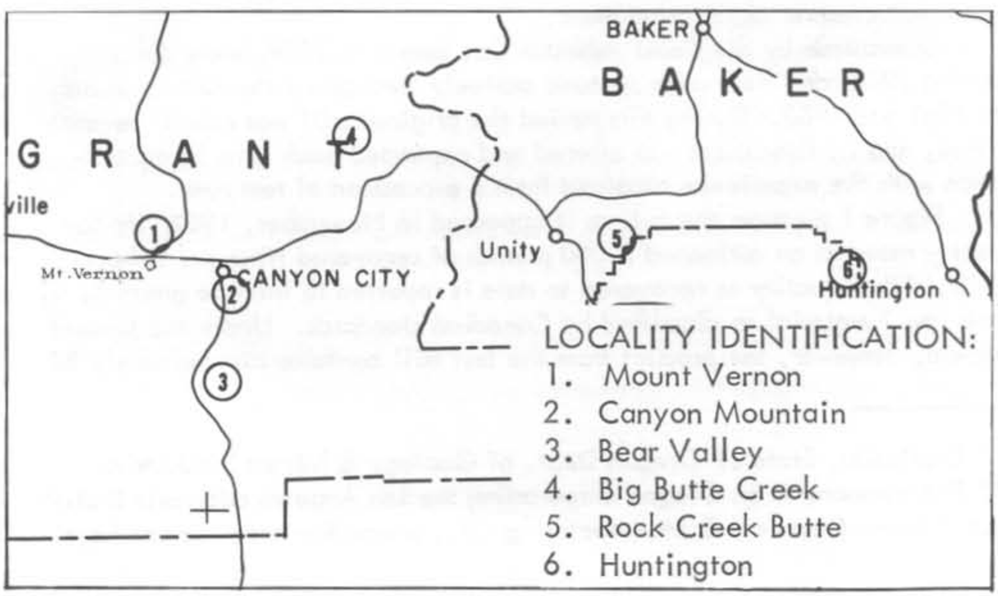


Figure 2. Map showing location of principal chrysotile occurrences in eastern Oregon. Locality No. 1 is described in this report.

percent fiber and 20 percent waste; final upgrading and quality control are accomplished in a plant in Los Angeles operated by the Western Chemical & Manufacturing Co.

The flow sheet at the pilot plant is divided into two sections. The "crude," or primary, section begins with a hammer mill in which pit run ore is reduced to minus 3/4 inches. This reduction is followed by drying in a 5- by 40-foot oil-fired rotary drier which discharges into another hammer mill where further reduction to minus ½-inch is accomplished. At this stage screening over a 16-mesh rotary screen eliminates minus 16-mesh material as waste. The plus 16-mesh material is stockpiled as "heads" for subsequent treatment.

The second, or finishing, section of the flow circuit begins with a shaker screen from which some long fiber is taken off from the plus 16-mesh feed and routed directly to a fiberizing mill and bagger. The plus 6-mesh feed material from this screening is diverted as tailings, and the minus 6-mesh fraction is then milled in a hammer mill and again screened over another 16-mesh rotary trommel. The fines from this screen are waste, but the over-size receives continued processing, first over a 20-mesh shaker screen where more fiber is recovered, and then through an attrition mill followed by two 30-mesh rotary screens. The minus-30 fines from this screening are treated as tailings, while the plus-30 material progresses through a 20-mesh shaker screen and a battery of Overstrom vibrating screens from which fiber is recovered at a series of screen stages to conclude the main stream treatment.

The plant has a supplemental circuit, consisting of a micro-mill and two 30-mesh rotary screens. Most of the tailings diverted from the main stream, second stage, prior to the Overstrom battery stage, are re-worked here. The plus-30 mesh fraction from this treatment is re-introduced into the main circuit at the Overstrom battery stage for final fiber salvage.

The entire plant is activated electrically with power from two diesel generators which give a 300-ampere total output. As stated previously, the product of this mill is shipped to Los Angeles for final upgrading and quality control. The fiber is sacked for shipment and shipments have been made by both truck-trailer and rail in carload lots.

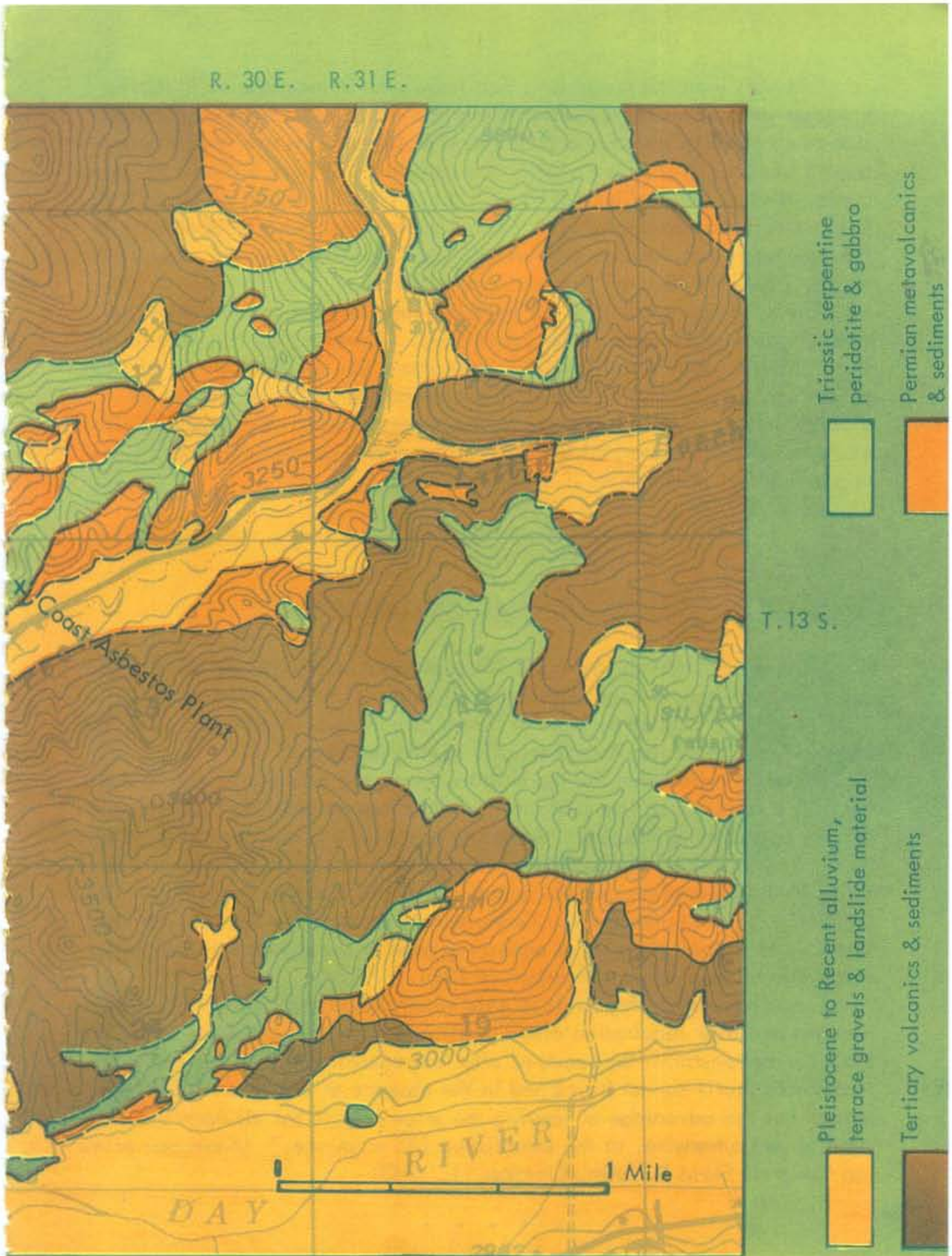
Western Chemical & Manufacturing Co., in whose plant the final upgrading is done, also serves as the sole and exclusive sales agent for the Coast Asbestos Co.'s output. So far, all fiber from the test operation has been marketed to consumers in the Los Angeles area, principally those engaged in manufacture of cement and acoustical products.

Mining is accomplished by dozing from a series of benches situated on the hillside directly above the mill. Only a portion of one bench is evident in figure 1.

Map prepared by
STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

(Base from Mt. Vernon Quadr

Figure 3. Geology in the area surrounding the Coast Asbestos Co.



le 1:62,500)

t, Grant County, Oregon. (Adapted from Thayer, 1956)

Chrysotile on the property is best known for its occurrence in narrow but well-defined stringers, which yield attractive collection specimens. However, much of the chrysotile content of the pit-run mill feed is believed to occur in the form of slip fibers, which are more difficult to recognize than the cross-fiber stringers. The slip fiber content of the host serpentine is indicated by the pilot milling experience, which, according to the operators, has shown a pit-run mill-head recovery average of approximately 7 percent fiber for the tests made thus far.

The company plans to make more test runs in order to determine the overall grade and extent of the occurrence. However, for the next test stage it anticipates boosting mill capacity to a 25- to 30-ton level of fiber output per day, by adding new drying and storage facilities and by replacing certain old machinery with modern equipment. The company also plans to investigate markets for fiber in the northwest and will add a final upgrading unit to the mill, if needed.

* * * * *

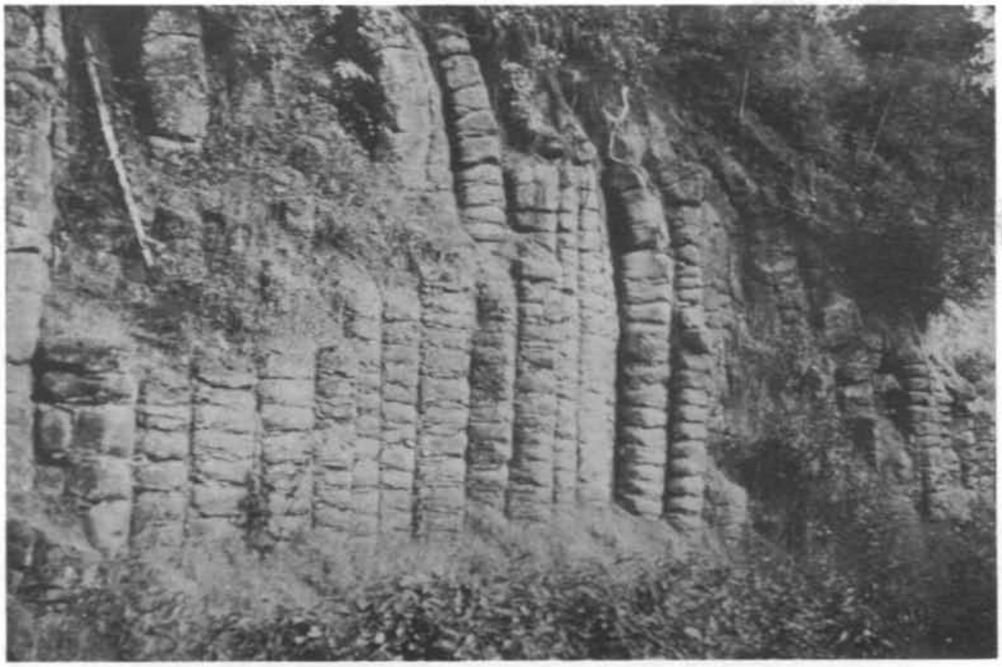
GOLD HEARINGS SLATED

The Minerals, Materials and Fuels Subcommittee of the Senate Interior Committee has scheduled open hearings on October 23 and 24 to consider S. 2125, a bill introduced by Senator Ernest Gruening of Alaska and other Senators to "revitalize the American gold mining industry."

When he introduced the legislation, Gruening told the Senate that the bill was a result of earlier subcommittee hearings considering legislation to aid the gold mining industry. Gruening said that this new legislation might be more effective in overcoming the essential obstacles to increase productivity in the gold mines and the opposition of the Treasury Department. The legislation would authorize the Government, through the Secretary of the Interior, to support the cost of producing gold to the extent this cost exceeds that of equivalent operations in 1940.

Gruening said: "Payments to gold miners would be carefully limited to amounts actually required to allow profitable operation and only where the producer demonstrates that costs of efficient operation are so excessive a reasonable profit cannot be earned in the absence of assistance. This approach has the advantage of leaving the price of gold for all purposes, commercial and otherwise, at the established $35 an ounce." (American Mining Congress News Bulletin, October 11, 1963)

* * * * *



GEOLOGIC BISCUITS   Photo by R. S. Mason

What are they? How did they get there? These are questions that many people ask when they drive past this unique rock outcrop. The photograph is the first in a series to appear from time to time in The ORE BIN, depicting unusual geologic features seen along Oregon highways.

The outcrop pictured above looks like stacks of petrified biscuits from the oven of Paul Bunyan. Each bun is about 15 inches in diameter and 8 inches thick, brown on the outside and light gray within. The location is on the Clackamas River road 4 miles upriver from Estacada and 35 miles southeast of Portland.

Geologically, the outcrop illustrates weathering and erosion of an unusual fracture pattern in andesite (a rock similar to basalt but lighter in color and having a slightly different chemical composition). Some 15 million years ago this was a flow of molten lava, perhaps 20 or 30 feet thick, which poured out of a nearby volcano. On solidifying and shrinking, the sheet of lava fractured vertically into columns. Further stresses created platy jointing at right angles to the columns. Later in geologic time the Clackamas River carved its valley downward through the layer of andesite, exposing the rock to the weather. Air and moisture penetrated the cracks, causing chemical breakdown of minerals in the andesite and disintegration of the rock surfaces. This had the effect of widening the cracks, separating the columns, and rounding off the sharp corners of the plates or biscuits. Rain water pouring down the cracks between the columns also helped to enlarge the gaps. Building of the Clackamas River road further exposed the rock to the elements.

The andesite at this locality is part of the Rhododendron Formation composed of volcanic mudflows and lavas of late Miocene age.

"Strategic Minerals" (continued from page 170)

The amount of mercury in the stockpile is given as 145,525 flasks, of which 16,000 flasks are in the supplemental or barter stockpile. There is no domestic mercury in the national stockpile.

Thorium, monazite, and the rare earths

Nothing was produced during 1962 in the heavy rare earths (thorium-monazite class) since the imports of foreign ores and finished or semi-finished products are the controlling factor. Some production has been maintained in light rare earths (cerium) from the Mountain Pass, California, property. However, it is understood that there was no increase in production in 1962 as compared to 1961.

Open market prices for thorium or monazite sand concentrates, had there been any sales in 1962, were such that freight to market would have absorbed 50 percent of the price. However, things have taken a turn for the better in the past six months. The price on monazite has been rising, owing to increased world demand.

If yttrium nodular iron is successful, as it seems to be, there will be an increased demand for all rare earths containing yttrium.

Our stockpile contains 9,127,549 pounds of thorium. Eight million pounds of this is in the supplemental (barter) stockpile. The Stockpile Report to the Congress shows 7,960 short tons of rare earths, of which 5,120 is domestic material.

Tungsten

The peak year of tungsten production was 1955, when there were 40 large producers and more than 700 other producers. Today there are three domestic producers.

Communist countries are using tungsten, like chrome, as a source of dollar exchange. In this instance, Red China is the country that is causing serious disruption in the market.* The ore goes to such countries as Japan to be processed into ferro and from this secondary source it reaches the Free World market, presumably without a red tinge.

Stockpiled tungsten amounts to 204,020,221 pounds. Nearly 6 million pounds of this is in the supplemental (barter) stockpile. In the national stockpile of 86 million pounds, 6 million pounds are listed as domestic materials.

* The Iron Age, Feb. 28, 1953.

Conclusion

With this very gloomy review of the former pride of the western mining industry in mind, I think that the importance of the stockpile is quite evident. We see it as a buffer in the economic warfare the communist countries are conducting in chrome, tungsten, and antimony. Its value will increase as other metals become involved. There is little doubt that they will.

We see, from the example of mercury, the care that must be taken when stockpile disposal is contemplated and we also see the necessity for continuing Congressional control of the stockpile.

We have learned from the sources of the stockpiled material one of the reasons why domestic mines have been unable to compete with foreign mines. Of the minerals covered by this review, 81.7 percent in the national stockpile has come from foreign sources. The dollar totals are $794 million for foreign ores and $128 million for domestic ores. Of the $4.8 billion total value of the 78 materials purchased under Public Law 520 funds through 1962 for the national stockpile, $3.5 billion, or 73.1 percent, are foreign materials. The dollar total of foreign materials in all of the stockpiles would undoubtedly boost this $3.5 billion to at least $5.5 billion. Furthermore, foreign purchases through barter of surplus agricultural commodities still continue. I think anyone would concede that this multi-billion-dollar market makes pretty tough competition for domestic mines. It can be concluded that foreign deposits do have a long-range minerals program -- our stockpile.

Unfortunately, the loss to the economy of the western states is not the only result of the destruction of these many parts of the strategic mineral industry. Probably the effect of not having an active prospecting and small mining nucleus is of greater national significance than the general curtailment of the economy. In 1960, 71 elements were in commercial use in the United States. This compares with 60 elements in 1950; 50 elements in 1940; and 29 elements in 1900. Who in the past 10 years has been trying to determine the potential and the reserves of this nation for these 10 new elements? What new elements will be used in 1970, and what is being done to locate these, and who will do the prospecting? Does mining have to be a time of crash programs, or uranium rushes? In this day of automation, exploration of space, and rapid transportation, this approach to mining just doesn't make sense.

I can't believe we are such a "have-not" nation as many people would have us think. It is true that no nation can hope to meet all its requirements from domestic sources. In the long term, however, the United States will have to provide the bulk of its own supplies, if only because other nations will consume a larger and larger share of their own production as they raise their levels of living.

Dr. Thomas Nolan, Director of the U.S. Geological Survey, made a very significant point in his speech, "Current Research of the U. S. Geological Survey," before the American Association of Petroleum Geologists, at Houston, Texas, March 28, 1963. He stated: "It is true, of course, that the amount of a given material in the earth's crust is finite. But which, and how much, of these materials are usable at any time and thus constitute a mineral resource, depends upon what man's knowledge and ingenuity make it possible for him to use to his advantage at that particular time."

I would add only that "ingenuity" includes Government actions and policies, domestic as well as foreign.

* * * * *

ALUMINA EXTRACTION METHOD DESCRIBED

Successful extraction of alumina from Oregon ferruginous bauxite by a double-leach process has been demonstrated by the Albany Metallurgy Research Center, Bureau of Mines, Albany, Oregon. The process recovers a greater proportion of alumina from high-silica ores than the conventional single-leach method. The recovery is accomplished by calcining the ore, removing reactive silica in a preliminary dilute caustic soda leach, and then applying a second leach to dissolve alumina. Eighty-percent recovery of alumina was obtained from Salem Hills bauxite containing as much as 15 percent SiO_2, 35 percent Al_2O_3, and 30 percent Fe_2O_3.

The process is described in Bureau of Mines Report of Investigations 6280, "Extraction of alumina from ferruginous bauxite by a double-leach process," by W. F. Holbrook and L. A. Yerkes. The report may be obtained free of charge from Publications Distribution Section, U.S. Bureau of Mines, 4800 Forbes Ave., Pittsburgh, Pa., 15213.

* * * * *

LIME COMPANY OPENS NEW QUARRY

Chemical Lime Co., Baker, Oregon, has recently completed a diamond-drill program on a limestone occurrence situated at the head of Baboon Creek in the Elkhorn Mountains, Baker County. This location is approximately $2\frac{1}{2}$ miles airline west of the company's Marble Creek quarry. Crushing at the new location started October 16.

* * * * *

RULES FOR COLLECTING PETRIFIED WOOD PROPOSED

In the August 6 issue of the FEDERAL REGISTER there was published a Proposed Rule Making for free use of petrified wood by individuals. These rules were as follows:

"Rules for collection of specimens.

(a) The following rules shall govern the removal without charge of specimens from public lands administered by the Department of the Interior:

(1) No application or permit for free use is required.

(2) The maximum quantity of petrified wood that any one person is allowed to remove without charge in any one day is 10 pounds in weight.

(3) Collection of specimens under the authority of this act must be accomplished in a manner that avoids unnecessary soil erosion or needless damage to the land or the resources.

(b) The head of the Bureau having jurisdiction over a free use area, or his delegate, may establish and publish additional rules for the free use of petrified wood for non-commercial purposes."

Mr. T. M. Tyrrell, Acting State Director of the Bureau of Land Management in Portland, replied on September 26 to an inquiry from this Department on the above as follows:

"Since the publication of the above, this office has suggested to the Director of the Bureau of Land Management that certain changes of the proposed rules might be appropriate, particularly regarding the 10-pound limit. Specifically, it was suggested that the maximum quantity of petrified wood any one person is allowed to remove without charge in any one day is 10 pounds in weight, and one specimen. As a result, the Director extended the time for receipt of comments covering the proposed petrified wood regulations to October 5, 1963. He also directed all State Directors to forward additional comments and, when feasible, to obtain the views of local organizations of rock collectors. These same instructions have been forwarded to all District Managers in the State.

"One mining engineer has been assigned this case and he is now in the process of collecting and preparing all information for submission to the Director. In addition, there has been a substantial volume of correspondence from individuals and rockhound societies who have contacted directly both the Director and the Department of the Interior. In most cases they were concerned about the 10-pound limit.

"We believe that with the information supplied by this office, plus the large amount of correspondence from individuals, there should result a set of regulations which are satisfactory to most of the people concerned."

In a letter dated October 11 in reply to another inquiry from this Department, Mr. Russell E. Getty, State Director of the Bureau of Land

Management, gave this information:

"The act of September 28, 1962, or Public Law 87-713, was passed by the Congress. It authorizes the disposal of certain mineral materials, including petrified wood, from public lands specified by the Secretary of the Interior. The Act also provides that the Secretary of Agriculture shall dispose of materials from lands [U.S. Forest Service] administered by him.

"As a result of the act of September 28, 1962, a notice was published in the FEDERAL REGISTER as a Proposed Rule Making, to designate all public lands administered by the Bureau of Land Management as free use areas. It also established basic rules for the collection of specimens of petrified wood. [A copy of the Proposed Rule Making appears above.]

"Public Law 87-713 directed the Secretary of the Interior to provide by regulations for the free use of petrified wood. In the case of the act of September 28, he has, to date, merely proposed a set of regulations and these proposals have been published in the FEDERAL REGISTER and publicized through news media. It is the policy of the Department of the Interior to afford the public the opportunity to participate in the rule making process, consequently he had requested interested persons to submit comments or objections by September 7, 1963. Because of the interest shown, this date was extended to October 5, 1963. From all the information available in this office at this time, this is the present status of the establishment of the rules and regulations for the disposal of these materials from public lands."

The law withdrawing petrified wood from location under the general mining laws and authorizing the Secretary of Interior to promulgate rules and regulations for its free use is as follows:

"No deposit of common varieties of sand, stone, gravel, pumice, pumicite, or cinders and no deposit of petrified wood shall be deemed a valuable mineral deposit within the meaning of the mining laws of the United States so as to give effective validity to any mining claim hereafter located under such mining laws: Provided, however, That nothing herein shall affect the validity of any mining location based upon discovery of some other mineral occurring in or in association with such a deposit. 'Common varieties' as used in this Act does not include deposits of such materials which are valuable because the deposit has some property giving it distinct and special value and does not include so-called 'block pumice' which occurs in nature in pieces having one dimension of two inches or more. 'Petrified wood' as used in this Act means agatized, opalized, petrified, or silicified wood, or any material formed by the replacement of wood by silica or other matter....The Secretary of the Interior shall provide by regulation that limited quantities of petrified wood may be removed without charge from those public lands which he shall specify. (Approved 9/28/62)"

It will be recalled that in October 1961 the Bureau of Land Management proposed that 20,000 acres in southeastern Oregon be withdrawn from location of mining claims for petrified wood. Following publication of this notice, a large number of requests for hearings were submitted to the Department of the Interior. However, prior to the time when hearings were to be held, the above law was introduced in Congress and passed, making withdrawals of these lands from mineral entry for petrified wood unnecessary.

It is hoped that when the final rules and regulations are published by the Department of the Interior and the Department of Agriculture, they will reflect the comments of the "rockhounds" and the "rockhound clubs." It behooves these organizations to call their views on this subject to the attention of the Departments of Interior and Agriculture. If the rockhounds do not do this, rules may be forthcoming that could damage rockhounding as a recreational pursuit. It also seems likely that the results of this legislation and its resultant rules could well set a future pattern for disposal of other mineral materials of interest to the rockhounds.

* * * * *

RUSSIAN CHROME PURCHASED

With U.S.- Russian peace efforts stimulated by the recent nuclear test ban treaty, talk of trade deals between East and West has greatly increased.

Topping the Russian list are several minerals and metals the Russians would love to sell the U.S. to pay for wheat and other short food items. These include manganese and chrome ores, ferroalloys, platinum, paladium, asbestos, potassium salt and large quantities of cheap iron ore. In return, they would like to buy some nonferrous metals from the U.S. - such as copper.

The big item the Russians are pushing, however, is chrome ore. Even now, they have practically shut down all the main Western chrome mines with high-grade, bargain chrome ore sales. In Turkey, mines are idle with surplus ore piled high.

American companies such as Union Carbide, have been buying quantities of Russian chrome ore simply because they can't afford not to. Carbide has even closed down some of its South African mines to increase purchases of the Russian ore.

More U.S. companies are expected to "buy Russian" in chrome ore and other minerals if the peace offensive keeps its present pace. Russian ore is considered the best in the world for chrome alloys. It comes in a hard, lumpy form that the metals companies like.

The Russians also want mining and smelting equipment, and have a reported $10-million order pending to buy automated "continuous miner" equipment from the U.S. to mine potash. [E&MJ Metal & Mineral Markets, October 7, 1963.]

* * * * *

AMC VIEWS ON LAND LAW STUDY BILL

"The fundamental basic principle of the general mining law is that the citizen may enter upon the public domain, search for, discover if he can, and develop and mine, the minerals discovered by him. Its cornerstone is individual endeavor, endeavor limited only by the industry of the individual. The spirit of that act is private enterprise in its most forthright form." So said W. Howard Gray, chairman of the Public Lands Committee of the American Mining Congress, in testifying October 3 before the Subcommittee on Public Lands of the House Interior Committee. He presented the Mining Congress' view of H. R. 8070 and related bills designed to establish a Public Land Law Review Commission which would study existing laws and procedures related to the administration of the public lands.

Gray said that "it is the hope of the American Mining Congress and the members of the mining industry that the basic principles and tenets of our mining law of 1872 be retained and that the act be touched only for the purpose of facilitating and encouraging private enterprise." Gray suggested that the scope of the commission's study be expanded to include a survey of the regulations promulgated by the various federal agencies administering the public lands.

The proposed legislation would create a commission composed of six members of the House, six members of the Senate and six members of the Executive Branch. Gray suggested that the commission be limited to members of the Senate and House Interior Committees. "We strongly urge that Congress not even intimate that the Executive Branch of our Government have any authority over the public domain except as the same may be given by express legislative enactment. By permitting the Executive Branch to share in duties of the commission, Congress has inferentially, at least, yielded its exclusive constitutional authority." Gray also suggested that the subpoena power given to the commission under the bill should be limited and recommended, as an example, the subpoena power given to the Civil Rights Commission which protects against possible abuses.

Similar recommendations were made by the National Lumber Manufacturers Association, the Independent Petroleum Association of America and the National Association of Manufacturers. While supporting the legislation, the NAM strongly urged that officials of the Executive Branch not be included on the commission. [AMC News Bulletin, October 11, 1963.]

* * * * *

The ORE BIN
Volume 25, No. 11
November, 1963

ZEOLITE-RICH BEDS of the JOHN DAY FORMATION, GRANT and WHEELER COUNTIES, OREGON

By Richard V. Fisher*

General Statement

This report, prepared for the purpose of locating zeolitized tuff beds, is, essentially, an extension of a report by the author (1962) on the Deep Creek Tuff, a zeolite-rich layer in the central portion of the Picture Gorge quadrangle, eastern Oregon. The John Day Formation within six 15-minute quadrangles and a large part of the 30-minute Mitchell quadrangle (Plate I) was the only formation included in this search. Relatively thick (greater than 5 feet) deposits of zeolite-rich tuff were located in only 4 of the quadrangles within the mapped area -- Picture Gorge, Kimberly, Richmond, and Mitchell -- and most extensively within the Picture Gorge quadrangle.

The variety of zeolite that prompted this survey is clinoptilolite which has the ability to capture radioactive cesium (Brown, 1962). Detailed tests to determine the chemical and physical variabilities of clinoptilolite (or its relationship to the close relative, heulandite) within a single bed have not been made. It would not be surprising, however, to find that zones of clinoptilolite-altered tuff are laterally equivalent to those altered to heulandite or other closely related zeolites. Thus, even though there are huge tonnages of zeolite-rich layers reported here, the amount of clinoptilolite cannot be accurately predicted. The origin of the zeolites of the John Day Formation has been discussed by Hay (1963).

Stratigraphy

The John Day Formation in parts of the present area has been described previously by other workers, including Merriam (1901), Coleman (1949), Fisher and Wilcox (1960), and Hay (1962, 1963). The formation attains 2,000 feet or more in thickness, but usually not in any one place, and has been divided into a lower, middle, and upper part (see accompanying

---

*Assistant Professor of Geology, University of California at Santa Barbara, University, California.

columnar section). In the area under discussion, the John Day Formation unconformably lies above the Clarno Formation (Eocene), and, where Clarno rocks are absent, above conglomerate, sandstone, and shale of probable Cretaceous age or above pre-Cretaceous quartzite and marble. A thick sequence of basalt flows (middle Miocene) called the Picture Gorge Basalt* (Waters, 1961), unconformably covers the John Day Formation.

The lower member of the John Day Formation is composed of deep red to red-brown volcanic claystones and siltstones. These rocks, described by Hay (1962) from near Mitchell, are poor in clinoptilolite. The middle member of the formation is composed of green, buff, and light red or light red-brown volcanic siltstones and sandstones. This member contains an ignimbrite (welded tuff) layer that occurs throughout much of the area under discussion, and forms an excellent stratigraphic reference horizon. The upper member is unzeolitized and light gray to buff in color in most areas.

The middle member, therefore, contains the clinoptilolite-rich zeolite beds at several horizons. One rather persistant zeolitized bed is the Deep Creek Tuff that occurs about 100 feet above the ignimbrite layer. In some areas, an ashfall layer that lies in contact with the basal part of the ignimbrite layer and a zeolite-rich bed (or beds) 150 to 200 feet below the ignimbrite are thick enough to form important deposits.

Rocks rich in clinoptilolite or related zeolites are composed almost exclusively of altered sand-size shards. These coarse-grained tuffs are usually poor in pyrogenic crystals, especially ferromagnesians and magnetite. Where they are thick, the beds generally form orange- or cream-colored cliffs and thus may be relatively easy to locate. Where the beds are thin (less than 5 feet thick), they weather to white or light-gray colors similar to layers containing abundant clay. Invariably, the John Day rocks that are colored green or red on fresh surfaces contain more clay than is desirable for a good quality clinoptilolite deposit. The formation of a zeolite-rich layer is dependent upon the coarseness and abundance of glass shards, because the fine-grained particles (original glass?) alter to clay, whereas the coarse-grained particles alter mainly to zeolite.

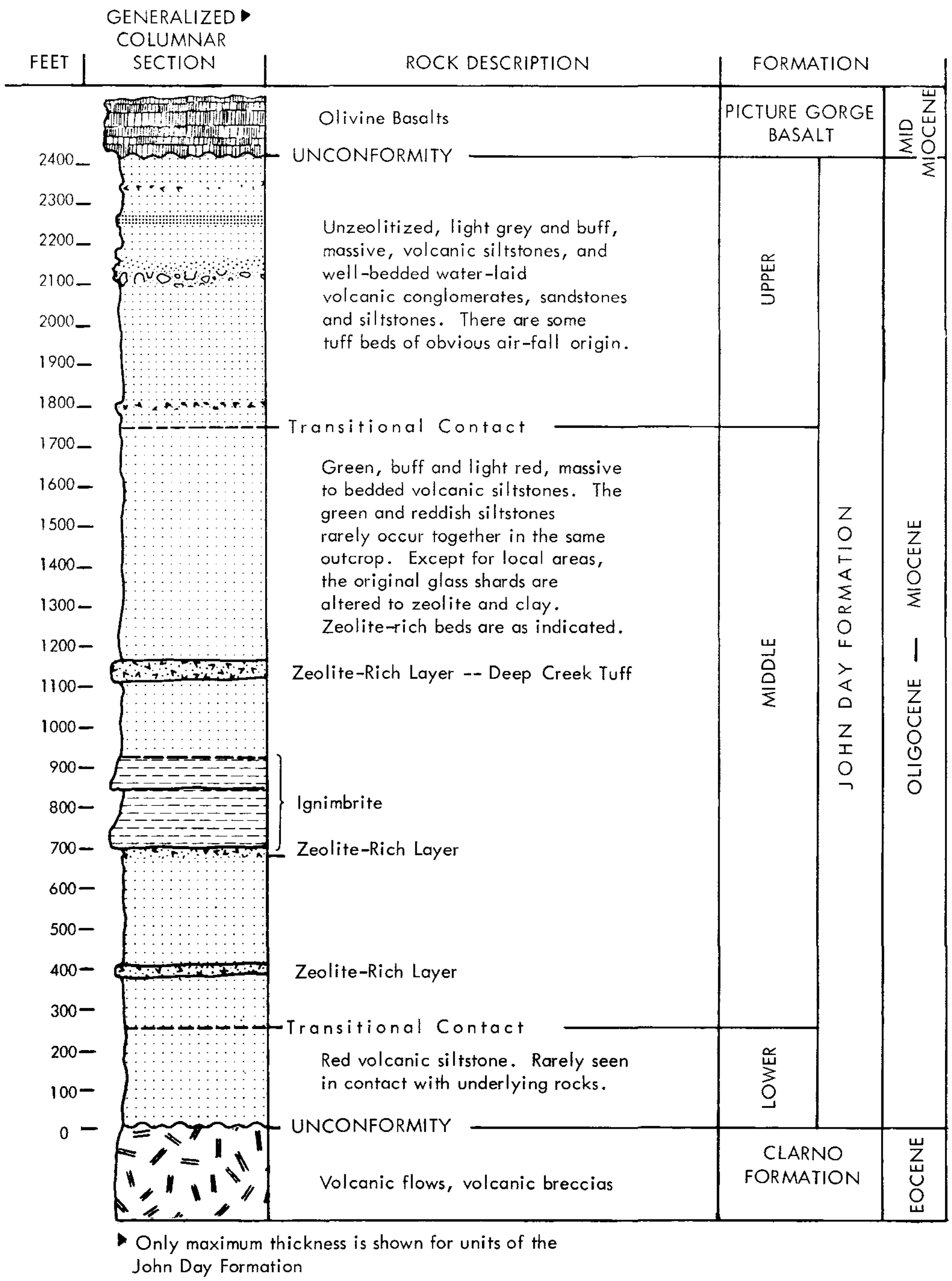
Zeolite-Rich Beds

Introduction

Thick and conspicuous deposits of coarse-grained zeolite-altered tuff

---

* Lower part of Columbia River Basalt.



Generalized geologic column showing relative position of the zeolite-rich tuff beds in the John Day Formation.

beds in the mapped area are relatively rare, occurring in a few scattered localities. The thickest and most accessible deposits occur within the Picture Gorge quadrangle in an area described previously by the author (1962), and in the Squaw Creek and Sheep Rock exposures (figure 1). These deposits are part of the Deep Creek Tuff, which has also been observed in the Kimberly quadrangle in Haystack Valley (sec. 21, T. 8 S., R. 25 E.) and in Kahler Basin (figure 2). Similar deposits occur in Parrish Creek (figure 3) and about a mile south of Dutch Flat (figure 4), although these layers may be greatly thinned, lateral equivalents of the ignimbrite layer.

Deep Creek Tuff

The Deep Creek Tuff, named for its thick exposures in Deep Creek (secs. 35 and 36, T. 10 S., R. 25 E.), has been identified in many places within the Picture Gorge quadrangle about 100 feet above the ignimbrite. No other layer of comparable coarseness and purity of zeolite has been found within the section above the ignimbrite. Thin (less than 5 feet thick) exposures of the Deep Creek Tuff have been mapped or observed throughout the Picture Gorge quadrangle, but the tuff is exceptionally thick in only two places outside those described earlier by the author; one is in sec. 5, T. 12 S., R. 26 E., about one mile northeast of Sheep Rock, and one is in sec. 14, T. 11 S., R. 25 E., in Squaw Creek (figure 1).

The exposure north of Sheep Rock is a composite ashfall layer about 30 feet thick that shows graded laminae and some coarse platy layers near its central part. It is easily visible from Oregon State Highway 19 as a cream-colored outcrop. The layer, which dips about 20° south, forms a dip slope near the 3,200-foot contour line about 1,000 feet above the John Day River. The tuff thins rapidly to the north and south, although it can still be identified around the west face of Sheep Rock, where it is lenticular and not more than 10 feet thick.

The Deep Creek Tuff in Squaw Creek is about 30 feet thick. There are at least three zones of graded laminae and a 1- to 2-foot zone of coarse platy tuff near its central portion. Some layers contain pink felsitic lithic fragments up to 3 mm in longest dimension that form nearly 5 percent of the rock. Even though the bed is about 3 miles west of State Highway 19, it is easily accessible by the unpaved Squaw Creek road.

The Deep Creek Tuff has been recognized in Haystack Valley, where it is thin and lenticular, and farther north in Kahler Basin (figure 2) in the Kimberly quadrangle. The exposure in Kahler Basin is about 10 feet thick and occurs in two easily accessible areas about 1 mile apart.

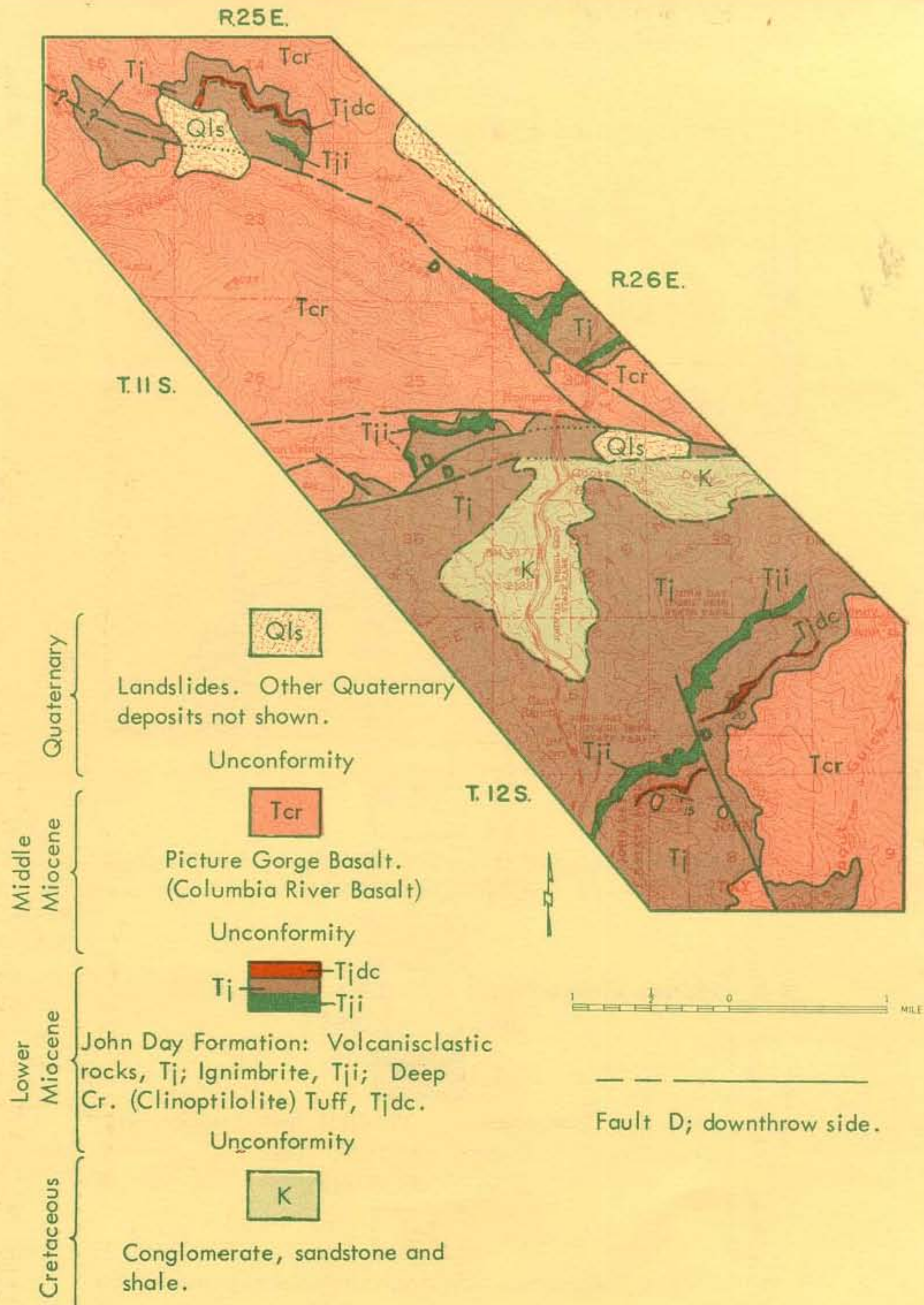


Figure 1. Geologic map of the Sheep Rock-Squaw Creek area, Picture Gorge quadrangle.

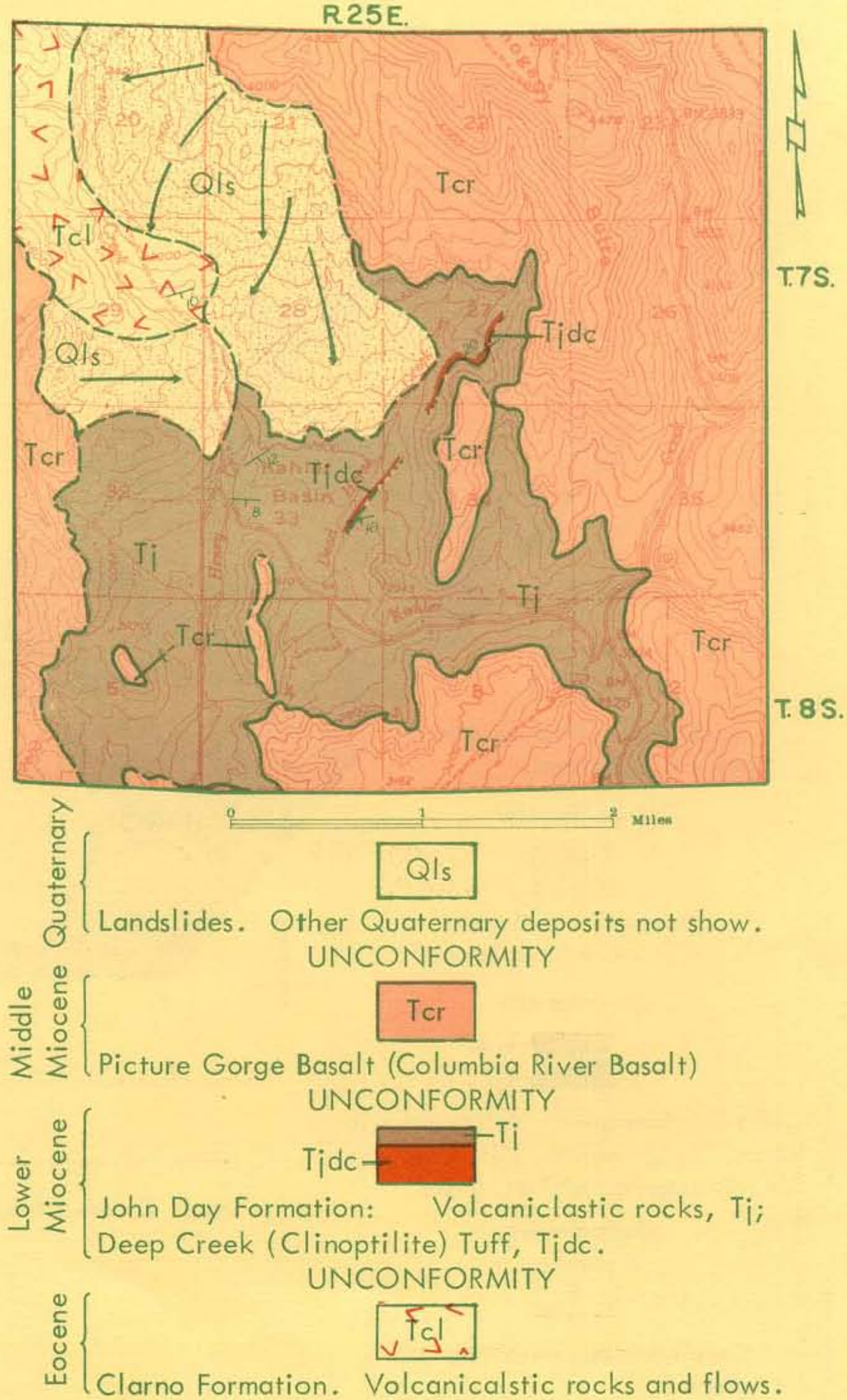


Figure 2. Geologic map of the Kahler Basin area, Kimberly and Spray quadrangles.

Ignimbrite layer and zeolitic tuffs

The ignimbrite layer is composed of two cooling units (as defined by Smith, 1960, p. 157) in some places, and only one cooling unit in others. It is underlain by a section approximately 10 feet thick of primary ashfall tuff showing graded bedding, and massive to fissile tuff that is gradational upward with the lower welded base of the ignimbrite. The welded base shows flattening of pumice and glass fragments and is either obsidian-like in appearance or is a hard lithic material with conchoidal fracture. The laminated and fissile tuff is commonly altered to zeolite, but is usually poorly exposed because it lies beneath the talus of the overlying pyroclastic flow. This tuff is as coarse and generally appears to be as rich in zeolite as the Deep Creek Tuff, but is less accessible because it lies beneath the usually well indurated welded tuff. Occasionally, it is absent or very thin. One of the thicker exposures of this basal tuff occurs in secs. 29 and 30, T. 10 S., R. 24 E. (figure 3) in the Richmond quadrangle.

At two rather widely separated localities are relatively thick deposits of coarse, zeolitized tuff that are lithologically similar to the Deep Creek Tuff. These may be stratigraphically equivalent to the ignimbrite layer. One area (figure 3) lies along the unpaved road between Spray and Waterman Flats in Parrish Creek (sec. 21, T. 10 S., R. 24 E.) in the Richmond quadrangle; the other deposit (figure 4) is just south of Dutch Flat (sec. 22, T. 8 S., R. 22 E.) in the Mitchell quadrangle.

The Parrish Creek deposit (figure 3), about 10 feet thick, is formed of at least 3 or more successive ashfalls. Its upper part, 3 feet thick, has green patchy areas that are caused by the alteration of pumice fragments to the blue-green clay, celadonite. About two miles farther south in secs. 29 and 30, T. 10 S., R. 24 E., the ignimbrite layer is exposed in what may be the same stratigraphic horizon.

The zeolitized tuff (figure 4) near Dutch Flat in the Mitchell quadrangle is 35 to 40 feet thick and forms the dip slope of a small knoll. This deposit is a little more than 2 miles from State Highway 19, but is easily accessible by a logging road requiring some repair. If the zeolite is all clinoptilolite, this deposit may prove to be important because of its thickness. The tuff is lithologically similar to the Deep Creek Tuff, but appears to occupy the same stratigraphic horizon as the ignimbrite that is exposed farther south in the Mitchell quadrangle along the west slope of Rock Mountain. Further mapping is required to clarify this stratigraphic relationship.

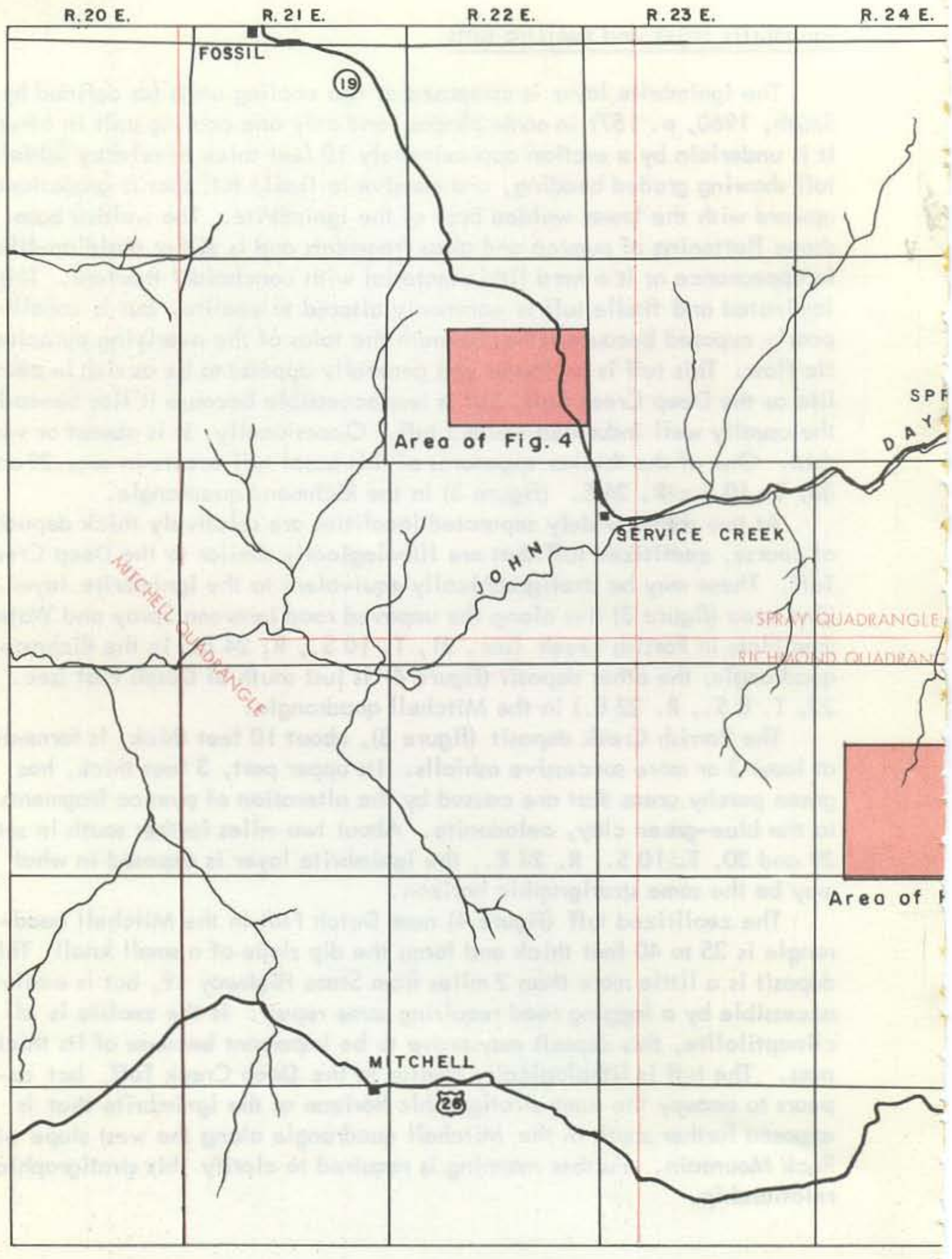
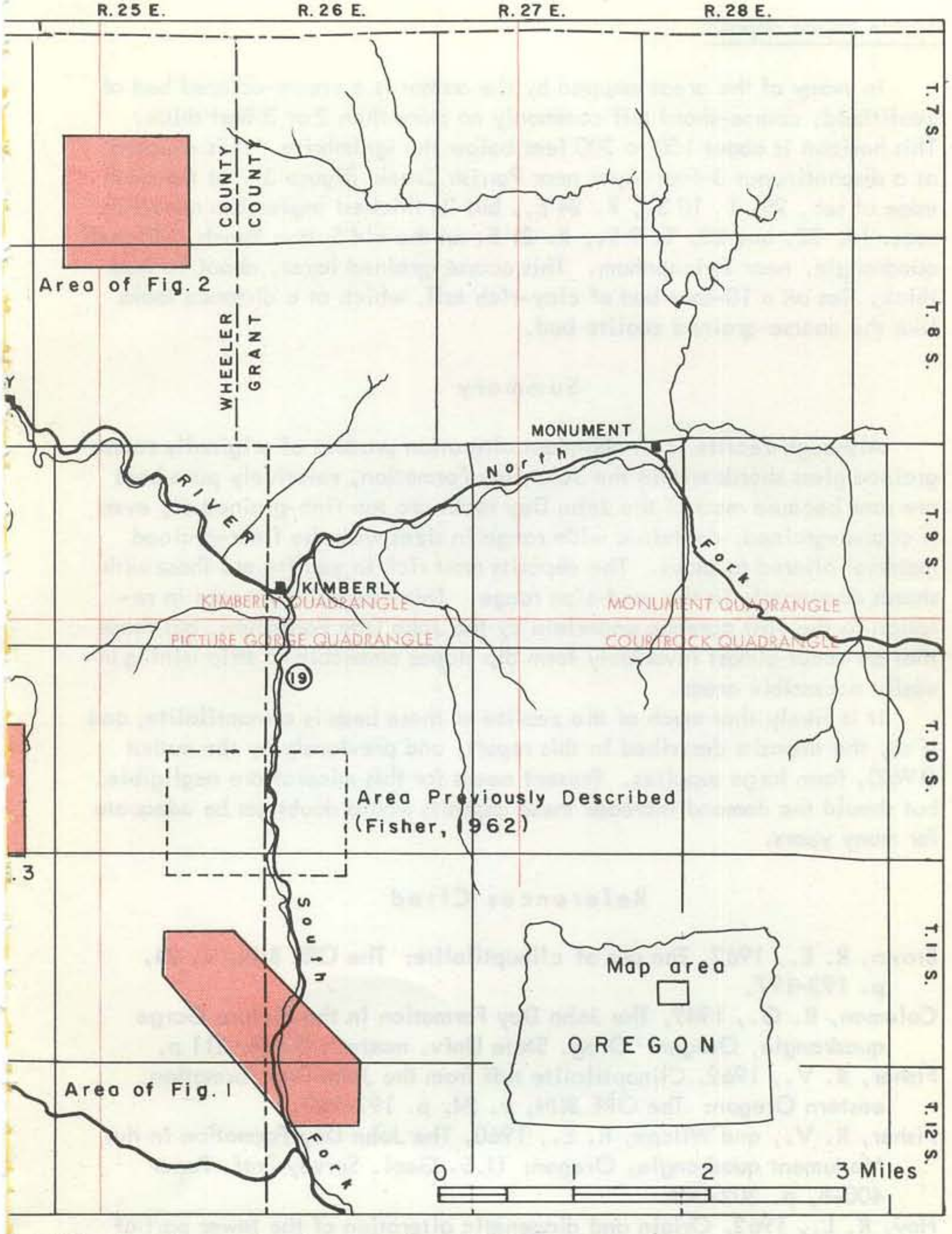


Plate 1. Index map of northwestern Grant County and c



ral Wheeler County showing location of five zeolite areas.

[redacted]

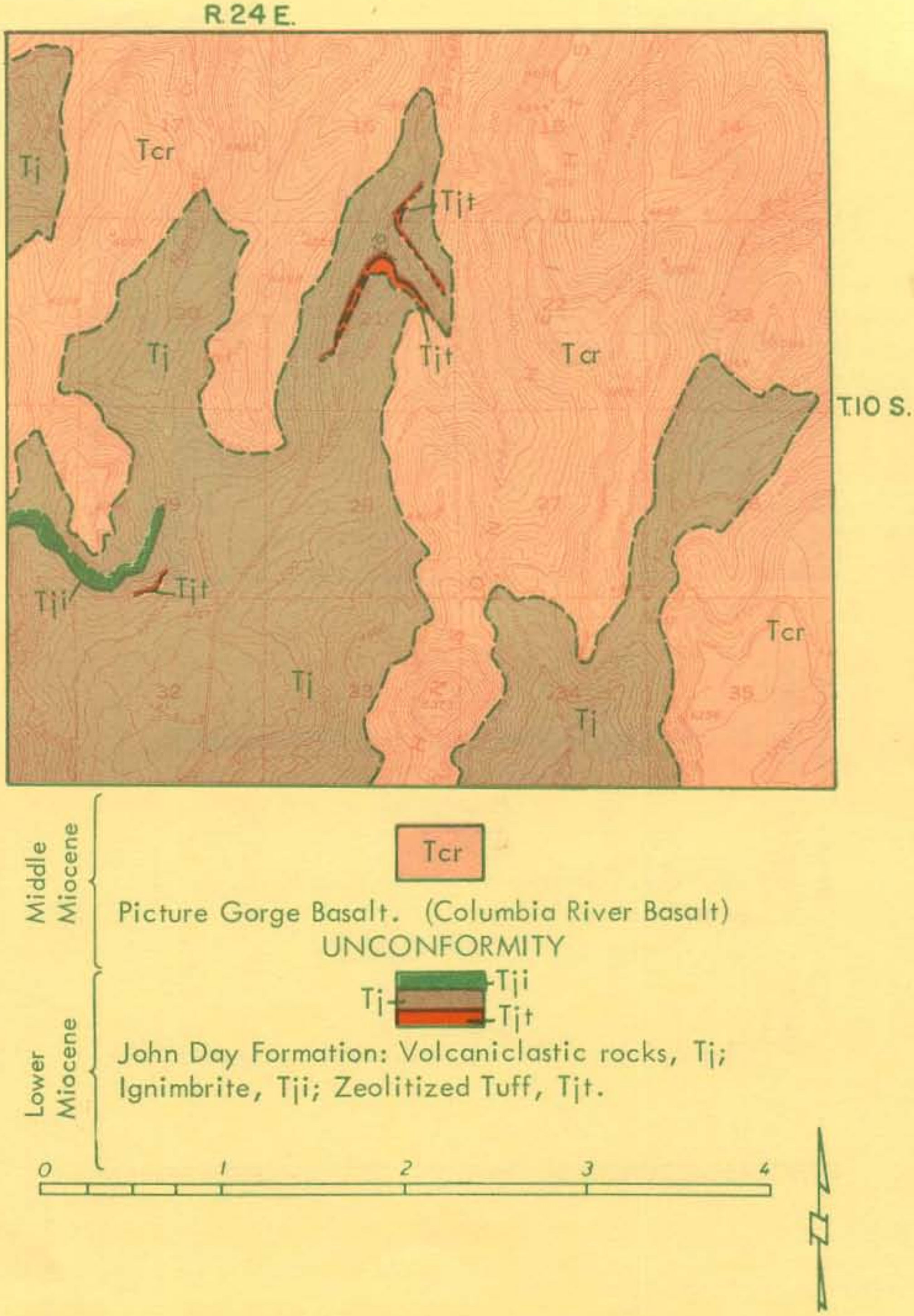


Figure 3. Geologic map of the Parrish Creek area, Richmond quadrangle.

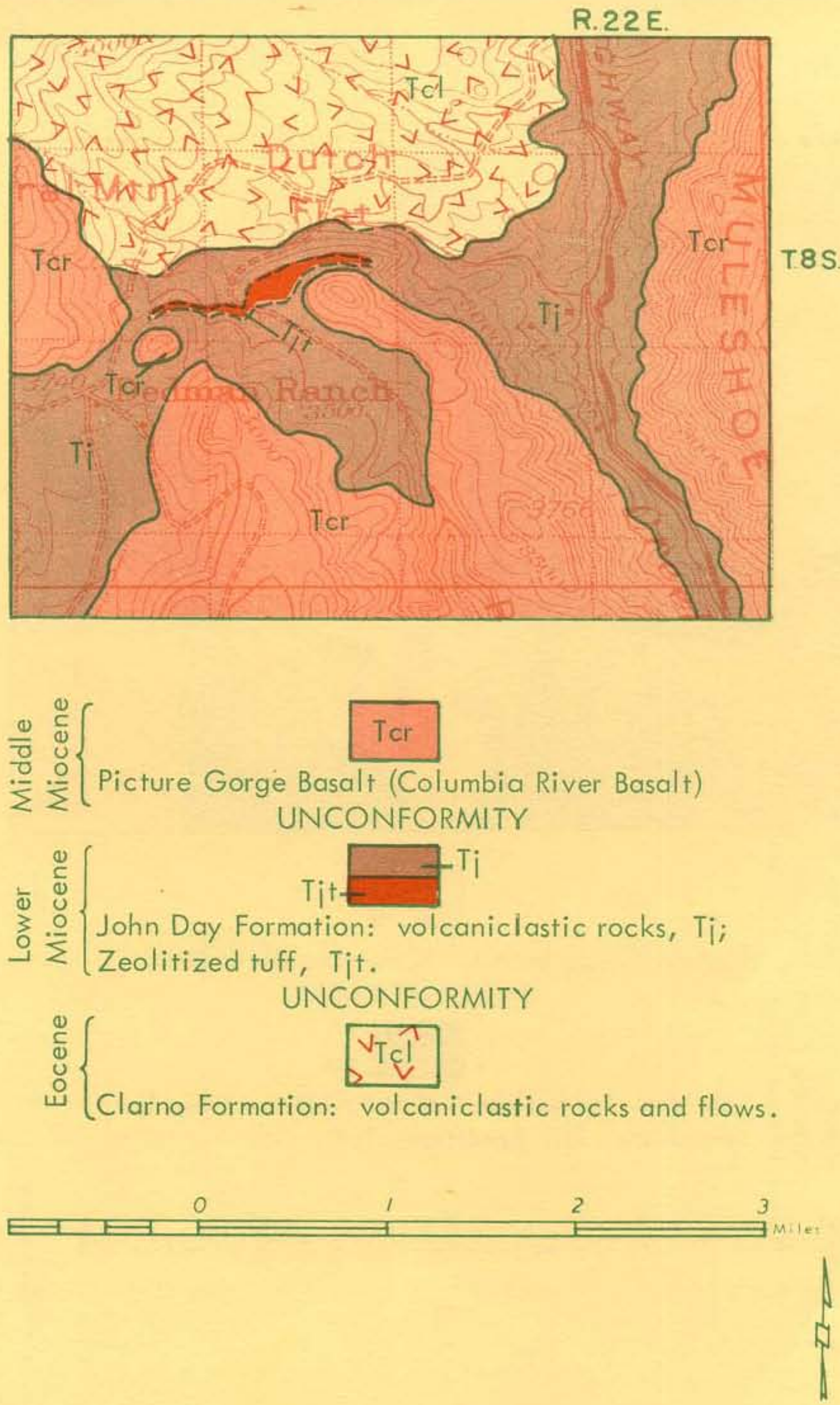


Figure 4. Geologic map of the Dutch Flat area, Mitchell quadrangle

Buddington Volume, p. 191-216.
Hay, R. L., 1963, Stratigraphy and zeolitic diagenesis of the John Day Formation of Oregon: Univ. Calif. Pub. Geol. Sci., v. 42, p. 199-262.
Merriam, J. C., 1901, A contribution to the geology of the John Day Basin, Oregon: Univ. Calif. Pub. Geol. Sci., v. 2, p. 269-314.
Smith, R. L., 1960, Zones and zonal variations in welded ash flows: U.S. Geol. Survey Prof. Paper 354-F, p. 149-159.
Waters, Aaron, 1961, Stratigraphic and lithologic variations in the Columbia River Basalt: Am. Jour. Sci., v. 259, p. 583-611.

* * * * *

WILLAMETTE VALLEY GROUND WATER UNDER STUDY

Two preliminary reports on ground-water resources in the northern Willamette Valley have been issued by the Oregon State Engineer in cooperation with the Ground-Water Branch of the U.S. Geological Survey. Recently made available is "Records of Wells, Water Levels, and Chemical Quality of Ground Water in the Molalla-Salem Slope Area," by E. R. Hampton. A similar report covering the French Prairie area adjacent to and west of the Molalla-Salem area was compiled by Don Price in 1961. The two reports present existing well data as an aid to location and development of ground-water resources in this region and are preliminary to a more comprehensive study to be published later by the U.S. Geological Survey. Persons having a use for these reports may obtain them free of charge from the Oregon State Engineer, Salem, Oregon.

* * * * *

PORTLAND BULLETIN AVAILABLE

"Geology of the Portland, Oregon, and adjacent areas," U. S. Geological Survey Bulletin 1119, by Donald E. Trimble (described in the August 1963 ORE BIN) is now for sale by this department at its Portland office. The price is $2.00 postpaid. It may also be obtained for the same price from the Government Printing Office, Washington 25, D. C.

* * * * *

NORTHWEST MINING ASSOCIATION ANNUAL CONVENTION SPOKANE, WASHINGTON, DECEMBER 6 AND 7

* * * * *

LAVACICLE CAVE

The picture was taken in Lavacicle Cave, a lava tube near Pilot Butte, approximately 40 miles southeast of the town of Bend. Other lava tubes, such as Derrick Cave, Lava River Cave, and Skeleton Cave, are common in this part of central Oregon and undoubtedly there are a great many more yet to be discovered. Lavacicle Cave is unique because of the well-developed lava pinnacles rising from the floor. Phil Brogan, geological writer and editor of the Bend Bulletin, has suggested the term "lavacicle" for these distinctive formations. We are therefore proposing that this name be adopted for all such volcanic dripstones found in lava tubes.

Geologists have observed that certain lava tubes served as channelways for later lava flows. Evidence of these younger flows is seen along the walls in the form of projecting shelves and gutters, representing the various stages of flooding as the lava stream rose and fell. Apparently, Lavacicle Cave was temporarily filled to the roof by a younger flow. Immediately after this lava drained out of the tube, the molten material coating the ceiling dripped to the floor, building pinnacles of rock. The tallest lavacicle shown here is about 6 feet high; hundreds of others scattered over the floor range from 1 to 2 feet in height. In contrast, lavacicles on the ceiling are only a few inches in length.

Lavacicle Cave was found by accident in the summer of 1959 when a forest fire swept through that area. One of the fire fighters noticed a small hole in the ground, just large enough to crawl through. From it issued a stream of cold air. His curiosity concerning the source of the air current led to the discovery.

Until the time when the lavacicles can be properly protected from destruction by man, the U.S. Forest Service has closed the entrance, but permission to visit the cave can be obtained from the District Headquarters in Bend.

[Photo by Dave Falconer]

COMMUNIST IMPORTS BLAMED FOR SICK TUNGSTEN MARKET

London (McGraw-Hill World News): As an ad hoc U.N. committee prepares for its October meeting to consider world tungsten supplies, the chairman of Beralt Tin and Wolfram Ltd. painted a grim picture of the industry.

Reporting to stockholders, George W. Flint blamed the troubles of the industry and of his own company wholly on the competitive pressure of Communist Bloc countries.

As a result of this pressure, he said, "the price of wolfram has continued to sag and it is now at a level at which few wolfram producers in the Free World can remain in production. It follows that Free World manufacturers of tungsten products are becoming more and more dependent upon supplies of concentrates from behind the Iron Curtain."

Although the London price has recovered somewhat from the 65-70s a stu. range of a month ago, the price is still at a distress level. The Oct. 15 range of 72s6d-80s compares with an average quotation of more than 115s during Beralt's fiscal year ending in Mar. 1962.

Flint estimated that Western Europe imported more than 7,000 metric tons of tungsten concentrates from Communist sources last year. Over 50 percent of the total 8,042 tons of concentrates imported by France, West Germany and Sweden last year came from the Communist Bloc. Austria and the U.K. also rely heavily on Soviet or Chinese supplies. Austria's 1962 import figures are not available but they are estimated to be at least 1,200 tons. U.K. purchases of 1,918 tons of Communist concentrates last year represent 34 percent of total imports.

The Beralt chairman pointed out that "large quantities of tungsten concentrates from the USSR, China and other Communist countries are still being imported to the U.K. and other West European countries."

Reviewing the consequent effects on Western mines during this past year, Flint's report seemed like a recap of the obituary columns and had about as much cheer.

"It was announced at the end of 1962 that Bolivian production of tungsten concentrates for that year would be more than 1,300 tons, compared with about 3,000 tons in 1961. About the same time production ceased in the Argentine. Operations at the Hamme Mine, N.C., were suspended in Feb. 1963, leaving Pine Creek in Calif. - a closed concern of Union Carbide - as the only mine still operating in the U.S. where tungsten concentrate is the principal product.

"In March, it was reported that Uganda producers had suspended operations. In May, it was Spain's turn. In July, production ceased in France and operations were suspended at the Flat River mine in the North West Territory of Canada, where a high-grade open-cast scheelite deposit had only recently been brought into production. Production of scheelite from Sweden is expected to be discontinued at the end of this month.

"This unhappy retrogression may well have serious repercussions for the Free World," Flint said.

The depressed market also resulted in a cutback of Beralt's wolfram production in Portugal, where monthly output of 160 tons in early 1962 dwindled to 86 tons in March of this year. (E&MJ Metal and Mineral Markets, October 21, 1963.)

* * * * *

PRICES OF SPECTROGRAPHIC ANALYSES ADVANCE

The department has found it necessary to increase the amounts set in 1942 for semi-quantitative spectrographic analyses done for the general public. New prices are listed below:

Spectrographic analysis for 60 elements	$10.00
Analysis for any three of the 60 elements	5.00
Spectrographic analysis for gold and platinum from assay bead, when done at the same time . . .	2.00

An Oregon resident may obtain a 15-percent discount by submitting an affidavit to the effect that the sample originated in Oregon.

* * * * *

NEW WILLAMETTE VALLEY OIL TEST SET

Gulf Oil Corp. of Denver, Colorado, was issued drilling permit No. 53 by the department on October 31, 1963. The company is making a deep test of Eocene marine sediments which form the central portion of the valley. The new well is located in the NE$\frac{1}{4}$ sec. 27, T. 13 S., R. 4 W., Linn County. It is approximately 16 miles southwest of the hole drilled by Reserve Oil & Gas Co. in the summer of 1962 near Lebanon. "T.J. Porter 1" (State Permit No. 53) is Gulf's first attempt to locate production in Oregon.

* * * * *

NOTICE

New and renewal subscriptions to The ORE BIN will be $1.00 per year, effective January 1, 1964.

The ORE BIN
Volume 25, No. 12
December, 1963

GEOMORPHOLOGY OF THE CONTINENTAL TERRACE OFF THE NORTHERN COAST OF OREGON

By John V. Byrne
Department of Oceanography
Oregon State University, Corvallis, Oregon

Introduction

The continental terrace off the central and southern coast of Oregon has been described in two earlier papers published in The ORE BIN (Byrne, 1962, 1963). This paper presents a bathymetric chart and a description of the major submarine geomorphic features of the continental shelf and continental slope off the northern coast of Oregon, from 45°00'N to 46°30'N. In this northern area, the continental terrace is traversed by Astoria Submarine Canyon, and the lower portion of the continental slope is overlapped by Astoria Fan*, apparently a depositional apron consisting of sediment discharged from the mouth of Astoria Canyon (figure 1).

The bathymetric chart of the area (plate 1) is based on the unpublished soundings from 22 distinct surveys of the U.S. Coast and Geodetic Survey, with supplementary soundings made by the Department of Oceanography, Oregon State University. Three different contour intervals are used on the chart, which includes the continental shelf and the upper two-thirds of the continental slope (to a depth of 1,000 fathoms). For depths less than 100 fathoms, the sounding density varies from 7 to 200 soundings per square mile, and a contour interval of 10 fathoms is used. Between 100 and 1,000 fathoms, where the sounding density is one to five soundings per square mile, a 50-fathom contour interval is employed. Where soundings are less than one per square mile, below 1,000 fathoms, the contour interval is 100 fathoms. It is thought that these contour intervals adequately portray the major features of the continental slope, and also give a more detailed picture of the features of the continental shelf.

---

* This feature was previously referred to as Astoria Cone, but in keeping with the list of terms for undersea features recently accepted by the U. S. Board of Geographic Names, the term "fan," rather than "cone," will be used henceforth.

As is true elsewhere off the Oregon coast, the continental shelf is narrower, steeper, and has its seaward edge in deeper water than is generally the case elsewhere around the world. For this northern area the shelf is widest south of the Columbia River, and has a maximum width of 30.3 nautical miles* at latitude 46°00'N. The shelf break, or outer edge of the shelf, trends essentially north-south in the area north of 45°50'N, but south of this latitude trends southeasterly, and consequently the shelf narrows to a minimum width of 13 miles off Cape Kiwanda. South of Cape Kiwanda there is a general increase in the width of the shelf, which is best seen on the chart for the area off the central coast of Oregon (Byrne, 1962).

The change in slope which marks the edge of the continental shelf (shelf break) occurs at about 80 fathoms north of Astoria Canyon, but generally increases in depth south of the canyon to 90 fathoms, and then to 100 fathoms in the southern part of the area. The slope of the shelf, determined from the shelf width and depth of shelf break, varies from 0°11' to 0°26'. For comparison, average values for the continental shelves of the world are: width, 40 nautical miles; depth of shelf break, 72 fathoms; average slope, 0°07' (Shepard, 1963, p. 257).

Although bottom notations made by the U.S. Coast and Geodetic Survey and samples collected by the Department of Oceanography indicate that the major portion of the continental shelf is covered by unconsolidated sediment, in several places outcrops of rock form shoals which rise above the general level of the shelf. These positive features, which are of interest to anyone concerned with the bedrock geology of the continental terrace, occur primarily near the edge of the shelf between latitudes 45°50'N and 46°00'N. In this area, a number of individual banks are delineated by the 80-fathom contour. This group of small hills is tentatively named "The Nehalem Banks." The largest of these is about 6 miles long, 2.5 miles wide, and 21 fathoms high. Bottom notations indicate that the material making up the banks is shale.

Another indication of rock exposed on the shelf occurs between the 70- and 80-fathom contours directly south of Astoria Canyon; the bottom notation on U. S. Coast and Geodetic Survey Chart 5902 indicates that the rock is shale. The Department of Oceanography collected a sample of this material from 75 fathoms of water at approximately 46°12.7'N,

---

* A nautical mile equals approximately one minute of arc of a great circle (one minute of latitude); officially, 6,076.115 feet. In this report, distances are expressed in nautical miles.

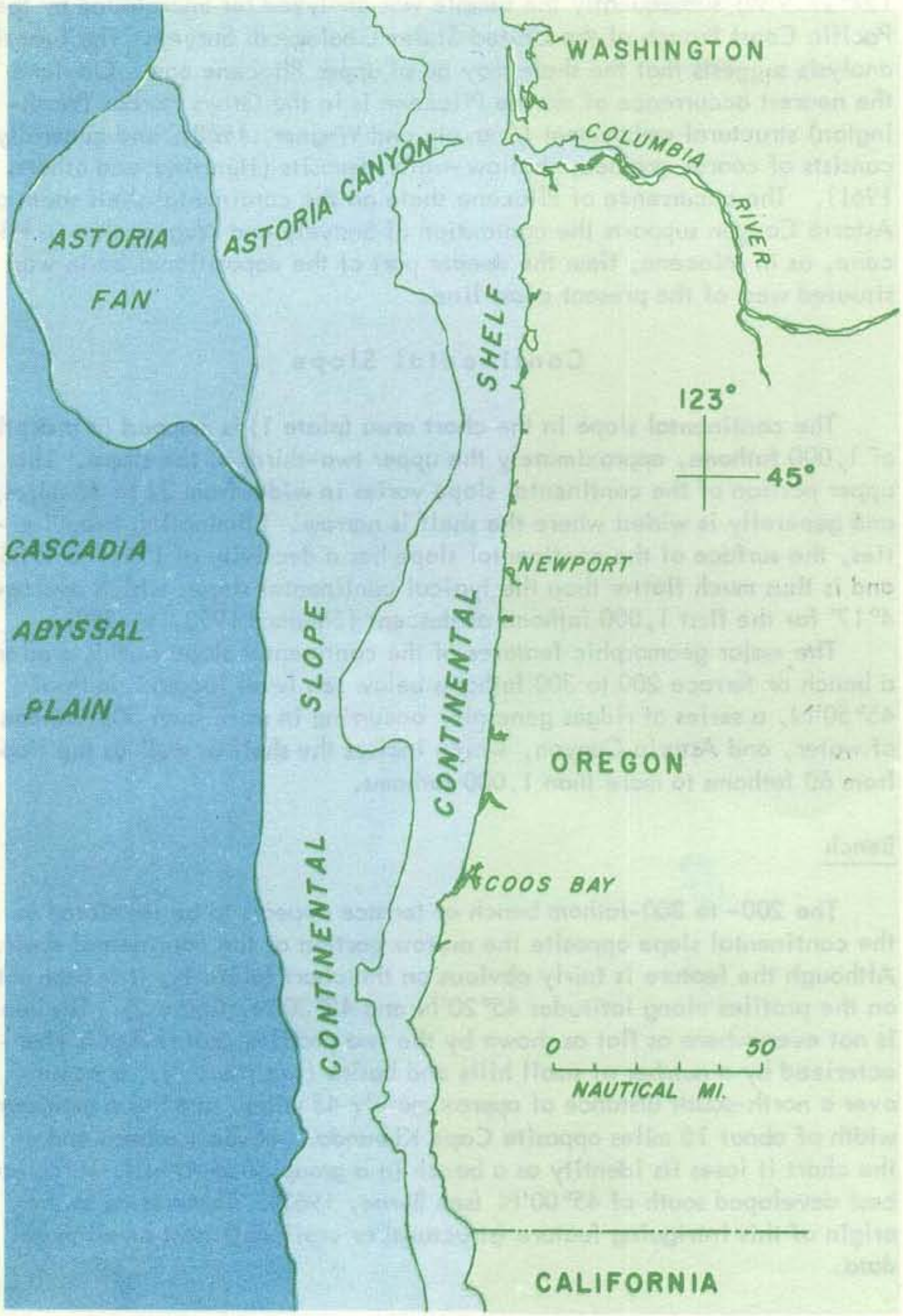


Figure 1. Index map of the submarine geomorphic features off the coast of Oregon.

124° 29.9'W; subsequently the sample was analyzed for microfauna by the Pacific Coast Branch of the United States Geological Survey. The faunal analysis suggests that the shale may be of upper Pliocene age. On land the nearest occurrence of marine Pliocene is in the Grays Harbor (Washington) structural embayment (Snavely and Wagner, 1963), and generally consists of coarse-grained, shallow-water deposits (Huntting and others, 1961). The occurrence of Pliocene shale on the continental shelf south of Astoria Canyon supports the contention of Snavely and Wagner that in Pliocene, as in Miocene, time the deeper part of the depositional basin was situated west of the present coast line.

Continental Slope

The continental slope in the chart area (plate 1) is mapped to a depth of 1,000 fathoms, approximately the upper two-thirds of the slope. This upper portion of the continental slope varies in width from 32 to 43 miles, and generally is widest where the shelf is narrow. Eliminating irregularities, the surface of the continental slope has a declivity of 1°11' to 1°35', and is thus much flatter than the typical continental slope, which averages 4°17' for the first 1,000 fathoms of descent (Shepard 1963, p. 298).

The major geomorphic features of the continental slope in this area are a bench or terrace 200 to 300 fathoms below sea level located south of 45°50'N, a series of ridges generally occurring in more than 500 fathoms of water, and Astoria Canyon, which incises the shelf as well as the slope from 60 fathoms to more than 1,000 fathoms.

Bench

The 200- to 300-fathom bench or terrace appears to be restricted to the continental slope opposite the narrow portion of the continental shelf. Although the feature is fairly obvious on the chart (plate 1), it is best noted on the profiles along latitudes 45°20'N and 45°30'N (figure 2). The bench is not everywhere as flat as shown by the two profiles, but rather is characterized by a number of small hills and basins (see plate 1). It occurs over a north-south distance of approximately 45 miles, and has a maximum width of about 15 miles opposite Cape Kiwanda. At the southern end of the chart it loses its identity as a bench in a group of small hills which are best developed south of 45°00'N (see Byrne, 1962). Theories as to the origin of this intriguing feature (structural or erosional) must await more data.

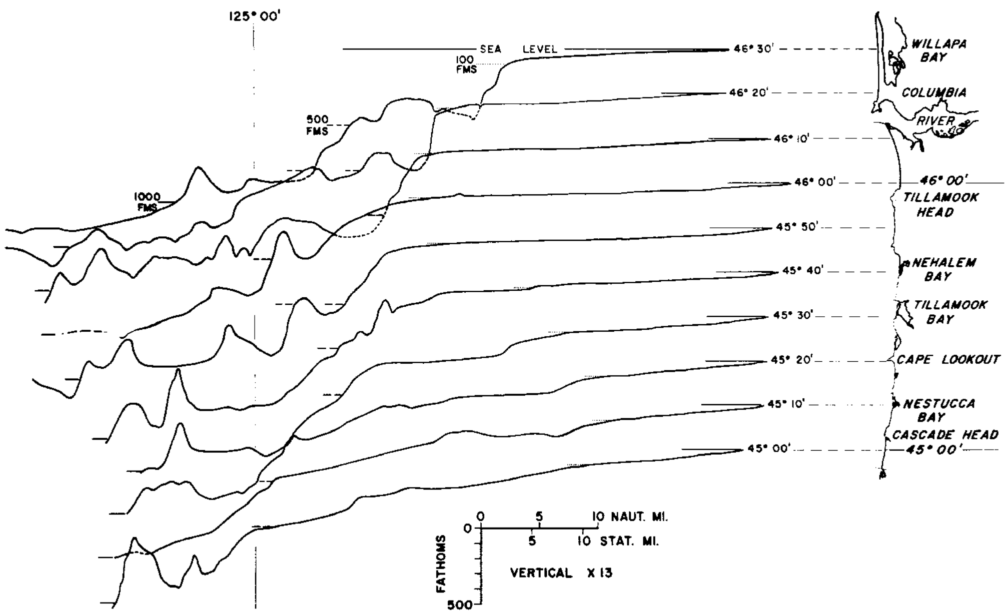


Figure 2. Profiles of the continental terrace from 45° 00'N to 46° 30'N.

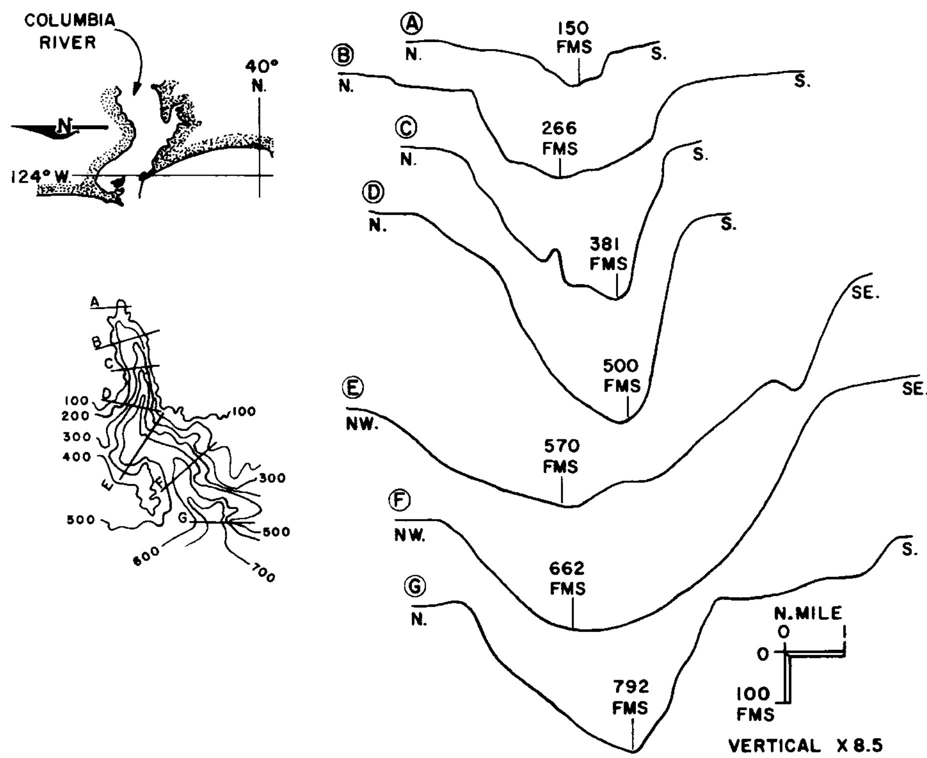


Figure 3. Transverse profiles of the upper portion of Astoria Canyon.

Ridges

At depths generally greater than 500 fathoms, the continental slope is characterized by a series of ridges and intervening troughs and basins. The ridges, which are 5 to 40 miles long, appear to be oriented primarily north-northwest, and because of the more or less uniform alignment, are considered to be structural features. They exhibit up to 376 fathoms of relief on the landward sides and up to 627 fathoms of relief on the seaward sides, but average about half those values. A measurement of the landward and seaward slopes indicates that the ridges are slightly steeper on the seaward flanks; the landward slopes are in most places 8 to 11 degrees, the seaward ones, 12 to 16 degrees. Possibly genetically related to the ridges is a series of scarps trending north-northeast along the south side of Astoria Canyon between 124° 40'W and 125° 00'W. The ridges and scarps appear to be developed along two linear trends at an angle to each other of 30 to 50 degrees. This angular relationship further suggests that the geomorphic features on this portion of the continental slope may be of structural origin.

Astoria Canyon

Astoria Canyon heads in about 60 fathoms of water approximately 10 miles west of the mouth of the Columbia River. The canyon is mildly sinuous and exhibits an overall orientation to the west-southwest. The general relationship between the sinuosity of the canyon and the scarps mentioned above presents the possibility that the course of the canyon is structurally controlled. The axis of the canyon can be traced fairly continuously to 800 fathoms, but the low sounding density makes the exact position of the canyon below that depth questionable. A distinct possibility exists that the axis of the canyon turns to the north between two elongate ridges, and that Astoria Canyon is a tributary of the canyon to the north. However, the position of the apex of Astoria Fan implies that the course of the canyon shown on the chart is the correct one.

Where the canyon is incised into the continental shelf, its boundaries are definite; in deeper water, the precise limits of the canyon may become confused by the ridge system. In the area of the outer shelf, the canyon is one to four miles wide, and has 300 to 400 fathoms of relief (figure 3). The slope along the axis varies irregularly from 0° 27' to 2° 34', but generally is one to two degrees. In its upper reaches, the canyon is steeper on the south side than on the north side. Measurements made from the original survey sheets indicate slopes of 5 to 35 degrees for the south wall, and slopes of 4 to 8 degrees for the north wall. Precision depth records made by the Department of Oceanography suggest that slumping occurs along the north wall, and may contribute material which ultimately is carried down the canyon to Astoria Fan.

Although the question of the origin of submarine canyons is a long way from being completely solved at the present time, many marine geologists feel that the upper or shallow portions of the canyons may have been initiated by subaerial erosion during a lower stand of the sea, probably during the Pleistocene, and that the movement of material down the canyon in response to gravity has served to erode the canyons into deeper water and to keep the existing canyons essentially clear of great quantities of sedimentary debris. The presence of sand in long cores taken from Astoria Fan is evidence that Astoria Canyon does serve as an avenue for the movement of fairly coarse material from shallow to deep water. The exact relationship of the Columbia River to Astoria Canyon is yet to be learned.

Acknowledgments

The writer is indebted to the Pacific Coast Branch of the United States Geological Survey for the faunal analysis of the rock sample. This study was carried out under contract with the Office of Naval Research, Contract Nonr 1286(02) Project NR 083-102.

References

Byrne, J. V., 1962, Geomorphology of the continental terrace off the central coast of Oregon: The ORE BIN, vol. 24, no. 5, p. 65-74.

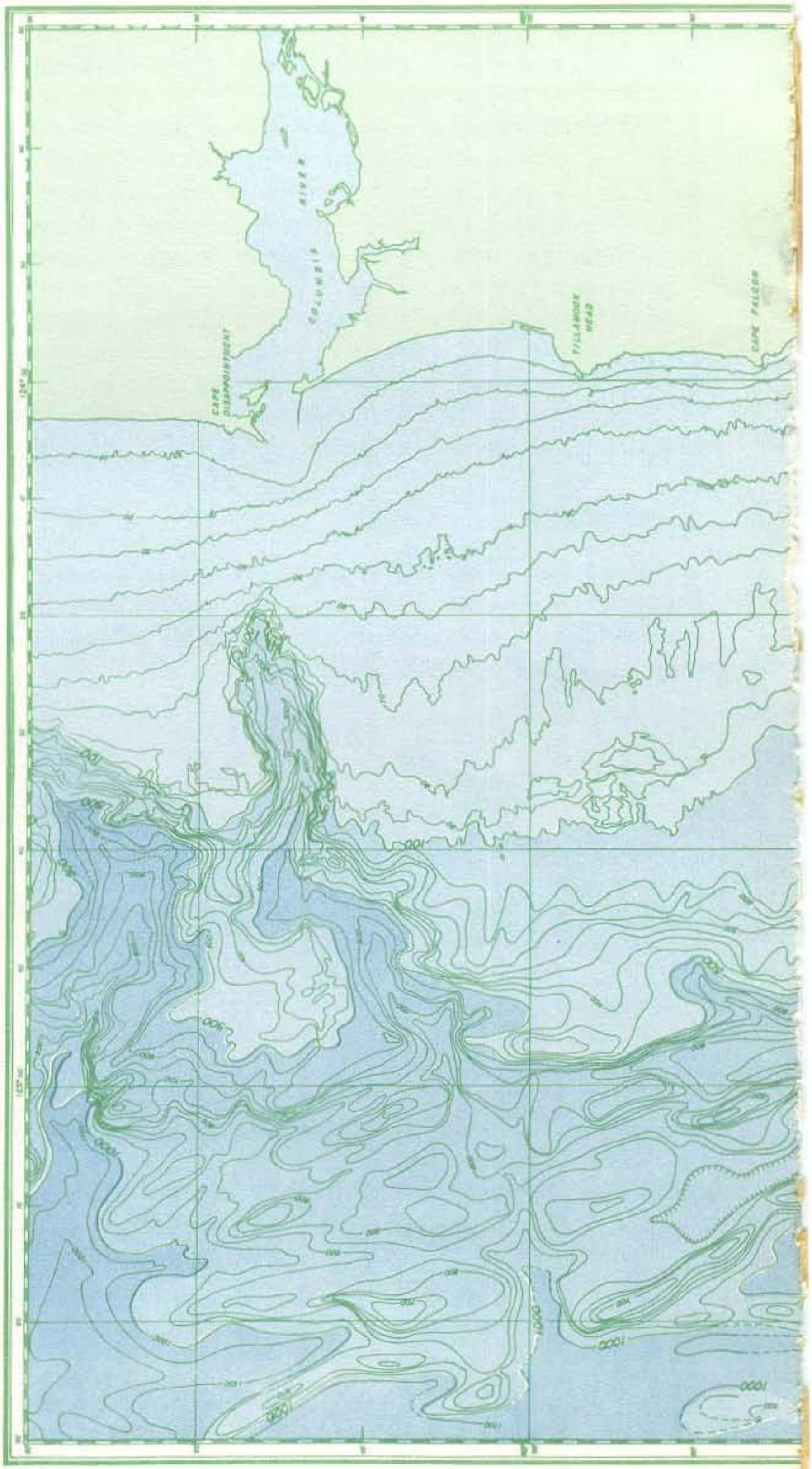
__________, 1963, Geomorphology of the Oregon continental terrace south of Coos Bay: The ORE BIN, vol. 25, no. 9, p. 149-157.

Huntting, M. T., Bennett, W. A. G., Livingston, V. E., and Moen, W. S., 1961, Geologic map of Washington: State of Wash. Dept. of Conserv., Div. of Mines and Geol.

Shepard, F. P., 1963, Submarine geology (second edition): Harper and Row, New York, 557 p.

Snavely, P.D., Jr., and Wagner, H.C., 1963, Tertiary geologic history of western Oregon and Washington: State of Wash. Dept. of Conserv., Div. of Mines and Geol., Rept. of Invest No. 22, 25 p.

* * * * *


COLUMBIA RIVER
CAPE DISAPPOINTMENT
TILLAMOOK HEAD
CAPE FALCON

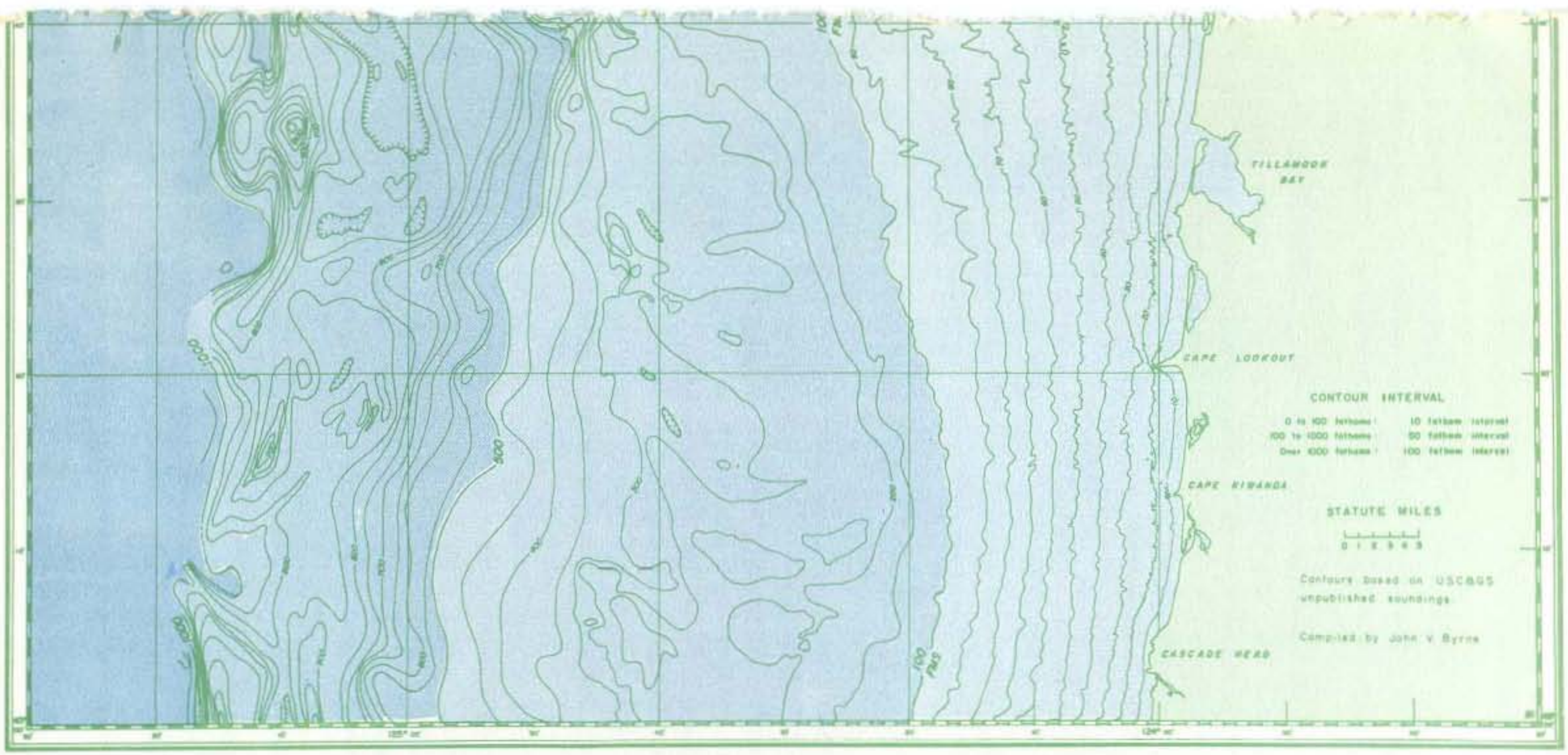


Plate 1. Bathymetric chart of the continental terrace off the northern coast of Oregon, 45°00'N to 46°30'N.

U.S.G.S. BEGINS ROCK ANALYSIS PROGRAM

Four igneous rocks have been collected in Oregon by geologists of the U.S. Geological Survey for use as standards of chemical composition. The Geological Survey plans to make these rocks available as analyzed samples for worldwide distribution.

The Oregon rocks will be carefully ground and split, and portions analyzed by a number of selected laboratories throughout the world. The analytical work will include measurements of major constituents by wet chemical methods, x-ray spectrometry, or other applicable techniques, and trace element measurements by many techniques including emission spectroscopy. Mineralogical studies of the rocks also will be made.

Samples of the analyzed rocks will be available to research institutions and universities. The present trend to instrumental methods of analysis makes comparison materials of this kind very important, and it is anticipated that these analyzed rocks from Oregon will be referred to repeatedly in the literature in comparing results and indicating the accuracy of analytical data.

The following are the rocks collected from Oregon for the standards program:

1. Flow rock, probably andesite, collected by George W. Walker from the east wall of Guano Valley, Lake County, Oregon. A dense greenish-gray, commonly mottled, locally flow-jointed rock that occurs on the flanks of a small, andesitic, strato volcano of probable middle or late Miocene age.
2. Rhyo-dacite, collected by George W. Walker about 10 miles NE of Lake Abert, Lake County, Oregon, from a mass that is probably a part of an exogenous dome or related flow of late Miocene (?) age.
3. Columbia River Basalt, collected by Aaron C. Waters from the upper part of a flow exposed in a quarry, Cooper Falls, Bridal Veil quadrangle, Oregon.
4. Nephelene syenite, collected by Parke D. Snavely, Jr., and Norman MacLeod from Table Mountain Sill, Georgia-Pacific Quarry on Table Mountain, Tidewater quadrangle, Oregon.

* * * * *

NOTICE

New and renewal subscriptions to The ORE BIN will be $1.00 per year, effective January 1, 1964. Available back issues will be 10 cents each.

NEW OIL AND GAS SERIES PROMULGATED

"Petroleum Geology of the Western Snake River Basin, Oregon-Idaho" by V. C. Newton, Jr., and R. E. Corcoran, Oil and Gas Investigations No. 1 published by this department, is now available at its three offices. The postpaid price is $2.50.

The 64-page volume contains three maps and two subsurface sections, 30 well logs, seven gas analyses, porosity and permeability data from six wells, and 47 references to earlier publications and graduate theses. The Western Snake River Basin was chosen for the first of this new series, because a large amount of subsurface information is available and the possibilities for developing commercial gas production appear encouraging.

The Western Snake River Basin is part of a much larger area usually referred to as the "Snake River Plain," a broad, relatively flat plain forming a belt across southern Idaho and extending into southeastern Oregon. The western portion, which has an area of about 2,000 square miles and an average elevation of about 2,300 feet, is roughly triangular in shape, with the base south of Boise and Nampa in Idaho and the apex north of Vale and Ontario in Oregon.

The first exploration for petroleum in the region began in 1902, and sporadic but unsuccessful drilling has continued to the present time. The major incentive for these activities was the fact that varying quantities of gas were encountered in many of the test wells. None of these drillings have produced commercial amounts for sustained periods, but several shallow wells provide gas for a few ranches.

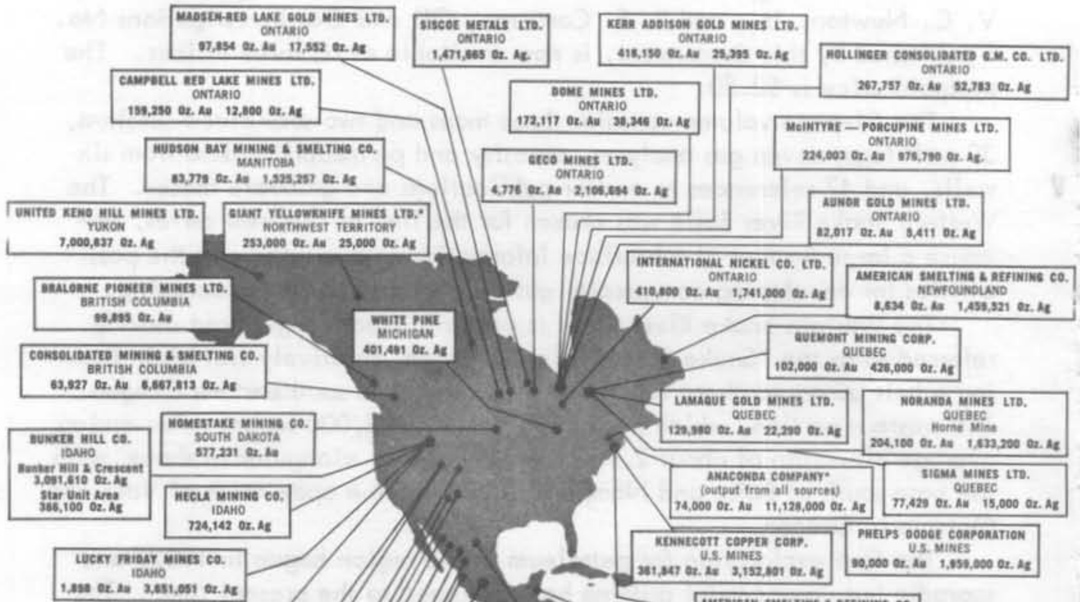
The basin is underlain by a nonmarine section of sediments and lavas at least 5,000 feet thick ranging in age from middle or late Miocene to Pleistocene. The high mountains that surround the area on three sides are composed of slightly metamorphosed Permian to Jurassic sediments and volcanics and Jurassic-Cretaceous plutonic rocks of the Idaho batholith.

The major structural feature of the basin is a broad downwarp of Pliocene and younger formations bounded on both sides by fault blocks of older rock. The best possibilities for entrapment of oil or gas appear to be in updip pinch-outs of sand horizons in the Pliocene section.

The similarity in rock types and depositional environment of the Western Snake River Basin to other well-known nonmarine basins in the world that now produce commercial amounts of oil and gas indicate that conditions suitable for the formation of hydrocarbons apparently existed in this region during late Miocene and early Pliocene time. The constantly increasing demand for gas in the Pacific Northwest and its nearness to the El Paso - Four Corners pipeline make the basin an attractive area for exploration.

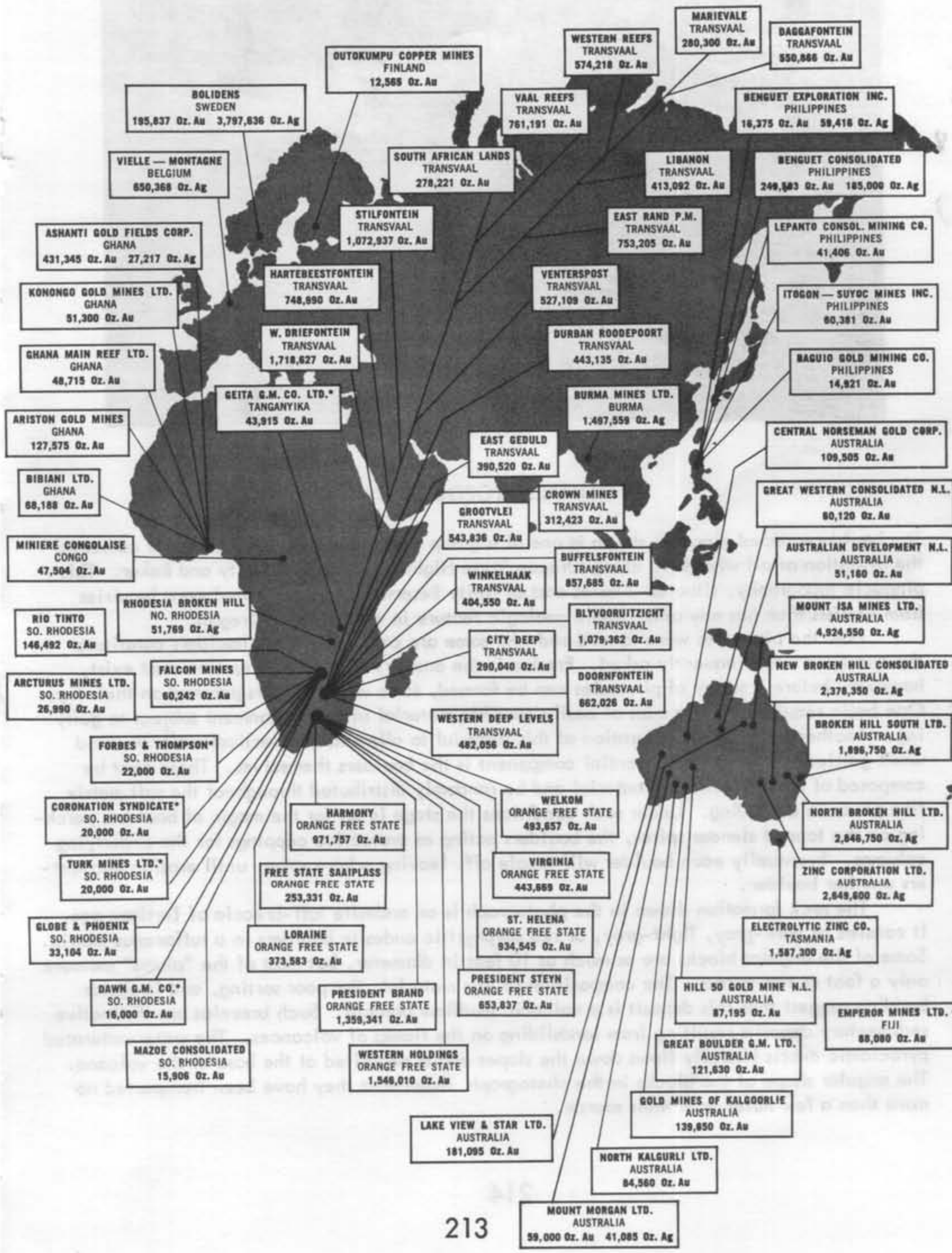
* * * * *

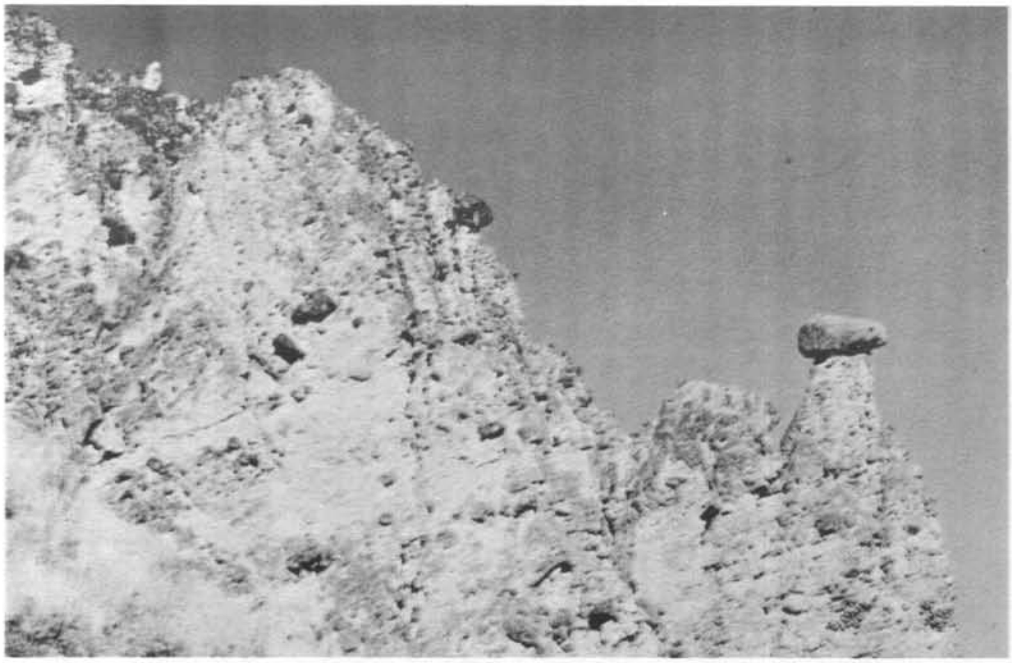
PRINCIPAL GOLD AND SILVER



Map shows 1962 gold and silver producers selected on basis of their economic importance to the areas in which they are located (Courtesy of American Cyanamid Co., New York).

PRODUCERS OF THE WORLD IN 1962





PINNACLE TOPOGRAPHY

The boulder-capped pinnacle shown is one of a group of picturesque rock spires that command the attention of all who drive along Oregon State Highway 7 between Unity and Baker. This pinnacle topography, situated 2 miles east of Unity Reservoir, has generated more inquiries from tourists than has any other single geologic feature in northeastern Oregon.

How the pinnacles were formed and why some are capped by large boulders constitute the questions most frequently asked. Erosion is the answer. A special situation must exist, however, before a swarm of pinnacles can be formed, some with boulders perched on their tops. One basic requirement is a mass of easily erodible material in an environment subject to gullying. Another is sufficient induration of this material to allow nearly vertical walls to stand when gullied. Finally, the essential component is the boulders themselves. These must be composed of erosion-resistant material and be randomly distributed throughout the soft matrix like plums in a pudding. Under such conditions the stage is set for the magic of boulders perching on the tops of slender spires, the boulders acting as protective cappings for the underlying columns. Eventually each boulder will topple off, leaving a bare spire until erosion encounters another boulder.

The rock formation shown in the photograph is an andesite tuff-breccia of Tertiary age. It consists of dark-gray, light-gray, or red porphyritic andesite boulders in a tuffaceous matrix. Some of the angular blocks are as much as 10 feet in diameter, but most of the "plums" measure only a foot or two across. The composition of this material, the poor sorting, and irregular bedding suggest that this deposit is a volcanic mudflow breccia. Such breccias are distinctive sedimentary deposits resulting from landsliding on the flanks of volcanoes. The water-saturated pyroclastic debris literally flows down the slopes and is deposited at the base of the volcano. The angular shape of the blocks in the photograph shows that they have been transported no more than a few miles from their source.

INDEX TO THE ORE BIN

Volume 25, 1963