

# **The Ore Bin**



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**STATE OF OREGON**  
**DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES**

## The Ore Bin

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STATE OF OREGON  
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## OREGON'S MINERAL AND METALLURGICAL INDUSTRY IN 1970

By Ralph S. Mason\*

In 1970 mineral production ranked third in dollar value among the natural resources produced in Oregon, outshadowed only by agriculture and forestry. The state also is rapidly becoming a major processor of metallurgical products, with most of the raw materials coming from points outside of Oregon. Another "natural resource" related to the mineral industry is the group of professional geologists and engineers living in the state who are not only knowledgeable about the state's mineral resources but find that they are being called upon more and more to help in the solution of a wide range of environmental problems.

Included in this issue is a summary of the Department's proposed activities for the next biennium, which starts in July. A rapidly changing world requires new approaches, presents new problems, and offers novel solutions. Some of the Department's programs are long range but some are brand new.

Oregon's mineral and metallurgical industries contributed more than \$700 million to the state's economy during 1970. Mineral production declined 3.3 percent below the 1969 level to \$58.2 million but metallurgical processing of ores originating in the state and imported from other states increased significantly. The construction of a third aluminum plant in the state, scheduled to start in early 1971, will boost production figures even higher.

In response to increased regulations for controlling pollution, the mining and metallurgical industries have been spending and will continue to spend millions of dollars in effluent treatment and stack-emission control equipment, plus new solid-waste disposal methods.

The slow-down in the over-all economy has been reflected in the slight decline in the state's mineral production, which is summarized in

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\*Mining Engineer, Oregon Department Geology and Mineral Industries.

the accompanying box. Unlike the general economy, however, unit prices of the principal mineral commodities, sand and gravel and crushed stone increased less than one percent over last year. The average price increase during the past 20 years for these critical "growth minerals" has been less than one and one-half percent per year, a remarkable testament to an industry which operates on a completely unsubsidized, tax-paying basis.

## The Metals

Oregon's metallurgical industry extends from aluminum to zirconium, with nearly a dozen other metals in between. Mercury is the only metal that is presently mined and refined in the state. All of the other metals

### Metallurgical products from Oregon plants

Aluminum  
Brick and tile  
Calcium carbide  
Cement  
Expanded shale  
Ferromanganese  
Ferronickel  
Ferrosilicon  
Lime  
Mercury  
Minor exotic metals  
Perlite  
Silicon  
Steel  
Titanium  
Vermiculite  
Zirconium

processed here originate beyond the state's borders, several of them coming from foreign countries. Two aluminum reduction plants, Reynolds Metals at Troutdale and Harvey Aluminum at The Dalles, and the American Metals Climax plant to be built this year at Warrenton in Clatsop County are located here because of cheap and abundant electricity and to a lesser extent deep water transportation. Oregon Steel Mills built its new plant near the mouth of the Willamette River to take advantage of deep water frontage and a new concept of transporting iron ore from Peru in the form of a slurry.

Reduction and fabrication facilities for processing titanium, zirconium, and a number of minor rare metals are also treated in the Albany area by Wah Chang Albany, Oregon Metallurgical, REM Metal, Zirtech, and TiLine. All of these operations are located near the U.S. Bureau of Mines Electrodevelopment Laboratory, which did pioneer work in the reduction and fabrication of the highly refractive metals. A

further, and more recent, related development in the Albany area has been the establishment of a Department of Metallurgical Engineering at nearby Oregon State University.

Hanna Mining Co. produced 1.2 million tons of nickel laterite ore at its open pit property located on top of Nickle Mountain in Douglas County. The ore contained 1.41 percent nickel and was treated in the Hanna Smelting Co. smelter at the foot of the mountain, where nearly 26,000 tons of ferronickel were smelted. Over 19,000 tons of ferrosilicon were produced in plant by the company for use in processing the ore.

In the face of a declining world price for mercury, Oregon production increased nearly seven times over the previous year. A total of 295

The Million-Dollar-a-Year Club, 1969 \*

<u>County</u>	<u>Value</u>	<u>County</u>	<u>Value</u>
Baker	\$4,566,000	Klamath	2,139,000
Clackamas	9,432,000	Lane	3,953,000
Coos	1,083,000	Linn	1,149,000
Jackson	1,049,000	Multnomah	7,937,000
Josephine	1,247,000	Washington	2,678,000

\* In addition to the values shown, there was a total of \$15,572,000 which could not be assigned to specific counties. Production from Columbia, Douglas, Harney, Hood River, Malheur, and Wasco Counties was concealed to avoid disclosing individual company confidential data. If the state's total mineral production had been divided equally among the 36 counties, each county would have produced an average of \$1,671,222 during the year.

flasks was produced with the bulk of the metal coming from the old Elk-head mine operated by Alcona Mining Inc. in Douglas County. A small amount of mercury was recovered at the Maury Mountain mine in Crook County, with some exploration and development reported at the Canyon Creek mine in Grant County, at a prospect on Connor Creek in eastern Baker County, and at the Doodle Bug mine in Jackson County.

Gulf Oil Corp. completed its investigation for uranium in eastern Oregon, and no activity was reported from either the Lucky Lass or White King properties, both former producers, in Lake County.

Reynolds Mining Co., a subsidiary of Reynolds Metals Co., conducted several small-scale mining experiments in Washington, Columbia, and Marion Counties. The company stockpiled the topsoil, removed the ore for test purposes, levelled the site, replaced the topsoil, and revegetated the disturbed area. All of these operations were carried out in the space of a few days. The tests were conducted to determine the best method for reducing the environmental impact during any subsequent mining activities.

Copper production was restricted to some secondary metal recovered from the production of hard-rock gold and silver at the Brass Ledge mine in Josephine County. Interest in copper mineralization in the state remained high with exploration programs by Nuclear Development Co. at the Standard and Copperopolis properties in Grant County, and by St. Joe Minerals Corporation in the copper belt of eastern Baker County.

Some of Oregon's Minerals at a Glance Preliminary Figures for 1970 (in thousands of dollars)		
	1969	1970
Clays	\$ 321	\$ 265
Diatomite	W	W
Gem stones	750	750
Gold (recoverable content of ores, etc.)	36	W
Lime	2337	2337
Mercury	22	121
Nickel (content of ore and concentrate)	W	W
Peat	---	---
Pumice and volcanic cinders	1139	1067
Sand and Gravel and stone	39,388	36,000
Silver (recoverable content of ores, etc.)	9	W
Talc and soapstone	---	---
Value of items that cannot be disclosed: Cement, copper (1969) and values indicated by symbol "W"	<u>16,162</u>	<u>17,659</u>
Total	60,164	58,199

#### The Enhanced Minerals

The transmutation of common sand and gravel into a wide variety of useful products exceeds even the wildest hopes of the medieval alchemists who hoped to change base metals into gold. The wealth generated by the producers of sand and gravel and crushed stone reaches into every section in the state and, in fact, provides the basic ingredient necessary for community growth and development. During 1970 each one of Oregon's citizens used an average of 12.5 tons of these "growth minerals," whether he realized it or not. On a dollars and cents basis, the value of the raw sand and gravel and stone came to an estimated \$36 million -- or exactly one million dollars for each of the state's 36 counties. Despite a nationwide trend to higher and higher unit costs, the sand and gravel industry in Oregon reported only a one-cent-per-ton rise.

Growing concern for future supplies of sand and gravel, particularly in Western Oregon was expressed during the year. The Department made several sand and gravel resource studies at the request of local government

bodies which desired information on the location and reserves of sand and gravel in their communities before making long-range plans. Unlike many other natural resources, mineral deposits cannot be transferred from place to place but remain fixed until mined out. This inflexibility places a premium on comprehensive planning by those agencies charged with the responsibility for preserving the environmental quality of a community while providing the necessary ingredients for its growth.

Production of clays, diatomite, pumice, and lime declined somewhat from last year's totals in response to the general slackening in demand.

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#### PRINCIPAL OREGON MINERAL PRODUCERS - 1969\*

Commodity and company	Address	Type of activity	County
NONMETALS			
Cement:			
Oregon Portland Cement Co. ....	111 S.E. Madison St. Portland, Oregon 97214	Plant. ....	Baker and Clackamas.
Clay:			
Central Oregon Bentonite Co. ....	Bear Creek Route Prineville, Oregon 97754	Pit and plant. ....	Crook.
Ceramco, Inc. ....	P.O. Box 5 McMinnville, Oregon 97128	....do. ....	Yamhill.
Columbia Brick Works. ....	1320 S.E. Water St. Portland, Oregon 97214	....do. ....	Multnomah.
Corvallis Brick & Tile Works, Inc. ....	P.O. Box 327 Corvallis, Oregon 97330	....do. ....	Benton.
Empire Lite-Rock, Inc. ....	9255 N.E. Halsey St. Portland, Oregon 97220	....do. ....	Washington.
Klamath Falls Brick & Tile Co. .	P.O. Box 573 Klamath Falls, Oregon 97601	....do. ....	Klamath.
Mandrone Mining Co., Inc. ....	Rt. 1, Box 337 Molalla, Oregon 97038	Pit. ....	Clackamas.
McMinnville Brick Co. ....	451 College Ave. McMinnville, Oregon 97128	Pit and plant. ....	Yamhill.
Monmouth Brick & Tile Co. ....	Rt. 1, Box 22 Monmouth, Oregon 97361	....do. ....	Polk.
Monroe Clay Products Co. ....	P.O. Box A Monroe, Oregon 97456	....do. ....	Benton.
Needy Brick & Tile Co. ....	Rt. 1, Box 102 Hubbard, Oregon 97032	....do. ....	Clackamas and Marion.
Oregon Portland Cement Co. ....	111 S.E. Madison St. Portland, Oregon 97214	Pit. ....	Baker.
Scholls Tile Co. ....	Rt. 2, Box 208 Hillsboro, Oregon 97123	Pit and plant. ....	Washington.
Tillamook Clay Works. ....	6690 Brickyard Road Tillamook, Oregon 97141	....do. ....	Tillamook.
Willamina Clay Products Co., Inc. ....	9780 S.W. Hunziker St. Tigard, Oregon 97223	....do. ....	Yamhill.
Diatomite:			
Keating Diatomaceous Earth Co. .	2019 Washington St. Baker, Oregon 97814	Mine and plant. ....	Baker.
A. M. Matlock. ....	P.O. Box 3307 Eugene, Oregon 97402	....do. ....	Lake.
Lime:			
Ash Grove Lime & Portland Cement Co. .	101 W. 11th St. Kansas City, Missouri 64105 (Portland, Oregon 97200)	Plant. ....	Multnomah.
Chemical Lime Co. ....	Baker, Oregon 97814. ....	....do. ....	Baker.
Pacific Carbide & Alloys Co. ....	P.O. Box 17008 Portland, Oregon 97200	....do. ....	Multnomah.
Perlite (expanded):			
Supreme Perlite Co. ....	P.O. Box 66 North Portland, Oregon 97043	....do. ....	Multnomah.

\* From U.S. Bureau of Mines Minerals Yearbook, 1969 preprint.

## Principal Oregon mineral producers - 1969, continued

Commodity and company	Address	Type of activity	County
NONMETALS—Continued			
Pumice:			
Central Oregon Pumice Co.....	5 Greenwood Ave. Bend, Oregon 97701	Mine and plant....	Deschutes.
Graystone Corp.....	Box 1087 Bend, Oregon 97701	....do.....	Do.
Chester Hiatt.....	147 N. 12th St. Redmond, Oregon 97756	....do.....	Do.
Oregon Portland Cement Co.....	111 S.E. Madison St. Portland, Oregon 97214	Mine	Baker.
Parks Pumice Mining.....	Box 54 Chemult, Oregon 97731	....do.....	Klamath.
Jed Wilson & Son.....	Box 125 La Pine, Oregon 97739	Mine and plant....	Lake.
Roofing Granules:			
Flintkote Co.....	P.O. Box 2744 Portland, Oregon 97208	Plant.....	Multnomah.
Sand and Gravel:			
Baker Rock Crushing.....	2030 E. Main St. Hillsboro, Oregon 97123	Pit and plant.....	Washington.
Bethel-Danebo Sand & Gravel....	150 Bertelsen Road S. Eugene, Oregon 97402	....do.....	Lane.
Copeland Sand & Gravel.....	695 S.E. J St. Grants Pass, Oregon 97526	....do.....	Josephine.
Delta Sand & Gravel.....	999 Division Ave. Eugene, Oregon 97402	....do.....	Lane.
Eugene Sand & Gravel.....	Box 1067 Eugene, Oregon 97401	....do.....	Do.
Glacier Sand & Gravel.....	5975 E. Marginal Way Seattle, Washington 98134	....do.....	Multnomah.
McKenzie Sand & Gravel.....	Box 347 Eugene, Oregon 97400	Pit and plant.....	Lane.
M.P. Materials.....	645 Seventh St. Salem, Oregon 97300	....do.....	Marion.
Milwaukie Sand & Gravel.....	1635 S.E. McLoughlin Blvd. Milwaukie, Oregon 97222	Dredge and plant...	Clackamas.
Morse Brothers.....	Lebanon, Oregon 97355	Pit and plant.....	Benton and Linn.
Chas. T. Parker Construction....	6457 N.E. Columbia Blvd. Portland, Oregon 97203	....do.....	Multnomah.
Portland Sand & Gravel.....	10717 S.E. Division Ave. Portland, Oregon 97266	....do.....	Do.
Rich Valley Top Soil Co.....	Box 30 Oregon City, Oregon 97045	....do.....	Clackamas.
Rock Creek Sand & Gravel.....	Clackamas, Oregon 97015	....do.....	Multnomah.
Roseburg Sand & Gravel.....	Box 1207 Roseburg, Oregon 97470	....do.....	Douglas.
Ross Island Sand & Gravel.....	4129 S.E. McLoughlin Blvd. Portland, Oregon 97200	Dredge and plant...	Multnomah.
Umpqua River Navigation Co....	Box 25 Reedsport, Oregon 97467	....do.....	Douglas.
Wildish Sand & Gravel.....	Box 1106 Eugene, Oregon 97401	Pit and plant.....	Lane.
Willamette Hi-Grade Concrete Co.	Foot N. Portsmouth Ave. Portland, Oregon 97203	Dredge and plant...	Multnomah.
Stone:			
L. V. Anderson.....	Box 757 Oakridge, Oregon 97463	Quarry and plant...	Lane.
Boise Cascade Corp.....	La Grande, Oregon 97850	....do.....	Union, Uma- tilla, Wallowa.
L. H. Cobb.....	8275 S.W. 145th Ave. Beaverton, Oregon 97005	....do.....	Washington.
J. C. Compton.....	Box 86 McMinnville, Oregon 97128	....do.....	Baker, Des- chutes, Harney.
Eckman Creek Quarries.....	Box 15 Waldport, Oregon 97394	....do.....	Lincoln.
Georgia-Pacific Corp.....	Drawer AA Pilot Rock, Oregon 97868	....do.....	Grant, Lincoln, Umatilla.
L. W. Govro.....	Rt. 4, Box 253-W Albany, Oregon 97321	Quarry and plant	Linn.
Roy L. Houck Sons.....	1158 Chemeketa N.E. Salem, Oregon 97301	....do.....	Coos, various.
Hughes & Dodd.....	Box 246 Medford, Oregon 97501	....do.....	Coos, Curry, Jackson.
Peter Kiewit Sons Co.....	Box 1777 Vancouver, Washington 98663	....do.....	Various.
Materne Bros.....	Box O—Rosewood Station Spokane, Washington 99208	....do.....	Do.



## Principal Oregon mineral producers - 1969, continued

Commodity and company	Address	Type of activity	County
<b>NONMETALS—Continued</b>			
<b>Sand and Gravel—Continued</b>			
Oregon Portland Cement Co.....	111 S.E. Madison St. Portland, Oregon 97214	...do.....	Baker.
Pacific Crushing Co.....	610 Irving Drive Eugene, Oregon 97402	...do.....	Klamath, Lane.
Pioneer Construction Co.....	7881 N.W. St. Helens Road Portland, Oregon 97229	...do.....	Multnomah.
Quality Rock Co.....	Rt. 2, Box 608 Beaverton, Oregon 97005	...do.....	Washington.
Rogue River Paving Co., Inc.....	1183 S. Riverside Medford, Oregon 97501	...do.....	Coos, Douglas Jackson, Josephine.
Roseburg Sand & Gravel Co.....	Box 1207 Roseburg, Oregon 97470	...do.....	Coos, Douglas, Lane.
Sunset Crushed Rock.....	Clatsop Airport Astoria, Oregon 97103	...do.....	Clatsop.
Jed Wilson & Son.....	Box 125 La Pine, Oregon 97739	...do.....	Lake.
Talc and Soapstone:			
John H. Pugh.....	2891 Elk Lane Grants Pass, Oregon 97526	Mine.....	Josephine.
Stauffer Chemical Co.....	P.O. Box 68 Portland, Oregon 97403	Plant.....	Multnomah.
Vermiculite (exfoliated):			
Supreme Perlite Co.....	P.O. Box 66 North Portland, Oregon 97043	...do.....	Do.
Vermiculite-Northwest, Inc.....	P.O. Box A Auburn, Washington 98002	...do.....	Do.
<b>METALS</b>			
Aluminum:			
Harvey Aluminum Co.....	The Dalles, Oregon 97058	Plant.....	Wasco.
Reynolds Metals Co.....	Troutdale, Oregon 97060	...do.....	Multnomah.
Ferrous alloys:			
Hanna Nickel Smelting Co.....	Riddle, Oregon 97469	...do.....	Douglas.
Union Carbide Corp., Mining and Metals Division <sup>1</sup>	Portland, Oregon 97200	...do.....	Multnomah.
National Metallurgical Co.....	Springfield, Oregon 97477	...do.....	Lane.
Gold and Silver:			
Baker Assets Co.....	Baker, Oregon 97814	Mine and mill.....	Baker.
Beaver Rock Products, Inc.....	Albany, Oregon 97321	Mine.....	Grant.
Cornucopia Placer Co.....	Halfway, Oregon 97834	Placer.....	Baker.
Ray Evans.....	Kerby, Oregon 97531	...do.....	Josephine.
Frank Ramsey.....	Baker, Oregon 97814	Mine.....	Baker.
Mercury:			
Alcona Mining, Inc.....	366 S. 79th St. Springfield, Oregon 97477	...do.....	Douglas.
C. F. Taylor.....	1128 Phelps Ave. San Jose, California 95117 (Prineville, Oregon)	...do.....	Crook.
Nickel:			
Hanna Mining Co.....	Riddle, Oregon 97469	...do.....	Douglas.
Steel:			
Cascade Steel Rolling Mills, Inc..	McMinnville, Oregon 97128	Plant.....	Yamhill.
Oregon Steel Mills.....	Portland, Oregon 97200	...do.....	Multnomah.
Titanium:			
Oregon Metallurgical Corp.....	Albany, Oregon 97321	do.....	Linn.
Zirconium:			
Wah Chang Albany Corp.....	Albany, Oregon 97321	...do.....	Do.

<sup>1</sup> Produces ferromanganese and silicomanganese.

## METALS AND MINERALS CONFERENCE PROGRAM FILLED

A total of 65 papers will be presented at the Pacific Northwest Metals and Minerals Conference which will be held at the Sheraton Motor Inn, Portland, April 5, 6 and 7, 1971. Technical sessions include: Minerals; Metals; Mining and Exploration; Oceanic and Atmospheric; Gold and Money; Geology; Industrial Minerals; Iron and Steel; Non-ferrous Alloys; Non-Ferrous Extraction; Titanium; Super Alloys; and Refractory Metals. Field trips and social activities round out the three-day conference.

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## OIL AND GAS EXPLORATION IN 1970

By V. C. Newton, Jr.\*

Exploration activity in Oregon during 1970 was the first of consequence since the offshore search in 1962-67. Two drilling permits were issued for shallow Willamette Valley wildcats, while another venture continued attempts to deepend an old hole in the central Oregon area. The most significant event in the state relative to petroleum during 1970 was the leasing in central Oregon by Texaco, Inc. Objectives appear to be Mesozoic-Paleozoic marine beds underlying Tertiary volcanics (see Fig. 1). No production has been found in Oregon to date but there is good reason to be optimistic when a major oil company decides on a drilling program. The wildcat scoreboard shows 32 deep dusters, 148 shallow dusters, and 0 discoveries. Average discovery odds in the United States are better than 50 to 1. Four holes drilled in Oregon during the past 15 years penetrated to depths below 12,000 feet before operations were halted. Production tests have been made on many of the holes drilled in the state but none of them showed more than a trace of oil.

### Leasing

Texaco assembled more than 200,000 acres of leases in Crook and Grant Counties near the location of the Standard "Pexco State" and Sunray "Bear Creek" tests which were drilled in 1955 and 1958. The leases include federal, state, and private land but the major portion is under federal ownership. The location of the lease block is believed to be near the eastern margin of Cretaceous marine sediments, so the drilling objective is probably for a stratigraphic type enclosure. Three deep holes have penetrated Mesozoic marine rocks which underlie Tertiary volcanics in central Oregon (see Fig. 2). Some minor oil and gas shows were encountered while drilling the older sediments.

Mobil Oil Co. holds an estimated 25,000 acres of leases in northwestern Oregon and 10,000 acres in southwestern Oregon which were acquired in 1967. Standard Oil of California and Texaco have offset acreage to Mobil's leases in northwestern Oregon amounting to approximately 15,000 acres. Mobil's interest lies within the Tertiary marine basin of western Oregon. The firm drilled a 9,000-foot hole in Douglas County in 1957 under its former name of General Petroleum Corp. The G-P Douglas County hole

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

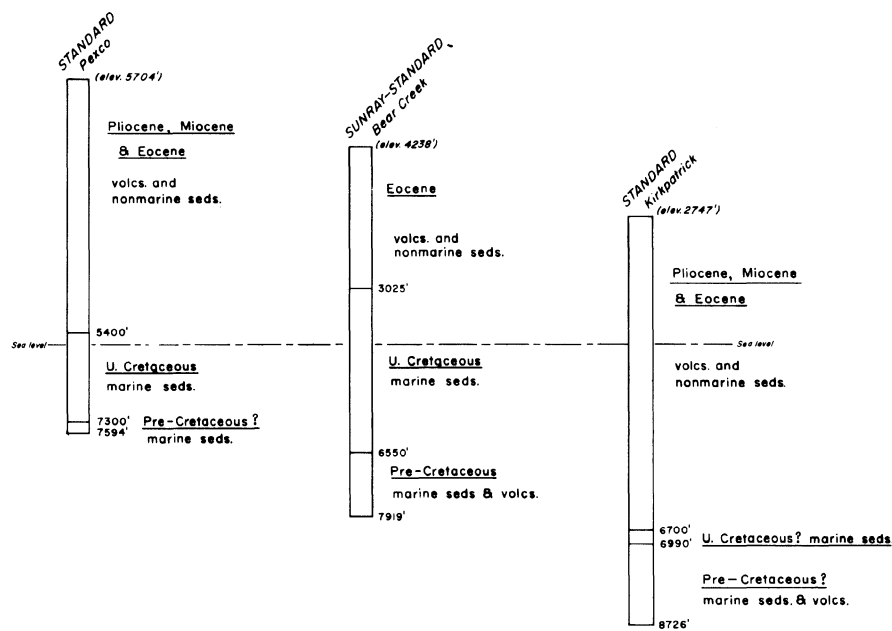


Figure 1. Mesozoic test holes in central Oregon.

tested middle Eocene marine sediments and bottomed in lower Eocene volcanics.

The Craig and Jackson-Dahl ventures have an estimated 8,000 acres under lease near Buena Vista in the Willamette Valley. Drilling and testing are continuing on two shallow wildcats near Buena Vista. R. F. Harrison and Associates of Seattle, Washington probably control more than 5,000 acres of leases in their venture near the town of Madras in central Oregon.

No lands are under lease off the Oregon coast at the present time. Standard of California and Union Oil Co. relinquished shelf lands in 1968 and 1969. Nine of the original bidders for Oregon shelf lands quitclaimed 400,000 acres of leases in 1966.

#### Expiration dates of offshore geophysical permits

<u>Company</u>	<u>Federal permit</u>	<u>State permit</u>
Humble Oil & Refining Co.	April 1971	- - -
Standard Oil of California	- - -	Sept. 1971
Texaco, Inc.	May 1971	May 1970

### Drilling activity

Wildcatters were the only contributors to exploration drilling in 1970. Wm. Craig - Producers Oil & Gas and Jackson - Dahl Leasing drilled shallow holes near Buena Vista in the Willamette Valley. Work was still being planned on both projects at the end of the year. Shows of gas in two holes drilled near Buena Vista by Portland Gas & Coke Co. in 1935 encouraged the present search. Objectives of the drilling are upper Eocene Spencer sands.

R. F. Harrison and Associates was hampered by caving hole and stuck tools in the effort to deepen the Central Oils, Inc., "Morrow Ranch" wildcat southeast of Madras in north-central Oregon. Pre-Tertiary marine rocks crop out 3 miles northeast of the drilling site (Peck, 1964).

#### Active drilling permits - 1970

<u>Company</u>	<u>Permit no.</u>	<u>Unique well no.</u>	<u>Location</u>	<u>Depth</u>	<u>Status</u>
R.F.Harrison	60-D	031-00002	SW $\frac{1}{4}$ sec. 18, T12S., R15E. Jefferson Co.	3300' (old T.D.)	Idle
Wm. Craig- Producers Oil & Gas	61	047-20001	NW $\frac{1}{4}$ sec. 24, T9S, R4W Marion County	1565'	Testing
Jackson-Dahl	62	047-20002	NE $\frac{1}{4}$ sec. 24, T9S., R4W Marion County	1585'	Suspended temporarily

### Rock outcrop map

The map (Figure 1) shows surface exposures of major rock types and locations of deep drillings. Three main drilling provinces are indicated: the western Tertiary marine, central Paleozoic-Mesozoic marine, and eastern Tertiary nonmarine intermountain basins. The western Tertiary marine rocks underlie the coast shelf, Coast Range, Willamette Valley, and an unknown portion of the Western Cascade Mountains. The central Paleozoic-Mesozoic marine basin west of the Blue Mountain uplift has been of interest for oil and gas exploration because rock exposures on this end of the Blue Mountains are unmetamorphosed. Farther east in the Blue Mountains, Paleozoic-Mesozoic marine sediments are metamorphosed. Thick sections of Tertiary nonmarine sediments and interbedded volcanic rocks in southeastern

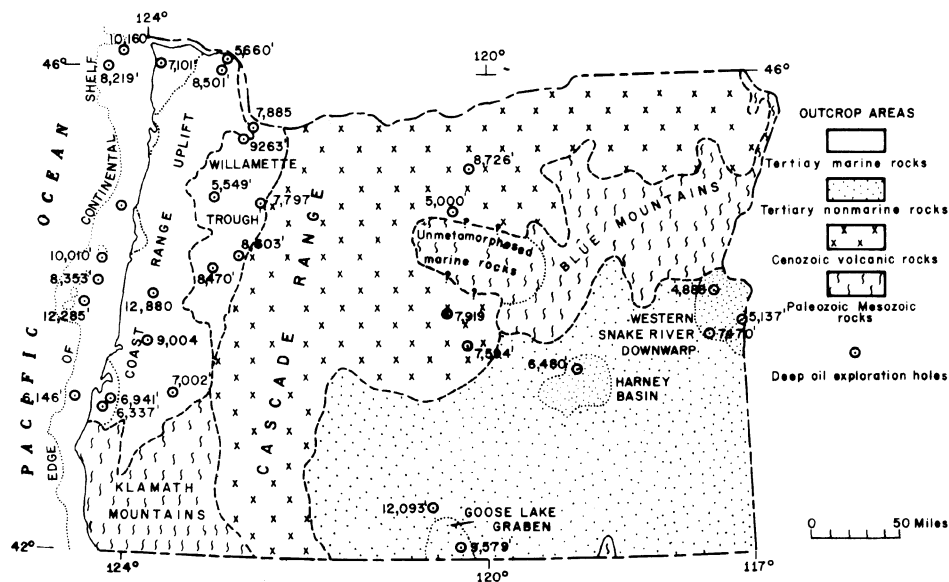


Figure 2. Major rock types and deep exploratory wells in Oregon (adapted from Wagner and Newton, 1969).

Oregon constitute the third drilling province.

#### Prospects

The onshore Tertiary marine basin has been fairly well drilled except for the eastern margin. Offshore, much work has been done, but seven holes are not enough to evaluate 7,000 or 8,000 square miles of basin area. The prospective eastern nonmarine areas have been fairly well evaluated by drilling, but more effort could be expended in the Western Snake River area. The two Humble wells in Lake County were designed to test pre-Tertiary marine sediments and do not reflect interest in the nonmarine rocks in the Goose Lake graben. Three deep exploratory holes have been put down in central Oregon to explore Paleozoic-Mesozoic marine rock below several thousand feet of volcanic rocks. Findings in these holes have been somewhat encouraging, but still very little is understood about the possibilities of the deeply buried older sediments. It is hoped that Texaco geologists will find encouragement enough in their studies to recommend deep drilling.

#### References

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## FIELD WORK IN OREGON DURING 1970

During the 1970 field season at least 80 geologic field studies were conducted in the State of Oregon. Listed below are the studies about which this Department is aware. For convenience, the state is subdivided into six sections, and the studies are grouped according to location. Also, a section dealing with water-resource studies is included in the list.

The list is probably not complete, and the Department would appreciate receiving information about other studies in progress in this state. Reports received will be included in the Summary of Field Work to be issued on a limited and unpublished basis by the Department in the early spring. With regard to the following list, resumes received thus far have been of immeasurable help, and the Department expresses its gratitude for these contributions.

### Regional Studies

#### Northwest Oregon

1. Sedimentary petrology of the upper Nehalem River basin, Oregon: R. O. Van Atta, doctoral candidate, OSU.
2. Geology of the Oregon Coast Range. P. D. Snavely and Norman MacLeod, U.S. Geological Survey, Menlo Park, Calif.
3. Engineering geology of the northern Willamette Valley. H. G. Schlicker, DOGAMI\*, and R. J. Deacon, consulting geologist, Shannon & Wilson Co.
4. Miocene igneous rocks of the Western Cascades. A. R. McBirney, professor of geology, UO.
5. Intrusive and extrusive rocks in the northern Western Cascades. Andrew Duncan and Jaroslav Lexa, graduate students, UO.

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\* DOGAMI = Abbreviation for State of Oregon Department of Geology and Mineral Industries.

6. Coastal landforms. E. Lund, professor of geology, UO.
7. Cenozoic stratigraphy and paleontology. W. O. Addicott, U.S. Geological Survey, Menlo Park, Calif.
8. Land sea transect in the Newport area. P. D. Snavely, Jr., U.S. Geological Survey, Menlo Park, Calif.
9. Trace elements in the 'Columbia River Basalt.' G. Goles, professor of geology, UO.
10. Latitudinal gradients of Tertiary molluscan faunas of the Pacific Coast. W. O. Addicott, U.S. Geological Survey, Menlo Park, Calif.
11. Urban land instability problems of Portland. L. A. Palmer, professor, PSU.
12. Geology of lower Willamette Basin. P. Howell, professor, PSU.
13. Transportation of volcanic rock fragments in various climates. P. Kersey, graduate student, Harvard Univ.

#### Southwest Oregon

1. Oregon black sands project. H. E. Clifton, U.S. Geological Survey, Menlo Park, Calif.
2. Alpine-type ultramafic rocks. R. Loney, U.S. Geological Survey, Menlo Park, Calif.
3. Geology of the Camas Valley and Tyee quadrangles. E. M. Baldwin, professor of geology, UO.
4. Petrology and structure of the Preston Peak area. A. W. Snoke, doctoral candidate, Stanford Univ.
5. Paleomagnetism of some Cenozoic intrusives. H. C. Clark, professor of geology, Rice Univ.
6. Geology of the Kalmiopsis Wilderness Area. Len Ramp, DOGAMI.
7. Siliceous sediments near Bandon. W. Orr, professor of geology, UO.
8. Decapod fauna in the Umpqua Formation. W. Orr, professor of geology, UO.
9. Geology of the Powers quadrangle. E. M. Baldwin and P. Hess, UO.
10. Specimens of Buchia in the Riddle Formation. D. Jones, U.S. Geological Survey, Menlo Park, Calif.
11. Seismic profiling. P. D. Snavely, Jr., U.S. Geological Survey, Menlo Park, Calif.
12. Minor structures of the Colebrooke Schist. G. T. Benson, professor of geology, PSU.
13. Stratigraphy and sedimentary petrology of the Colestin Formation at the type locality, Jackson County, Oregon. R. Carlton, graduate student, OSU.
14. Geology and mineral deposits of Eden Valley-Saddle Peaks and vicinity, southeastern Coos County, Oregon. W. Utterback, OSU.
15. Limestone samples from Grants Pass area. A. Boucot, professor of geology, OSU.
16. Mapping of Ordovician through Devonian rocks in the eastern Klamath Mountains. Potter, A., Zdanowic, T., Rohr, D., graduate students, OSU.
17. Sand and gravel resources of the Applegate River valley. H. G. Schlicker, DOGAMI, and R. J. Deacon, consulting geologist, Shannon & Wilson Co.

### North-central Oregon

1. Petrology of the Oregon Cascade Range. A. R. McBirney, professor of geology, UO.
2. Trace element geochemistry. G. Goles, professor of geology, UO.
3. Middle and Lower Jurassic faunas of eastern Oregon. R. Imlay, U.S. Geological Survey, Washington, D.C.
4. Seismicity. Morris Brown, UO.
5. Petrochemical comparison of various High Cascade volcanoes. T. L. Steinborn, graduate study, UO.
6. Geology of the Long Creek quadrangle. T. Thayer, U.S. Geological Survey, Menlo Park, Calif.
7. Cenozoic floras of the Pacific Northwest. J. A. Wolfe, U.S. Geological Survey, Menlo Park, Calif.
8. Mapping in the Parkdale area. P. H. Hammond, professor of geology, PSU.
9. Chemical analyses of rock units in the central High Cascades. E. M. Taylor, assistant professor of geology, OSU.
10. Petrography of the Clarno Formation. H. Enlows, professor of geology, OSU.
11. Stratigraphy and petrography of the Rattlesnake Formation at the type locality. H. Enlows, professor of geology, OSU.
12. Clay mineralogy of the Cretaceous rocks of the Mitchell area. C. Jarman, OSU.
13. Stratigraphy and sedimentology of the Madras sequence in the Deschutes drainage. D. Stensland, OSU.
14. Stratigraphy and geology of the Clarno Formation. K. Oles, professor of geology, OSU.
15. Chemical petrology of part of the Clarno Formation. J. Rogers (advisor to two unnamed master's candidates), Rice Univ.

### South-central Oregon

1. Seismicity of Crater Lake National Park. J. K. Westhusing, on leave of absence from Lockheed Electronics, at UO.
2. Seismicity of the Klamath Falls-Lakeview area. M. Brown, graduate student, UO.
3. Geomorphology of the Warner Valley-Hart Mountain area. D. Weide, graduate student in geography, UCLA.
4. Geothermal steam investigations. R. Bowen and N. Peterson, DOGAMI.
5. Geology of proposed waste management areas, Lake and Klamath Counties, Oregon. V. C. Newton, DOGAMI.
6. Diatomite occurrences in Klamath County. N. Peterson, DOGAMI.
7. Uranium and quicksilver in Lake County. N. Peterson, DOGAMI.
8. Dating of volcanic events at Newberry Crater. N. Peterson, DOGAMI.
9. Mapping of the Lava Butte area. P. Hammond, professor of geology, PSU.
10. Culminating explosions of Mount Mazama. J. Lidstrom, graduate student, OSU.

### Northeast Oregon

1. Geology of the Huntington quadrangle. H. Brooks, DOGAMI.



2. Geology of the Snake River Canyon. T. Vallier, professor of geology, Indiana State Univ.
3. Tertiary geology of the Baker AMS quadrangle. James McIntyre, DOGAMI.
4. State Geologic Map Project. G. W. Walker, U.S. Geological Survey, Menlo Park, Calif.
5. Middle and Lower Jurassic faunas of eastern Oregon. R. Imlay, U.S. Geological Survey, Washington, D.C.
6. Geology of the Wallowa Mountains. W. H. Taubeneck, professor of geology, OSU.
7. Landslide geology of the LaGrande area. H. Schlicker, DOGAMI, and R. J. Deacon, consulting geologist, Shannon & Wilson.
8. Stratigraphy of the Columbia River Basalt in the Wallowa Mountains. W. Taubeneck, professor of geology, OSU.
9. Structure, petrography, and petrology of granitic rocks in the Wallowa Mountains. W. Taubeneck, professor of geology, OSU.
10. Structure, petrography, and petrology of granitic rocks of the Bald Mountain batholith in the Anthony Butte and Limber Jim Creek quadrangles. W. Taubeneck, professor of geology, OSU.
11. Geologic investigation of the Eagle Cap Wilderness. P. Weis, U.S. Geological Survey, Spokane, Wash.
12. Structural geology of the Canyon Mountain complex. H. G. Avé Lallemant, graduate student, Rice Univ.
13. Zeolites of the Durkee Basin. R. A. Sheppard, U.S. Geological Survey, Federal Center Building, Denver, Colo.

#### Southeast Oregon

1. Geology of the Diamond Craters volcanic field. C. Rowan, U.S. Geological Survey, Denver, Colo.
2. Geology and mineralization of the Cordero quicksilver district, Oregon-Nevada. R. C. Greene, U.S. Geological Survey, Menlo Park, Calif.
3. Lacustrine environments. R. E. Miller, U.S. Geological Survey, Menlo Park Calif.
4. Geology of the Pueblo Mountains. H. Enlows, professor of geology, OSU.
5. Geology and ore deposits of the central Pueblo Range. D. Tower, graduate student, OSU.
6. Petrography, distribution, and origin of the Danforth Ignimbrites, Harney Basin. D. Parker, graduate student, OSU.

#### Water Resource Studies

1. Ground water of the Eugene-Springfield area. F. Frank, U.S. Geological Survey, Portland, Ore.
2. Ground water of the Corvallis-Albany area. F. Frank, U.S. Geological Survey, Portland, Ore.
3. Ground water in the dune-sand area north of Coos Bay. J. Robison, U.S. Geological Survey, Portland, Ore.
4. Ground water of the Grants Pass quadrangle. J. Robison, U.S. Geological Survey, Portland, Ore.

5. Ground water of part of the Klamath River basin. Al Leonard, U.S. Geological Survey, Portland, Ore.
6. Flood mapping reports for Rogue River and Elk River in Jackson County. D. Harris, U.S. Geological Survey, Portland, Ore.
7. Flood mapping report for the Applegate River in Jackson County. D. Harris, U.S. Geological Survey, Portland, Ore.
8. Movement of radionuclides in the Columbia River estuary. D. Hubbell and J. Glenn, U.S. Geological Survey, Portland, Ore.

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## GEOTHERMAL ACTIVITY IN 1970

By R. G. Bowen\*

Interest and activity in geothermal power production accelerated noticeably in 1970. The Larderello field in Italy, with a capacity of 400,000 kw, continued to be the largest developed geothermal field in the world. Exploration activity has been directed to the south in the Naples area, and efforts are now under way to develop new resources in that region. In New Zealand, where the Wairakei field with an installed capacity of 200,000 kw is the second largest, a new field, Brodlands, is currently being drilled. The first units are expected to be in production during the early 1970's. The Geysers field in northern California continues to be the world's third largest production facility, with an installed capacity of 83,000 kw. This is being expanded with two new plants of 110,000 kw each, now under construction and expected to be on stream in 1971 and 1972. In Japan, where installed capacity is a little more than 30,000 kw from two areas, expansion programs are under way.

Exploration programs sponsored by the United Nations are going on in El Salvador, Turkey, Chile, Kenya, and Ethiopia. During the year significant discoveries of dry steam were made in widely scattered parts of the world: Guadeloupe, West Indies; Los Alamos, New Mexico; and Los Negritos, Mexico. In southern California a program is under way to evaluate the geothermal potential of the Imperial Valley, an area where preliminary drilling has found fluids with temperatures of nearly 700°F and geophysical studies indicate these may be widespread. Development there has stopped because of the high salinity of the geothermal fluid, but it is expected that lower salinity fluids amenable to development will be found in other parts of the valley. A few miles to the south in Cerro Prieto,

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\*Economic Geologist, Oregon State Department of Geology and Mineral Industries.

Mexico, low salinity fluids have been found, and development is under way on the first 75,000 kw unit of a planned 300,000 kw plant.

Probably the most important development in the United States during the year was President Nixon's signing of the Federal Geothermal Leasing Law on Christmas Eve. The passage of this act allows exploration and development on federal lands, withholding national parks, wildlife refuges, wilderness areas and Indian trust lands. This bill was of particular importance because it is believed that at least 75 per cent of the land with a potential for producing geothermal resources is owned by the Federal Government.

During the year numerous articles about geothermal power appeared in the newspapers and magazines, as the press and public became aware of the promise of geothermal energy and its capacity for producing electricity with minimal impact on the environment. The public's growing enthusiasm for this clean power source is well founded because the geothermal boiler is deep within the earth and requires no combustion with its attendant smoke, sulfur oxides, nitric oxides, and fly ash. Nor is there any radioactivity associated with either the generating plant or the supporting activities.

The public's attitude toward geothermal energy, along with its proven economic advantages, has caused the electric power utilities to show more interest in the possibilities of geothermal power generation. During the hearings in Washington, D. C. on the Federal Steam Leasing Law, other utility companies, besides Pacific Gas & Electric, testified that they supported the development of geothermal energy even though their funds for research activities are limited. Southern Edison is furnishing some of the funds for the Imperial Valley studies of Dr. Robert Rex and his group at the University of California, Riverside. Sierra Pacific Power is working with Magma Power Co. to develop a method for producing electrical power from hot water reservoirs. Both of these companies, along with the Northern California Power Agency, have expressed interest in purchasing natural steam.

World-wide interest in geothermal energy was demonstrated in 1970 by the Second International Symposium on Geothermal Resources, sponsored by Italy and the United Nations, held in Pisa, Italy, during September. (The first international meeting was in Rome in 1961.) Papers presented at Pisa summarized the developments of geothermal energy around the world since 1961, and presented new ideas for its exploration and utilization.

The exploration for geothermal resources is going through a transitional period as new ideas are being put forth, tested in the field, and in many cases rejected. Geologic thought is changing from: "Find a hot spring and drill it" to more basic theories developed from studies of volcanology, plate tectonics, and sea floor spreading. One of the tools being used most extensively is temperature gradient surveys. By this method areas of high heat flow can be located, the first requirement for a geothermal field, but

it does not necessarily indicate the presence of a reservoir containing geothermal fluids. The detection of characteristic seismic impulses radiating from the geothermal reservoir at depth is the principle of the geothermal ground noise and microseismic methods. These methods have apparently figured in the recent dry steam discoveries in Mexico and New Mexico.

Several factors combine to predict widespread utilization of geothermal resources in the western United States during the 1970's. First is the passage of the Federal Leasing Law thereby making large blocks of land available on which to explore. Next is the recognition that electricity can be produced by this method with a minimal effect on the environment. A third factor is new financing coming in from oil and mining companies that are beginning to explore for geothermal resources. This is occurring at a time when exploration philosophies are crystallizing and sophisticated geophysical tools are becoming available.

Within the Department of Geology and Mineral Industries, our main activity has been to act as a "clearing house" for information on geothermal resources. During the year we have been called on many times to provide information on this subject from groups as diverse as high school students and members of the Congress of the United States. One staff member, R. G. Bowen, attended the International Symposium for development and utilization of geothermal resources in Pisa, Italy. A map listing thermal springs and wells (Miscellaneous Paper 14) was published by the Department in December. Several geothermal gradients were measured in wells drilled for other purposes in eastern Oregon and "borrowed" for study by the Department. A published report will appear on these gradients later in 1972.

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#### FUTURE DEPARTMENT PROGRAMS

In the past, the State of Oregon Department of Geology and Mineral Industries has engaged in a wide variety of activities and short- and long-range programs without benefit of any formally published pronouncement, other than that appearing in the biennial reports. Starting with the next biennium, which begins July 1, 1971, the Department will use a fully detailed set of activities as a guide. A summary of the more important and interesting portions of these activities appears below. Although there are no plans for publication of the complete document, interested persons may examine an open-file copy at the Department's Portland office at any time.

Activity 1 Geologic Studies for Protection and Enhancement of the Environment. Geology is the study of the earth and man is steadily damaging the earth by dumping his waste materials without regard to the environment. The Department plans to continue its studies of suitable sites for disposal of

solid, chemical, and nuclear wastes. Selection of the best sites for construction of homes, factories, and public improvements and the identification of economic reserves of sand and gravel and stone will occupy a considerable portion of the Department's activities.

Environmental concern caused by power-generation plants has spurred research by the Department into possible sources in the state for geothermal steam. Oregon has a wealth of volcanic areas of very recent origin. The hot rocks lying at depth under these areas offer possible sites for developing steam at high temperature and pressure. Geothermal power is "clean," in that there is no air or water pollution and there is a minimum of alteration of the environment.

Activity 2 Oil and Gas. The Department is charged with the responsibility for administering the Oil and Gas Conservation Act. The Department enforces safe drilling practices for test wells, prevents the transfer of subsurface waters, and ensures that all holes are permanently filled and capped. Records of all test wells eventually become available for inspection, and the Department publishes compilations and test results based on these and other data. The Federal Tax Court has ruled that geothermal steam is mineral in character, and since the problems encountered in drilling for high pressure steam are closely similar to those met in gas and oil wells, the Department plans to draw up rules and regulations designed to protect the public, the environment, and the resource itself from undue danger.

Activity 3 Economic Geology Studies. Geology is a many-faceted science. One of the most important facets is mineral economics. Our level of civilization has been largely achieved by our ability to extract mineral wealth at a minimum expense. Over the years[and with continued emphasis for the coming biennium] the Department has conducted basic studies designed to define target areas where better-than-average chances for discovering mineral reserves exist. Publication of the findings of these studies leads, hopefully, to their exploration by mining companies. A long-range geochemical program of stream-sediment sampling will be continued and approximately 2000 square miles of the state will be mapped geologically.

Activity 4 Interagency Assistance. The Department assists approximately 30 other state agencies in various ways. Assistance will be given in the drafting of some proposed legislation for the mining of offshore hard minerals in areas administered by the state.

Activity 5 Special Services. The Department serves as a clearing house for all types of geologic information. It is anticipated that about 750 requests for information will be received from industry, local governments and other agencies during the coming biennium. Basic geologic information

will be provided to several local governments to assist them in long-range planning.

Activity 6 Public Services. The Department has always provided the public with free assays of rocks and minerals found in the state. The Department also operates a spectrographic laboratory which makes a nominal charge for its services to both industry and the public generally. Hundreds of requests for rock, mineral, and fossil identification are also handled in addition to an expected 13,500 other requests for information on Oregon geology by the public. The Department issues The ORE BIN, the only state publication distributed on a subscription basis. Approximately 80,000 copies will be printed during the coming biennium.

Activity 7 Recreation Geology. Oregon's wide variety of interesting geologic phenomena ranges from the spectacular coastline to the glaciated mountains, surging rivers, barren deserts, and volcanic areas just barely cool. Excellent highways make most of these features readily accessible and the demand for geologic information increases yearly. The Department plans to publish a series of articles on some of the outstanding features and several road logs for scenic highway stretches. A history of Oregon mining will be printed as well as the geology of five more of the state's parks.

Activity 8 Information and Education. Geology used to be taught only in colleges. Now instruction is being given in high schools and grade schools and both teachers and pupils are calling on the Department for information. The Department is planning to prepare a series of basic course outlines in geology for classroom use, as well as some pamphlets of general interest. At the adult level the Department will continue to provide access to materials in its collections of publications, reports, minerals, fossils and industrial products, as well as present radio and television programs on geologic subjects.

Activity 9 Preparation for Geologic Catastrophies. The Department operates very much like a fire department. Immediately after a geologic catastrophe such as a landslide, an earthquake, a seismic sea wave, volcanism, flooding, or land subsidence, the Department receives calls from concerned citizens, local governments, and industry. On the other hand, the Department spends much of its time with studies and investigations designed to either eliminate these geologic hazards or lessen their effect. These studies begin with a geologic reconnaissance of the region, followed by more intensive studies of potentially hazardous areas, and finally recommendations for site use and suggested procedures to reduce likelihood of the hazard's occurrence.

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## AVAILABLE PUBLICATIONS

(Please include remittance with order. Postage free. All sales are final and no material is returnable. Upon request, a complete list of the Department's publications, including those no longer in print, will be mailed.)

### BULLETINS

8.	Feasibility of steel plant in lower Columbia River area, rev. 1940: Miller	0.40
26.	Soil: Its origin, destruction, preservation, 1944: Twenhofel	0.45
33.	Bibliography (1st supplement) of geology and mineral resources of Oregon, 1947: Allen	1.00
35.	Geology of Dallas and Valsetz quadrangles, Oregon, rev. 1963: Baldwin	3.00
36.	Vol. 1. Five papers on western Oregon Tertiary foraminifera, 1947: Cushman, Stewart, and Stewart	1.00
	Vol. 2. Two papers on foraminifera by Cushman, Stewart, and Stewart, and one paper on mollusca and microfauna by Stewart and Stewart, 1949	1.25
37.	Geology of the Albany quadrangle, Oregon, 1953: Allison	0.75
46.	Ferruginous bauxite deposits, Salem Hills, Marion County, Oregon, 1956: Corcoran and Libbey	1.25
49.	Lode mines, Granite mining dist., Grant County, Ore., 1959: Koch	1.00
52.	Chromite in southwestern Oregon, 1961: Ramp	3.50
53.	Bibliography (3rd supplement) of the geology and mineral resources of Oregon, 1962: Steere and Owen	1.50
57.	Lunar Geological Field Conference guide book, 1965: Peterson and Groh, editors	3.50
58.	Geology of the Supplee-Izee area, Oregon, 1965: Dickinson and Vigrass	5.00
60.	Engineering geology of the Tualatin Valley region, Oregon, 1967: Schlicker and Deacon	5.00
62.	Andesite Conference Guidebook, 1968: Dole, editor	3.50
63.	Sixteenth Biennial Report of the State Geologist, 1966-68	Free
64.	Mineral and water resources of Oregon, 1969	1.50
65.	Proceedings of the Andesite Conference, 1969: McBirney, editor	2.00
66.	Reconnaissance geology and mineral resources, eastern Klamath County & western Lake County, Oregon, 1970: Peterson & McIntyre	3.75
67.	Bibliography (4th supplement) geology & mineral industries, 1970: Roberts	2.00

### GEOLOGIC MAPS

Geologic map of Oregon (12" x 9"), 1969: Walker and King	0.25
Preliminary geologic map of Sumpter quadrangle, 1941: Pardee and others	0.40
Geologic map of Albany quadrangle, Oregon, 1953: Allison (also in Bull. 37)	0.50
Geologic map of Galice quadrangle, Oregon, 1953: Wells and Walker	1.00
Geologic map of Lebanon quadrangle, Oregon, 1956: Allison and Felts	0.75
Geologic map of Bend quadrangle, and reconnaissance geologic map of central portion, High Cascade Mountains, Oregon, 1957: Williams	1.00
GMS-1: Geologic map of the Sparta quadrangle, Oregon, 1962: Prostka	1.50
GMS-2: Geologic map, Mitchell Butte quad., Oregon, 1962: Corcoran et al.	1.50
GMS-3: Preliminary geologic map, Durkee quad., Oregon, 1967: Prostka	1.50
Geologic map of Oregon west of 121st meridian: (over the counter)	2.00
folded in envelope, \$2.15; rolled in map tube, \$2.50	
Gravity maps of Oregon, onshore and offshore, 1967: [Sold only in set]: flat	2.00
folded in envelope, \$2.25; rolled in map tube, \$2.50	

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### SHORT PAPERS

2. Industrial aluminum, a brief survey, 1940: Motz . . . . . \$ 0.10
18. Radioactive minerals the prospectors should know (2nd rev.), 1955:  
White and Schafer . . . . . 0.30
19. Brick and tile industry in Oregon, 1949: Allen and Mason . . . . . 0.20
20. Glazes from Oregon volcanic glass, 1950: Jacobs . . . . . 0.20
21. Lightweight aggregate industry in Oregon, 1951: Mason . . . . . 0.25
23. Oregon King mine, Jefferson County, 1962: Libbey and Corcoran . . . . . 1.00
24. The Alameda mine, Josephine County, Oregon, 1967: Libbey . . . . . 2.00

### MISCELLANEOUS PAPERS

1. Description of some Oregon rocks and minerals, 1950: Dole . . . . . 0.40
2. Key to Oregon mineral deposits map, 1951: Mason . . . . . 0.15  
Oregon mineral deposits map (22" x 34"), rev. 1958 (see M.P. 2 for key) . . . . . 0.30
3. Facts about fossils (reprints), 1953 . . . . . 0.35
4. Rules and regulations for conservation of oil and natural gas (rev. 1962) . . . . . 1.00
5. Oregon's gold placers (reprints), 1954. . . . . 0.25
6. Oil and gas exploration in Oregon, rev. 1965: Stewart and Newton . . . . . 1.50
7. Bibliography of theses on Oregon geology, 1959: Schlicker . . . . . 0.50
7. (Supplement) Bibliography of theses, 1959 to Dec. 31, 1965: Roberts . . . . . 0.50
8. Available well records of oil & gas exploration in Oregon, rev. '63: Newton . . . . . 0.50
11. A collection of articles on meteorites, 1968: (reprints, The ORE BIN) . . . . . 1.00
12. Index to published geologic mapping in Oregon, 1968: Corcoran . . . . . Free
13. Index to The ORE BIN, 1950-1969, 1970: M. Lewis . . . . . 0.30
14. Thermal springs and wells, 1970: R.G. Bowen and N.V. Peterson . . . . . 1.00

### MISCELLANEOUS PUBLICATIONS

- Oregon quicksilver localities map (22" x 34"), 1946 . . . . . 0.30
- Landforms of Oregon: a physiographic sketch (17" x 22"), 1941 . . . . . 0.25
- Index to topographic mapping in Oregon, 1968 . . . . . Free
- Geologic time chart for Oregon, 1961 . . . . . Free

### OIL and GAS INVESTIGATIONS SERIES

1. Petroleum geology of the western Snake River basin, Oregon-Idaho, 1963:  
Newton and Corcoran. . . . . 2.50
2. Subsurface geology of the lower Columbia and Willamette basins, Oregon,  
1969: Newton . . . . . 2.50