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for compiling this information will be appreciated.

Oregon's mineral production during 1969 slackened somewhat from that of the previous year, largely because of local economic conditions. The minerals industry is remarkably resilient, however, and it is predicted that there will be an upswing in activity during the coming decade, particularly in the field of industrial minerals. Petroleum exploration in the state was at its lowest level in many years, mostly because of the recent discovery of several large oil fields in northernmost Alaska.

As in past years, the Department staff has summarized Oregon's mineral and metallurgical industry and petroleum exploration in the January ORE BIN. This year, in addition to the summary, we are reporting on other current geological studies in the state, particularly those with which our Department is concerned. Although we are continuing the fundamental programs of geologic mapping and economic mineral investigations, we have become increasingly involved in several other projects that were not even thought of when the Department was formed more than 30 years ago. Large-scale urbanization in the United States began in the latter part of the 19th century, and this phenomenon, coupled with the population "explosion," has created an environment that is threatening the health and welfare of the general public.

Our Department is working in cooperation with other state agencies and with county and local planning commissions to carry out environmental geologic studies in the more heavily populated areas of Oregon. Those who are charged with the responsibility of preventing further environmental pollution are relying on data provided by our geologists and engineers in order to establish a basic geological framework for urban planning.

R.E.C.

OREGON'S MINERAL AND METALLURGICAL INDUSTRY IN 1969

By Ralph S. Mason*

Responding to the economic pressures of the times, Oregon's mines and metallurgical plants slacked up a bit on their productive efforts during the year. Both mining and metallurgy are productive only in response to demand, and since they are neither subsidized for producing surplus materials nor paid for nonproduction, they must necessarily trim their activities to fit the requirements of industry and the public generally. Total mineral production for 1969 has been estimated by the U.S. Bureau of Mines at \$63 million, down 2.4 percent from the previous year.

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

Some of Oregon's Minerals at a Glance. Preliminary Figures for 1969 (in thousands of dollars)		
	1968	1969
Clays	\$ 284	\$ 253
Diatomite	W	W
Gem stones	750	750
Gold (recoverable content of ores, etc.)	1	15
Lime	2,407	2,387
Mercury	502	24
Nickel (content of ore and concentrate)	W	W
Peat	11	10
Pumice and volcanic cinders	977	960
Sand and gravel and stone	42,625	42,400
Silver (recoverable content of ores, etc.)	1	7
Talc and soapstone	1	W
Value of items that cannot be disclosed: Cement, copper (1968), lead (1968), and values indicated by symbol "W"	16,890	16,137
Total	\$64,449	\$62,943

The Metals

The ferrous metals industry in the state saw two developments during the year. In the Rivergate district of Portland, Oregon Steel Mills, a subsidiary of Gilmore Steel Co., approached completion of a \$35-million steel manufacturing complex which will use iron ore from Peru. The imported ore, which leaves Peru in a semiliquid state, arrives at its destination as a firmly compacted, dense concentrate containing about 8 percent water. High-pressure

water jets are needed to return the material to a slurry for pumping ashore into reservoirs. The material is then converted into metallized pellets in a plant owned by Midland Ross adjacent to the steel complex. At McMinnville, Cascade Steel Rolling Mills began operating on steel scrap obtained locally.

Production of aluminum from the two smelters located in the state declined 2.4 percent compared with that of the previous year. Reynolds Metals produced 100,000 tons of metal at its Troutdale plant and began construction of a fifth potline which will increase its present capacity by 30 percent when completed in 1971. At The Dalles, Harvey Aluminum produced 87,000 tons of aluminum and made plans to spend \$3.25 million on a fluoride fume recovery installation.

Reynolds Metals announced that it had acquired the ferruginous bauxite holdings of the Aluminum Co. of America in Columbia, Washington, and Multnomah Counties. The State of Oregon Department of Geology and Mineral Industries discovered the extensive low-grade aluminum deposits in 1944. Reynolds has additional holdings in the same general area as well as in the Salem Hills district of Marion County.

The Lower Powder River and Sparta districts of Baker County were the scene for additional exploration for copper during the year. Baker Mountain Copper, Ltd. of Vancouver, B.C. conducted a soil-sampling program in the same general area reported on by the Department as a result of its geochemical survey there a number of years ago. Baker Mountain's activities are centered on 100 claims owned by the Oregon Copper Co.

Plans for a major gold and silver mining and milling operation in the Bourne area of Baker County were abandoned late in the fall by Omega Mines Co., Ltd. of Vancouver, B.C. Omega had done extensive work on one of the strongest vein systems in the district for several years. The mineralized zone extends for approximately 18,000 feet. Mines in the Bourne area include the Columbia, North Pole, E and E, Tabor Fraction, and others which have produced at least \$8 million since the first production in the 1870's, with principal activity during the period 1874-1916. Also in Baker County, the Bald Mountain mine operated by Tony Brandenthaler shipped concentrate, following a development program. Placer mining in the state was confined to a few small seasonal operations. Cornucopia Placers, Inc. in Baker County diverted the waters of Pine Creek and opened a gold placer pit during the year. The operation reuses its water and no stream pollution has resulted. Pine Creek, which flows past the famous and now defunct Cornucopia mine, contains many large boulders and the bedrock is deep. Early efforts to work the stream were thwarted by these factors.

As has been the case for the past 10 years, recreational gold panning and skin diving for gold constituted a favorite pastime for many vacationing individuals and families in both northeastern and southwestern Oregon.

The state, which has been an important mercury producer over the years, ended 1969 without a single operator despite an average annual price per flask of mercury of \$504. During the year only 47 flasks were produced, an extreme reduction from the 938 furnished the previous year. In Jefferson County an exploration program, partly financed by Office of Minerals Exploration funds, was under way just west of the famous old Horse Heaven mine which closed in 1958, twenty-five years after its discovery. The Canyon Creek mine just south of Canyon City in Grant County was being negotiated for by Dennis Holdings, Ltd. of Vancouver, B.C. Active prospects also included the Elkhead mine in Douglas County and the Polaris in Lake County. A few flasks were recovered during clean-up operations at the Black Butte mine in Lane County following its closure late in 1968.

Hanna Mining Co. continued its nickel operations at Riddle, Douglas County, at about the same level as in recent years. Hanna mined slightly more than 1 million tons of nickel laterite containing 1.41 percent nickel. The company marketed 25,991 tons of ferronickel containing 13,227 tons of nickel.

Large areas of Harney and Malheur Counties were explored again this year by the Nuclear Fuels Division of Gulf Oil Corp. in its search for uranium. In addition to using airborne sensing equipment, Gulf drilled some of the more critical areas.

The metallurgical treatment of various modern metals continued to increase during 1969. Oregon Metallurgical Corp. at Albany began construction of a plant to process rutile, a titanium ore, into titanium tetrachloride, an intermediate product before final reduction to titanium metal.

The Million-Dollar-a-Year Club, 1968*

<u>County</u>	<u>Value</u>	<u>County</u>	<u>Value</u>
Baker	\$5,812,000	Jackson	\$1,191,000
Clackamas	11,439,000	Klamath	1,097,000
Columbia	1,068,000	Lane	6,944,000
Curry	1,911,000	Multnomah	7,448,000
Douglas	9,295,000	Washington	2,054,000

* In addition to the values shown, there was a total of \$7,706,000 which could not be assigned to specific counties. Production from Clatsop, Gilliam, Grant, Harney, Malheur, Union, 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 \$1,785,000 during the year.

The first boatload of ore from Australia arrived late in the year in anticipation of a March 1970 start-up. Wah Chang Albany Corp. developed a columbium alloy suitable for airplane castings and REM Metals Corp., also located in Albany, produced the first contamination-free casting with the new alloy. Wah Chang, which produces a variety of modern metals and alloys, entered the fertilizer business late in the year when it began producing ammonium sulfate from waste fumes developed by some of its reduction processes. The plant will produce about 10 tons of crystals daily.

Precision Castparts, which has been turning out precision castings in various metals for a number of years, has added investment casting of titanium to its operations located in Portland. Investment casting, also known as the "lost wax" method, has been used by artisans and dentists for many years to make small metal objects patterned after a wax model. Precision can pour castings measuring up to 3 feet in diameter and weighing several hundred pounds. Ti-Line Corp., Albany, originally producing titanium-lined castings backed up by common metals, has now switched to all-titanium spun castings. The company can pour shapes 100 inches in diameter and weighing more than a ton. Zirconium Technology Corp. completed its 30,000-square-foot facility at Albany for drawing small-diameter high-alloy tubing and bar stock. The company specializes in forming zirconium for nuclear reactors and aircraft. Ground was broken in midyear by Advanced Alloys, Inc. for a space-age metals plant in the Tualatin area. The company will produce alloy metals for the aerospace industry. Refractory Metals Fabrication announced plans early in the year for a 16,000-square-foot plant to be erected in the Albany area. Initial plant and equipment investment would amount to \$250,000.

Growth Minerals

One of the minor miracles of the mineral industry is its ability to take common sand and gravel, limestone, clay, and a few other minerals and, with a bit of alchemy, produce an endless variety of concrete structures limited only in size and design by the needs, the financial resources, and the imagination of man. The final value of the raw materials, by the time they become incorporated into structural concrete, becomes evident when the total picture is seen. As the raw materials leave the pit, they are worth approximately \$1.25 per cubic yard; when delivered to a job, their value is about 10 times greater; and when placed in a steel-reinforced concrete building, they are worth more than 100 times their original cost.

There is no substitute construction material available for sand and gravel, the principal ingredient in concrete. Even though communities are dependent upon these raw materials for continued growth, the sand and gravel reserves are being treated, in many instances, as though they were inexhaustible. Unfortunately, although the total state reserves are large, some areas will be critically short of readily available sand and gravel within 10 years, unless immediate steps are taken to protect deposits from urbanization until they can be utilized.

In a period characterized by rapid price increases, the sand and gravel industry has held prices down to less than a one-percent annual gain for the past 10 years. In 1969 the industry produced 33 million cubic yards of stone, sand, and gravel worth \$42.4 million. These figures compare with the previous year's very closely, since volume increased slightly but value declined fractionally, resulting in a 2-cents-per-yard drop in average value. Another stabilizing economic factor is also provided by the sand and gravel industry in the form of steady work. Labor statistics show that the industry enjoys almost total full-year employment, in sharp contrast to many other segments of the economy which have seasonal fluctuations.

Natural Hot Water

At Klamath Falls, hot water continues to be sought for and utilized. During 1969 at least three wells were drilled, one to heat the new Ponderosa Retirement apartments and two to provide heating and hot water for the new Ponderosa Junior High School.

At Lakeview, Desert Farms, Inc. is evaluating an interesting pilot greenhouse project where tomatoes are being grown for local markets. The greenhouse is heated from a hot-water well on the property. Initial results have been successful and construction is under way on a larger greenhouse. Near-surface natural heat at this location appears to be sufficient for any considered expansion.

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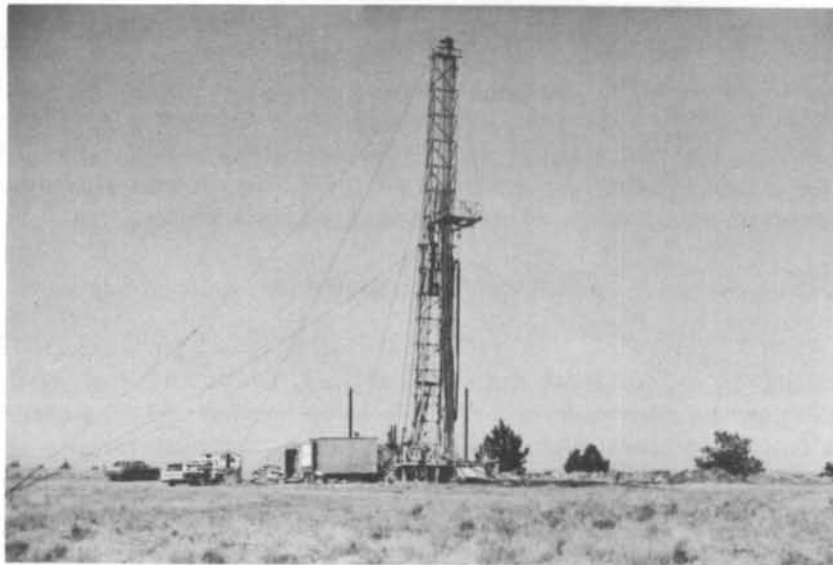
OIL AND GAS EXPLORATION IN OREGON IN 1969

By V. C. Newton, Jr.*

Petroleum exploration in Oregon during 1969 was at the lowest level in many years. The slump in activity can be attributed to large discoveries of oil in Alaska and to recent disappointment with results of drilling offshore in Oregon. Oregon has never produced commercial amounts of oil or gas, but there are still regions in the state that have not been tested and that may prove to be productive at some time in the future. Drilling in Oregon has been cyclic in the past, with the latest cycles showing the greatest amplitude. The last cycle, represented by the 1960-1967 period of exploration of the continental shelf, terminated after eight deep holes were drilled offshore. During that 7-year period, 12 firms spent approximately \$60 million on exploration studies along the Oregon coast.

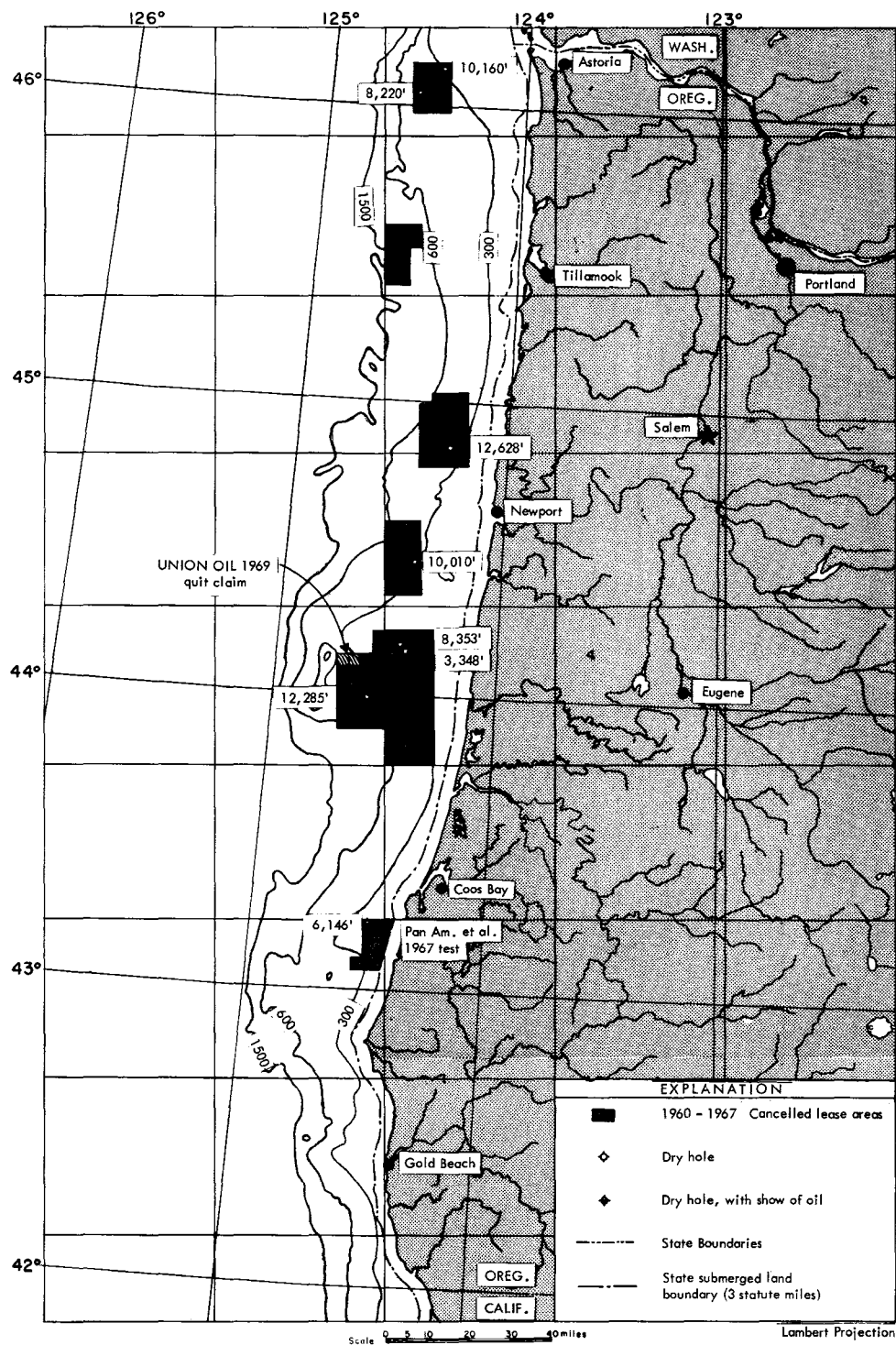
Onshore Activity

Approximately 85,000 acres of land are presently under lease in the state for oil and gas minerals. This total, compared to more than a million



R. F. Harrison - Morrow No. 1
located 8 miles southeast of Madras in central Oregon.

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



OREGON OFFSHORE EXPLORATION

acres leased in 1962, demonstrates the low level of activity in 1969. An estimated 60,000 acres of leases in western Oregon obtained in 1967 by Mobil, Texaco, and Standard Oil Companies are still in effect. The R.F. Harrison Group from Seattle, Wash. (formerly Central Oils, Inc.) has retained at least 5000 acres of federal leases in central Oregon. The U. S. Bureau of Land Management reported it had 37 oil and gas leases in effect in 1969 totaling 23,905 acres. The State Lands Division did not lease any lands for oil and gas minerals in 1969.

Active permit

<u>Company</u>	<u>Lease</u>	<u>Location</u>	<u>Status</u>
R.F. Harrison	Morrow ranch	Sec. 18, T. 12 S., R. 15 E. Jefferson County	Depth 3300'. At- tempting to deepen original hole.

Offshore Activity

The latest hole drilled offshore from Oregon was begun in April 1967 and abandoned in May of that year at a depth of 6146 feet. This wildcat, located 7 miles offshore from Cape Arago on the southern Oregon coast, was the joint effort of Pan American Petroleum and eight other companies. By 1967 most of the companies had terminated their offshore drilling leases. Union Oil Co.'s two remaining parcels (P-085 in tract No. 39, and P-086 in tract No. 40) offshore from Florence, Ore., expired November 30, 1969 (see accompanying map).

During the past few years several oil companies have been conducting limited seismic surveys off the coast in order to refine earlier data. In 1969, five firms held exploration permits to conduct geological and geophysical studies on state and federal lands off Oregon.

Active Exploration Permits in 1969

<u>Company</u>	<u>Outer Continental Shelf</u>	<u>State Submerged Lands</u>
Mobil	1- 1-69 to 6-30-69	-
Shell	12-31-68 to 6-30-69	-
Standard	-	9- 1-69 to 9- 1-71
Texaco	4-16-69 to 11- 6-69	5-14-68 to 5-14-70
Humble	10-23-69 to 4-23-70	-

* * * * *

FIELD WORK IN OREGON

During the 1969 field season the number of geologists working in Oregon, excluding private-company personnel, totaled nearly 90. This number is approximately the same as last year, and reflects a general leveling off of field activity over the past two or three seasons.

Listed below are the various geologic studies in the state. For convenience in showing where these field projects are located, the state is divided into six districts. Separate sections are added which list water resource, oceanographic, and soils studies. It should be noted that this list probably is not complete, and the Department would appreciate receiving information about other geologic field studies in progress in Oregon of which we are not aware.

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. Snively, Jr., and Norman MacLeod, U.S. Geological Survey, Menlo Park, Cal.
3. Paleomagnetism of late Tertiary intrusives in the Western Cascades. Michael Fuller, Chairman, Department of Earth and Planetary Sciences, Univ. Pittsburgh.
4. Engineering geology of the northern Willamette Valley. H. G. Schlicker, DOGAMI*, and R. J. Deacon, consulting geologist, Shannon & Wilson Co.
5. Geology of the Columbia River Gorge. A. C. Waters, Chairman, Division of Natural Sciences, Univ. California Santa Cruz.
6. Petrology of the Scott Creek pillow basalt, upper McKenzie River valley. E. H. Lund, Professor of Geology, UO.
7. Trace-element geochemistry, Western Cascades. R. L. Beyer, Center for Volcanology, UO.
8. Chemical and paleomagnetic stratigraphy of the Yakima Basalt in northwestern Oregon and southwestern Washington. Clive Kienle, doctoral candidate, Univ. California Santa Barbara.
9. Remanent magnetism and cooling histories of igneous materials: Cedar Creek sill and other small intrusives in the Coast Range. Alice E. Hickcox, doctoral candidate, Rice Univ.

Southwest Oregon

1. Oregon black sands project. H. E. Clifton, U.S. Geological Survey, Menlo Park, Cal.

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

2. Marine-fluvial interface, coastal Oregon. R. J. Janda, U. S. Geological Survey, Menlo Park, Cal.
3. Alpine-type ultramafic rocks. Robert Loney, U.S. Geological Survey, Menlo Park, Cal.
4. Oregon blueschist tectonic belt, Roseburg to Gold Beach. Robert Loney, U.S. Geological Survey, Menlo Park, Cal.
5. Petrology of an alpine-type gabbro and its bearing on the origin of the Josephine peridotite, Klamath Mountains, Oregon. David Jorgenson, doctoral candidate, Univ. California Santa Barbara.
6. Geology of the upper Chetco River area. Len Ramp, DOGAMI.
7. Sand and gravel deposits of Jackson County. H. G. Schlicker, DOGAMI, and R. J. Deacon, consulting geologist, Shannon & Wilson Co., Portland, Ore.
8. Geology of the Tiller area. M. A. Kays, Professor of Geology, UO.
9. Petrologic significance of plutonic ejecta at Crater Lake, Oregon. John Lidstrom, doctoral candidate, OSU.
10. Geochemistry of late stage Mount Mazama rocks. Frank Radke, Jr., doctoral candidate, Center for Volcanology, UO.
11. Stratigraphy and sedimentary petrology of the Late Cretaceous Hornbrook Formation in the vicinity of Hornbrook, Siskiyou County, Cal., and Jackson County, Ore. Monty Elliott, doctoral candidate, OSU.
12. Geology of the NW $\frac{1}{4}$ of the Bone Mountain quadrangle. A. Krans, master's candidate, UO.
13. Geology of the Camas Valley and Tyee quadrangles. E. M. Baldwin, Professor of Geology, UO.
14. Geology of the Tiller and Days Creek quadrangles. M. A. Kays, Professor of Geology, UO.
15. Petrology and structure of the Preston Peak area. Arthur W. Snoke, doctoral candidate, Stanford Univ.
16. Trace element geochemistry, Western Cascades. R. L. Beyer, Center for Volcanology, UO.
17. Petrography of quartz diorites in southwest Oregon. E. H. Lund, Professor of Geology, UO.
18. Fluorescent tracer analysis of fluvial sediments, southwestern Oregon. Sam Boggs, Jr., Professor of Geology, and Charles Jones, master's candidate, UO.
19. Size and shape sorting of pebbles in the Elk River, southwestern Oregon. Fred Swanson, master's candidate, UO.
20. Petrology and structure of the Ashland pluton, southwestern Oregon. M. Allan Kays, Professor of Geology, UO.
21. Petrology and structure of the May Creek Schist belt. M. Allan Kays, UO.
22. Geology and mineral deposits of Eden Valley-Saddle Peak and vicinity, southeast Coos County, Oregon. Wm. C. Utterback, master's candidate, OSU.
23. Stratigraphy and sedimentary petrology of the Colestin Formation from the type locality at Colestin Springs, Jackson County, Oregon to Hornbrook, Siskiyou County, California. Richard W. Carlton, doctoral candidate, OSU.
24. Differentiation of vaporous and ionic origin of trace mercury in soils. Paul B. Trost, doctoral candidate, Colo. School of Mines, and Ramon E. Bisque, Professor of Geochemistry and Head, Dept. Chemistry, Colo. School of Mines.

North-central Oregon

1. The Yakima Basalt of western Oregon and Washington. Clive Kienle, doctoral candidate, Univ. California Santa Barbara.
2. Geologic and paleomagnetic mapping of volcanic units of east slope of Cascades between Broken Top volcano and town of Sisters, southern one-half of Green Ridge and westward to crest line. E. M. Taylor, Professor of Geology, OSU.
3. Geology and petrology of the Rattlesnake Formation, central Oregon. H. E. Enlows, Professor of Geology, OSU, and the late W. D. Wilkinson, Professor of Geology, OSU.
4. Petrography of the Rattlesnake Formation of the upper Crooked River drainage area in central Oregon. Ronald E. Davenport, doctoral candidate, OSU.
5. Geochemical prospecting, western Blue Mountains. R. G. Bowen, DOGAMI.
6. Petrology of the Oregon Cascade Range. A. R. McBirney, Chairman, Dept. of Geology, UO.
7. Trace element geochemistry: Columbia River Basalt and High Cascade Range, Oregon. G. G. Goles, Professor of Geology, and M. Osawa, Visiting Professor, Center for Volcanology, UO.
8. Trace element geochemistry: Three Sisters area in Oregon, Mount Shasta in California, Mount Adams in Washington. T. L. Steinborn, Center for Volcanology, UO.
9. Strontium and lead isotopic compositions of Cascade andesite and their bearing on andesitic genesis. Stanley Church, doctoral candidate, Univ. California Santa Barbara.
10. Mammalian fauna from the Clarno Formation, Camp Hancock locality, Oregon. Bruce Hanson, doctoral candidate, Dept. of Paleontology, Univ. California Berkeley.
11. Middle and Lower Jurassic faunas of eastern Oregon. R. W. Imlay, U. S. Geological Survey, Washington, D.C.
12. Geology and petrology of the Rattlesnake Formation, central Oregon. H. E. Enlows, Professor of Geology, OSU.
13. Tethyan fusuline fauna of central Oregon. David A. Bostwick, Professor of Geology, OSU.
14. Cretaceous marine embayment, central Oregon. Also, Bedrock geology, SE $\frac{1}{4}$ Mitchell quadrangle. Keith F. Oles, Professor of Geology, OSU.

South-central Oregon

1. Geology of Hole-in-the-Ground and Big Hole maars. V. W. Lorenz, Center for Volcanology, UO.
2. Geothermal steam investigations in south-central Oregon. R. G. Bowen and N. V. Peterson, DOGAMI.
3. Geology of proposed waste management areas, Lake and Klamath Counties, Oregon. V. C. Newton, Jr., DOGAMI.
4. Petrology of the Oregon Cascade Range. A. R. McBirney, Chairman, Department of Geology, UO.
5. Seismicity investigations in the Cascade Range. H. R. Blank, Professor of Geology, and M. M. Brown, doctoral candidate, Center for Volcanology, UO.

6. Trace element geochemistry, Newberry Crater. D. J. Lindstrom, Center for Volcanology, UO.

Northeast Oregon

1. Geology of the Olds Ferry and Huntington quadrangles, Oregon. H.C. Brooks, DOGAMI.
2. Geology of the Snake River Canyon. T. L. 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, Cal.
5. Middle and Lower Jurassic faunas of eastern Oregon. R.W. Imlay, U.S. Geological Survey, Washington, D.C.
6. Permian stratigraphy of central and eastern Oregon. David A. Bostwick, Professor of Geology, OSU.
7. Sulfur isotope investigation of sulfate and sulfide minerals of the Oregon-Idaho border area. C. W. Field, Professor of Geology, and Wayne R. Bruce, OSU.
8. Evolution of the Wallowa Mountains. W.H. Taubeneck, Professor of Geology, OSU.
9. Paleomagnetism of the Miocene(?) Strawberry Volcanics, Strawberry Lake area. Donald Heinrichs, Professor of Geology, Dept. of Oceanography, OSU.

Southeast Oregon

1. Geology of the Diamond Craters volcanic field. L. 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, Cal.
3. Trace element geochemistry, Owyhee area. D. J. Lindstrom, Center for Volcanology, UO.
4. Geology of south-central Pueblo Mountains, Oregon-Nevada. W. A. Rowe, master's candidate, OSU.
5. Geology of the southern Pueblo Mountains. H. E. Enlows, Professor of Geology, OSU.

WATER RESOURCE STUDIES

1. Relationship between sedimentary environment and radionuclide concentrations in the Columbia River estuary. David Hubbell and Jerry Glenn, U.S. Geological Survey, Portland, Ore.
2. Ground-water study of the Klamath Basin. A. R. Leonard and A. B. Harris, U.S. Geological Survey, Portland, Ore.
3. Ground-water studies in Medford-Ashland area, Jackson County, Oregon. James H. Robison, U.S. Geological Survey, Portland, Ore.
4. Ground-water studies in Eugene-Springfield area, southern Willamette Valley. F. J. Frank, U.S. Geological Survey, Portland, Ore.

5. Water resources in the Harney Basin, Harney County, Oregon. A. R. Leonard, U.S. Geological Survey, Portland, Ore.
6. Ground-water and dam-site feasibility studies; problems of sanitary land fill. W. S. Bartholomew, State Engineers Office, Salem, Ore.
7. Dam-site investigations, Little Luckiamute River and Teal Creek tributary, Polk County; Lower Powder River area, Baker County, Oregon. Roger Paul, U.S. Soil Conservation Service, Baker, Ore.
8. Erosion and sedimentary damage studies, Succor Creek and Upper Bully Creek, Malheur County, Oregon. Frank F. Reckendorf, U.S. Soil Conservation Service, Salem, Ore.
9. Flood-plain studies, Goshen area, Lane County, and Milk Creek-Molalla and Pudding Rivers, Clackamas County, Oregon. Frank F. Reckendorf, U.S. Soil Conservation Service, Salem, Ore.
10. Dam-site investigations and sedimentation studies, Big Creek watershed, Baker and Union Counties; Malloy Dam site, upper Succor Creek, Malheur County. Peter V. Patterson, Soil Conservation Service, Portland, Ore.
11. Sedimentation and erosion study, Rock Creek watershed, Gilliam and Morrow Counties. Peter V. Patterson, Soil Conservation Service, Portland, Ore.
12. Design investigation, Wolf Creek Dam site, Union County. Peter V. Patterson, Soil Conservation Service, Portland, Ore.

OCEANOGRAPHIC STUDIES

1. The economic minerals of the Oregon shelf, present and future potential. K.C. Bowman, Dept. of Oceanography, OSU.
2. Seasonal ecology of benthic foraminifera on the central Oregon shelf. Fred J. Gunther, Dept. of Oceanography, OSU.
3. Paleocology and biostratigraphy of Cenozoic strata, Heceta Bank, central Oregon shelf. Gary B. Muehlberg, Dept. of Oceanography, OSU.
4. The geology of the Juan de Fuca and Gorda Ridges with specific emphasis on gross sediment distribution and clay mineralogy. James B. Phipps, Dept. of Oceanography, OSU.
5. Petrology and petrography of deep-sea volcanic ash layers. Kenneth F. Scheidegger, Dept. of Oceanography, OSU.
6. Marine geology of the Oregon continental margin from Cape Blanco to the Oregon-California border. Joseph J. Spigai, Dept. of Oceanography, OSU.
7. Stratigraphy of Globigerina pachyderma in deep-sea cores from the Juan de Fuca Ridge. Sandra G. Sumich, Dept. of Oceanography, OSU.

SOILS STUDIES

1. Physico-chemical properties of soils from volcanic ash. M. E. Harward, D.P. Moore, R. A. Schmitt, and W. H. Doak, Dept. of Soils, OSU.
2. Crystalline and amorphous clays in fine volcanic ash deposits from Mount Mazama, Oregon. M. E. Harward, D. G. Knox, C. T. Youngberg, Delmar Dingus, Marvin Dudas, and Billy Harris, Dept. of Soils, OSU.

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STATE MAP PROJECT

During the past year, field work on the State Geologic Map project has shown excellent progress. Most of the eastern half of the state has been completed through the efforts of geologists and graduate students from the State of Oregon Department of Geology and Mineral Industries, the U.S. Geological Survey, and the universities. Personnel from the Federal Survey are beginning to compile all available geologic maps of eastern Oregon in order to assemble the final map at a scale of 1:500,000. Progress on some of the last areas under investigation is summarized below.

G.W. Walker, Chief, Oregon State Map Project, U.S. Geological Survey, continued geologic studies in different parts of eastern Oregon directed primarily toward resolving several major problems of Tertiary stratigraphy. Reconnaissance mapping was completed in Paulina Basin and mapping was extended discontinuously eastward to Bear and Silvies Valleys and into the upper Malheur River drainage to the vicinity of Castle Rock in an attempt to establish a stratigraphic column keyed to several widespread early and middle Pliocene ash-flow tuffs. The "basal," crystal-rich ash-flow tuff of the Danforth Formation (lowest in the Devine Canyon sequence north of Burns) has been recognized and traced discontinuously throughout most of this region and, hence, serves as an extremely useful marker horizon.

Systematic reconnaissance mapping was continued in several other areas in eastern Oregon in the southwest part of the Baker (AMS) quadrangle, the southeast corner of the Pendleton (AMS) quadrangle and southwest corner of the Grangeville (AMS) quadrangle.

Samples of ash-flow tuffs and some rhyolite flows of Miocene or older age were collected for isotope dating from outcrops near Silvies, Castle Rock, Ironside Mountain, and Dooley Mountain.

An uncolored geologic map of the east half of the Bend (AMS) quadrangle (scale 1:250,000) by D. A. Swanson was placed in open file and a full-color map of the area is in press. Also, compilation of a geologic map of the Burns (AMS) quadrangle by R. C. Greene, G. W. Walker, and R.E. Corcoran was completed.

Tracy Vallier, Department of Geology, Indiana State University, completed the first of a two-phase reconnaissance geologic mapping program in Snake River Canyon north of Hells Canyon Dam. The project has been financially supported by the Department and, to a lesser extent, the Idaho Bureau of Mines and involves the northward continuation of mapping that Vallier did for his doctoral dissertation during 1963-65. Part of this work has been published in The ORE BIN (December 1967 and December 1968).

Phase one of the project, which was in progress during parts of the 1967, 1968, and 1969 field seasons, involved compilation of a strip map of

the canyon bottom (ranging up to 1000-2000 feet in elevation above river level) between Hells Canyon Dam and the Washington border. Except for an area near that border, very little geologic information had been available for this extremely rugged and inaccessible region. Most of the mapping was accomplished by back-packing from base camps which were moved periodically by boat.

Phase two, which will involve the upper reaches of the canyon walls above the limits of phase one, remains to be done. It is hoped that funds will be made available for Vallier to continue and complete this highly important project.

James McIntyre, consulting geologist for the Department, spent the 1969 field season studying the Tertiary geology in the Baker AMS sheet area. His purpose is to try to alleviate confusion regarding the stratigraphic relationships of some of the Tertiary units which has developed over the years among students of the region. McIntyre is remapping critical areas, particularly parts of the old Baker 1:125,000 quadrangle, for which 1:24,000-scale topographic coverage has recently become available.

Howard Brooks continued detailed stratigraphic study of the Triassic and Jurassic sedimentary and volcanic rocks in the Huntington and Olds Ferry quadrangles. He has spent parts of several field seasons in that area and hopes to complete work by the end of 1970, but notes that indistinctive lithologies, structural complexities, and scarcity of fossils make detailed mapping difficult and slow.

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DEPARTMENT PROGRAMS

Environmental Geology

Oregon is beginning to feel the pressures of a population increase which is destined to become a major problem within a very few years. Planners and government officials are already faced with decisions that require professional geologic knowledge. They need information on the stability of foundation sites, the availability of ground water, and the potential for mineral resources. Population growth always gives rise to contamination problems because of increased consumption of surface and ground water combined with the increased use of septic tanks, dumping of refuse, and disposal of industrial waste. To understand the limits to which the ground can be utilized, the geology must be studied and the data made available to the persons responsible for land-use planning.

The Department has been involved in a number of studies related to environmental geology. The work has consisted of land-use studies in urban areas of western Oregon and of waste-disposal investigations in south-central and southeastern Oregon.

Land-use studies in urban areas

After completing a report on the engineering geology of the Tualatin Valley region, Herbert G. Schlicker and Robert J. Deacon began a study of the Mid-Willamette Valley. At the request of the Mid-Willamette Valley Council of Governments, the project was temporarily diverted to Marion County and the data restricted to that which was needed to complete the county's Water and Sewer Study. The information was published by Marion County in 1969.

The Jackson County Court requested an immediate study of the sand and gravel resources of Rogue River and Bear Creek valleys, so that land-use planning could include the construction resources needed for development of this area and still protect the scenic beauty of Bear Creek and the sport fishing in Rogue River. Schlicker and Deacon completed this study in December 1969. Several important facts were brought out by their report; one, that unless other gravels are made available the present supply of Bear Creek and Rogue River flood-plain gravels will be gone by 1982; another, that about 800 acres of land in the Agate Desert and adjacent terraces will be required to produce the gravel needed by the year 2005. The report also pointed out that, although some of these gravels have been considered in the past to be of marginal quality, suitable treatment will allow satisfactory production of gravel aggregate.

The Mid-Willamette Valley study, which includes part of Polk, Yamhill, and Clackamas Counties, will be continued and should be completed after about one year's additional work.

Waste disposal investigations

The Department participated in cooperative studies with the Environmental Health Science Center of Oregon State University by investigating waste-disposal sites at two locations in eastern Oregon in 1969. The OSU project, which was funded by a National Science Foundation research grant, was designed to determine biodegradation rates of herbicide wastes and ion exchange-absorption reactions with other chemicals in clay soils. Alkali Lake in Lake County and Merrill dump in Klamath County were selected as possible sites for the experiments, and the Department did auger drilling at both localities to determine relationships between the regional geology and local conditions at the project sites, so that residents in the two areas could be assured that no hazard would result from the waste-disposal experiments.

Public concern about pollution of the environment, along with promulgation of stringent disposal regulations, has stimulated research by the staff into the possibilities of underground disposal of chemical wastes. Concurrent studies were also begun to define some of the geologic parameters required for storage of radioactive chemicals. The Department made recommendations regarding a proposal by a chemical firm to store radioactive

wastes at a remote location in Harney County. The geologic requirements were for a site underlain by impermeable sediments and removed from contact with surface water and ground water. The advent of nuclear power generation and increased use of radioisotopes in industry and medicine pre-sage wider utilization of underground storage and disposal sites.

Geothermal Steam Energy

During 1969 activities within the Department relating to geothermal steam exploitation consisted of a field trip to the Geysers steam field in northern California, shallow temperature measuring projects at specific locations in southern and central Oregon, and continuing research and promotional work.

The highlight of the year occurred in May, when three members of the Department staff, R. G. Bowen, E. A. Groh, and N. V. Peterson, spent a day in the Geysers area escorted by James Koenig of the California Division of Mines and Geology. The tour included a close look at the developing steam field, a visit to well sites, and a tour through one of the power plants. During the tour there was ample opportunity to discuss geothermal power development with Mr. Koenig, a leading expert in the field.

Field work consisted of shallow temperature probing by Bowen and Peterson in the Klamath Falls geothermal zone, where temperatures were taken with a thermistor at a depth of one meter. A rough grid survey, in which 70 measurements were made in two days, outlined two northwest-southeast-trending zones which closely correlated with areas where hot water is known to exist at shallow depths. This inexpensive type of survey appears to have promise in predicting areas where hot water for heating or industrial processing might be found at shallow depths. Several square miles could be surveyed in this manner for the cost of one shallow well.

Preliminary studies were also made in the Burns area by Bowen, Groh, Peterson, and V. C. Newton, Jr. to determine the feasibility of measuring geothermal gradients in shallow holes. Here holes were drilled from 30 to 40 feet deep and temperature measurements taken with a thermistor at intervals up the hole. By this technique areas of anomalous heat flow can be detected and outlined for deeper exploration. The theory behind this method is that the only source that would produce a large heat-flow rate over an area of more than just a few acres would be an intrusion of magma cooling at depth. This is the type of heat source needed for geothermal power generation.

Staff members are continuing to accumulate published information on geothermal power and related subjects, and the file of data is growing increasingly valuable as more individuals and industry are becoming aware of the capabilities of this form of energy. Because we feel that this low-cost natural energy has a potential to supply a large share of the new generating

facilities needed by Oregon and the western United States in the future, members of the Department are taking every opportunity to acquaint the public with the advantages of geothermal power.

Large-scale exploration and development of geothermal energy remain in limbo until a federal steam-leasing law is passed that will allow private enterprise to appraise the risks and rewards of tapping the earth's own "boiler."

Assistance to Other Agencies

During 1969 the Department provided assistance to a large number of governmental agencies throughout the state, and to service groups, schools, and private individuals.

At the federal level, cooperative help was expended with the U. S. Geological Survey on field examinations in connection with the state geologic mapping program which is nearing completion after many years. Assistance was also provided to the topographic mapping section. Considerable effort was given to the preparation of the bulletin "Mineral and Water Resources of Oregon." Cooperation with the U.S. Bureau of Mines included reviewing the annual reports on mineral activity in the state and checking the list of active mineral producers for the Bureau's annual canvass. Considerable time was spent with the U.S. Bureau of Land Management in investigating the lava tubes in the Rome area of Malheur County, in working on the Mining Law Review subcommittee, and serving on two Multiple Use Advisory Committees.

At the state government level, assistance was given to more than 25 agencies during the year. Services were provided the Game Commission at its Kelly Prairie Reservoir site in Morrow County, the Department of Revenue on mineral evaluations, the Corporation Division on offering circulars by mining companies, the Department of Agriculture on waste disposal, the Division of State Lands on mineral leases, and the Highway Department on the geology of some state parks.

At the county government level, the Department assisted: Jackson County with a sand and gravel study; Coos County with mineral evaluations of county land; Baker County with a mineral economics study of the county; Josephine County with an economic development study; Curry County with advice on conducting an over-all economic study; and Douglas County with assistance on leasing mineral lands.

Assistance was also given to various other local governments on problems ranging from solid waste disposal sites to information on rockhounding and other recreational activities based on geology. The Department continued its educational program by giving talks and leading field trips for youth leaders and teachers, with emphasis placed on the role of geology in environmental planning.

Analytical Activities

Assay and chemical laboratory

During 1969 the assay and chemical laboratory had a moderate increase in activity over that of 1968, which was a very active year. We received a total of 995 samples, of which 257 were sent in by the Grants Pass office, 158 by the Baker office, and the balance of 580 were either brought in or sent in by mail directly to the Portland office. These 995 samples represented 2764 determinations, or an average of 2.77 determinations per sample. This is compared to 1968 which had an average of 2.52 determinations per sample from a total of 963 samples and 2429 determinations. For the year we averaged 83 samples per month, the peak month being August with 136.

We received samples from 30 of the 36 counties in Oregon, with the bulk coming from three general areas: 1) southwest Oregon (Josephine, Jackson, Douglas, and Curry Counties), 409 samples; 2) eastern Oregon (Baker and Grant Counties), 247 samples; and 3) Western Cascades (Linn and Lane Counties), 134 samples.

Thirty-eight different elements were analyzed for and seven different physical tests, such as specific gravity, loss on ignition, moisture, and expansion, were made.

There were 742 gold, 730 silver, 122 platinum, 225 copper, and 96 mercury assays. The 849 remaining determinations were scattered among the other 33 elements and 7 physical tests.

Spectrographic laboratory

The spectrographic laboratory of the Department uses an emission spectrograph to analyze rocks, minerals, metals, glass, paint, water, or unknown materials for the various elements present. An estimate is made of the percentage of each contained. During 1969 a total of 345 analyses was made for Department projects and tests. Besides ore samples, crystals and minerals were identified and 11 possible meteorites were checked.

The spectrographic laboratory also assists many commercial firms and individuals in identifying unknown materials. Corrosion products, scales, and dusts were checked to determine sources of trouble. Research projects were assisted by analyses of chemical compounds, paper ash, slags, and coke. Metal producers were helped during the year by identification of inclusions in both slags and castings.

Problems concerned with health which were brought into the laboratory included analyses of polluted water and drink mixes, and paper-mill waste.

Spectrographic analyses of suspected criminal evidence boomed in 1969 with 40 glass samples and 32 pieces of fire residue. Other possible

criminal samples included bullet lead, drugs, automobile paint, and fire-clay from safes. Criminal evidence was examined for the State Crime Detection Laboratory, City of Portland Police Laboratory, and County Courts. Glass sample studies during the year were primarily concerned with matching pieces of broken window glass with particles found on a suspect's clothing or in automobiles.

Geochemical investigations

During 1969 the data collected by the Department on the geochemistry of stream sediments in southwestern Oregon were released in the form of an open-file report. This information consisted of approximately 400 pages of analytical data from more than 3000 sites where samples were collected. As a service to those who wanted copies of this report, photocopies were sold for \$25 a set. For those who did not wish to buy a set, copies were available for public inspection at the Department's Portland, Baker, and Grants Pass offices. The information is now being compiled into a bulletin for publication at a future date.

The sediment-sampling program was moved in 1969 to central Oregon. For the next few years the work will be concentrated in the eastern half of the Bend AMS quadrangle and in the Canyon City AMS quadrangle. During the summer field season, collecting centered around Prineville in an area that has a history of mercury and gold and silver production. Because of this past productivity and because of the numerous shows of quicksilver scattered around this region, it was felt that a geochemical study would have a good chance of uncovering some overlooked mineral deposits. The stream sediments will be analyzed for mercury using a modified Lemaire mercury detector, and for copper, silver, lead, zinc, nickel, and molybdenum by an atomic absorption spectrophotometer recently purchased for this purpose by the Department.

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OREGON ACADEMY OF SCIENCE IN EUGENE

The annual meeting of the Oregon Academy of Science is to be on Saturday, February 28, 1970 at the Science Building, University of Oregon, Eugene. Chairmen of the Geology Section are Ray Broderson, Oregon College of Education, and Harold E. Enlows, Oregon State University. There will be morning and afternoon sessions, with registration starting at 8:30 a.m. The main part of the program will be a symposium at 3:15 p.m. on the chemistry and geology of Apollo 11 and Apollo 12 moon rocks by Gordon G. Goles, Roman A. Schmitt, and Daniel F. Weill.

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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

2.	Progress report on Coos Bay coal field, 1938: Libbey	\$ 0.15
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
56.	Fourteenth biennial report of the State Geologist, 1963-64	Free
57.	Lunar Geological Field Conference guide book, 1965: Peterson and Groh, editors	3.50
58.	Geology of the Suplee-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

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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| 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 Almeda mine, Josephine County, Oregon, 1967: Libbey | 2.00 |

MISCELLANEOUS PAPERS

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| 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 |
| 10. | Articles on Recent volcanism in Oregon, 1965: (reprints, The ORE BIN) . . | 1.00 |
| 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 |

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| Oregon quicksilver localities map (22" x 34"), 1946 | 0.30 |
| Landforms of Oregon: a physiographic sketch (17" x 22"), 1941 | 0.25 |
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OIL and GAS INVESTIGATIONS SERIES

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Newton and Corcoran | 2.50 |
| 2. | Subsurface geology of the lower Columbia and Willamette basins, Oregon,
1969: Newton | 2.50 |