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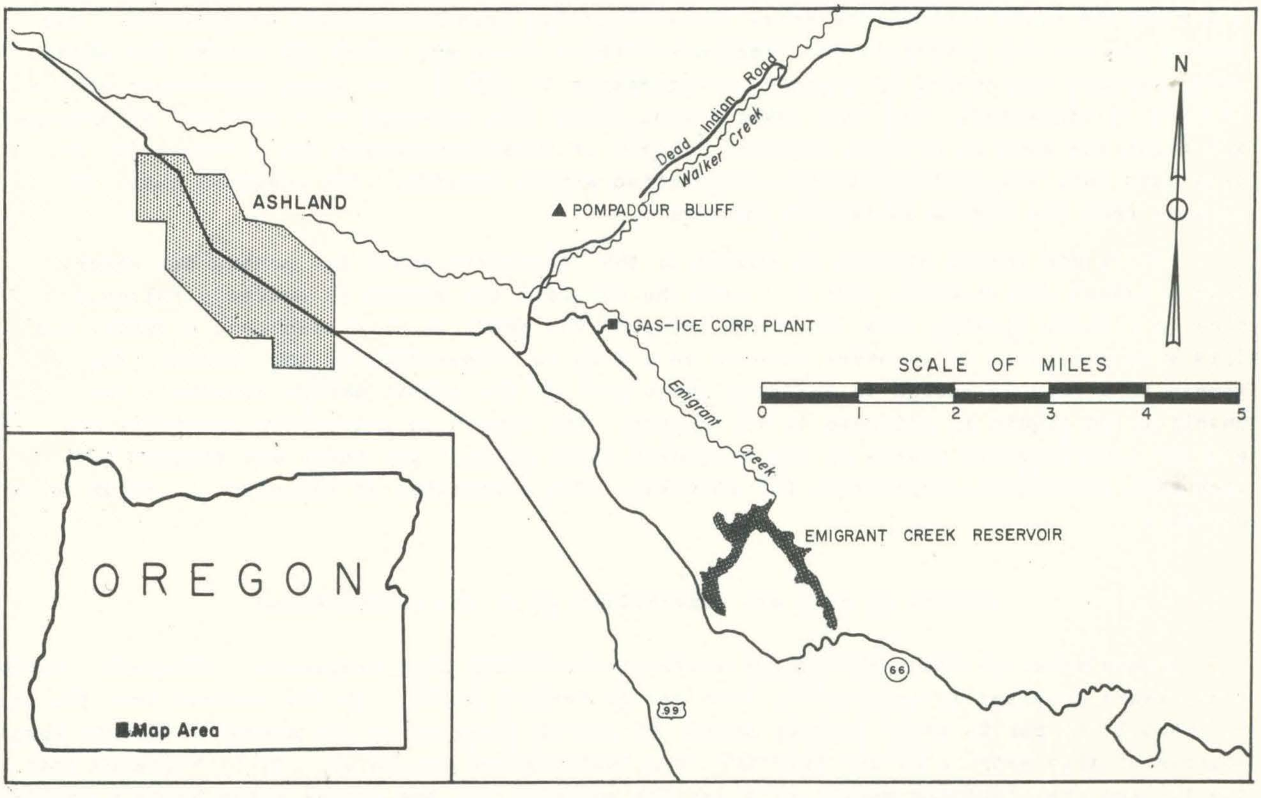
OCCURRENCE AND UTILIZATION OF CARBON-DIOXIDE-RICH WATER NEAR ASHLAND, OREGON

By

Max Schafer*

Introduction

Natural carbon-dioxide gas for the manufacture of solidified carbon dioxide (dry ice) is one of Oregon's lesser-known mineral products. Southeast of Ashland, Gas-Ice Corporation, whose headquarters are in Seattle, Washington, has an operation that obtains carbon dioxide from ground water in such quantities that in 1952 (latest U.S. Bureau of Mines figures) Oregon was the third-ranking state in the nation in the value of this product. The Ashland plant is the only one in the State that produces natural carbon dioxide. Portland Gas and Coke Company manufactures a liquid carbon dioxide scrubbed from flue gases.



Index Map

Reportedly the dry-ice industry came into being because of a British surgeon's liking for soda water with his Scotch whiskey. At his station in India, natural carbonated water, which came for the most part from Vichy, France, was often hard to come by. Through experimenting he was finally able to produce solidified carbon dioxide with which he could carbonate tap water, and he was happily assured of a steady supply of soda water. This use of dry ice for soda water is still important, although the refrigerating uses have since far surpassed it. Almost all "soda pop" and soda water is artificially carbonated with dry ice at the bottling plants.

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The long-distance transportation of perishable foodstuffs and frozen foods accounts for the greater part of the dry-ice market today. Packing of ice cream containers with dry ice is a common practice. Fruits and vegetables can be transported for days with dry ice because of the slowness in loss of the ice and also because they seem to keep better in an atmosphere of carbon-dioxide gas. An advantage of dry ice is that it "sublimes" or goes directly from a solid to a gas, unlike regular ice which melts to water. Foodstuffs packed with dry ice can be sent through the mail because of this desirable characteristic. The future of refrigeration for the dry-ice industry is threatened because of the increasing use of ammonia- and freon-refrigerated railroad cars and trucks.

Operation of Gas-Ice Corporation's Ashland Plant

The Gas-Ice Corporation plant and wells are located about 3 miles southeast of Ashland on the west side of Emigrant Creek in the SW$\frac{1}{4}$ sec. 7, T. 39 S., R. 2 E. (see index map).

The plant has ten wells from which carbon-dioxide-rich water is pumped. Most of the wells are from 200 to 300 feet deep and bottom in a shale layer of the Umpqua (?) formation. Total production of water from the wells is about 1000 gallons per hour. Water from the wells is pumped into a separator, a tank with a pipe at the top and an outlet at the bottom. The gas bubbles rise to the top and are drawn off to the plant. The water flows out through the bottom of the tank and is diverted to the stream.

The gas pumped from the separating tanks enters a cooler and dehumidifier where the moisture is removed. Formerly some sulphur was present, necessitating a charcoal filter but when the wells lowered the water table slightly, this contaminant disappeared. The cooled gas is then pumped to the "condenser" where it is put under 500 pounds per square inch pressure and cooled by ammonia refrigeration to -10° F. At these conditions most of the gas is liquefied. The very small amount (less than one-half of 1 percent) of nitrogen and argon gas that is present does not liquefy at this temperature and pressure and is sent back into the system with the unliquefied carbon dioxide. The unwanted gases are cleaned from the system at regular intervals.

The liquid carbon dioxide is pumped to the "receiver" under 150 pounds per square inch pressure and at about -40° F. From the receiver the liquid is suddenly released through a small opening into the "snow press." The press is at atmospheric pressure and this sudden release of pressure results in a drop in temperature of the liquid. The temperature drop is enough to solidify about half of the liquid carbon dioxide. The unsolidified liquid is returned to the system. The "snow" or solidified particles are pressed into 80-pound blocks by the hydraulic "snow press," and these are wrapped in cardboard cartons in preparation for shipment. The production of the plant is about 10 tons per day.

Source of Heat and Mineralization of the Ground Water

Ground water in the Ashland area shows an abnormally high temperature gradient. Normal temperature gradient is about 1° F. rise per 80 feet of depth. In the Ashland area the rise is about 1° F. per 25 to 30 feet of depth, or nearly three times the normal gradient. Possible sources of this extra heat are friction from faulting and volcanism. It is believed that in the Ashland area faulting merely provides the conduits for the heated water while a cooling magma is the source of the heat.

Some of the wells and springs in the Ashland area contain unusually high concentrations of lithium, carbonate, chlorine, and sulphur, and show a predominance of carbonate over calcium and a low calcium-magnesium ratio. According to studies that have been made by Winchell (1914), White and Brannock (1950), and Behre and Garrels (1943) these are characteristics of waters from a volcanic environment. Minerals in ground water can be derived from solution of the rock penetrated by the water and from volcanism. Since no limestone or salt deposits are known to occur in the Ashland area from which the concentrations of minerals found in the waters could be derived, it seems likely that the minerals emanated along with fluids escaping from cooling magma. Only a small fraction of the water is likely to be of volcanic source. Most of it is probably deep meteoric water which has been returned to the surface.

Volcanism has taken place on a large scale and in relatively recent times in the Cascade Range, and this activity, although dormant at the present time in Oregon, is without doubt responsible for the heating and mineralization of the Ashland waters.

Geology of the Area

General

The region near the wells is hilly with a relief of about 600 feet. Emigrant and Walker creeks flow across the mapped area (see geologic map opposite page 51) and are tributary to Bear Creek. All are part of the Rogue River drainage system. Pompadour Bluff is the most prominent topographic feature near the wells. Briefly the regional geology is as follows: To the west, metasediments and metavolcanics of the Triassic Applegate formation are intruded by granodiorite of the Ashland stock. Marine sandstones of the Cretaceous Chico formation unconformably overlie the Triassic rocks and the granodiorite. Lying unconformably on the Chico formation is the Eocene Umpqua formation which in this area is a series of nonmarine sediments and volcanic rocks. To the northeast, Tertiary lavas and pyroclastics of the Western Cascades overlie the Umpqua rocks. The Umpqua formation and the Tertiary volcanics are intruded by basalt and diorite sills and dikes. Remnants of recent volcanic flows are present northwest of Medford.

Geologic units

Umpqua formation

The oldest rocks that crop out in the mapped area are the nonmarine sediments and volcanics of the Eocene Umpqua formation. The Umpqua formation has been subdivided in this report as follows:

Undifferentiated sediments: Sandstone is the predominant material in the undifferentiated sediments. It ranges in color from greenish-gray to buff and contains varying amounts of quartz, feldspar, mica, and volcanic glass fragments. The sandstone usually does not form prominent outcrops except where conglomerate lenses are present, as in Pompadour Bluff. Beds range in thickness from 1 inch to 10 feet. Coal has been found in shale of the undifferentiated sediments. On the east side of Emigrant Creek across from the dry-ice plant is the abandoned shaft of the Ashland coal mine. Parks and Swartley (1916) reported a good grade of sub-bituminous coal that attained a width of 6 inches and contained coaly shale separations.

Shales and siltstones: The shales and siltstones are fine-grained equivalents of the coarser sediments except that mica is usually absent. These rocks are usually finely interbedded with sandstone and the layers are generally less than 6 inches thick.

Conglomerates: Boulders and cobbles as much as 6 inches in diameter are contained in a sandstone matrix that ranges from medium to coarse. The boulders are of quartzitic and metamorphic material and are usually present in soil developed on the Umpqua formation. The conglomerates thicken and thin noticeably within a very few feet.

well rounded pebbles tough quartzite

Tuffs: Two layers of tuff, made up of quartz and volcanic glass, were found in the area mapped. One of the layers is a flaggy, white tuff that contains carbonized plant fragments, apparently the remains of stems or limbs.

Andesite flow: An andesite flow, conformable within the Umpqua formation, is present on the east side of Emigrant Creek near the dry ice plant. The flow is porphyritic, containing phenocrysts of feldspar, and ranges in color from gray to buff. A crude columnar jointing is developed.

Tertiary volcanics

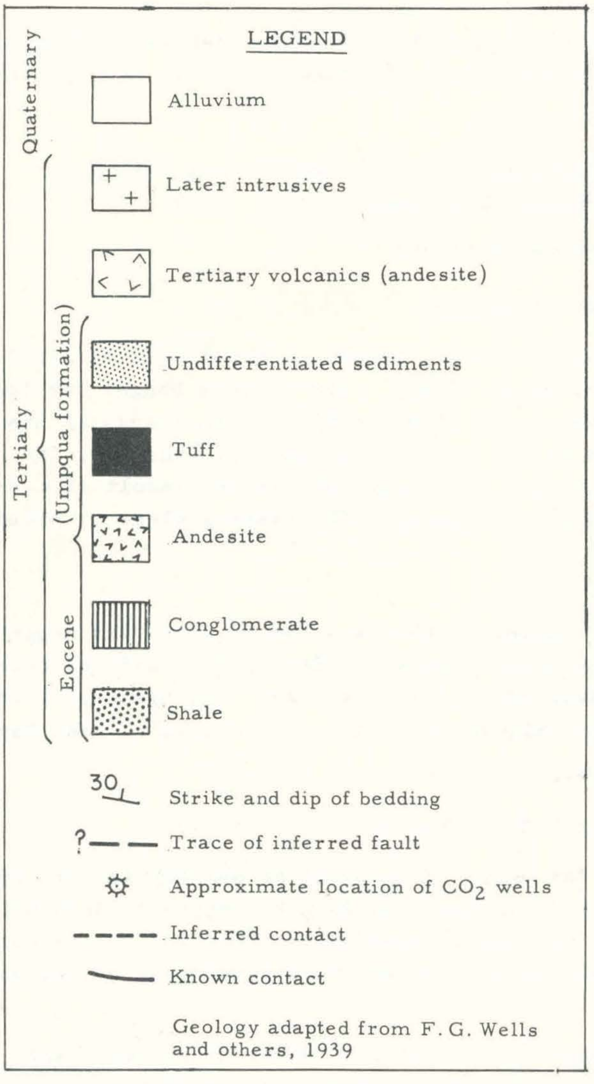
The northeast corner of the mapped area is underlain by flows of dark gray andesite. These flows often show a well-developed columnar jointing. The columns are 1 to 2 feet wide and are broken up approximately every 2 inches by fracturing parallel to the surfaces of the flow.

Later intrusives

Two exposures of diorite which may represent a single body are shown on the map. In the field the outcrops form knobs and the soil is a dark reddish-brown that is easily distinguished from the dull, dark gray of the soil developed on the Umpqua formation.

Alluvium

Stream deposits have been laid down in recent times by Walker and Emigrant creeks. These unconsolidated sediments are composed of sand, gravel, silt, and boulders. The larger material is well-rounded and includes many boulders from the Umpqua conglomerates.



Structure

The sediments and volcanics of the Umpqua formation and the Tertiary volcanics have a regional dip to the northeast. Folding and faulting occurred after the Tertiary flows were extruded. Later intrusives are probably younger than the faulting.

A fault has been plotted on the map along Emigrant Creek. Lack of continuity of beds across the creek, the occurrence of the hot water wells along the creek, and the drainage pattern are evidence for the fault. Young (1953) plotted a fault along Emigrant Creek southeast of the mapped area.

Acknowledgement

The author wishes to express his gratitude to Mr. C. E. Smith, manager of the Gas-Ice Corporation plant, for information and assistance given.

Bibliography

Behre, C. H., Jr., and Garrels, R. M.
1943 Ground water and hydrothermal deposits: Econ. Geol, vol. 38, no. 1, p. 65-69, Jan.-Feb. 1943.

Minerals Yearbook
1952 U.S. Bureau of Mines, 1952.

Parks, H. M., and Swartley, A. M.
1938 Handbook of the mining industry of Oregon: Oregon Bur. Mines and Geology, Mineral Res. of Oregon, vol. 2, no. 4, 1938.

Stevens, J. C.
1944 The dry ice industry in the Pacific Northwest: Ore.-Bin, vol. 6, no. 11, p. 71-74, Nov. 1944.

Van Orstand, C. E.
1939 Observed temperatures in the earth's crust. In Physics of the Earth, p. 147, 1939.

Wells, Francis G.
1939 Preliminary geologic map of the Medford quadrangle, Oregon: Oreg. Dept. Geol. and Mineral Indust. Map, 1939.

White, D. E., and Brannock, W. W.
1950 The sources of heat and water supply of thermal springs, with particular reference to Steamboat Springs, Nevada: Am. Geophy. Union Trans., vol. 31, no. 4, 1950.

Winchell, A. N.
1914 Petrology and mineral resources of Jackson and Josephine counties, Oregon: Oregon Bur. Mines and Geology, Mineral Res. of Oregon, vol. 1, no. 5, 1914.

Young, R. A.
1953 Ground-water resources of the Rogue River Basin, unpublished report in preparation by Ground-Water Division, U.S. Geol. Survey, 1953.

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EASTERN OREGON MINING NEWS

The Comstock Uranium-Tungsten Company, Inc., of Elko, Nevada, assumed control April 1, 1955, of the lease on the Haggard and New mine, Grant County. The company bought out the Burt Hayes interest in the lease last fall. Mr. J. J. Kinsella will be in charge of the Comstock Company's work and the Oregon address of the company is Box 416, John Day. Mr. Kinsella reports that the company has started driving a low-level adit as the result of a drilling program which indicated extension of the ore body with depth. The company plans to examine other chromite properties in the area.

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Work on the Mott, Spider, and Last Chance claims which are situated above the Haggard and New property on Dog Creek, Grant County, has been resumed by Earl Lyman, and two lots of development ore have been milled and concentrates shipped this season. The Lyman mill is located on Dog Creek about a mile south of State Highway 26, east of the town of John Day.

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DOLE APPOINTED DEPARTMENT DIRECTOR

Hollis M. Dole was appointed Director of the Oregon Department of Geology and Mineral Industries at a meeting of the Department's Governing Board on July 9, 1955. In announcing the appointment, Mason L. Bingham, Chairman of the Board, pointed out that Mr. Dole's long residence and wide geological experience in the State of Oregon were considered by the Board as important factors in its choice.

Mr. Dole has been a resident of Oregon since 1917. He obtained his bachelor's and master's degrees from Oregon State College, and completed scholastic requirements for a doctorate degree at the University of Utah. Dole has been with the Department since 1946. In August 1954 he was made Assistant Director and in November of the same year, at the retirement of F. W. Libbey, was appointed Acting Director.

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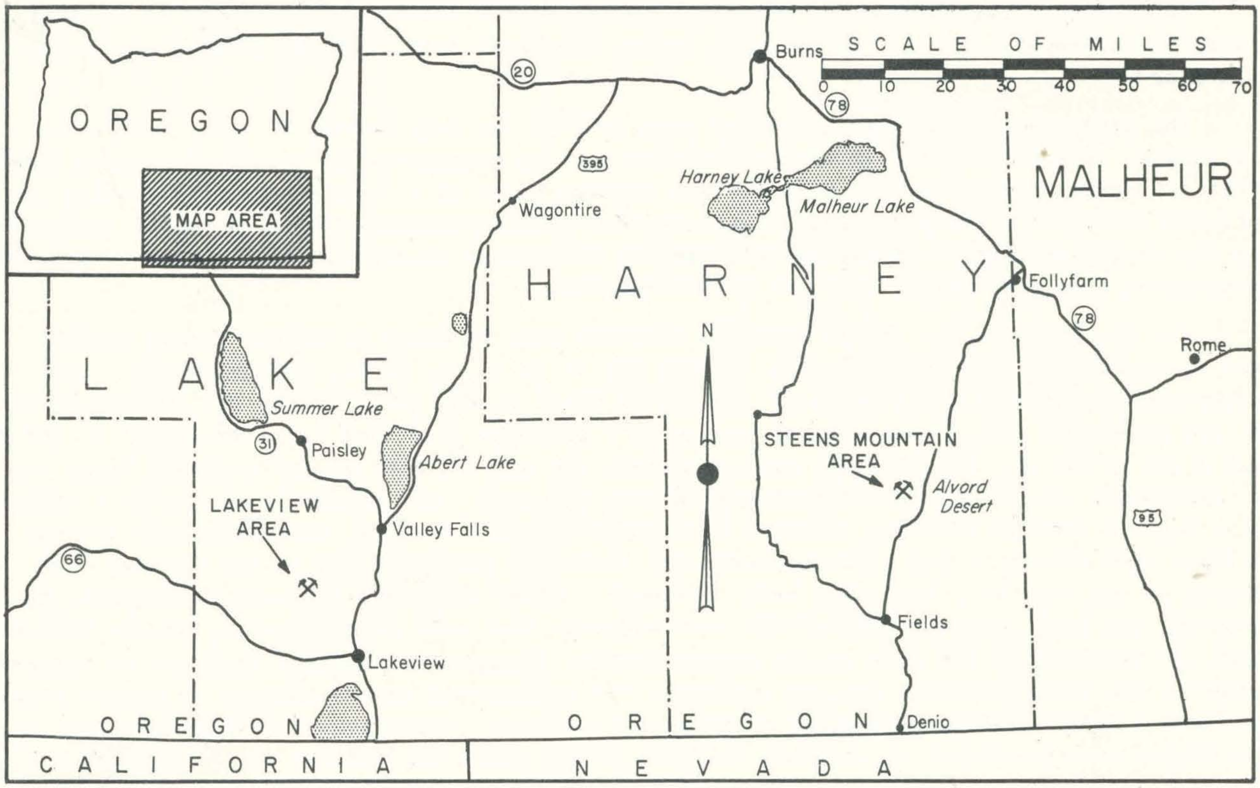
COMMERCIAL URANIUM DEPOSITS FOUND IN OREGON

Discovery of commercial-grade uranium deposits in two separate localities (see index map) in Oregon during June has recently been announced. Examinations of the prospects by geologists of the State of Oregon Department of Geology and Mineral Industries confirmed the presence of secondary uranium minerals and high radioactive anomalies in the areas of the prospects. Preliminary development indicates that both localities are capable of furnishing some tonnage of ore.



Index Map

Deposits near Lakeview are located on Augur Creek in sec. 30, T. 37 S., R. 19 E. and in sec. 25, T. 37 S., R. 18 E. The area is approximately 14 miles northwest of Lakeview in Lake County. The original discovery was made on claims of the White King group by John Roush and Don Tracy, Lakeview. The early development work on these claims shows that a fluorescent, yellowish-green mineral thought to be autunite and a bright green, nonfluorescent mineral which may be torbernite are the principal uranium minerals. Associated minerals are mercury sulphide (cinnabar) and arsenic sulphides (realgar and orpiment). The host rock is volcanic tuff that has been silicified and altered. In places it is banded and is similar to opalite, a rock consisting of a mixture of chalcedony, quartz, and opal. Flaky crystals and masses of autunite fill fractures in the brittle opalite, and irregular disseminations of torbernite and autunite are found in the clayey, altered tuff. Occasionally a bright-green mineral, torbernite (?), is found as bladed aggregates in the form of rosettes, which may be as much as half an inch in diameter, and as small rectangular crystals. The mercury and arsenic sulphides occur as small irregular streaks and crystals in the host rock. Northwest-trending fractures cut the rocks of the exploration pits and may possibly control the mineralization. The exploration to date indicates an outcrop width of about 100 feet, and high radioactive anomalies are found along what is thought to be the strike for at least 300 feet. No definite uranium mineral is found in the pits until a depth below the soil zone of a foot or more is reached.

Less than 1 mile northwest of the White King claims another occurrence of autunite-torbernite is being opened up by a group from Lakeview headed by Bob Adams, Jr. The prospect, known as the Lucky Lass, is in a weakly sheared zone in an altered lithic-lapilli tuff or agglomerate. The sheared zone as exposed in the only cut opened at the time of visit is approximately 8 feet wide and trends northwest. Length and depth of mineralization is unknown. The predominant mineral visible is powdery or flaky and when freshly exposed is grass-green in color. Under the ultraviolet lamp the claylike rock shows bright yellowish-green fluorescent spots scattered through it. A soil zone three to four feet thick blankets the deposit. The discovery was made in a small cut in a logging road.

The tuffs or agglomerates in which the prospects are located are Tertiary in age and, lying unconformably over the pyroclastic rocks, are black lava flows of probable late Tertiary age.

The Lake County Examiner, Lakeview, reports that the U.S. Bureau of Mines laboratory at Albany, Oregon, obtained an analysis of 1.3 percent uranium oxide on select samples taken from the White King claims and 0.66 percent uranium oxide on a "run-of-the-pit" sample. A pit-run sample from the Lucky Lass claims ran 0.7 percent uranium oxide. Chemical analyses by the Oregon Department of Geology and Mineral Industries on samples obtained by Department geologists from both groups have not been completed.

The discovery in the Steens Mountain area was made by Dewey M. Quier, Burns, Oregon, and is located on Pike Creek in secs. 17 and 20, T. 34 S., R. 34 E., Harney County. The prospects are about 3 miles south of the Alvord Ranch in the foothills of the eastern front of the mountain. The mineralization occurs in a fracture zone that has a strike of S. 30° W. and a dip of 60° E. The fracture zone parallels the eastern face of the mountain range and is apparently one of the normal faults common to the area. The mineralized rock is a silicified lapilli tuff in the late Tertiary Pike Creek volcanic series. Mineralization extends outward from fractures for several inches and where the radioactivity is the highest the matrix of the rock is a dull dark red. Although a minor amount of fluorescent autunite is present, the high radioactivity of the rock suggests that some other mineral, as yet unidentified, is responsible for most of the radioactivity. Results of chemical analyses on samples taken by the Department are not yet available but radiometric determinations on select pieces indicate a uranium oxide equivalent of about 0.5 percent. Insufficient development work on the claims does not allow an accurate estimate of the grade and tonnage of ore present but the high radioactive anomalies and float boulders found over a fairly wide area indicate a substantial quantity of ore may be present.

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SALEM HILLS BAUXITE BEING EXPLORED

Aluminium Laboratories Limited, a Canadian organization, is exploring the bauxite of the Salem Hills in Marion County, Oregon. Exploration is being done by four drill rigs under the supervision of company geologists. Mr. H. R. Hose, Chief Geologist of Aluminium Laboratories Limited, is in charge of the exploration work and Salem Sand and Gravel Company is doing the drilling. Samples are being tested at the company's laboratories in Arvida, Canada. Description of the area under investigation was published in the September 1954 and April 1955 issues of The Ore.-Bin.

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TWO NEW PERMITS TO DRILL ISSUED

Drilling Permit No. 12 was issued July 22, 1955, to Oroco Oil and Gas Company, 2 North 8th, Payette, Idaho, to drill in the SW$\frac{1}{4}$ sec. 16, T. 18 S., R. 47 E., Malheur County. The lessor is J. D. Lane, Ontario, Oregon.

Drilling Permit No. 13 was issued July 26, 1955, to Sinclair Oil and Gas Company, 1010 Broadway Building, Portland, Oregon, for a test east of Jamieson, Malheur County. Drilling Permit No.13 takes the place of Permit No. 10 which was issued to R. N. Ranger, 1007 Broadway Building, Portland, Oregon. The test is in the SW$\frac{1}{4}$ sec. 15, T. 16 S., R. 44 E. The lessor is Eastern Oregon Land Company, San Francisco, California.

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PUBLICATIONS*

Oregon Department of Geology and Mineral Industries

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ULLETINS**

No.	Title	Prices (subject to chang
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14.	Oregon metal mines handbooks: by the staff	
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	(2d vol.) Two papers on foraminifera from the Tertiary of Western Oregon and Western Washington, 1949: Cushman, Stewart, and Stewart; and one paper on mollusca and microfauna of Wildcat coast section, Humboldt County, California, 1949: Stewart and Stewart	1.25
37.	Geology of the Albany quadrangle, Oregon, 1953: Ira S. Allison	0.75
39.	Geology and mineralization of the Morning mine and adjacent region, Grant County, Oregon, 1948: Rhesa M. Allen, Jr.	(withdrawn pending revision)
40.	Preliminary description of the geology of the Kerby quadrangle, Oregon, 1949: Wells, Hotz, & Cater	0.85
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43.	Eighth biennial report of the Department, 1950-52	Free
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Prelim. geologic map of the Kerby quadrangle, Oregon, 1948: Wells, Hotz, & Cater (also in Bull. 40)	0.80
Geologic map of the Albany quadrangle, Oregon, 1953: Ira S. Allison (also in Bull. 37)	0.50
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