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COVER PHOTO

Oregon's first "Christmas tree," Reichhold's Columbia County No. 1, located near Mist, Oregon. The assembly of pipes and valves on the top of this successful gas well will control the flow of gas from the well. See story beginning on the next page.

Sixth Gold and Money Proceedings released

The Oregon Department of Geology and Mineral Industries now has available copies of the *Proceedings* of the Sixth Gold and Money Conference, held May 1978 in Portland. This publication contains several papers on the world monetary situation as well as technical papers on current heap leaching methods and on operations at gold mines in Nevada and Oregon.

Copies may be obtained from the Portland office of the Oregon Department of Geology and Mineral Industries. Price is \$6.50 postpaid, and checks should be made payable to **Gold and Money Session**. □

Department geothermal specialist attends workshop

Joseph F. Riccio, Geothermal Specialist with the Department, attended a workshop on "Application of Heat Flow and Geothermal Gradient Techniques to Geothermal Exploration" April 29-May 3, 1979. The U.S. Geological Survey Geothermal Research Program sponsored the workshop, which was organized by Southern Methodist University and held at the Fort Burgwin Research Center, Taos, New Mexico.

Fifty-one participants representing industry, government agencies, universities, and research laboratories attended. Meetings were chaired by David Blackwell, Southern Methodist University, and Donald Klick, Extramural Geothermal Research Branch of the U.S. Geological Survey.

Research items covered by individual papers and discussions included: "Basic Heat Flow and Geothermal Gradient Exploration Techniques," "Heat Flow and Geothermal Gradient Techniques in Deep and Shallow Holes," "Interpretation of Conduction and Convection Techniques," and "Regional and Local Case Histories."

A field trip to the Jemez Mountains to view the results and progress of Union Oil Company's Redondo Peak geothermal prospect concluded the workshop. □

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Oregon's first gas wells completed

by Vernon C. Newton, Jr., Petroleum Engineer, Oregon Department of Geology and Mineral Industries

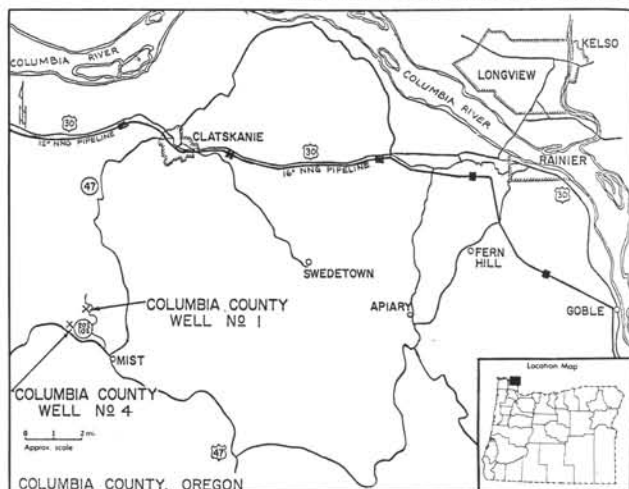
On May 2, 1979, Governor Victor Atiyeh announced the completion of an exploratory natural gas well in SE¼NW¼ sec. 11, T. 6 N., R. 5 W., Columbia County, near the town of Mist, Oregon. Reichhold Energy Corporation's Columbia County No. 1 flowed an estimated 2 million cu ft per day on test, making it Oregon's first commercial natural gas well. The discovery marks the end of a four-year search by Reichhold. On May 14, Columbia County No. 4, a second well half a mile away, was tested and appeared to be as successful as the first well.

Reichhold Energy Corporation was the operator of the wells; Northwest Natural Gas Company, Portland, Oregon, and Diamond Shamrock Company, Cleveland, Ohio, were partners.

The first oil and gas exploration well in Oregon was put down near the town of Newberg in 1901. Since then, more than 200 dry exploration holes have been drilled in the state. Pressure recovery following the flow test on Columbia County No. 1 was very rapid, indicating good reservoir characteristics. These data, however, do not provide conclusive information for determining the extent of the reserves of natural gas which may be available in the area.

When Columbia County No. 1 was first drilled by Reichhold and Diamond Shamrock in 1978, there was a minimal show of natural gas. When the hole was re-drilled in May 1979, it was directed toward a more favorable location. A formation test indicated that the zone was commercial, so casing was run into the well, and the well was completed with production tubing on May 1, 1979.

Map courtesy Northwest Natural Gas

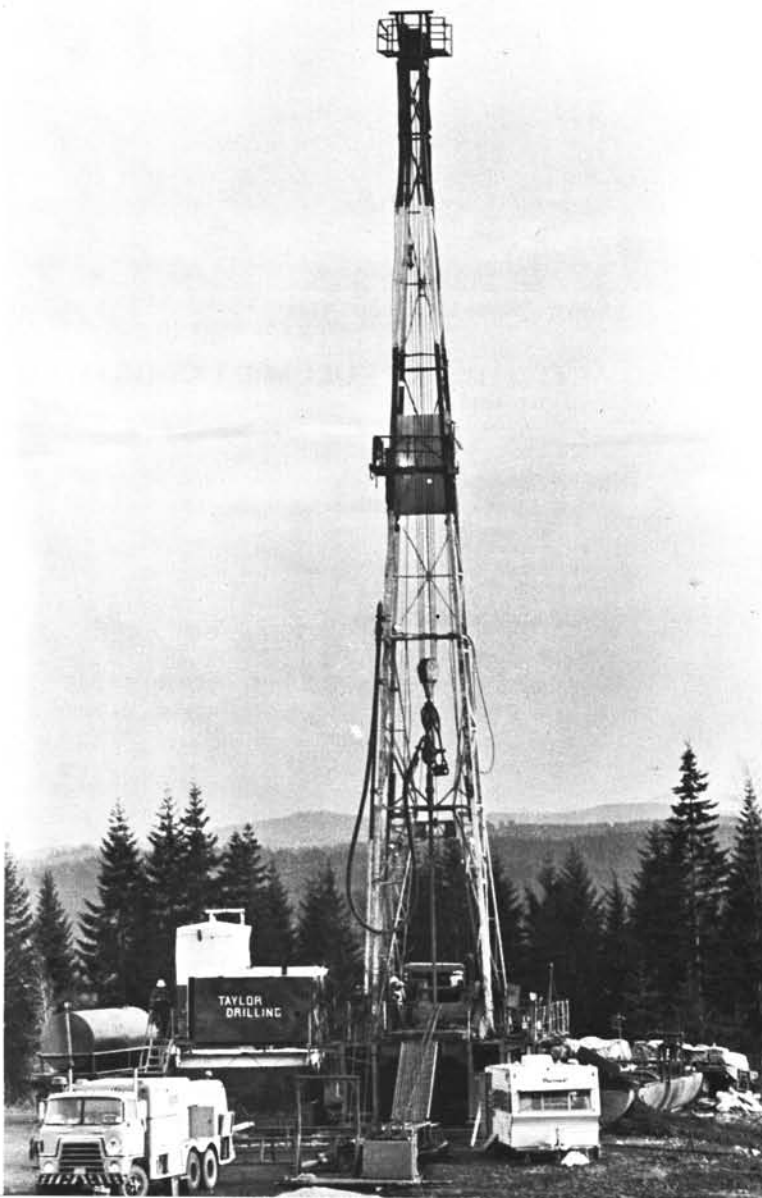


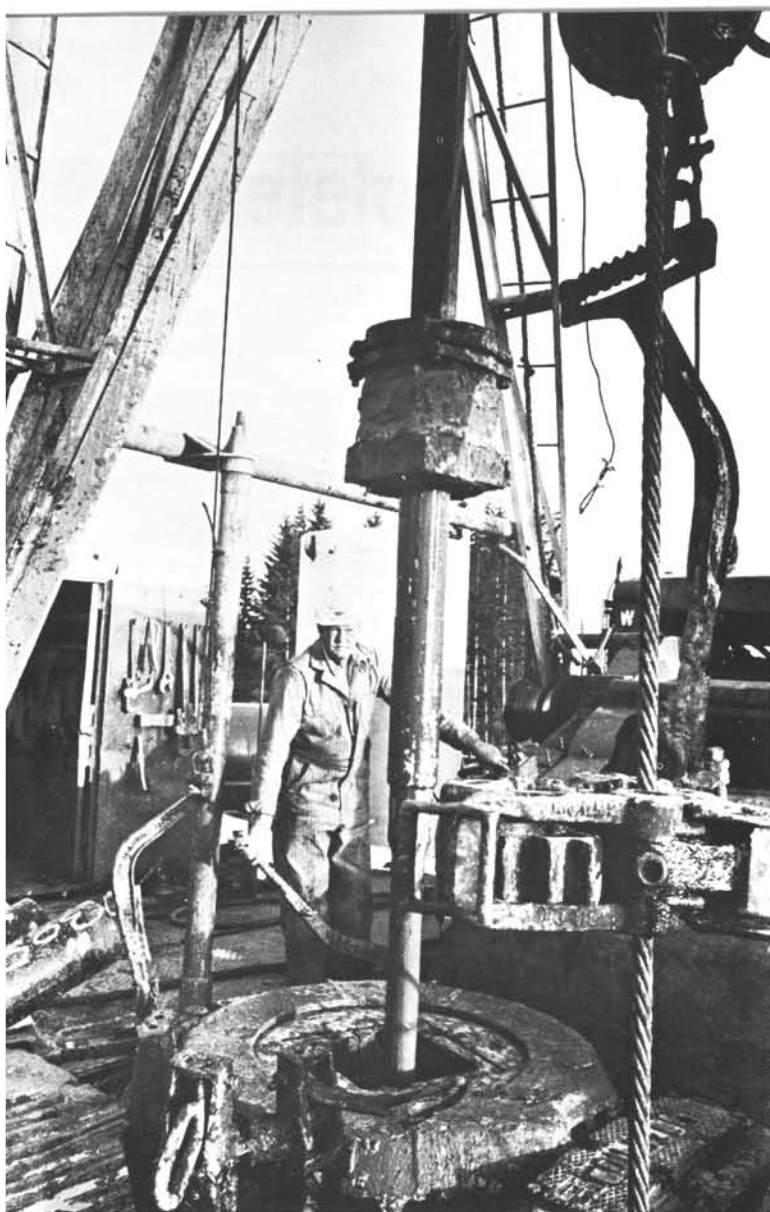
While the flows from these first wells are considered to be acceptable amounts, additional wells will be required to establish the extent of the reservoir and its adequacy for commercial production.

Reichhold Energy, the operator for the group, hopes to use part of the gas developed in the Mist area in its ammonia-urea plant located near St. Helens, Oregon. This plant uses natural gas as a chemical feedstock. Northwest Natural Gas will utilize its share of any gas produced at Mist to supplement its existing supply, but the impact on its operations cannot be determined at this time.

As the discovery well name indicates, Columbia County is the owner of minerals on the land containing

Columbia County No. 1, Oregon's first gas well.





Pulling the kelly to add drill pipe.



Adding "gel" to drilling mud.

Circulating mud prior to running logs.



Checking mud tanks.



DRILLING ACTIVITIES AT COLUMBIA COUNTY NO. 1

Photos courtesy Northwest Natural Gas



Columbia County No. 1 wellhead pressure.



Vern Newton, Petroleum Engineer, Oregon Department of Geology and Mineral Industries, checking pressure gauge on first discovery gas well in Oregon.



Vern Newton, Oregon Department of Geology and Mineral Industries, and Tex Patterson, Drilling Superintendent, Reichhold Energy Corporation, discussing plans for Columbia County No. 4.



Derrick was lowered to ground after successful drilling of Columbia County No. 1 so it could be moved to next drilling site.



Derrick from Columbia County No. 1 being hoisted onto truck so it can be used in drilling Columbia County No. 4.

Additional well data from Columbia County No. 1

Natural gas formation depth	Approximately 2,400 ft	
Flow tests	1,629,000 cu ft per day through a restricted orifice, flowing pressure 800 psig	
Static pressure	895 psig	
Gas composition	Nitrogen	6.9 %
	Methane	92.8 %
	Carbon dioxide	.03 %
	Butane	.26 %
Heating value	946 BTU per cu ft	

the well. Royalties from production will go to the county government and thus be a benefit to local citizens. Longview Fibre Company and Crown Zellerbach Corporation are owners of the surface property around the well and also mineral owners on some of the nearby leases. As gas wells probably will be spaced one per 160 acres, surface disturbance caused by field development will be minimal. Access to wells can be provided by existing logging roads.

Cartoon courtesy Art Bemrose, *The Sunday Oregonian*



The number of exploratory oil and gas wells drilled in Oregon translates into approximately one well per 400 sq mi. The search is just beginning.



Photo courtesy Northwest Natural Gas

Owner Al Cavanaugh stands outside Mist General Store, center of much activity resulting from successful drilling of gas wells near Mist.

Geologic mapping was done in northwestern Oregon by J.S. Diller in 1896. More detailed mapping was done later by C.E. Weaver (1937); W.C. Warren, H. Norbistrath, and R.M. Grivetti (1945); and R.O. Van Atta (1971). The Oregon Department of Geology and Mineral Industries extended geologic mapping of the area in 1975, outlining prospects for natural gas production and underground storage of pipeline gas in the Department's Oil and Gas Investigation No. 5, *Prospects for Natural Gas Production and Underground Storage of Pipeline Gas in the Upper Nehalem River Basin, Columbia-Clatsop Counties, Oregon*.

Rocks exposed at the surface in Columbia County range in age from Pliocene to upper Eocene. Miocene basalt is found in the eastern portion of the county. Marine sedimentary rocks underlie the lavas in this area to depths of 8,000 to 10,000 ft. Thus far, exploration drilling has shown that the best reservoir sands occur in the upper Eocene Cowlitz Formation.

The first drilling in the county was done by Texaco, Inc. In 1945, this firm put down two deep test holes, one south of the town of Clatskanie, and the other near the community of Mist. It was the findings in the Mist well that encouraged additional mapping in Columbia County and the eventual drilling program by Reichhold.

Results in the next few test holes will reveal more data regarding the size and extent of the new gas field. An increase in leasing activity has already begun, however, and news that Oregon will very likely join ranks with producing states is spreading. □

The Western Gold Dredging Company of John Day, Oregon

by John T. Leethem, geology student, Oregon State University

Author's note: The following article is an attempt by the author to preserve a part of Oregon's colorful history on gold dredging. It is the result of research and a series of four interviews with Ted Styskel, whose father was one of the owners of the dredging company. I am greatly indebted to him for his help and insight. Also, I would like to thank Howard C. Brooks, Oregon Department of Geology and Mineral Industries, for reviewing the article.

In 1934, Congress increased the price of gold from \$20.67 to \$35.00 per ounce, touching off renewed interest in gold dredging. In 1936, the Consolidated Western Dredging Company of John Day began exploration. The company was formed during the depression, when S.P. Lowengart, E.C. Styskel, and Ben Ettelson incorporated and invested in a dredge. Initial investment for prospecting, land, and equipment came to about half a million dollars. The men purchased mineral rights along the John Day River, and the dredge was set up near the city limits of John Day.

Production began in November 1937 near the confluence of the John Day River and Canyon Creek. Soon after, the name of the company was changed to the Western Gold Dredging Company.

The area where dredging began was known as the Old China Diggings and was the richest land ever worked by the dredge. The China Claims were rich placer deposits which had been worked around the turn of the century by Chinese laborers using shovels, gold pans, rockers, and sluices. The early-day mining ventures had attracted the Chinese to John Day, where they had built their own little Chinatown.

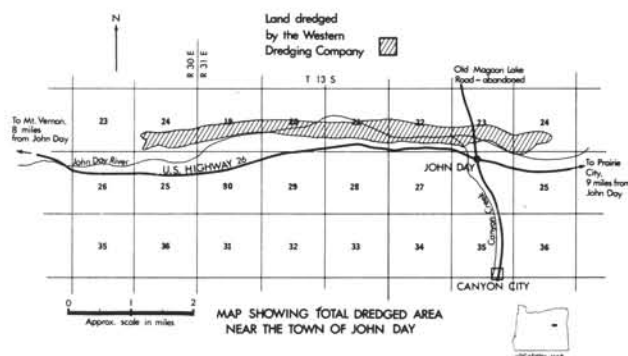
From the town of John Day, the dredge followed the John Day River west to the property of J.H. Ferris and J.W. Marchbank (NE $\frac{1}{4}$ sec. 25, T. 13 S., R. 30 E.), roughly halfway between the towns of John Day and Mt. Vernon. Ferris and Marchbank were already operating a dragline dredge or "doodlebug" with a $4\frac{1}{2}$ -yd bucket and a floating washing plant that contained a hopper for receiving gravel dug by the dragline, a

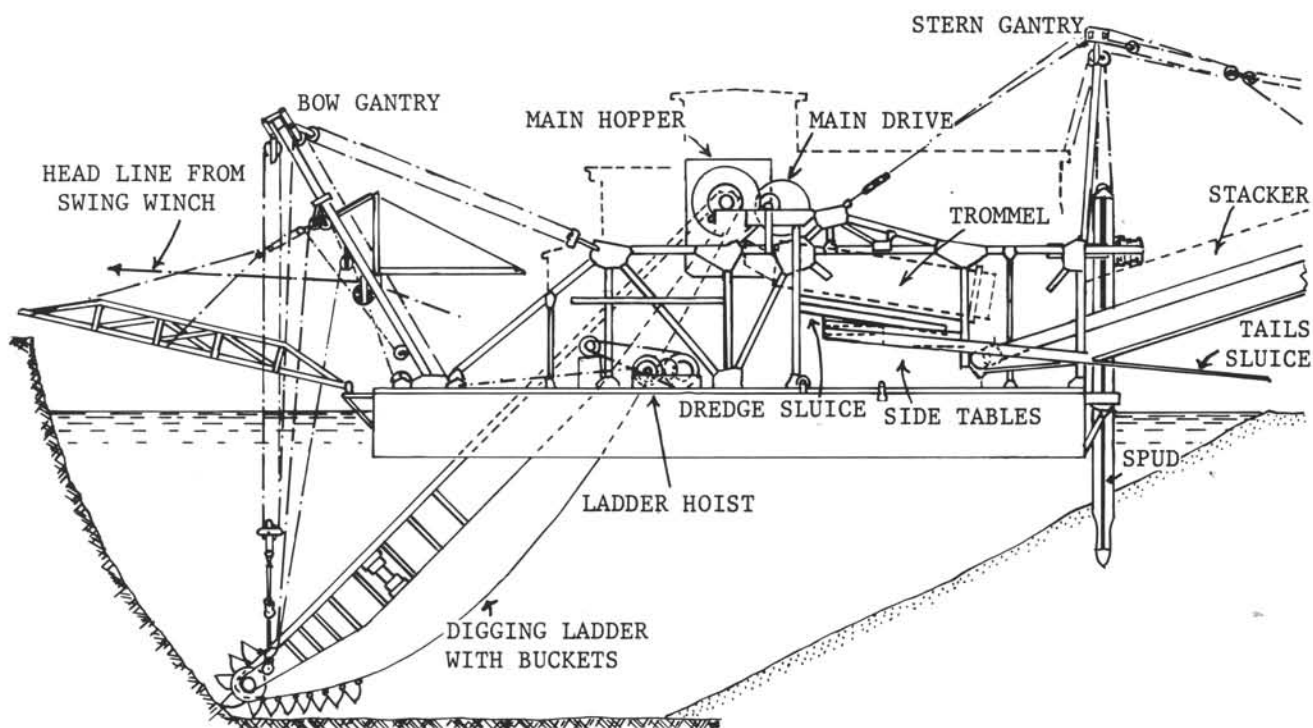
revolving screen, riffled sluices or a revolving pan amalgamator, and a tailings stacker.

From this point, the Western Gold Company dredge turned around and went east back to John Day, dredging just north of the earlier dredged land. When the dredge came to the place where the road crossed the river, it was stopped until an agreement was reached with the city to tear down the bridge, run the dredge through, and build a new bridge. Then the dredge followed the river east for about $1\frac{1}{2}$ mi until it became unprofitable to operate. At that point, the dredge was dismantled and trucked to Mt. Vernon, 8 mi west of John Day.

The Western Gold Company dredge was of the bucket-line type. Each bucket had a capacity of 6 cu ft of gravel. Later, the bucket lips were redesigned to increase the capacity to 7 cu ft. The number of buckets used could be varied from 68 to 81, which also changed the depth the dredge could dig.

Front view of Western Gold Dredging Company's gold dredge, in operation on John Day River. Bucket line in front carried fluvial material into dredge. (Photo courtesy Ted Styskel)





Generalized side view of gold dredge. (After Peele, 1941)

During its operation, this dredge was the second largest in Oregon. It was three stories high, about 100 ft long, and powered by two 200-horsepower diesel engines. One engine ran direct drive to the bucket line, and the other ran a generator that powered the pumps and winches.

The dredge was secured to the shore by cables attached to deadmen or pilings. These cables were on winches. To move the dredge, the winchman would simultaneously tighten one cable and loosen the other. When the dredge was digging, a huge counterweight called a spud was sunk down to the bed rock to provide a pivot for the boat to turn on. The boat required a large

source of water in order to operate. Because the dredge virtually dug its own channel as it worked its way through the river deposits, it has often been said, "Where the dredge goes, the river follows."

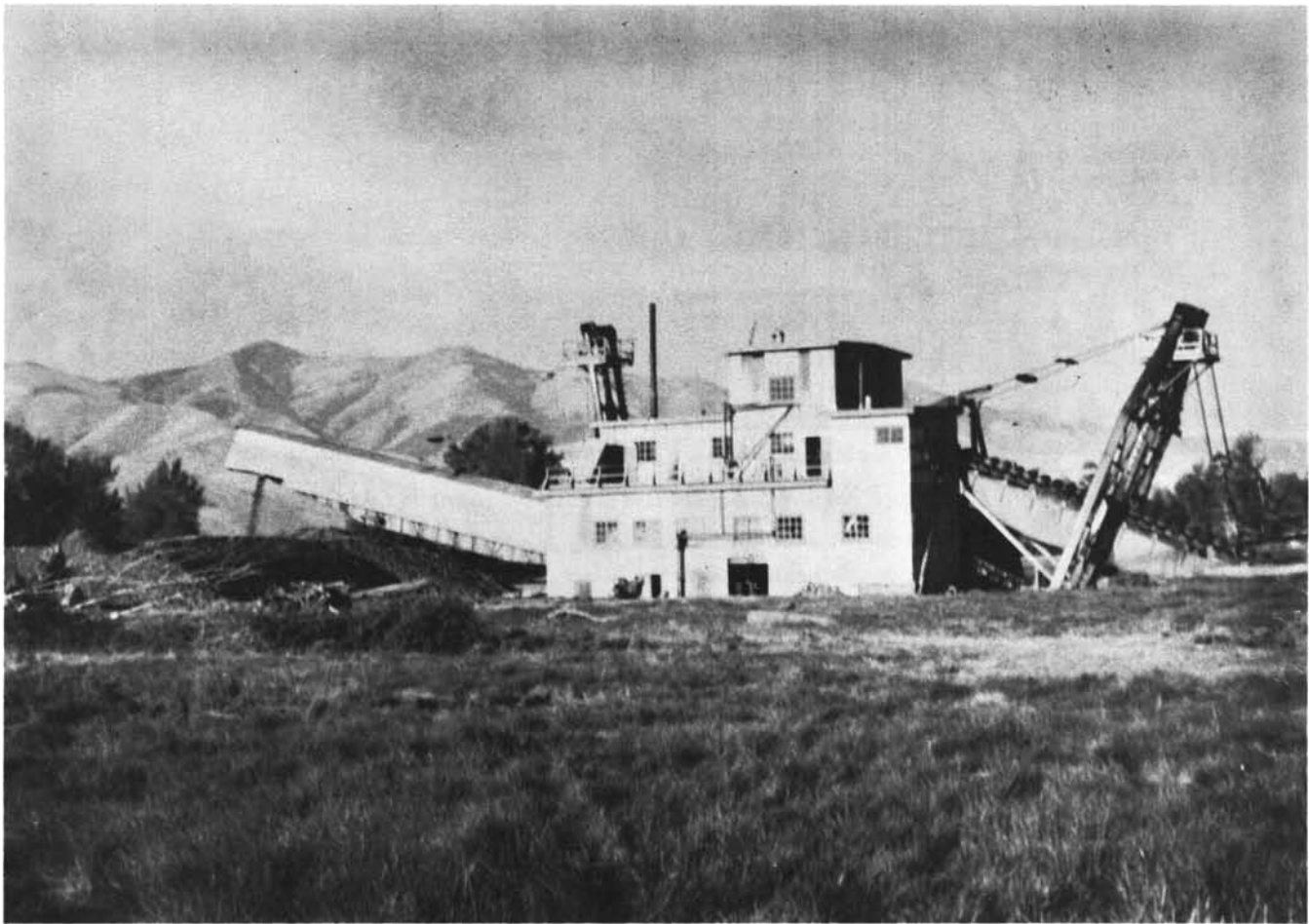
The buckets were continually dumping the fluvial deposits into a revolving screen called a trommel while water from spray nozzles washed the finer material through holes in the trommel. From the lower end of the trommel, boulders and coarse gravel were taken on a stacker (conveyor belt) and dumped in piles behind the dredge.

The finer gravel and silt that washed through the trommel ran over the dredge sluices. A sluice is a long, sloping table over which placer gravel is carried by a stream of water. The dredge sluices had a thin layer of liquid mercury on top of mats. When gold or silver went over the sluices, it amalgamated or alloyed with the mercury. Because these first tables recovered 90 percent of the gold, they were locked up. The last 10 percent of the gold was recovered in sluices called side tables or tailings sluices. These were simply shallow troughs with steel grating over which water ran and gold accumulated behind riffles (transverse bars in a sluice or table to trap gold and other heavy minerals). Approximately every two weeks, the amalgam was washed out of the mats, and the riffles were cleaned.

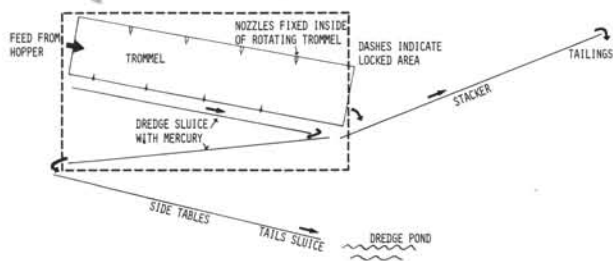
During the first several years of operation, heavy black sands were found along with the gold and silver. At first, they were thought to be worthless, so they were

Ferris and Marchbank operation, showing dragline and floating washing plant.

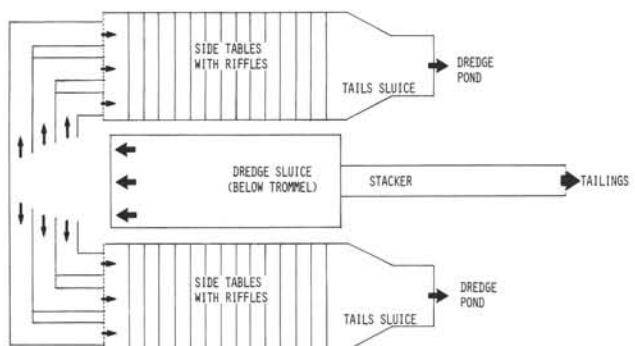




Side view of dredge in operation near town of John Day. Note coarse material deposited by stacker on tailings pile behind stern of dredge. (Photo courtesy Ted Styskel)



Side view of gold-saving equipment on gold dredge. Dashes indicate locked area. Material from stream bed was carried by buckets into hopper and from there was fed into trommel (revolving screen). Fine material washed through trommel onto dredge sluice below, where mercury on mats helped catch the gold, and then went to side tables, tails sluice, and dredge pond. Coarser material that did not fall through trommel was carried by stacker (conveyor belt) out to tailings pile.



Top view of gold-saving equipment. Material was washed onto dredge sluice from trommel and then onto riffled side tables. Then it flowed over tails sluice and into dredge pond.



Western Gold Dredging Company's bucket-line dredge operating in Old China Diggings.



Looking north across John Day today, where reclaimed dredged land is being used in variety of ways. John Day River is in background, at base of hills in line of trees. All flat area in middle ground was once dredged but is now being used as shopping center site, mobile home court, and State storage yard for heavy machinery and supplies. Airport was originally located on site of present-day mobile home court. (Photo courtesy Ted Styskel)

discarded. When they were assayed, however, the assay showed the metals to be the platinum-group metals osmium and iridium, the heaviest naturally occurring substances known.

The recovered amalgam was taken to a retort house, where a propane furnace vaporized the mercury. The mercury vapor rose through tubes to a gooseneck with water jacket, where it was condensed and recovered. The gold sponge left after the mercury was driven off was heated in a different crucible, and the impurities came to the surface. The surface impurities were then poured off into a base bar, which contained gold, silver, and other substances. The remaining relatively pure gold was then poured into a bullion bar. Average cleanup every two weeks produced one bullion bar and one base bar. These bars were then taken for further refining to Selby, California, where the American Smelting and Refining Company further processed the gold for the U.S. Treasury Department.

When the Western Gold Dredging Company began operations, it was quite a buoying force in the local economy. The company employed about 25 men, and it acquired its land by buying mineral rights at \$200 an acre from many farmers, thereby enabling some of them to keep their ranches during the depression.

In 1942, during World War II, legislation stopping all gold mining and dredging was passed. After the war, the company, renamed the Buffalo Gold Dredging Company, operated its dredge in 1948 and 1949 until it became uneconomical to continue. In 1950, the company was liquidated; in 1971, a Seattle scrap company cut up the dredge and hauled it away.

Since the time the land was dredged, most areas of the John Day Valley have been reclaimed. Flattened by bulldozers, dredged land is ideal for many uses because of its flatness and good drainage. Several cattle and sheep feedlots have been made on dredged ground by spreading sawdust on the earth. Alfalfa has been grown successfully on dredged land used for several years previously as a feedlot. Homes have been built on dredged ground because it provides good drainage and solid support for foundations. Gravel is easily quarried on the dredged ground by the State Highway Department for use on roads and by private firms for use in construction. The John Day airport was once located on the flat land but has since been moved. Dredged land along the John Day River has become the site of a trailer park, three sawmills, lumber drying yards, the Grant County High School, the city park, and a shopping center.

Persons wishing to see a gold dredge in Oregon may visit the Sumpter gold dredge, which today exists as a museum in Sumpter. Guided tours are conducted through it for a fee. For further information, contact Ray Barzee, Sumpter, Oregon 97877; phone: (503) 894-2311 or 894-2229.

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Sulfide mineralization reported in Benton County

by Jerry J. Gray, *Economic Geologist*,
Oregon Department of Geology and Mineral Industries

During the field surveying of stone quarries for the Department's Short Paper 27, *Rock Material Resources of Benton County, Oregon* (Schlicker, Gray, and Bela, 1978), field assistant Garwood Allen reported so much pyrite in stone-quarry sites 116 and 117 that he could smell it.

This author's curiosity was whetted, so he visited the sites and took grab samples in and between the two quarries. The major sulfide mineral giving the sulfur odor was identified as pyrrhotite (magnetic pyrite), which can range in composition from Fe_7S_6 to $\text{Fe}_{16}\text{S}_{17}$. The samples assayed gold, trace; copper, 60 ppm; zinc, 91 ppm; cobalt, 5 ppm; molybdenum, 3 ppm; nickel, 5 ppm; and mercury, 0.7 lb per ton. The two quarries are on the east end of a long, narrow dike of gabbro.

The outcrop and quarry walls are highly colored with yellow and brown from the oxidation of the pyrrhotite. Both quarries are in sec. 32, T. 13 S., R. 5 W. on Pigeon Butte, which is part of the William L. Finley National Refuge. The exact localities are shown on the map in Short Paper 27. The assay values of all metals assayed, particularly the gold, molybdenum, and mercury, appear to be anomalous. □

Columbia River Basalt bibliography completed

by James L. Bela, *Environmental Geologist,*
Oregon Department of Geology and Mineral Industries

Open-File Report 0-79-1, *Annotated Bibliography of the Geology of the Columbia Plateau (Columbia River Basalt) and Adjacent Areas of Oregon*, was released March 3, 1979. It contains approximately 2,000 entries and includes both a complete alphabetical listing and also a topical listing with 14 separate categories: pre-Plateau basalt geology, general geology of areas marginal to the Columbia Plateau in Oregon, basalt stratigraphy, basalt laboratory studies, post-Plateau basalt geology, geologic mapping, structural geology, seismicity and tectonics, geophysical studies, remote sensing studies, hydrologic studies, test wells, paleontological and archaeological findings, and mineral resources.

The bibliography was prepared by the Department of Geology and Mineral Industries as Subcontract SA-913 in partial fulfillment of the provisions of Contract Number EY-77-C-06-1030 with the U.S. Department of Energy. The contract is being administered through Rockwell Hanford Operations, Richland, Washington, as part of their Basalt Waste Isolation Program.

The objective of this program is to determine the feasibility of storing nuclear waste within the Columbia River Basalt Group, with special emphasis on the Pasco Basin in Washington. Under the geologic portion of this program, the stratigraphic, structural, tectonic, seismic, and hydrologic aspects of the Columbia Plateau are being examined. Other aspects of the Basalt Waste Isolation Program are concerned with systems integration, engineered barriers, engineering testing, and construction of a near-surface test facility.

Similar compilations for bibliographies of geologic and related studies of the Columbia Plateau in Washington and Idaho have been completed by the Washington State Department of Natural Resources (1978) and the Idaho Bureau of Mines and Geology (1978).

Comprehensive geologic information about the Hanford site in the Pasco Basin is needed for a proper evaluation of that area for nuclear waste disposal purposes. Although the basin is located in southeastern Washington, proper handling of some of the geologic issues requires additional geologic information from surrounding areas. Thus, basalt flows, Quaternary units, basement rocks, and structures which extend from the Pasco Basin into neighboring Oregon are properly understood only if geologic information and features in Oregon are addressed as part of the overall investigation. Furthermore, the delineation of other

potentially favorable geologic sites within the Columbia River Basalt Group in Washington, Oregon, and Idaho is a major goal of the geologic mapping programs presently underway.

Accordingly, the Department of Geology and Mineral Industries prepared the bibliography to (1) serve as a research tool for later work in Oregon, (2) aid in the identification of problem areas in Oregon in need of further study, (3) function as part of the data base for the Columbia Plateau, and (4) function as a first step in the generation of various Oregon Index Maps.

A similar program at another U.S. Department of Energy site in Nevada is evaluating the feasibility of storing nuclear waste within granite, shale, and tuff. In addition, a test facility in a salt formation near Carlsbad, New Mexico, is also being studied.

The open-file report is not for sale but is available for inspection at the Oregon Department of Geology and Mineral Industries in Portland and in field offices located in Grants Pass, Albany, and Baker. □

Oregon's rock material economic demand model—a progress report

by Jerry J. Gray, *Economic Geologist,*
Oregon Department of Geology and Mineral Industries

On a statewide basis, the Department recognizes the need to establish an inventory data base for rock materials, because the resource is being lost to urban growth and inconsistent zoning. Several countywide and one substate area inventory studies have already been completed by the Department.

Department inventory data along with data taken from the completed studies and used as a statistical sample of the entire state suggest that Oregon has 12,000 to 15,000 pits and quarries, of which 3,000 to 4,000 are active in any 12-month period. Annual output from these mines ranges from 30 to 50 million tons.

As land planning laws are passed and placed into effect, the need for rock resource assessments is becoming more acute. This need is formalized by ORS 215.055 and through Land Conservation and Development Commission (LCDC) Goal 5, Topic B, both of which formally direct counties and cities to take into consideration lands that are, can, or should be utilized for material sources or for the processing of mineral aggregates in the adoption of any land use ordinance.

Inventorying of rock material supply addresses only one-half of the problem. The amount of material needed today and in the future should also be known. In this way, supply and demand can be considered in mak-

ing land use decisions. Under LCDC Goal 9, Guideline A-2, demand is recognized in the statement that, "The economic development projections and the comprehensive plan which is drawn from the projections should take into account the availability of the necessary natural resources to support the expanded industrial development and associated populations. The plan should also take into account the social, environmental, energy, and economic impacts upon the resident population."

Funding for the current study was obtained in August 1978 from the Army Corps of Engineers and the Northwest Regional Commission. The Department then invited proposals from the private sector to prepare economic demand forecasts for the entire state and for the several substate areas to show the need for mineral aggregate (sand and gravel and crushed stone) in Oregon for the next five, ten, and fifty years. Economic Consultants Oregon, Ltd., (ECO) of Eugene was the successful bidder. The study was started in November 1978. The purpose of the study was to produce:

1. Projections of demand for state and substate areas for five, ten, and fifty years in the future for (a) sand and gravel and (b) stone, based on end-use modeling for each commodity.
2. Appendices presenting production data and explaining the development of the forecasting model or models.
3. An explanatory text setting forth procedures and conclusions in terms understandable to well-informed planners and including properly qualifying data, assumptions, and conclusions.

Progress to date includes the development of two kinds of models by commodities, a growth-rate model and an econometric model. The substate areas that were chosen for demand modeling were:

1. Portland metropolitan area (Clackamas, Columbia, Multnomah, and Washington Counties)
2. Umatilla County
3. Medford-Ashland metropolitan area of Jackson County
4. Lincoln County
5. Willamette National Forest

These substate areas were chosen to fit a full range of economic and geographic market types. It was reasoned that appropriate models could then be picked as examples for any other part of the state.

Several interesting problems and relationships have surfaced during this model building. Some of them are:

1. The inadequacies of data available from any one source.
2. Irregularities of demand in areas of large construction projects.
3. Variable behavior patterns over time for different economic sectors.
4. The poor relationship between the demand for

rock materials from public agencies and economic indicators.

5. The erratic demand for stone as a result of higher costs relative to sand and gravel.
6. The partial interdependence of population and employment, two of the econometric explanatory variables.

The major conclusion of the study to date is that the demand for rock material is much larger than was commonly thought. This very interesting project is on schedule and the published report should be available from the Department after July 1979. The report should help fill a very real need. □

Reminder to our readers

The Post Office does not automatically forward all of your mail when you give notice of address change. To keep your *Oregon Geology* coming, be sure to send your new address to the Portland office of the Oregon Department of Geology and Mineral Industries. □

NOTICE MINING CLAIM OWNERS

Your Mining Claim Will be Void . . .

unless you file a copy of your location certificate with the Bureau of Land Management (BLM)* as well as the county recorder.

If You Located a Mining Claim After October 21, 1976 . . .

you have 90 days to file with BLM.

If You Located a Mining Claim Before October 22, 1976 . . .

you have until October 21, 1979 to file with BLM.

You Are Required to File with BLM . . .

1. A copy of the notice of location recorded in the county records;
2. A statement providing the legal description, indicating Township, Range, Meridian, State, Section, and Quarter Section;
3. A map showing the survey or protraction grids on which is depicted the location of the claim; and
4. A \$5.00 service fee for each claim.

Mining Claims in Oregon-Washington Are Filed at . . .

Mining Claim Recordation Office
Bureau of Land Management
729 NE Oregon Street
P.O. Box 2965
Portland, Oregon 97208
(Telephone: 503-234-3361)

(Complete instructions may be obtained by contacting the above Recordation Office.)

*If your claim is within a National Park, you must record it with the National Park Service.

ABSTRACTS

GEOLOGY AND MINERAL DEPOSITS OF THE BOHEMIA MINING DISTRICT, LANE COUNTY, OREGON, by Michael Paul Schaub (M.S. in Geology, Oregon State University, 1978)

The Bohemia District is located in the Western Cascade Range, Lane County, Oregon. Over one million dollars worth of metals have been produced from mines of this area since 1872, making it one of the most important districts of the Cascades.

Bedrock consists of a portion of the Oligocene-Miocene Little Butte Volcanic Series and is composed principally of a thick section of pyroclastic tuffs overlain by massive interstratified flows of andesite and basalt. Other volcanic lithologies include flows of dacite porphyry and a multi-lithic breccia. Folds of small amplitudes and low angle unconformities of local distribution are widespread throughout the volcanic sequence and are interpreted to have formed by gentle deformation related to shallow subvolcanic magmatism.

Felsic plutons of probable Miocene age intrude the volcanic pile, and there are over 40 small plugs in addition to the Champion Stock. The plugs are predominantly quartz diorites, whereas the composite Champion Stock contains granodiorite, quartz monzonite, and felsic aplite.

Vein-type mineralization is widespread in both the volcanic and plutonic rocks of the district. Although gold has been the most important metal, the deposits are dominated by zinc, lead and copper that occur in veins containing chiefly quartz, carbonates, sphalerite, galena, chalcopyrite and pyrite. The veins have two principal orientations; the dominant vein set trends N. 65° W. and the secondary cross-veins trend N. 20° E.

Contemporaneous with vein mineralization was the formation of at least eight breccia pipes. These bodies are roughly cylindrical in shape, vertically oriented, and vary from 3 m to over 100 m in diameter. The constituent clasts are derived from the nearby country rocks and range from 1 mm to 0.5 m in diameter. The breccia fragments and surrounding country rock have been intensely altered to a quartz-sericite \pm tourmaline assemblage. An admixture of quartz and tourmaline cements the breccias. Because the pipes grade upward into shatter breccias of highly fractured rock with little displacement, they are interpreted to have originated by collapse.

Low temperature propylitic alteration is widespread throughout the district and affects both volcanic and plutonic lithologies. Smaller zones of higher rank quartz-sericite and potassic alteration are localized in areas of structural weakness, such as breccias, and shear and fracture zones.

Geochemical abundances of trace elements in rock samples indicate that the district is zoned with respect to base metals. Anomalously high concentrations of copper, zinc, and lead are progressively encountered from east to west across the district. The molybdenum

anomaly is coincident with that of copper, and these are roughly centered upon the zone of potassic alteration.

Hydrothermal alteration and mineralization of the district are related to the pluton. Evidence for such a genetic relationship includes the close association of all Cascades mineral districts with felsic intrusions, structural features related to these intrusions, and chemical and mineral zonations within the district. Geologic and geochemical evidence that includes alteration patterns, fluid inclusions, breccia pipes, and mineral and trace element zonations, collectively suggest that only the highest levels of the hydrothermal system are exposed, and that it is possible that porphyry-type mineralization is present at depth.

THE PETROLOGY AND STRATIGRAPHY OF THE PORTLAND HILLS SILT, by Rodney Thomas Lentz (M.S. in Geology, Portland State University, 1977)

The present investigation carefully examines the lithology and stratigraphy of the Portland Hills Silt on the basis of field observations and detailed lateral and vertical sampling. Over 100 uniform and variable depth samples were obtained from outcrops and 4.7-13.4 m (15-45 ft) deep sections located in and around the Tualatin Mountain region, Oregon and Washington.

The Portland Hills Silt is uniform both in texture and composition. The average grain size distribution indicates 77 percent silt-, 19 percent clay- and 5 percent sand-sized particles, very poor sorting and a fine skewed grain size distribution. The median grain size fines westward from about .041 mm near the Portland basin, to .022 mm to the west slope of the Tualatin Mountains.

Quartz and feldspar constitute 35 to 36 percent respectively of the total mineral composition. Clay minerals (15%), coarse-grained micas (6%), rock detritus and volcanic glass (5%), and heavy minerals (3%) make up lesser quantities. The heavy mineral suite is composed of hornblende (41%), opaques (17%), epidote (15%), augite (10%), a variety of metamorphic species and very minor hypersthene.

The Portland Hills Silt is overlain by the Willamette Silt and underlain or possibly interstratified with the Boring Lava. Carbon-14 age dating and paleomagnetic data suggest deposition between approximately 34,000 and 700,000 (?) years B.P. The silt's thickness decreases from about 37 m (120 ft) on the east side of the Tualatin Mountains to near zero in the Chehalem Mountains, some 27 km (18 mi) to the west.

The deposit is basically massive. However, deeper exposures may reveal up to four 2-8.5 m thick silt units, which are delineated by darker paleosols. The units are tentatively correlated with major glacial deposits of western Washington; the Orting and Stuck Drifts and the Upper and Lower Tills of the Salmon Springs Drift. The silt is also correlated, in part, with the Palouse Soil of eastern Washington.

The distributional, textural and morphological character of the Portland Hills Silt strongly indicates a loessial origin from the sediments of the Columbia River flood plain. □

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