The Ore Bin

Vol. 31, No. 11
November 1969

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

The Ore Bin
Published Monthly By

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
Head Office: 1069 State Office Bldg., Portland, Oregon - 97201
Telephone: 226 - 2161, Ext. 488

FIELD OFFICES

2033 First Street
Baker 97814

521 N. E. "E" Street
Grants Pass 97526

Subscription rate $1.00 per year. Available back issues 10 cents each.

Second class postage paid
at Portland, Oregon

State of Oregon
Department of Geology
and Mineral Industries
1069 State Office Bldg.
Portland Oregon 97201

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CLINOPTILOLITE IN WATER-POLLUTION CONTROL

Basil W. Mercer*

Clinoptilolite is a zeolite mineral which occurs in substantial deposits in the John Day region of Oregon (Fisher, 1962) and in other areas of the western United States (Hay, 1966). Because of its ion-exchange properties and potential low cost, clinoptilolite may find extensive use in the control of water pollution as an agent for the removal of ammonia nitrogen from wastewater. As previously reported, clinoptilolite is highly effective for selectively removing cesium-137 from radioactive wastewaters (Brown, 1962). It is also sufficiently selective for ammonium ion to be of potential value in a rather unusual ion-exchange process which will be subsequently described.

Ammonia as a Pollutant

Early in the developing science of water-pollution control, the presence of ammonia in surface and ground-water supplies was regarded as a strong indication of recent pollution (Babbit and Bauman, 1958). As water-quality science progressed, it became apparent that the presence of ammonia in water has implications far more serious than merely serving as an index of recent pollution (Jones, 1964; Sawyer, 1947; Betz, 1962; and Behrman, 1968). It was demonstrated that:

1. Ammonia can be toxic to fish and aquatic life.
2. Ammonia can contribute to explosive algae growths, thereby promoting eutrophication.
3. Ammonia can restrict wastewater renovation and water reuse.
4. Ammonia can have detrimental effects on disinfection of water supplies.
5. Ammonia can be corrosive to certain metals and materials of construction.

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* Senior Research Scientist, Pacific Northwest Laboratory, Batelle Memorial Institute, P. O. Box 999, Richland, Wash. 99352.

As a result, the removal of ammonia will become a necessary step in the treatment of municipal, agricultural, and industrial wastewater in many areas of the United States.

More than 90 percent removal of ammonia will be required for municipal sewage treatment plant effluents in some areas which will be involved with very large volumes of wastewater. For example, the City of Detroit, Mich., discharges daily into Lake Erie an average of 687 million gallons of wastewater (U.S. Dept. Interior, 1968) containing an estimated 45 tons of ammonia. The discharge of wastewater from this and other cities in the Lake Erie drainage basin contributes heavily to the accelerated eutrophication of this lake.

Ion Exchange Process

Laboratory and pilot-plant studies on ammonia removal from wastewater by sorption on clinoptilolite have been conducted at the Pacific Northwest Laboratory (Mercer and others, 1969). The clinoptilolite used in these studies was obtained from Hector, Cal. Clinoptilolite and other zeolites, such as mordenite, erionite, and chabazite, exhibit a high affinity for ammonium ion in the presence of other ions commonly found in natural waters (Na^{+}, Ca^{+2}, and Mg^{+2}). A comparison of the amount of ammonium ion (NH_4^+) adsorbed from a mixed ammonium and calcium solution is shown in figure 1, for Hector clinoptilolite and a conventional ion-exchange resin, IR-120*. The clinoptilolite much prefers the ammonium ion to the calcium ion under these conditions. This selectivity for ammonium ion over calcium ion permits the use of an inexpensive chemical, lime, for regeneration of the clinoptilolite.

In the ammonia-removal process, the clinoptilolite is used in a granular form, normally 20 X 50 mesh, packed in an ion-exchange column. The wastewater is pumped through the bed of granular zeolite until the NH_4^+ sorptive capacity of the zeolite is exhausted. The bed of zeolite is then regenerated or renewed by pumping a lime solution or slurry through the bed. The alkalinity of the lime converts the sorbed NH_4^+ ion to NH_3 which flows out with the waste regenerant solution. The NH_4^+ ion is replaced with Ca^{+2} ion from the lime. The zeolite bed is then ready for service.

This process has a distinct advantage over conventional ion exchange processes in that no liquid waste regenerant requires disposal. The waste regenerant is air stripped to remove the ammonia and is reused after the addition of make-up lime. A photograph of the mobile pilot plant used to demonstrate the process at the Richland, Wash. sewage-treatment plant is shown in figure 2. Using this process, an estimated 480,000 cubic feet of clinoptilolite would be required to treat the wastewater presently discharged from the City of Detroit, Mich.

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* Amberlite IR-120 product of the Rohm & Haas Co., Philadelphia, Penna.

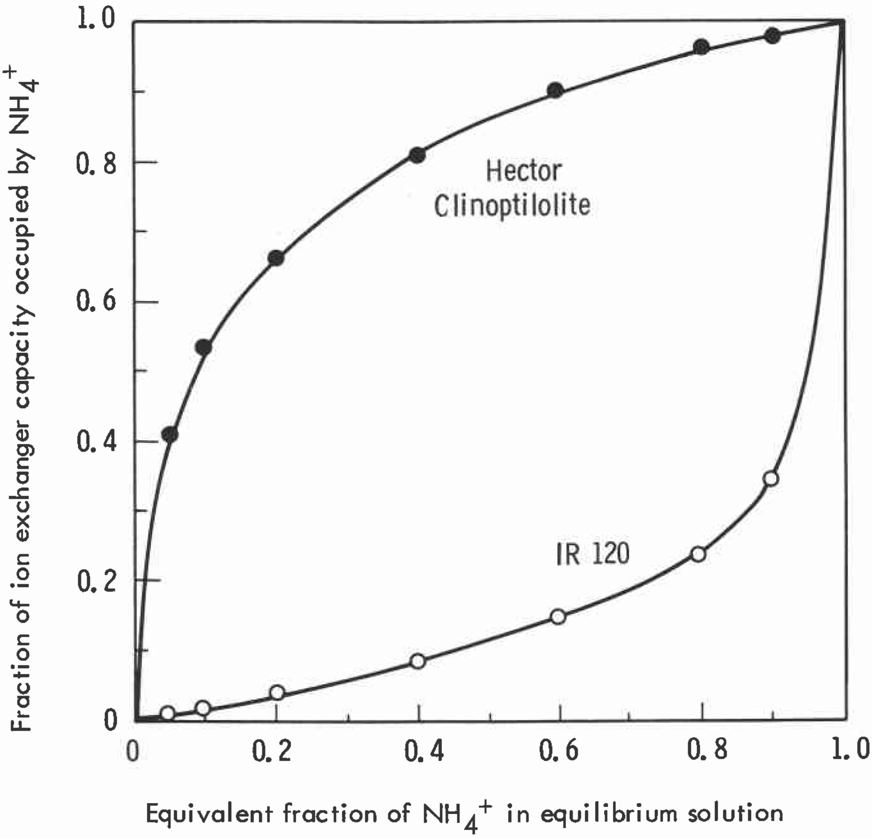

Figure 1. Comparison of the amount of NH_4^+ adsorbed from a mixed ammonium and calcium solution under equilibrium conditions.

Total equilibrium solution normality = 0.1

Clinoptilolite Quality

High resistance to chemical and physical attrition as well as a high percentage of clinoptilolite is required in the granular form of the material used in the ion-exchange beds. The clinoptilolite obtained from Hector, Cal., is contained in an altered tuff with about 15 percent quartz, feldspar, and unaltered glass. The ion-exchange capacity is about 1.7 milliequivalents per gram of zeolite. When crushed, sieved, and thoroughly washed with agitation to remove fines, clay, and other impurities, 20 X 50 mesh Hector clinoptilolite gave a wet attrition test of 3 percent. The wet attrition test determines the amount of fines (less than 100 mesh) generated by 25 grams of the granular zeolite during rapid mixing with 75 milliliters

Figure 2. Photograph of mobile pilot plant. (Photograph courtesy Battelle Memorial Institute.)

of water on a paint shaker for 5 minutes. Commercial zeolites, such as erionite and chabazite which are powdered, mixed with clay binder, extruded, and fined, will generally give a wet attrition test of about 6 percent or twice that of the Hector clinoptilolite. Low wet attrition is important because back flushing with fluidization of the ion exchange beds is required after regeneration with lime.

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IRONSIDE BULLETIN ON OPEN FILE

"Geology of the Ironside Mountain Quadrangle, Oregon," by Wallace D. Lowry, has been placed on open file in the Department's Portland office. The 79-page bulletin is camera ready for publication, but because funds for this purpose are not available a Xerox copy of the report is now placed in open file in the Department library, where it can be consulted. A color-key proof of the geologic map and the photographic illustrations can also be seen. The Ironside Mountain 30-minute quadrangle spans parts of Grant, Baker, Malheur, and Harney Counties in northeastern Oregon.

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MINING POLICY BILL PASSES

A major step toward establishing a much-needed national mining and minerals policy was taken last month with the passage of Senate Bill 719. The measure, which would provide guidelines for orderly development of our mineral resources, was passed in the U.S. Senate on September 5 and sent to the House.

Many in the mining industry feel that such a policy is essential if the U.S. is to continue as the world leader in the mineral industry. While extensive training and research programs have improved the conservation and use of agricultural crops, forests, soils, wildlife, and water resources, no such foresight has been used in the case of mineral resources. The mining industry has been more or less left to fend for itself with little outside support. It has developed practical solutions for many of the problems encountered in exploiting nonrenewable mineral resources and in improving a deteriorating environment. Technical difficulties and costs involved, however, have imposed limitations because they mean the difference between feasibility and infeasibility in the mining industry economic picture in many cases.

Ultimately, the industry will have to turn to lower grade ore deposits and deposits at great depths to satisfy mineral requirements. Such endeavors will, of course, require considerable research. S.719 establishes the policy of fostering such research -- both government-sponsored and private -- to deal with the technological problems of locating and extracting such mineral deposits.

As mineral resource problems increase, the number of mining departments in universities has dwindled -- from 26 in 1962 to only 17 in 1967. The national policy bill also emphasizes the need for technological training as well as strong research and instructional programs. The advantages of publishing and disseminating technical information are also pointed out.

Minerals are critical and essential to the nation's economy and the national mining and minerals policy, S.719, which passed the Senate last month, is the first step in providing guidelines for their wise and efficient use. (Missouri Geological Survey Missouri Mineral Industry News, v. 9, no. 10, October 1969, p. 137.)

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ROCK AND MINERAL BOOKLET REPRINTED

"A Description of Some Oregon Rocks and Minerals," by Hollis M. Dole, has just been printed for the fifth time by the Department. This popular 41-page booklet, designated as Miscellaneous Paper 1, was originally published in 1950, and although reprinted three times, the supply has been exhausted since 1963. Miscellaneous Paper 1 is for sale for 40 cents by the Department at its Portland, Baker, and Grants Pass offices.

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THE SEMIPRECIOUS GEM INDUSTRY OF OREGON

Professor Leslie L. D. Shaffer*
and
Steve T. Hashimoto, MBA**

Rockhounding, the lively art of searching for, cutting, shaping, and polishing a wide variety of quartz-family semiprecious gemstones, has become the most popular of all recreational activities based on natural resources in the state. More family hours are spent on rockhounding in Oregon than on any other outdoor activity. The following article was suggested to the authors by Ralph S. Mason, mining engineer with the State of Oregon Department of Geology and Mineral Industries, and much of the background information was supplied from the Department's files. Additional material was provided by Jerry Gray, geologist at the U.S. Bureau of Mines, Albany, Oregon. "The Semiprecious gem industry of Oregon" appeared in the Oregon Business Review, publication of the University of Oregon Bureau of Business and Economic Research, v. 28, no. 7, July 1969, 4 pages. (Editor)

Interest in working stones into objects of artistic or utilitarian use is older than the written history of man. Within the general category of stone working there has always been special interest in semiprecious and precious gems. Refining rough material into display quality gem stones was a skill passed on by demonstration even before written instructions were available. The work was surprisingly good even by modern standards, especially in view of the primitive tools which were available.

Rather complete instructions for the working of semiprecious gem material were available about 1800 (Sinkankas, 1962), but the attention of a large number of amateurs did not arise until the advent of the diamond-edge saw and the availability of electric furnaces produced grinding substances -- about 1940. Development of interest has been quite rapid since these technical changes were introduced and especially in the last 15 years.

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* Professor of Management in the College of Business Administration, University of Oregon.
** Graduate student in Management, University of Oregon.

Production Data

The U.S. Bureau of Mines reports that 38 states produced semiprecious gem materials of significant amounts during 1967 (Petkof, 1968). Some believe that Oregon may be first among the states if several factors are considered. The presence of substantial deposits of rough material, the number of persons searching out material, and the number engaged in working rough to finished items, all need to be considered in this judgment. The total value of production for the state during 1967 has been estimated at $1,000,000 (the ORE BIN, 1965). However, it is quite probable that the actual total exceeds the above figure. It is difficult to establish an accurate total dollar value, because much of the collecting of rough material is done by amateurs, both resident and tourist. Also, a large part of the finished stones are never offered for sale.

Other states reporting semiprecious gem production of some value include the following in order of importance: California, Idaho, Arizona, Texas, Wyoming, Colorado, Montana, and Nevada, with each state providing materials exceeding $100,000 in value (Petkof, 1968).

Sources of Gem Material

Gem stones are divided into two general categories: precious and semiprecious. A precious gem stone has beauty, durability, and rarity, whereas a semiprecious gem has only one or two of these qualities (Schlegel, 1957). Examples of precious gems would include diamond, emerald, precious opal, ruby, and sapphire. With the exception of small amounts of precious opal and sapphire, nothing of significance in this category has been found in Oregon (Schrader and others, 1917). However, many varieties of semiprecious gem stones can be located in different areas of Oregon. As noted in table 1, 22 counties in the state have deposits of usable rough material.

In comparison to other minerals produced, gem stones rank only fourth as indicated in table 2. It can be observed, however, that those categories of higher total value include commodities such as sand and gravel, pumice and volcanic cinder, and other bulk items.

There are several reasons why interest in semiprecious gems has developed into a significant activity in the state of Oregon. These include:

1. A great variety of semiprecious material is found in Oregon compared with other states.
2. Regardless of weather conditions, there is always some area in Oregon where raw materials can be obtained.
3. A large part of the raw material is found on public land and access is relatively unrestricted.

Table 1. Principal gem stone localities in Oregon.*

Counties	Gem materials
Baker	Agate, jasper, petrified wood
Benton	Agate
Coos	Fossil wood
Crook	Agate, carnelian, geode, moss agate
Curry	Jade
Deschutes	Agate, carnelian, geode, jasper, moss agate
Douglas	Agate
Grant	Agate, petrified wood
Harney	Agate, obsidian
Jackson	Agate, bloodstone, jasper, petrified wood, rhodonite
Jefferson	Agate, amethyst, geode, opal
Lake	Geode, obsidian
Lane	Agate, petrified wood
Lincoln	Agate, agatized coral, bloodstone, jasper, petrified wood, sagenite, sardonyx
Linn	Agate
Malheur	Agate, geode, jasper, petrified wood
Morrow	Agate, geode
Polk	Agate, jasper, petrified wood
Union	Agate
Wallowa	Agate
Wasco	Agate, amethyst, bloodstone, chalcedony, geode, jade, jasper, opal, quartz, sagenite.

*Petkof, Benjamin, 1965, Gem stones: in Mineral facts and problems: U.S. Bureau of Mines Bull. 630, p. 367.

The expense involved in obtaining semiprecious gem stones is not necessarily great -- it depends upon the degree of interest the collector might have. Lapidary equipment is priced over a wide range. The collecting and finishing of gem stones is an activity that is open to all groups, regardless of age or experience. In addition, the search for gem material can be intellectually stimulating to many persons, since they learn about Oregon's geography, history, and geology. Also, there is always the possibility of discovery of fossils, arrowheads, artifacts, and other unusual items.

Gem Locations

During 1967, the primary locations in Oregon where significant amounts of gem stones were found included sections along the Oregon coast and areas near Lebanon, Prineville, Lakeview, and Nyssa. In these

Table 2. Mineral production in Oregon, 1968.*

Mineral		Quantity	Value (thousands)
Clays	thousand short tons	203	$ 338
Diatomite	short tons	40	3
Gem stones	. . .	NA	750
Gold	troy ounces	15	**
Lime	thousand short tons	111	2,311
Mercury	76-pound flasks	940	509
Nickel	short tons	16,732	W
Perlite	short tons	W	W
Pumice and volcanic cinder	thousand short tons	850	1,200
Sand, gravel, stone	thousand short tons	40,000	55,440
Silver	troy ounces	W	W
Talc and soapstone	short tons	3	**
Value of items that cannot be disclosed:			
Cement, copper, peat		XX	$77,547

Key: NA = Not available. XX = Not applicable. W = Withheld to avoid disclosing individual company's confidential data. ** = Less than $1000.
* Source: Gray, J.J., Kingston, G.A., McComb, M.A., 1968, Mineral Industry of Oregon in 1968, preliminary annual report: U.S. Bureau of Mines, p. 2.

locations, the most sought-after semiprecious gem stones include obsidian and cryptocrystalline* varieties of quartz -- thunderegg, moss and plume agate, jasper, and petrified wood (Collins and others, 1968, p. 668). No one knows where all deposits are, and each road-construction project seems to produce its own variety and quantity of interesting material. It is of interest to note that rockhounding has now developed to the point where the state of Oregon, as well as many cities, provides maps showing locations where different types of raw material can be found.

Every year and in increasing numbers individuals search the Oregon beaches as well as the gravel beds of many coastal rivers for gem material. Local collectors report that winter is the best season for obtaining beach agates, because storms are more violent at this time of the year. Also, winter rains assist in exposing agates and other gem materials.

Among the beach gems most prized are the unique agates having various inclusions of colorful mineral matter. These stones are identified under

* Cryptocrystalline refers to crystalline structures consisting of crystals too small to be seen with the microscope.

the general name of sagenite agate. Also beach agates sometimes contain movable bubbles of water (enhydros) and these make interesting cabinet specimens (Dake, H. C., 1962).

Rockhound Meetings

Lebanon, Oregon has become well known for its semiprecious gem materials. In 1965 the Pow-Wow Rockhounds of America held a formal Memorial Day convention there which attracted more than 500 enthusiasts*. In the Lebanon area, many owners of well-known locations charge a fee of $2.00 per day which permits individuals to search for gem stones. Carnelian agate, highly prized for its deep-red color, banded agates, opal, jasper, and petrified wood are found on a large swath of prehistoric river bottom approximately 2 miles south of the city. There are several other productive locations within the Lebanon area - one near Scio, several near Sweet Home and Brownsville, and others on McDowell Creek (Albany Democrat-Herald, 1968).

Perhaps the most outstanding gathering of individuals interested in semiprecious gems occurs in Prineville, Oregon. An estimated 85,000 rockhounds gather annually in this city for a "Pow-Wow." This single event brings in nearly half a million dollars revenue from out-of-state visitors who require food, lodging, gas, and other supplies. Approximately one-half of the gem stones in this area are obtained from private holdings where owners charge a fee. Prices charged at these sites range from 10 to 15 cents per pound of raw materials obtained with a $3.00 minimum per person per day. In addition, the city of Prineville has established several good locations where no fees are charged.

In 1966, the town of Nyssa proclaimed itself "The Thunderegg Capital of Oregon," and conducted a three-day celebration (Thunderegg Days) bringing 3000 visitors and collectors from 42 states (Collins and others, 1967, p. 651). According to Mrs. Kay Brendle, "Many of these out-of-state visitors (including some families composed of up to seven members) stayed in the area for an average of three days bringing in additional income for local businessmen." The festival is now sponsored annually by the Nyssa Chamber of Commerce and the Treasure Valley Gem and Rock Club.

Thunderegg -- Oregon State Rock

The thunderegg is an agate-filled nodule found in parts of central

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* The Pow-Wow Rockhounds of America is a national organization composed of members interested in the earth sciences, rock collecting, lapidary, jewelry making, and archaeology. "Rockhound" has been defined as one who hunts and collects gem stones or minerals as a hobby.

and eastern Oregon, and is Oregon's unique contribution to rockhounding. It became the official state rock on March 5, 1965 (The ORE BIN, 1965, p. 192).

Thundereggs are spherical masses of rock that range in size from less than an inch to several feet in diameter. Most are about the size of a baseball. They have a knobby rind of drab, siliceous rock around either a cavity or a core of agate or crystals. From the outside they appear uninteresting, but when sawed open and polished they may reveal exquisite and colorful designs ranging from five-pointed stars to miniature gardens. They are highly prized by gem collectors who come from every state to search for them. Thundereggs make handsome jewelry, book ends, paper weights, pen stands, and other decorative objects. Each year they contribute thousands of dollars to Oregon's gem-stone industry (The ORE BIN, 1965, p. 192).

The thunderegg may owe its name to a legend of the Indians of central Oregon. The story related that these hard, almost spherical rocks were missiles hurled from the craters of Mount Hood and Mount Jefferson whenever the gods inhabiting the mountains became angry (ibid., p. 196). J. Lewis Renton probably deserves recognition for first putting the term "thunderegg" into print (Renton, 1936, p. 12) and for attributing the name to the Indian legend (The ORE BIN, 1965, p. 192).

Geologists are uncertain about the origin of these spherical objects, and various theories have been advanced to explain the process of their formation. It appears that there may have been at least two separate stages of activity. First, small gas pockets were formed explosively in a semi-solid light-colored lava flow, and second, the pockets were filled at a later time with agate or opal (Ross, 1941, p. 732; Staples, 1965).

Activity and Prices

At the present time in Oregon, there are 54 gem and mineral clubs (Lapidary Journal, 1968, p. 261-262) compared to 40 such organizations in 1957 (Lapidary Journal, 1957, p. 144-146) (see table 3).

Table 3. Gem and mineral clubs in Oregon*

Year	Number of clubs	Year	Number of clubs
1957	40	1963	45
1958	41	1964	49
1959	47	1965	52
1960	47	1966	51
1961	49	1967	54
1962	52	1968	54

* Source: Lapidary Journal, April issues of each year.

This is an indication of the growing interest in Oregon's semiprecious gems. The total number of persons directly involved in this activity in Oregon is unknown, since no survey has been taken. However, it is estimated that some 1900 individuals are actively interested (Northwest Federation of Mineralogical Societies, 1968). In addition, there are about 70 gem-stone retailers, several wholesalers of finished gems, and a fluctuating number of lapidary equipment and supply manufacturers (Lapidary Journal, 1967, p. 194). This would amount to about 2000 individuals in Oregon either interested or actively engaged in this activity. These figures do not include tourists or those enthusiasts who have sophisticated semiprecious gem collections but who are not members of clubs.

Prices for semiprecious gems at any particular time will vary according to several factors including beauty, durability, rarity, and supply and demand. From information obtained in contacting individuals involved in this industry, it was found that raw gem-material prices ranged from free to several dollars per pound or even per square inch of cut material. Unusual and rare items sell for even higher prices. For example, rare plume agate and some limb casts found in central Oregon will sell for as much as $35 per pound.

Polished and mounted gem stones have similar variations. For instance, a plume agate mounted in a necklace can be priced from $3 to $4 up to $15 to $18, depending upon its quality and the location of the retailer. It is apparent that there are no standardized prices for either raw material or finished products.

Prospects

Based upon the increased interest in gem stones indicated by new mineral clubs, larger gem displays in stores, and the volume of inquiries concerning gem locations, it would appear that this activity has considerable attraction and some industrial potential. The data concerning the impact of semiprecious gem stones upon Oregon's economy is incomplete. A more detailed study would provide useful information in this respect, including the following considerations:

1. The precise size and structure of the industry.
2. An analysis of areas open to both fee and free digging.
3. Problems in the administration and control of semiprecious gem locations.
4. A more precise determination of production and valuation of gem stones and gem materials produced annually.
5. The impact upon the state as well as local economies.
6. Possible guidelines and recommendations for future action with regard to growth and development of the industry.

If the income from the sale of lapidary equipment, display fittings, mountings, tools, gem and mineral books, magazines, and living accommodations for vacationing rockhounds are included, it is quite probable that the semiprecious gem-stone "industry" of Oregon is larger than has been estimated. The supply of gem-stone material in Oregon is good, and new locations are continuously being found. There is opportunity for more individuals to make a living from the activity.

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FRANCIS G. WELLS

Early on the morning of October 20, 1969 Dr. Francis Gerritt Wells, affectionately known to his many friends as "Francois" or "Duke," died of pneumonia in Sarasota, Fla.

Francois was born in Boston, Mass. on February 18, 1898. He was educated as a geologist, first at Massachusetts Institute of Technology, where he received his Bachelor of Science degree in 1922, and later at the University of Minnesota, where he received his doctoral degree in 1928. Dr. Wells worked briefly as a geologist in the eastern United States and, later, in Arkansas, Arizona, Utah, and Alaska. He first came to southwest Oregon in 1930 -- the locale for the greater part of his life's work on the U.S. Geological Survey. Much of his early work in southwest Oregon involved the study of mining districts; this work led to the publication of reports on gold, base metals, mercury, and chromite. During World War II he ably supervised a study of chromite deposits in Oregon and California under the U.S. Geological Survey's Strategic Minerals Program and, at the same time, supervised the geologic mapping of the region from Medford to the coast.

As a result of his many years of work on the geology of Oregon, Francois was selected to direct the Survey's program to prepare a geologic map of the entire state. The western part of this map was published in 1962, shortly before his retirement.

Francois exerted a great influence on the lives of the many geologists who were associated with him, and all will remember his rigorous training camps, his stimulating discussions, and his delightful stories.

- George W. Walker, Menlo Park, Cal.

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NORTHWEST OREGON SUBSURFACE STUDY PUBLISHED

"Subsurface Geology of the Lower Columbia and Willamette Basins, Oregon," has been published as the second in the Department's Oil and Gas Investigations series. Author is Vernon C. Newton, Jr., Petroleum Engineer for the Department. In this report Mr. Newton has gathered data from 25 deep exploratory wells in northwestern Oregon basins and has correlated this information with surface mapping. The region selected for the study is underlain by 10,000 to 20,000 feet of Tertiary marine sedimentary and volcanic rocks. Oil and Gas Investigations No. 2 is a 121-page book accompanied by a subsurface geologic map and six sections. The publication can be purchased for $2.00 at the Department's offices in Portland, Baker, and Grants Pass.

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BAKER COUNTY GOLD MINE REACTIVATED

Development work conducted by Anthony Brandenthaler of Baker on the old Bald Mountain mine in Baker County resulted in the shipping of one 60-ton carload of gold-bearing quartz ore to the Tacoma smelter during the latter part of October. This is in addition to a carload of mill concentrates scheduled for shipment to the Selby smelter in California in November.

The Bald Mountain mine and its nearby companion, the Ibex, are located in the Cracker Creek district on the western end of the well-known mineralized vein system of the Bourne area. Both mines have a history of productive operation prior to having been closed down by war-time curbs in 1941, and this is the first time that either has been reactivated since. The present output originates from a newly developed ore shoot on a drift at a point about 1500 feet from the portal. Additional shipments of the high-silica quartz ore will be made during the winter if the returns from the present shipment meet current expectations, which preliminary sampling reportedly indicates should be around half an ounce of gold and 17 ounces of silver to the ton. Four men have been employed at the mine and the George Reed Trucking Co. is transporting the ore from the mine to a rail siding at the Chemical Lime plant near Baker.

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DEPARTMENT HIRES NEW CARTOGRAPHER

John Newhouse, cartographer for the Department from June 1962 until October 1969, has left this position to go into environmental planning work, a field he is well qualified to follow as a result of his education in geography at Portland State University and his broad experience in map making for the Department. In the seven years he was on the Department staff, John helped to raise the standards of the Department's publications by introducing many new ideas on content, design, and color. He was responsible for the execution of the high-quality geologic maps appearing in The ORE BIN, GMS Map Series, Bulletins, and other Department publications.

Replacing John Newhouse is Steven R. Renoud, who joined the Department staff in August 1969. Steve is a native of Sweet Home, Oregon. He graduated from the Sweet Home High School in 1963 and entered the service that same year. In 1964 he re-enlisted to attend the U.S. Army Engineer's School for Cartography at Fort Belvoir, Va. During the next four years he obtained a wide range of training and experience in cartography with the Army Map Service. One year of this period was spent in Vietnam and another year teaching map drafting to trainees at Fort Lewis. Steve is taking over the job of preparing illustrations and maps for the Department's publications.

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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
27.	Geology and coal resources of Coos Bay quad., 1944: Allen and Baldwin .	1.00
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
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	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
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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
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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
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GMS-1: Geologic map of the Sparta quadrangle, Oregon, 1962: Prostka . .	1.50
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GMS-3: Preliminary geologic map, Durkee quad., Oregon, 1967: Prostka . .	1.50
Geologic map of Oregon west of 121st meridian: (over the counter) . . . . . folded in envelope, \$2.15; rolled in map tube, \$2.50	2.00
Gravity maps of Oregon, onshore and offshore, 1967: [Sold only in set]: flat . folded in envelope, \$2.25; rolled in map tube, \$2.50	2.00

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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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