

GRAVITY MEASUREMENT PROGRAM IN OREGON

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The earth derives its gravitational field from the distribution of density within it and its motion. In addition, the field is affected by the attraction of external bodies. As can be seen in Figure 1, it is layered in shells about the central core. The density ranges from 12.3 grams/cc at the center to

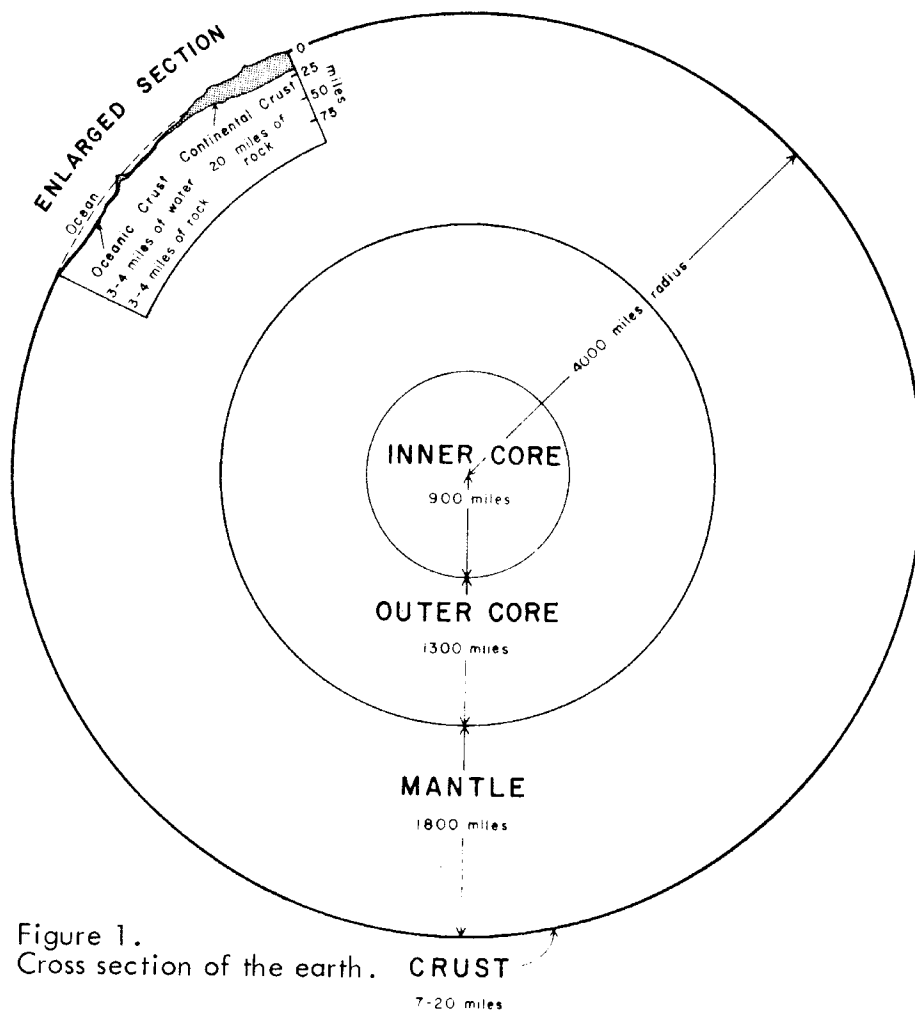


Figure 1.
Cross section of the earth.

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about 2.6 gr/cc at the surface. The average density of the earth is about 5.5 gr/cc. The gravity varies from 978 cm/sec² (or gals) at the equator to 983 gals (or cm/sec²) at the poles. This variation is generally termed the "latitude" effect and is due to a combination of the earth's equatorial bulge (more mass) and the centrifugal force from rotation. Also, there may be variations of gravity with longitude because of the figure of the earth being better approximated by a triaxial ellipsoid than an ellipsoid of revolution. Aside from this, the earth is assumed to be fairly uniform in density distribution below a few hundred kilometers beneath its surface. However, considerable variation of the earth's gravity field can be attributed to near-surface mass variations.

Measurements of the earth's gravitational accelerations can be made by modern instrumentation to 1 part in 100 million (10^{-2} mgal.) of the total field. These measurements are made with a gravity meter. A simplified diagram of a gravity meter is shown in Figure 2. The instrument is essentially a pendulum which is sensitive to vertical accelerations. The deflections of the beam at various locations on the earth's surface are related to variations in the gravitational field.

Figure 3 shows an actual La Coste-Romberg geodetic gravity meter. In order to measure the vertical component of gravity, the meter must be level. Also, it is thermostatically controlled to maintain an operating temperature to within $\pm 0.1^\circ$ centigrade. It is a portable instrument, weighs about 30 pounds, and is easily carried by one man.

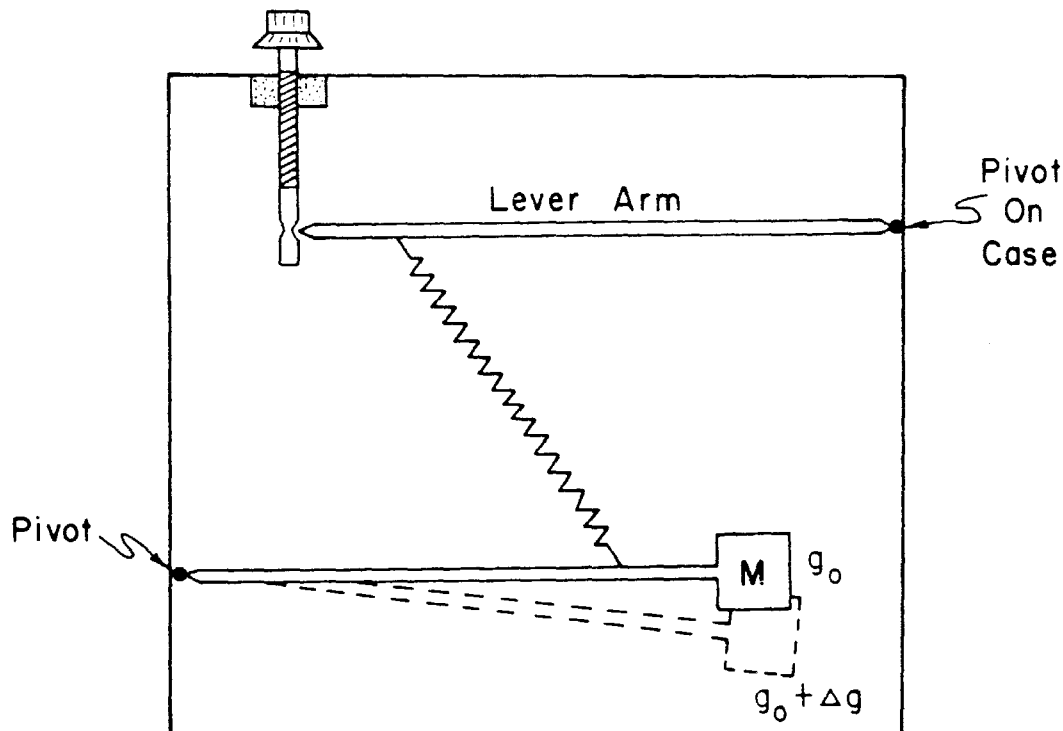
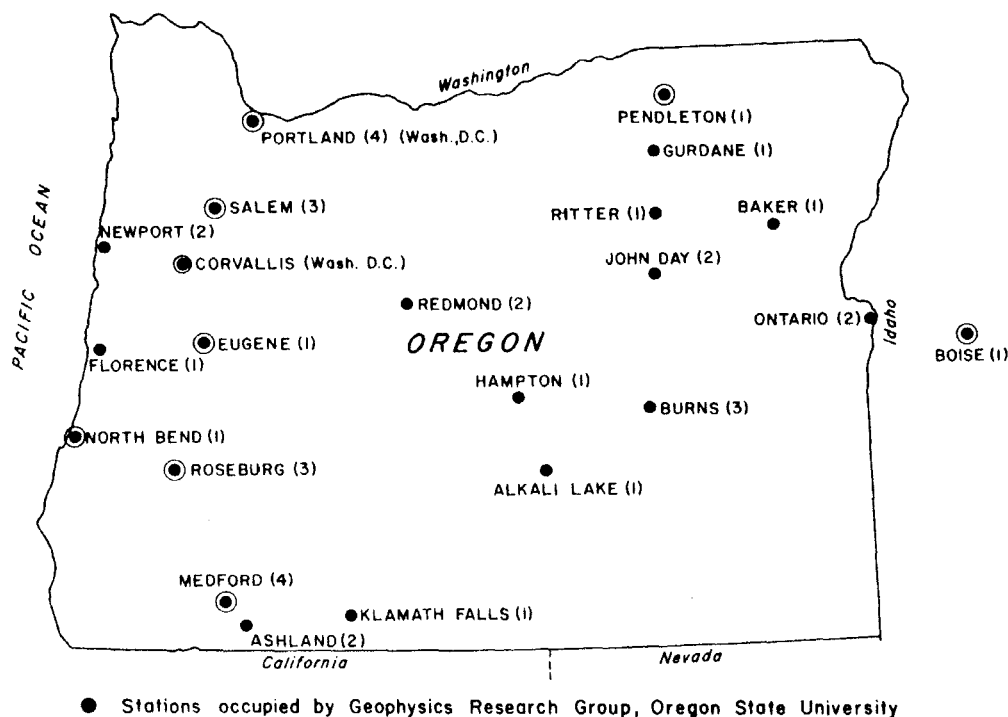


Figure 2. Simplified diagram of La Coste-Romberg gravity meter.



Figure 3. La Coste-Romberg gravity meter in use.



- Stations occupied by Geophysics Research Group, Oregon State University
 - Stations for which gravity base values are given by Woollard and Rose (1963)
- MEDFORD (4) : Medford gravity base station occupied four (4) times relative to Corvallis, Oregon
- (Wash., D.C.) : Tied twice directly with gravity base station at Carnegie Institute of Washington, D.C.

Figure 4. Gravity base station control in Oregon.

Gravity measurements vary about 0.1 mgal per foot of change in elevation, increasing in magnitude as one goes toward the center of the earth. For interpretation purposes, it is necessary to correct gravity measurements to a datum elevation. Thus, the elevation of gravity stations must be measured. In some cases, when a low order (± 10 ft.) of control is necessary, altimeters can be used. When high-order control (± 0.1 ft.) is required, precise surveying techniques must be used.

It is important to have accurate gravity base-station control. This is usually accomplished by establishing base stations in the area of interest. The gravitational acceleration of a base station is very accurately determined. Dr. George Woollard (Woollard and Rose, 1963) initially established about 10 gravity base stations in Oregon. Gravity values at these stations were measured relative to Potsdam, Germany. We have upgraded his work and increased the number of base stations to 32 (Berg and Thiruvathukal, 1965), as shown in Figure 4. All other gravity measurements in the state are relative to the gravity values of these base stations.

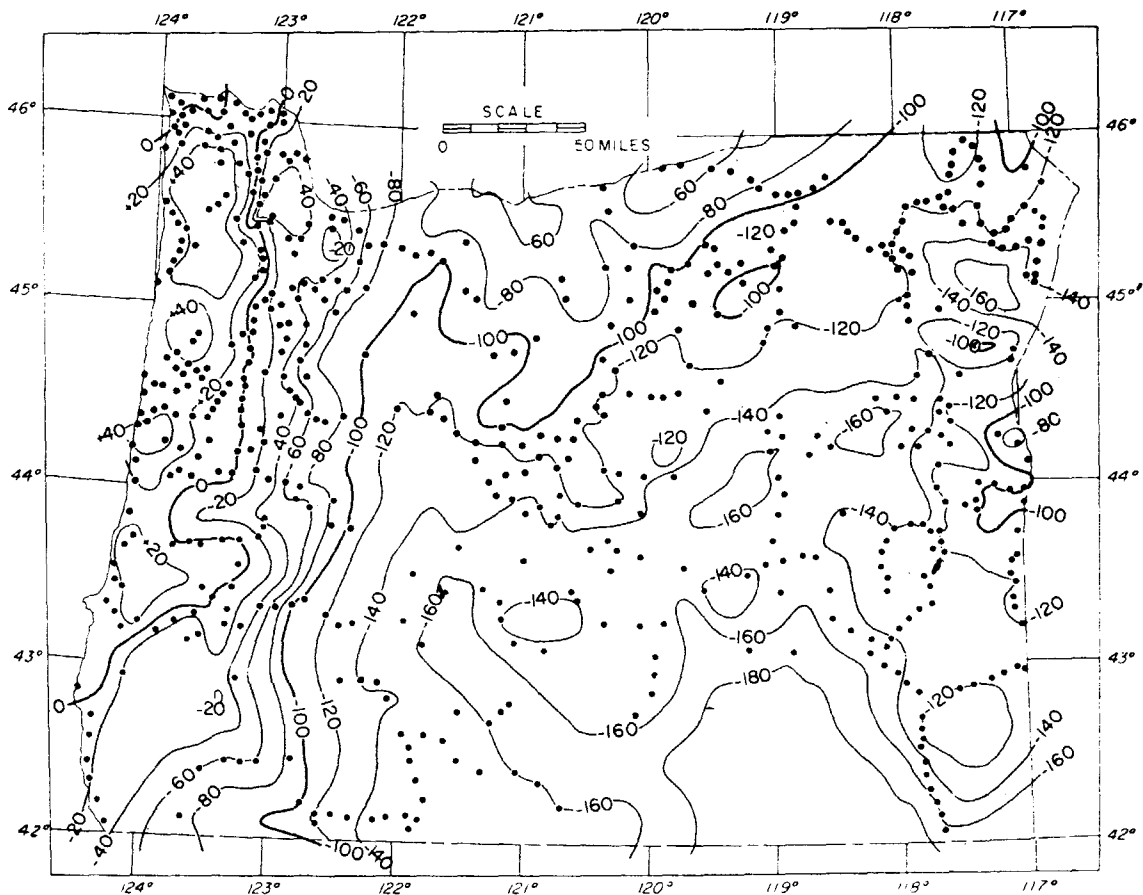
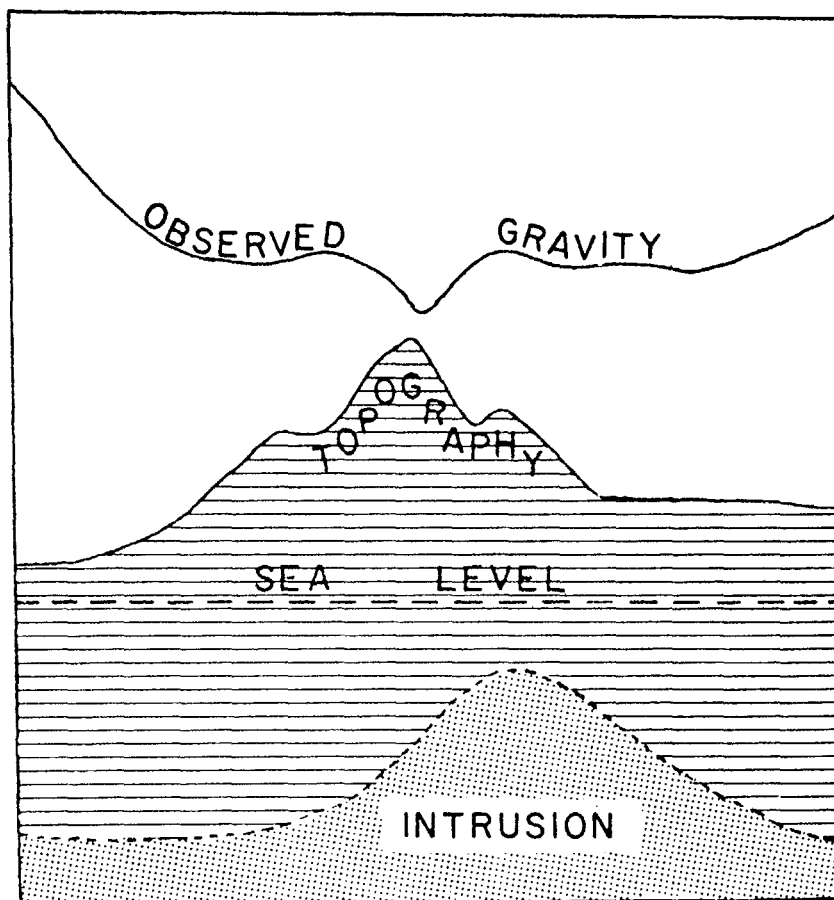


Figure 5. Bouguer anomaly gravity map of Oregon (Woollard and Rose, 1963).

More than 8,000 gravity measurements have been taken in Oregon by oil companies, governmental agencies, and universities. Figure 5 shows a preliminary gravity map of Oregon (Woollard and Rose, 1963) based on about 1800 measurements. The contour interval of this map is 20 mgal ($20/1000 \text{ cm/sec}^2$).

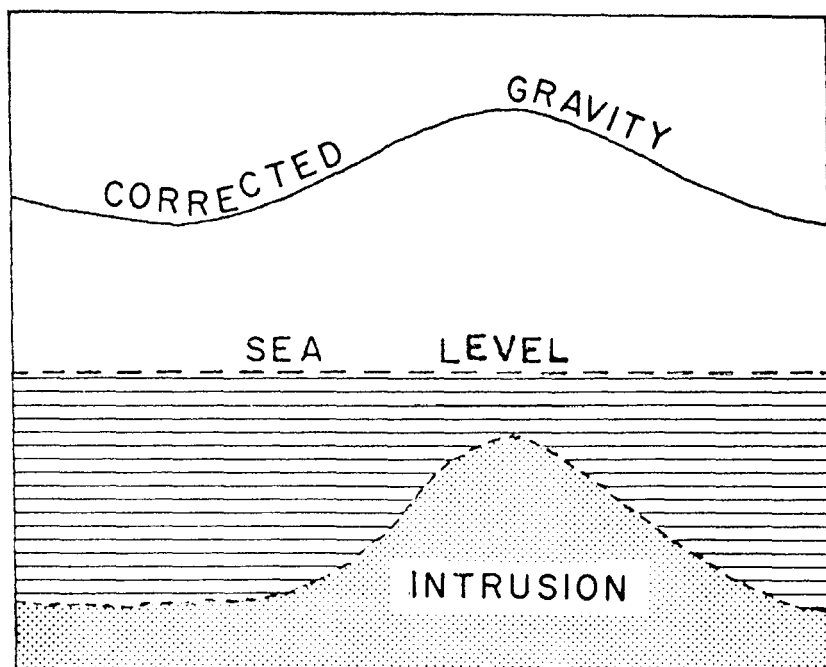
Distinctive features of this map are: (1) the isolated highs along the coast indicating basalt flows; (2) the steep gradient about 50 miles east of the coast, indicating major structural features (such as faulting); (3) the serpentine contours in the vicinity of the Cascades, probably related to the distribution of volcanism; and (4) the generally decreasing field to the southeast, probably related to major variations in regional geology (such as greater thickness of the earth's crust to the east).

Interpretation of gravity measurements is generally made in terms of subsurface mass distributions. For example, Figure 6a shows a hypothetical observed gravity profile (corrected for latitude). The measurements as shown on Figure 6a would be influenced by topography and subsurface mass distributions. To facilitate interpretation, the gravity readings should be corrected to the datum elevation (sea level in this case). This is done by



(a)

Figure 6a. Hypothetical uncorrected gravity profile.



(b)

Figure 6b. Hypothetical corrected gravity profile.

removing the effects of the land mass above sea level and also applying corrections for the elevations of the stations.

Figure 6b shows the corrected gravity profile. The effect of the sub-surface mass is quite evident in these data. Usually, an interpretation is made using the corrected data with the aid of high-speed computers. Interpretations of gravity data are usually made of mass distributions in the crust and mantle of the earth. In addition to the above, information regarding the shape of the earth can be determined from the data.

Currently, more gravity measurements are being made in cooperation with the Army Map Service to provide better station density in Oregon. We have finished processing all data on hand for the state and are starting a new map which will show considerably more detail than the one shown in Figure 5. The tentative completion time is about the spring of 1966.

Acknowledgments

This work is being sponsored by the National Science Foundation under Grant GP 4465.

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PIERRE R. HINES HONORED

Fifty years of membership and service in the American Institute of Mining, Metallurgical, and Petroleum Engineers has been celebrated by Pierre R. Hines. A retired consulting mining engineer with experience in many parts of the world, Hines was honored by the Oregon Section of AIME with the presentation of the Society's Legion of Honor scroll March 18. He has been identified with the Gold and Money sessions which were a feature of the past two Northwest Metal and Mineral conferences held in Portland. The final chapter of Hines' four-part article, "What Price Gold?", appeared in the February, 1966, ORE BIN.

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THE PRINCIPLE OF DISCOVERY AND THE PROBLEMS ARISING THEREFROM*

By Raymond B. Holbrook**

The Constitution of the United States says Congress shall have power to dispose of and make all needful rules and regulations respecting property belonging to the United States. In the exercise of this authority, Congress passed the General Mining Law.

The heart and core of the General Mining Law is discovery of mineral. It is both the reward for the labor and anxiety of the discoverer and the incentive for others to search for essential minerals.

It is very clear that discovery of a valuable mineral deposit is required for a valid mining location. These terms are not defined in the Mining Law and it does not indicate the extent or value of minerals necessary for a valid location. The most frequently quoted definition of discovery is the "prudent man rule" given in an 1894 decision of the Department of the Interior. This rule has now been drastically changed, the most serious changes being made recently.

By 1933 the Department of the Interior had adopted the rule that a valid discovery for a placer claim located for sand and gravel required a showing that the material could be mined at a profit. By 1960 this rule had been extended to several other commonplace minerals (pumice, gypsum, limestone, clay, building stone). In 1961 the Department held that a discovery which merely warrants further exploration is not sufficient, but that the discovery must warrant development of the deposit.

Until 1964 the Department of the Interior consistently maintained that it was not necessary for metalliferous minerals to be found in paying quantities or have commercial value for a valid discovery. Then the Department extended the marketability rule to manganese, a valuable metallic mineral, by holding in the Denison and related cases that the claims did not have valid discoveries because the manganese ore could not be mined at a profit. It is generally believed that this decision eliminated the prudent man rule, as it has been known, and extended the marketability rule to include all locatable minerals. The marketability test requires a discovery of ore that

* Presented at the 1965 Mining Show, American Mining Congress, Las Vegas, Nevada, October 11-14, 1965.

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can be mined, processed, shipped, and sold with a resulting profit.

The Department of the Interior has acknowledged these changes in the Mining Law. I quote from a paper delivered in 1964 by H. R. Hochmuth, then Associate Director of the Bureau of Land Management:

"There can be no gainsaying that the Mining Law of 1872 is not administered as it was originally written and intended. There has been a definite trend in decisions toward more stringent requirements to establish the validity of the claim. The requirements are innovations which have been superimposed on the basic law by the need for standards which can serve to prevent the subversion of the law for non-mineral purposes. Examples of this may be found in the narrowing application of the rule of discovery, the employment of the rule of marketability and the concern for economic values...."

The impact of this concept of discovery requirements is illustrated by applying it to locations for deposit of the following ores:

1. A newly discovered deposit of uranium ore for which there is no present market.
2. A complex ore that cannot be treated with satisfactory results by presently known methods, even though the deposit looks attractive in the light of anticipated metallurgical improvements.
3. A porphyry deposit which is too low grade for a profitable mining operation, but would be profitable if technical developments reduce mining or treatment costs, or metallurgy improved, or metal prices increased.

I doubt such locations are valid under the marketability test.

Another change in rules by the Department of the Interior has increased the risk of applying for patent. Prior to 1960, when a patent application was denied on the ground of inadequate discovery, the Department of the Interior merely rejected the application and the mining claimant could retain possession of the claim and continue to develop it, no worse off with respect to its validity than before the application was filed. In 1960 the Department ruled that an adverse decision on the issue of discovery in a patent proceeding necessarily results in a declaration that a claim is null and void. Now an applicant for patent is betting that his claim will be found valid; failing, his claim is lost. It is a "win or lose" proposition.

The adverse effect of the Department of the Interior's narrow and unrealistic discovery requirements on development of our mineral resources is demonstrated by the decreasing number of applications for mineral patent being filed and the number of patents being issued. They are only a fraction of what they used to be. How long will risk capital be available under a

system where one doing exploration work is a mere tenant at will, subject to dispossession by the Department of the Interior; where there is no real security of tenure until he has proven by a profitable operation that the mineral showing he relied on in spending his labor and money is a valuable mineral deposit.

We have referred to "erosion of the Mining Law." In my opinion, administrative decisions have now made the law practically inoperable. It has been admitted that the Law is not being administered as it was originally written and intended. This I view as administrative legislation. If the Mining Law is to be repealed, the repeal should be by action of Congress and not by an administrative course which renders it unworkable.

I believe the only real relief from these problems will come from Congress' reasserting its constitutional power to make all needful rules and regulations respecting the public domain.

Until subverted, the General Mining Law served us well. It is my firm conviction that its basic principles should be preserved. I have no suggestions at this time as to how this should be done, but I am certain that the mining industry will give all needed assistance and fully cooperate with the Public Land Law Review Commission in developing an effective program.

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PACIFIC NORTHWEST MINERALS & METALS CONFERENCE SET

The annual Pacific Northwest Minerals and Metals Regional Conference will be held on April 21-22, 1966, at the Olympic Hotel in Seattle, Wash. The conference is jointly sponsored by the American Institute of Mining, Metallurgical and Petroleum Engineers and the American Society for Metals. Two days of technical sessions will include papers on a wide variety of subjects. Of prime interest to Northwest geologists will be the three papers to be presented on off-shore mining and oil exploration, with special emphasis on the areas lying off the Oregon, Washington, British Columbia, and Alaska coasts.

The current interest in gold mining is reflected in three papers which will review conditions at the Homestake mine in South Dakota, the Bralorne-Pioneer mine in British Columbia, and the new Carlin mine in Nevada.

There will also be six papers dealing with extractive metallurgy. One entire session will be devoted to the use of nuclear explosives in mine blasting. Numerous other papers in the fields of exploration, geology, physical metallurgy, and metal working will be presented. Further information may be obtained by writing Mr. Tom Van Zandt, Registration Chairman, 2700 16th S. W., Seattle, Wash. 98134.

Plans are already well along for next year's meeting, which will be held at the Sheraton Motor Inn in Portland April 19-21. One of the features of this meeting will be the Third Gold and Money Session.

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LAKEVIEW URANIUM MINE AND MILL TO REOPEN

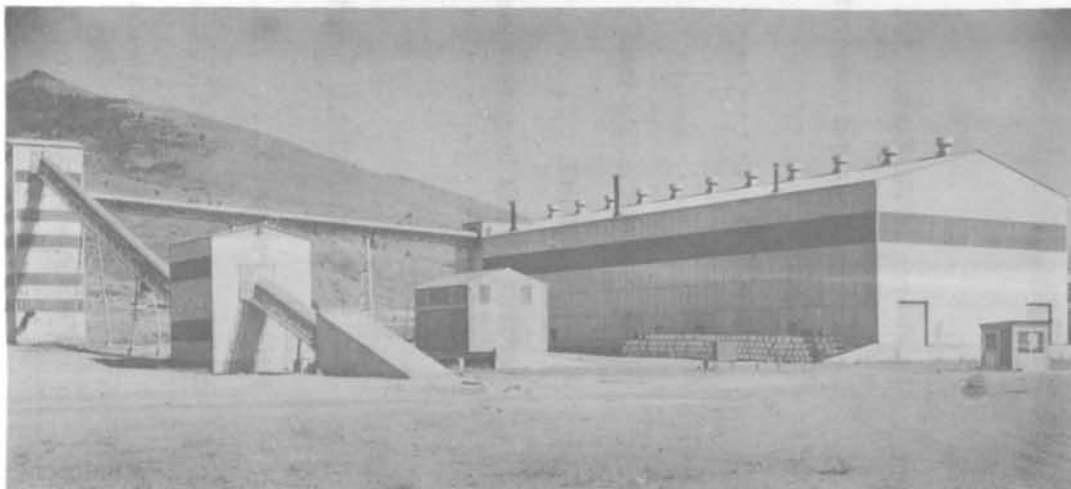
Preparations to reopen the uranium reduction plant (see photograph below) and the Lucky Lass and White King uranium mines near Lakeview have been announced by Clemons M. Roark, vice-president and general manager of Continental Mining & Milling Co. of Chicago. Continental has been granted an Atomic Energy Commission contract for the sale of 230,000 pounds of uranium oxide from ores to be produced through December 31, 1966.

Roark said his company's plans for the plant, in addition to re-establishing the leaching process for uranium ores, includes installation of a flotation circuit for such minerals as lead, silver, gold, and copper, and a concentration circuit for mercury. First on the agenda is the uranium, including reopening the two mines to begin stockpiling ore, and replacement of equipment in the plant itself. The start of uranium ore reduction will depend on delivery of equipment, but Roark said he is encouraged in having already located most of the needed machinery.

Sale of the reduction plant was completed at Eugene March 4 after AEC announced approval of the contract. The plant was sold to Continental by Oregon Pacific Industries Corp., a local group of six investors that bought the plant a year and a half ago from Kermac Nuclear Fuels Corp. of Oklahoma City, with the specific idea of inducing an industry to open an operation there and re-establish local payrolls. Negotiations with Roark have been carried on for many months. Other members of Oregon Pacific are Roy Matchett, vice-president, Nancy Taylor, treasurer, Jim Olson, and Ed Taylor.

Continental has leased the Lucky Lass and White King mines from the owners, and work has been started in opening the roads and hauling pumps and other equipment to the mines. White King owners are Don Tracy, John Roush, Wayland Roush, and Walter Leehmann, Jr. Lucky Lass owners are Don Lindsey, Bob Adams, Clair Smith, and Choc Shelton.

(From the Lake County Examiner, March 10, 1966.)



GOVERNMENT LAND ACQUISITION IN OREGON ^{1/}

A Summary of Land Acquisition by Federal,
State, and Local Governments up to 1964.

Land area of the State 61,598,720 acres

Land in government ownership and
control --

Federal 32,089,445 acres

State 1,621,605 acres

Tax-exempt Indian land 690,348 acres

Total 34,401,398 acres

Percent of land in government ownership
and control 55.8%

FEDERAL LAND BY ORIGIN

Public domain 30,565,521 acres

Acquired 1,523,923 acres

Total 32,089,445 acres

FEDERALLY OWNED LAND BY PREDOMINANT USAGE AND COST*

Predominant Usage	Acres	Cost
Agriculture	770	\$ 15,000
Grazing	3	0
Forest and wildlife	31,458,635	75,356,000
Parks and historic sites . .	160,895	52,000
Office building locations . .	36	2,512,000
Military (excl. airfields) . .	4,563	1,882,000
Airfields	95,746	132,000
Harbor and port facilities .	876	308,000
Power development and distribution	31,016	9,378,000
Reclamation and irrigation.	257,719	5,194,000
Flood control & navigation .	44,205	109,110,000
Institutional	895	283,000
Housing	1	0
Storage	17,252	118,000
Research and development.	14,641	134,000
Vacant	49	3,000
Other land	2,144	3,241,000
Totals	32,089,445	\$207,718,000

Source: General Services Administration.

* Original cost, not present valuation.

^{1/} Reprinted courtesy of American Forest Products Industries, Inc.

FEDERALLY OWNED LAND BY AGENCIES
As of June 30, 1962 *

<u>Agency</u>	<u>Public Domain (acres)</u>	<u>Acquired Land (acres)</u>	<u>Total Acres</u>
Agricultural Research Service	14,594		14,594
Forest Service.	14,408,036	1,060,416	15,468,452
Maritime Administration		906	906
Public Health Service		1	1
Bureau of Mines.		47	47
Bureau of Land Management.	15,321,175	93,466	15,414,641
Fish and Wildlife Service.	244,639	205,659	450,298
National Park Service	158,303	2,592	160,895
Bureau of Indian Affairs		1,252	1,252
Bureau of Reclamation	244,025	28,536	272,561
Bonneville Power Administration	40	1,550	1,590
Bureau of Facilities		15	15
Coast Guard	460	166	626
General Services Administration.		52	52
Veterans' Administration.		475	475
Federal Aviation Agency	617		617
Federal Communications Commission		109	109
Army.	8,440	10,892	19,332
Air Force.	269	741	1,010
Navy	37,320	61,035	98,355
Corps of Civil Engineers.	16,422	46,789	63,211
Totals	30,454,340	1,514,698	31,969,039

Source: PUBLIC LAND STATISTICS, 1963. U. S. Department of the Interior.

* Latest year for which this tabulation is available.

GOVERNMENT-OWNED RECREATION AREAS, 1960

<u>Owner</u>	<u>Number of Areas</u>	<u>Total Acres *</u>
National Park Service	3	160,872
U. S. Forest Service	14	14,960,840
U. S. Fish and Wildlife Service	12	469,822
Corps of Engineers	8	57,767
Bureau of Reclamation	7	133,420
State Parks and Recreation Division	174	59,730
State Board of Forestry	6	743,740
State Game Commission	72	61,114
State Highway Commission	24	2,517
Counties	116	10,232
Other	10	6,715
Totals	446	16,666,769

Source: "List of Public Outdoor Recreation Areas, 1960," Outdoor Recreation Resources Review Commission Study Report No. 2.

* Land and water.

NOTE: Since the above list was compiled, the Congress passed Public Law 88-607, which provides that certain lands administered by the Bureau of Land Management of the Department of the Interior shall be managed under principles of multiple use and to produce "... a sustained yield of products and services, and for other purposes." Outdoor recreation is specified as one of the uses for which these lands are to be managed.

LAND ACQUISITIONS PROPOSED OR UNDER CONSIDERATION BY GOVERNMENT As of July 1, 1964

Federal

- The Fish and Wildlife Service has been given approval to purchase 5,371 acres in Benton County to establish a Willamette National Wildlife Refuge.
- S. 1137 would authorize acquisition of private land variously estimated at from 4,000 to 15,000 acres

to establish an Oregon Dunes National Seashore. The proposed boundary of the area would include an estimated 15 private residences and two commercial enterprises as well as two State Parks.

AREAS IN OREGON NATIONAL FORESTS INCLUDED IN WILDERNESS PRESERVATION SYSTEM BY
PUBLIC LAW 88-577, THE WILDERNESS ACT OF 1964

Name of Area	Gross Acres
Diamond Peak	35,440
Eagle Cap	220,280
Gearhart Mountain Fremont	18,709
Kalmiopsis	78,850
Mountain Lakes	23,071
Mt. Hood	14,160
Mt. Washington	46,655
Strawberry Mountain	33,653
Three Sisters	196,708
Total	667,526

LAND ACQUIRED BY THE FEDERAL GOVERNMENT BETWEEN JULY 1, 1962 AND JUNE 30, 1963

9,225 acres

STATE-OWNED LAND BY MAJOR USES
1962

Farming and grazing	652,303 acres
Forest land not grazed	793,541 acres
Special public services*	125,761 acres
All other land**	50,000 acres
Total	1,621,605 acres

Source: Economic Research Service, U. S. Department of Agriculture.

* Areas used primarily for parks, wildlife reserves, institutional sites and miscellaneous other special uses. Includes an undetermined acreage of forest and woodland some of which has commercial value.

** Consists largely of State-grant land not under lease and with no reported use.

HOUSE BILLS CONCERN MINING INDUSTRY

S. 1446 - Establish National Wild Rivers System - Church (Idaho) Leg. Bull. 65-10, p. 3). Passed, amended, by Senate January 18. Now in House Interior Committee.

As amended would initially establish these seven Wild Rivers (all or portions thereof): Salmon (Idaho), Clearwater (Idaho), Rogue (Oregon), Rio Grande (New Mexico), Eleven Point (Missouri), Cacapon (West Virginia), and Shenandoah (West Virginia). Would also provide for the study of 18 additional rivers for possible later inclusion in the system.

Would not affect the applicability of U.S. mining and mineral leasing laws within the system, except that all activities under these laws would be subject to "such regulations as the Secretary of the Interior, or the Secretary of Agriculture in the case of national forest lands, may prescribe to effectuate the purposes of this Act."

H. R. 4665 - Deductibility of exploration expenditures - Ullman (Ore.) (Leg. Bull. 66-1, p. 2). Unanimously approved February 7 by House. Now in Senate Finance Committee.

Would allow a taxpayer to elect to deduct currently all exploration expenditures incurred before the beginning of the development stage of a mine. Would require, however, that if such exploration expenditures result in a producing mine, the taxpayer include in his income, or reduce his depletion deduction by, the amount of exploration expenditures properly chargeable to that mine. In addition, if a mining property is sold or otherwise disposed of, any gain would be taxable as ordinary income to the extent of the exploration expenditures incurred with respect to the property sold. Would apply only to expenditures for exploration in the United States or the Outer Continental Shelf; would apply to all minerals except coal, oil and gas.

H. R. 8989 - Federal noncoal mine safety code - O'Hara (Mich.) (Leg. Bull. 66-1, p. 2). Senate Labor subcommittee scheduled public hearings on March 21 and 22 on this and similar Senate bills.

Would authorize a federally promulgated and enforced mine health and safety code. Would also provide for state promulgation and enforcement of mine health and safety regulations if the state plan is approved by the Secretary of the Interior.

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OREMET ADDS TITANIUM SPONGE PLANT

Oregon Metallurgical Co., Albany, has added a titanium-sponge plant to its facilities. Initial production has begun and the company plans to expand the operation to three units, each capable of producing 1.2 million pounds of titanium sponge per year, according to Stephen M. Shelton, president and general manager.

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