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Main Office: Suite 965, 800 NE Oregon Street # 28, Portland 97232, phone (503) 731-4100, FAX (503) 731-4066.

Baker City Field Office: 1831 First Street, Baker City 97814, phone (503) 523-3133.

Grants Pass Field Office: 5375 Monument Drive, Grants Pass 97526, phone (503) 476-2496. Thomas J. Wiley, Resident Geologist.

Mined Land Reclamation Program: 1536 Queen Ave. SE, Albany 97321, phone (503) 967-2039. Gary W. Lynch, Supervisor.

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Oregon Geology is designed to reach a wide spectrum of readers interested in the geology and mineral industry of Oregon. Manuscript contributions are invited on both technical and general-interest subjects relating to Oregon geology. Two copies of the manuscript should be submitted, typed double-spaced throughout (including references) and on one side of the paper only. If manuscript was prepared on common word-processing equipment, an ASCII file copy on 5-in. diskette may be submitted in addition to the paper copies. Graphic illustrations should be camera-ready; photographs should be black-and-white glossies. All figures should be clearly marked, and all figure captions should be typed together on a separate sheet of paper.

The style to be followed is generally that of U.S. Geological Survey publications. (See the USGS manual *Suggestions to Authors*, 7th ed., 1991 or recent issues of *Oregon Geology*.) The bibliography should be limited to references cited. Authors are responsible for the accuracy of the bibliographic references. Names of reviewers should be included in the acknowledgments.

Authors will receive 20 complimentary copies of the issue containing their contribution. Manuscripts, news, notices, and meeting announcements should be sent to Beverly F. Vogt, Publications Manager, at the Portland office of the Oregon Department of Geology and Mineral Industries.

Cover photo

Mining by Glenbrook Nickel Company near Riddle in Douglas County: Contract miners are removing laterite (nickel ore) from Nickel Mountain for the Glenbrook smelter. The mine's production nearly doubled in 1992 over 1991 and provided the largest share of the growth of mineral production in 1992. See related summary report beginning on page 57.

OIL AND GAS NEWS

Mist gas wells sold

Nahama and Weagant Energy, Bakersfield, California, in partnership with Oregon Natural Gas Development Company, Portland, Oregon, have puchased 23 wells at the Mist Gas Field in Columbia County from ARCO Oil and Gas Company. This purchase includes natural gas producing wells, water-disposal and shut-in or suspended gas wells, as well as undeveloped leaseholds in the field. Nahama and Weagant Energy is now the operator of all gas wells at Mist Gas Field. The other operator present at this time, Northwest Natural Gas Company, operates the Mist Natural Gas Storage Project.

Mist Gas Field Report revised

The Mist Gas Field Report has been revised and is now available with all 1991 activity and changes shown, indicating operator, well name, location, depth, and status of all wells.

Accompanying the map is a report for all gas producers at the field since it was discovered in 1979. The report contains monthly production and revenue figures pressures, annual and cumulative production, and other data.

The Mist Gas Field Report, Open-File Report O-92-1, is now available at the publication outlet of the Oregon Department of Geology and Mineral Industries: The Nature of Oregon Information Center, Suite 177 in the State Office Building, Portland, phone (503) 731-4444. The price is $8. See further ordering instructions on the last page of this issue.□

MLR office moves

The change is so small that you may not have noticed it yet: The office of the Mined Land Reclamation Program of the Oregon Department of Geology and Mineral Industries (DOGAMI) has moved—just down the street—which changed the number in its street address: **1536** Queen Avenue SE, Albany, OR 97321. The phone number remains unchanged. (See also the listing on the left side of this page.) □

Vancouver USGS phone changes

For an update on the conditions at Mount St. Helens you will have to call a new number: A recorded message that is updated regularly can be reached now by calling **(206) 750-5057**. This service is provided by the USDA Forest Service for Gifford Pinchot National Forest and by the U.S. Geological Survey Cascades Volcano Observatory—both in Vancouver, Washington.

Please note that the message at this number gives you **geologic** information. For any other information, visitors to the volcano area are advised to call the following USDA Forest Service numbers and ask for assistance from a public affairs officer: Vancouver office of the Supervisor for Gifford Pinchot National Forest, (206) 750-5000; Mount St. Helens National Volcanic Monument Headquarters in Amboy, Washington, (206) 247-5473, or Visitors Center, (206) 247-6644.

Incidentally, Forest Service plans for the Volcanic Monument include the addition of visitors centers at Coldwater Ridge in 1993 and at Johnston Ridge in 1995—places from which the visitor will have a direct view into the crater. □

Correction

In the last issue of *Oregon Geology* (v. 54, no. 2, March 1992), the photo credit for the picture of Cow Creek Gorge (page 33) should have been to Jim **Hunt** of the USDA Forest Service. We apologize to him and to our readers for this error.

Shear wave velocity measurements in the Willamette Valley and the Portland Basin, Oregon

by Matthew A. Mabey and Ian P. Madin, Oregon Department of Geology and Mineral Industries

ABSTRACT

For the purpose of mapping the hazard represented by amplification of earthquake ground shaking by the sediment column, the Oregon Department of Geology and Mineral Industries (DOGAMI) has begun measuring shear wave velocities in the Willamette Valley and Portland Basin. These measurements are made by recording the time it takes a shear wave generated at the surface to reach a geophone located in a borehole. The shear wave velocity of unconsolidated sediments will be used to model how the sediments will respond to earthquake ground shaking.

INTRODUCTION

In order to fulfill its obligation to assess earthquake hazards in the state of Oregon, DOGAMI is developing hazard maps of areas in the state. The initial efforts are focused on the population centers in the Willamette Valley and Portland Basin. One hazard that is being mapped is the potential for amplification of ground shaking by the sediment column at a given site. A critical parameter for assessing the amount of amplification that takes place is the shear modulus of the soil. The shear wave velocity is one way to measure the shear modulus of a soil. The measurement of the travel time for shear waves generated at the surface down to a geophone located in a borehole gives a direct measurement of both average and interval shear wave velocities in the sediments between the source and receiver. These measurements have been made at seven sites so far. The shear wave velocity can then be used to develop a dynamic model of how the sediment column responds to ground shaking.

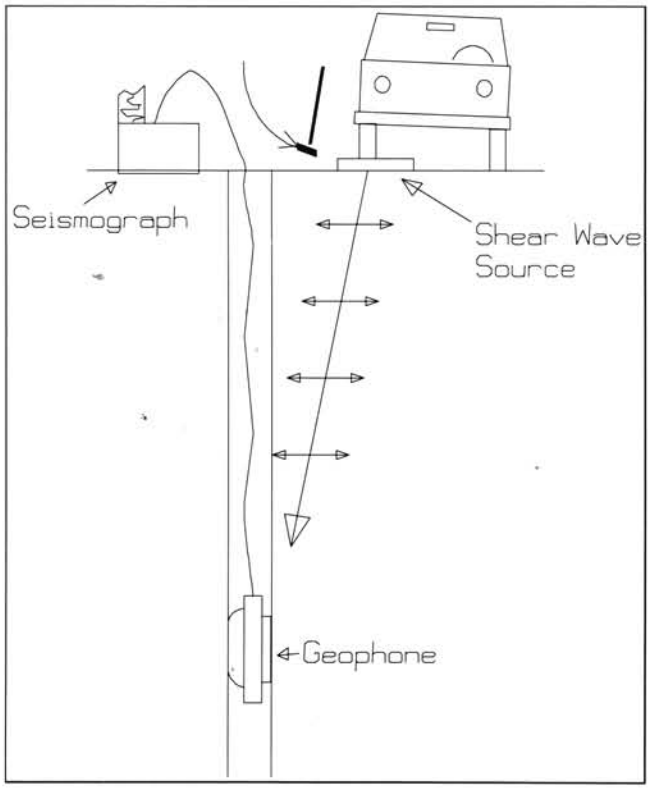


Figure 1. Diagram representing the procedure for collecting shear wave velocity data.

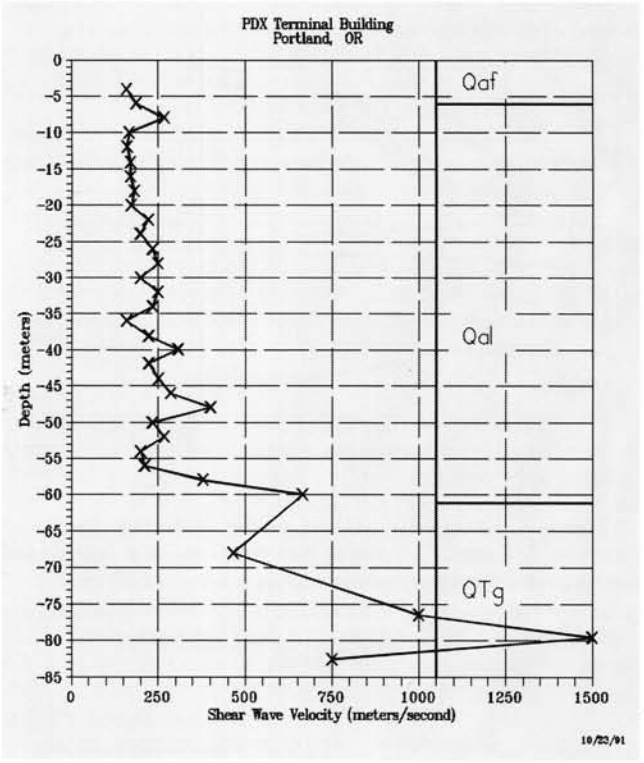


Figure 2. Shear wave velocity profile at Portland International Airport. This profile was measured in a hole immediately to the north of the main terminal building.

MEASUREMENT PROCEDURE

The shear wave velocities are measured by means of a procedure that is in common use (Stokee, 1991). The following is a brief description of some of the specifics of the implementation used for the data presented here. A Bison Series 5000 seismograph is used to record the vibrations. This seismograph is a 12-channel instrument and is equipped with digital filters. It is also a signal stacking recorder so that multiple recordings of a source-receiver configuration can be summed to increase the signal-to-noise ratio. An Oyo Geospace "Borehole Pick" (down-hole geophone) is used to detect the vibrations. This geophone is a three-component instrument that records vibrations in two orthogonal horizontal directions and in the vertical direction.

The source used to generate the shear waves is a beam struck by a sledge hammer (Figure 1 depicts the logging process). The beam is laid on the ground. Parking the wheel of a truck on top of the beam holds the beam firmly in place against the ground. Originally, a wooden beam was used, but the wood was found to deteriorate too rapidly under repeated hammer blows. The system being used now, which seems to perform very well and is very durable, is a 4-ft length of 4-in. by 4-in. steel I-beam with a 1-in. steel plate welded to one end. When the sledge hammer is hit against the end of the horizontal beam, vibrations that are predominantly horizontal shear waves are transmitted into the ground. The beam is placed 3 m horizontally away from the borehole to avoid generating tube waves in the borehole.

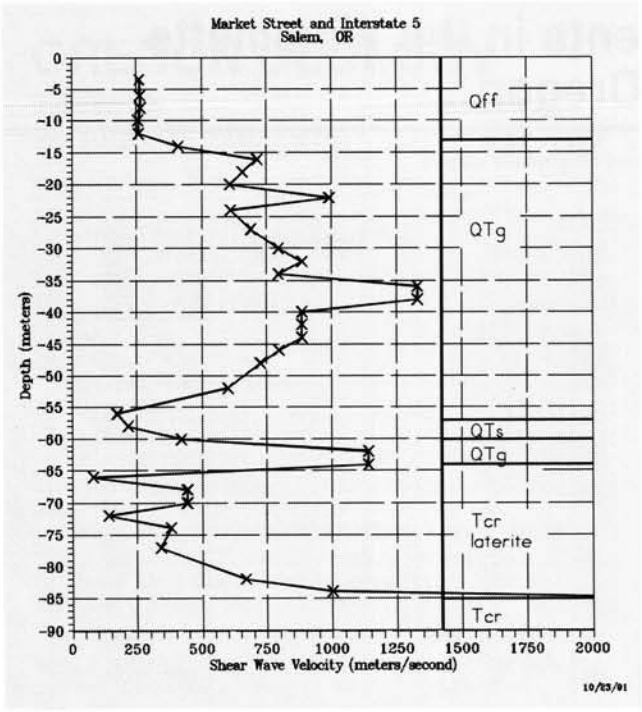


Figure 3. Shear wave velocity profile at Market Street and Interstate 5, Salem. This profile was measured in a hole drilled northeast of the overpass where Interstate 5 crosses Market Street.

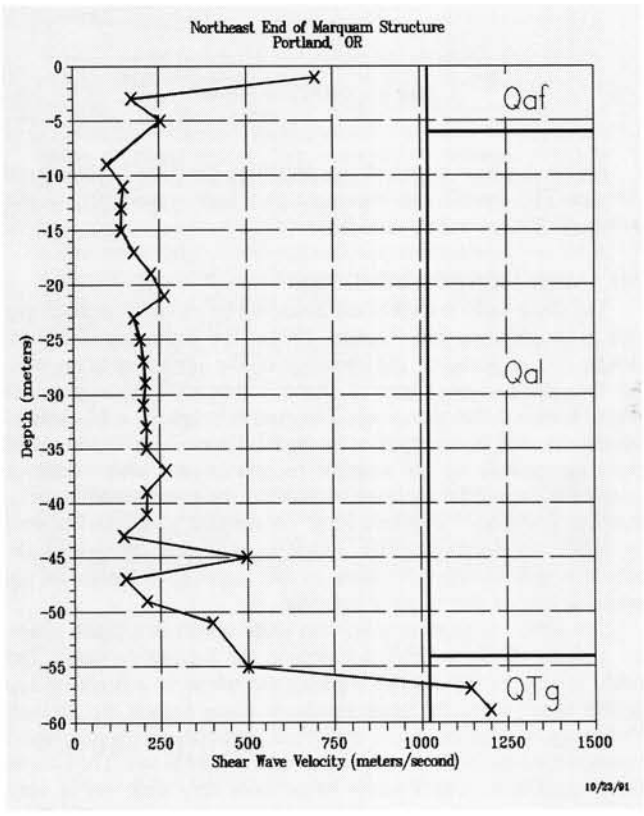


Figure 4. Shear wave velocity profile at the northeast end of the Marquam Bridge structure, Portland. This profile was measured in a hole drilled between the railroad tracks and Interstate 5, on the east side of the Willamette River, immediately north of SE Stark Street.

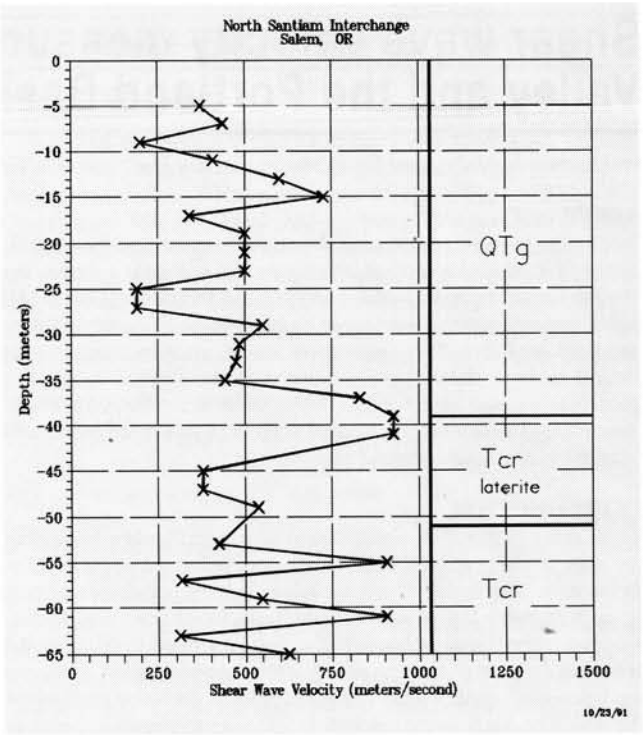


Figure 5. Shear wave velocity profile at the interchange where Interstate 5 crosses the North Santiam Highway near Salem. The profile was measured in a hole drilled to the southwest of the intersection.

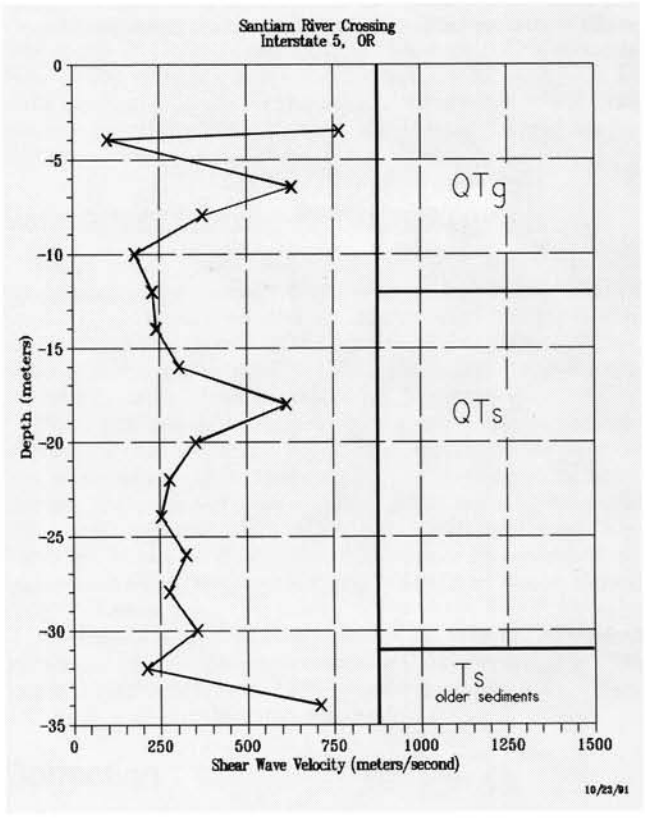


Figure 6. Shear wave velocity profile at Santiam River crossing of Interstate 5. The profile was measured in a hole drilled between the two lanes of Interstate 5, immediately south of the river.

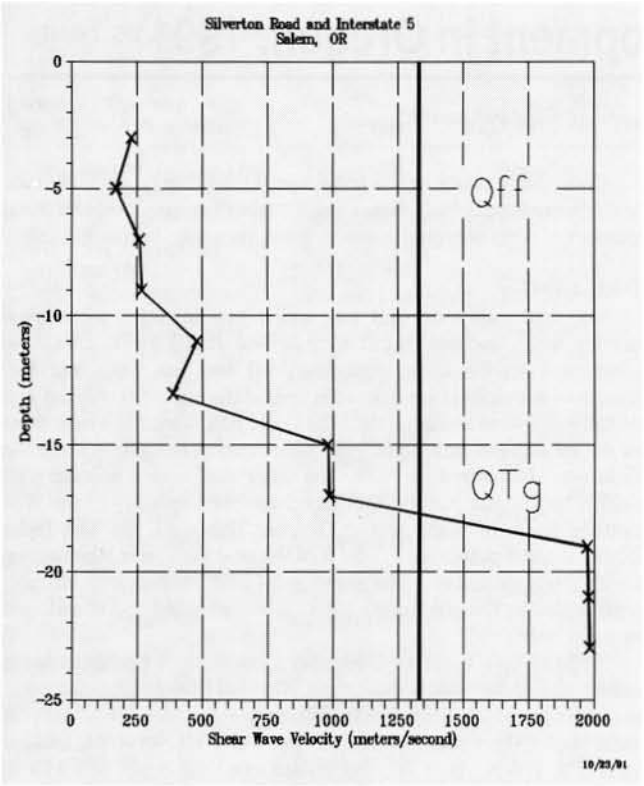


Figure 7. Shear wave velocity profile at Silverton Road and Interstate 5 in Salem. The profile was measured in a hole drilled to the southeast of the overpass where Silverton Road crosses under Interstate 5.

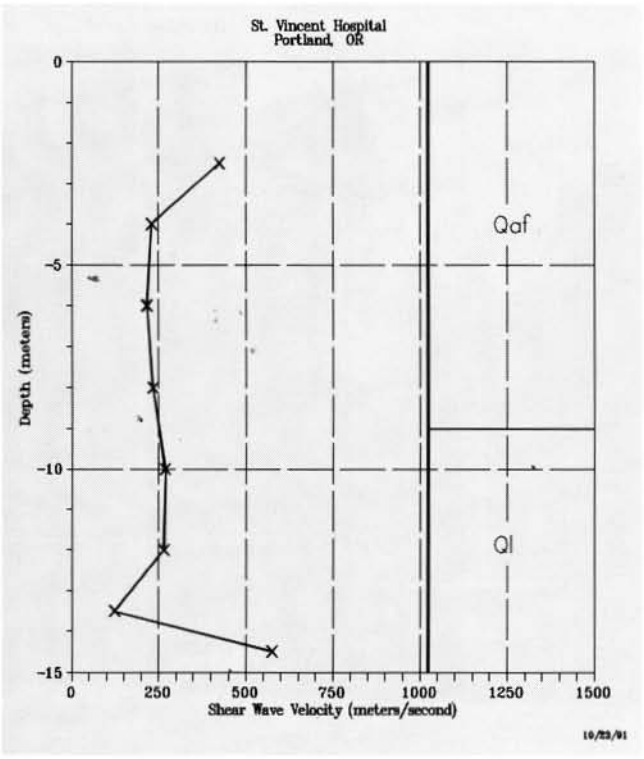


Figure 8. Shear wave velocity profile at St. Vincent Hospital, Portland. The profile was measured in a hole drilled beside the helipad that is located south of the administration building.

The generated vibrations are recorded as they arrive at the geophone, which has been lowered down a borehole. The practice has been to lower the geophone to the bottom of the hole to start. The geophone is secured in place by a pressurized rubber bladder that pushes a metal plate on one side of the geophone against the side of the borehole.

The boreholes have been completed by grouting 2- to 3-in. inside diameter PVC casing in them. The 2-in. diameter represents the smallest casing into which the geophone will fit. Casing larger than 3 in. in diameter could be logged if shims are attached to the geophone. This has not been done to date.

After a recording has been made at a given level, the pressure is released from the bladder, and the geophone is free to be raised to a higher level in the hole. Presently the recordings are being made at 2-m intervals. This process is repeated until the geophone is within 1 or 2 m of the surface.

The data recorded by the seismograph are downloaded to a laptop computer, so that they can be preserved in digital format on floppy disk. This also allows for computer-based digital processing of the data. The files are downloaded as multiplexed (intermixed in a specific pattern) time series of the three recorded channels.

DATA REDUCTION

The data that have been stored on disk are processed on a computer and yield an interval velocity profile of the soil column. The first step is to "demultiplex" the data into three separate time series or traces representing the three components of the geophone. The three recorded traces can then be displayed on a computer screen.

Arrival picks for the shear wave based on a single component of the geophone were found to be dependent on which trace was being used. Correlating waveforms from level to level was also difficult. Creating a vector sum of the two horizontal components allows extremely good correlation of the waveforms at different levels, and a single, unequivocal arrival pick is the result.

A cross-correlation function is used to aid the interpreter's choice of arrival picks and correlations of traces at different levels. The travel times are automatically corrected by the computer program for the geometric effect of the wave path varying with the depth of the measurement. An interval travel time for each 2-m logging interval is the result.

VELOCITY LOGS

Figures 2 through 8 are the results from the seven holes logged so far. These figures are plots of the measured interval shear wave velocity versus depth. Also plotted are generalized lithology logs for the holes. The lithologic units depicted correspond to the Quaternary units mapped in DOGAMI Open-File Report O-90-2 (Madin, 1990). The shear wave velocities reported here should not be viewed as a substitute for site-specific measurements. As additional shear wave velocity data are collected, the resulting profiles will be published in *Oregon Geology*.

ACKNOWLEDGMENTS

The Oregon Department of Transportation, GeoEngineers, Inc., and Rittenhouse-Zeman and Associates, Inc., provided access to the cased bore holes used to collect these data, and this indispensable assistance is gratefully acknowledged.

REFERENCES CITED

Madin, I.P., 1990, Earthquake-hazard geology maps of the Portland metropolitan area, Oregon: Oregon Department of Geology and Mineral Industries Open-File Report O-90-2, 20 p., 8 maps, scale 1:24,000.

Stokee, K.H., 1991, Application of stress waves to soil measurements: Second International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics, St. Louis, Mo., March 11-15, Proceedings, S. Prakash, ed., v. III, Rolla, Mo., University of Missouri-Rolla, in press. □

Oil and gas exploration and development in Oregon, 1991

by Dan E. Wermiel, Petroleum Geologist, Oregon Department of Geology and Mineral Industries

ABSTRACT

Oil and gas leasing activity declined during 1991. Four U.S. Bureau of Land Management (BLM) lease sales were held, with no leases purchased. There were no over-the-counter filings for BLM leases during the year. The total number of federal acres under lease at year's end was 230,000 acres. Three State of Oregon leases were acquired during the year. Columbia County held a lease sale at which three leases were purchased.

Five exploratory wells and one redrill were drilled at the Mist Gas Field during the year by Nahama and Weagant Energy Company, and three of them were successful gas wells. Northwest Natural Gas Company drilled two service wells at the Mist Natural Gas Storage Project. Oregon Natural Gas Development Company drilled a wildcat well in the Willamette Valley during the year; the well was plugged and abandoned.

At year's end, Mist Gas Field had sixteen gas producers and seven suspended gas wells awaiting pipeline connection. A total of 2.8 billion cubic feet (Bcf) of gas was produced during 1991 with a value of $3.9 million. DY Oil Company abandoned a depleted well during the year.

The Oregon Department of Geology and Mineral Industries (DOGAMI) revised its statutes and rules during the year, primarily those relating to application and annual fees for exploration and development wells drilled in Oregon.

DOGAMI continues a study of the Tyee Basin, located in Douglas and Coos Counties, and has published maps and reports on the oil, gas, and coal resources of the area.

LEASING ACTIVITY

Leasing activity declined during 1991, which is a continuation of the pattern that began during 1988. Activity included four public lease sales by the U.S. Bureau of Land Management (BLM); no bids were received at these sales. BLM received no over-the-counter filings for leases during the year. Federal leases that were terminated or that expired during 1991 totaled 240,000 acres. This includes 188,300 acres terminated for nonpayment of rentals and located primarily in eastern Oregon in Umatilla, Gilliam, Wheeler, Grant, Crook, Sherman, and Wasco Counties. The total number of federal acres under lease in Oregon at the end of 1991 amounted to approximately 230,000 acres. This includes assignments covering 159,000 acres of federal land that were approved for Hunt Oil Company and are located in Wasco, Gilliam, Jefferson, Wheeler, and Crook Counties. Total rental income during 1991 was about $310,000.

During the year, three State of Oregon leases were acquired by Nahama and Weagant Energy Company. The leases cover a total of 897 acres in Clatsop County. Leases on approximately 10,000 acres of State of Oregon lands expired or were terminated, leaving a year-end total of some 39,000 acres of State of Oregon lands under lease. The 1991 rental income was about $39,000.

Columbia County held a lease sale during 1991, at which three leases were bought by Nahama and Weagant Energy Company. Total number of acres acquired was 676 acres, for a total bonus of $1,690.

DRILLING

Six exploratory oil and gas wells, two injection-withdrawal service wells, and one redrill were drilled during 1991. This is an increase from the three exploratory oil and gas wells and two injection-withdrawal service wells drilled during 1990. All but one of the wells were drilled at the Mist Gas Field, which is where most of the oil and gas drilling activity has occurred in Oregon since the field was discovered in 1979. The other well was a wildcat well drilled by Oregon Natural Gas Development Company in the Willamette Basin of north-central Oregon. This well, the Van Dyke 32-26, located in sec. 26, T. 1 S., R. 4 W., near Gaston in Washington County, was drilled to a total depth of 3,432 ft, making it the deepest well drilled in Oregon during 1991. It was plugged and abandoned as a dry hole.

At Mist Gas Field in Columbia County, two operators were active during the year. Nahama and Weagant Energy Company was the most active, drilling five exploratory wells and one redrill. Of these wells, three were successful gas wells: CC 44-8-64, located in sec. 8, T. 6 N., R. 4 W., and drilled to a total depth of 1,810 ft; CER 14-26-64, located in sec. 26, T. 6 N., R. 4 W., and drilled to a total depth of 2,702 ft; and the redrill well CC 34-31-65 RD, located in sec. 31, T. 6 N., R. 5 W., and drilled to a total depth of 1,902 ft. The other three wells, CC 23-35-75, located in sec. 35, T. 7 N., R.

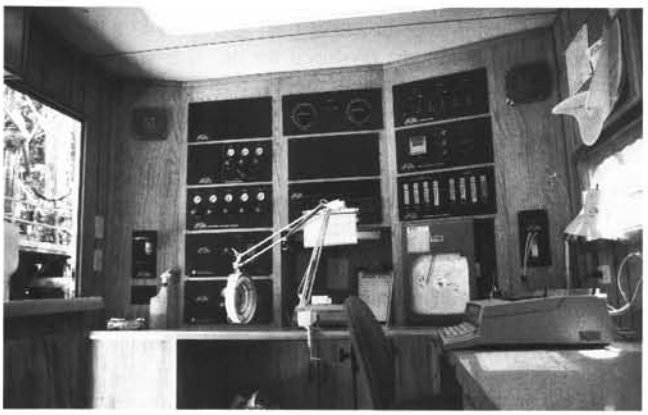
Nahama and Weagant Company drilled this well (CC 34-31-65 RD) and completed it as a successful gas producer at the Mist Gas Field during 1991. Drilling was performed by Rig 7 of Taylor Drilling Company.

Table 1. *Oil and gas permits and drilling activity in Oregon, 1991*

Permit no.	Operator, well, API number	Location	Status, depth(ft) TD=total depth PTD=proposed TD
438	Oregon Nat. Gas Dev. Van Dyke 32-26 36-067-00004	NE¼ sec. 26 T. 1 S., R. 4 W. Washington County	Abandoned, dry hole; TD: 3,432.
441	NW Natural Gas IW 13b-11 36-009-00267	SW¼ sec. 11 T. 6 N., R. 5 W. Columbia County	Completed, service well; TD: 2,905.
443	NW Natural Gas IW 23d-3 36-009-00269	SW¼ sec. 3 T. 6 N., R. 5 W. Columbia County	Completed, service well; TD: 3,079.
452	Nahama & Weagant CC 23-35-75 36-009-00278	SW¼ sec. 35 T. 7 N., R. 5 W. Columbia County	Abandoned, dry hole; TD: 3,374.
453	Nahama & Weagant CC 42-3-65 36-009-00279	NE¼ sec. 3 T. 6 N., R. 5 W. Columbia County	Permit issued; PTD: 3,300.
454	Nahama & Weagant CC 22-2-65 36-009-00280	NW¼ sec. 22 T. 6 N., R. 5 W. Columbia County	Permit issued; PTD: 3,000.
455	Nahama & Weagant CC 14-32-75 36-009-00281	NW¼ sec. 32 T. 7 N., R. 5 W. Columbia County	Permit issued; PTD: 3,500.
456	Nahama & Weagant Adams 31-34-65 36-009-00282	Ne¼ sec. 34 T. 6 N., R. 5 W. Columbia County	Permit issued; PTD: 3,600.
457	Nahama & Weagant CC 23-31-65 36-009-00283	SW¼ sec. 31 T. 6 N., R. 5 W. Columbia County	Permit issued; PTD: 2,340.
458	Nahama & Weagant CC 34-31-65 and RD 36-009-00284 and 36-009-00284-01	SE¼ sec. 31 T. 6 N., R. 5 W. Columbia County	Suspended, gas; TD: 2,064 and RD: 1,902.
459	Nahama & Weagant CC 44-8-64 36-009-00285	SE¼ sec. 8 T. 6 N., R. 4 W. Columbia County	Suspended, gas; TD: 1,810.
460	Nahama & Weagant LF 22-31-65 36-009-00286	NW¼ sec. 31 T. 6 N., R. 5 W. Columbia County	Abandoned, dry hole; TD: 1,991.
461	Nahama & Weagant CER 14-26-64 36-009-00287	SW¼ sec. 26 T. 6 N., R. 4 W. Columbia County	Suspended, gas; TD: 2,702.
462	Nahama & Weagant Oregon 31-36-66 36-007-00023	NE¼ sec. 36 T. 6 N., R. 6 W. Clatsop County	Permit issued; PTD: 2,430.
463	Nahama & Weagant CC 34-8-64 36-009-00288	SE¼ sec. 8 T. 6 N., R. 4 W. Columbia County	Permit issued; PTD: 1,350.
464	Nahama & Weagant CER 12-26-64 36-009-00289	NW¼ sec. 26 T. 6 N., R. 4 W. Columbia County	Permit issued; PTD: 2,790.
465	Nahama & Weagant CER 31-26-64 36-009-00290	NE¼ sec. 26 T. 6 N., R. 4 W. Columbia County	Permit issued; PTD: 3,120.
466	Nahama & Weagant CC 23-19-65 36-009-00291	SW¼ sec. 19 T. 6 N., R. 4 W. Columbia County	Permit issued; PTD: 3,000.
467	Nahama & Weagant Johnston 11-30-65 36-009-00292	NW¼ sec. 30 T. 6 N., R. 5 W. Columbia County	Permit issued; PTD: 2,700.
468	Nahama & Weagant CER 24-22-64 36-009-00293	SW¼ sec. 22 T. 6 N., R. 4 W. Columbia County	Permit issued; PTD: 2,600.

Drilling crew ("roughnecks") working on the drill floor at the Nahama and Weagant Energy Company well CC 22-31-65, a dry hole drilled at the Mist Gas Field during 1991.

Mud pits at the Nahama and Weagant Energy Company well CC 34-31-65. Mud pits hold the drilling mud that is pumped to the bottom of the drill hole to lift rock cuttings (produced at the bit) to the surface for examination. The drilling mud is also needed to contain the underground pressure that is exerted by the fluids in the rock formation surrounding the hole, to maintain the stability of the well, and to lubricate and cool the drill bit.



The inside of the mud loggers' trailer. Mud loggers and their trailer are present at all drill sites to examine well cuttings, monitor well conditions, and look for oil or gas shows.

Table 2. *Withdrawn permits, 1991*

Permit no.	Operator, well, API number	Location	Issue date	Reason
445	Nahama and Weagant CER 12-12-55 36-009-00271	NW¼ sec. 12 T. 5 N., R. 5 W. Columbia County	8-9-90	Application withdrawn.
448	Nahama and Weagant CER 22-16-64 36-009-00274	NW¼ sec. 22 T. 6 N., R. 4 W. Columbia County	8-9-90	Application withdrawn.
451	Nahama and Weagant CER 14-16-64 36-009-00277	SW¼ sec. 16 T. 6 N., R. 4 W. Columbia County	10-29-90	Application withdrawn.

5 W., and drilled to a total depth of 3,374 ft; CC 34-31-65, located in sec. 31, T. 6 N., R. 5 W., and drilled to a total depth of 2,064 ft; and LF 22-31-65, located in sec. 31, T. 6 N., R. 5 W., and drilled to a total depth of 1,991 ft, were plugged and abandoned.

The second active operator was Northwest Natural Gas Company, drilling two injection-withdrawal service wells at the Mist Natural Gas Storage Project. The IW 13b-11, located in sec. 11, T. 6 N., R. 5 W., was drilled in the Bruer Pool to a total depth of 2,905 ft; and the IW 23d-3, located in sec. 3, T. 6 N., R. 5 W., was drilled in the Flora Pool to a total depth of 3,027 ft.

Total drilling footage for the year was 22,705 ft, an increase from the 12,245 ft drilled during 1990. The average depth per well was 2,523 ft, an increase from the 2,416 ft per well drilled during 1990.

During 1990, DOGAMI issued 17 permits to drill (Table 1), while 3 permits were withdrawn during the year (Table 2).

DY Oil plugged and abandoned the Neverstill 33-30 well, located at the Mist Gas Field in sec. 30, T. 6 N., R. 5 W. This well was drilled in 1989 and was no longer capable of economic production.

DISCOVERIES AND GAS PRODUCTION

Mist Gas Field saw three new successful gas wells, an increase from the two gas wells drilled during 1990. Nahama and Weagant Energy Company is the operator of the new producers, the CC 44-8-64, CER 14-26-64, and CC 34-31-65 RD. All are located at the Mist Gas Field in Columbia County.

During 1991, twenty wells produced gas at the Mist Gas Field. At the end of the year, two companies, ARCO Oil and Gas Company and Nahama and Weagant Energy Company, were operating sixteen gas producers at the field. In addition, seven wells were suspended, awaiting pipeline connection at year's end.

Gas production for the year totaled 2.8 Bcf. This is the same amount that was produced from the field during 1990. The cumulative field production as of the end of 1991 was about 43.8 Bcf of gas. The total value of the gas produced for the year was about $3.9 million, which is approximately the same as the value of the gas produced during 1990. Gas prices ranged from around 14 cents to 15 cents per therm, which is about the same as during 1990.

GAS STORAGE

During the year, Northwest Natural Gas Company drilled two new service wells at the Mist Natural Gas Storage Project. The well IW 13b-11 is an injection-withdrawal well drilled in the Bruer Pool and the IW 23d-3 is an injection-withdrawal well drilled in the Flora Pool. The storage project now has a total of nine injection-withdrawal wells, five in the Bruer Pool and four in the Flora Pool. The pools have a combined storage capacity of 10 Bcf of gas. This allows for cycling of reservoirs between approximately 400 and 1,000 psi and will provide for an annual delivery of one million therms per day for 100 days. Gas from the Mist Natural Gas Storage Project is delivered to the Portland metropolitan area via the South Mist Feeder Pipeline.

At the Northwest Natural Gas well IW 23d-3, an injection-withdrawal well at the Flora gas storage pool, preparations are in progress to install surface casing. The surface casing consists of large-diameter pipe that is cemented in the well for protecting fresh-water resources, anchoring blowout-prevention equipment, and maintaining the integrity of the surface hole.

OTHER ACTIVITIES

Statute changes to oil and gas exploratory and development drilling laws were passed by the legislature during the year. The administrative rules relating to oil and gas exploration and development in Oregon were also revised. The major statute and rule changes relate to a change in the application fee for a permit to drill, which increased to $250 per application, a fee of $250 for a renewal of a permit, and an annual fee of $500 to be assessed on the anniversary date of each active permit. Copies of these rules (OAR 632, Division 10) are available from DOGAMI.

DOGAMI continues the study of the oil and gas potential of the Tyee Basin, located primarily in Douglas and Coos Counties in southwestern Oregon. The study, which is funded by land owners in the study area and by county, state, and federal agencies, is intended to investigate those characteristics needed to generate and trap gas and oil: source rock, stratigraphy, and structural framework. In this investigation, DOGAMI has developed and published a number of maps and reports that present a revised understanding of the geologic framework of the Tyee Basin. Additional maps and reports will be published during the current year.

During 1991, development of a transect was initiated: It will present the geology, including a geophysical cross-section, of a strip extending from a location east of the Mist Gas Field to the vicinity of Astoria and across the continental shelf and slope. This publication will be released in late spring of 1992.

The Northwest Petroleum Association (NWPA) remained active during the year. At its regular monthly meetings, speakers gave talks related to energy matters in the Pacific Northwest. For 1992, plans are to hold the annual symposium October 11-14 in Lincoln City, Oregon. The theme will be "Pacific Northwest Oil and Gas Development: Geology, Geophysics, Land, and Legal." For details, contact the NWPA, P.O. Box 6679, Portland, Oregon, 97228. □

Mining and exploration in Oregon during 1991

by Frank R. Hladky, Resident Geologist, Grants Pass Field Office, Oregon Department of Geology and Mineral Industries

ABSTRACT

Oregon's mineral industry showed an estimated 16-percent increase in value over 1990. Mineral production in 1991, including natural gas, was estimated at nearly $274 million, mostly from sand, gravel, cement, crushed stone, and nickel. The largest single growth factor was the result of the near-doubling of nickel production by Glenbrook Nickel Company. Industrial mineral industry growth was also robust, increasing at a rate of 39 percent. New metals production included Formosa Exploration, Inc., which shipped its first copper and zinc concentrate to Japan from the Silver Peak Mine in Douglas County.

The intensity of gold exploration in Oregon diminished as companies generally cut back projects, staffs, and exploration dollars, not only in Oregon, but nationwide. Two major projects nearing development remained in exploration status, as Atlas Precious Metals continued permitting activities at Grassy Mountain in Malheur County, and Plexus, Inc., continued to pursue permitting of its Bornite project in Marion County.

The Oregon Department of Geology and Mineral Industries continued mineral exploration projects in the Boise and Medford 1° by 2° sheets.

PRODUCTION HIGHLIGHTS

The value of Oregon's 1991 mineral production, excluding natural gas, was nearly $270 million, mostly from sand, gravel, cement, crushed stone, and nickel, according to estimates by the U.S. Bureau of Mines (USBM) (see Table 1 and Figure 1). The value of natural-gas production in Oregon in 1991 was $3.9 million, unchanged from 1990. The total of nearly $274 million was 16 percent greater than in 1990. Production of ferronickel at the Glenbrook Nickel Company smelter at Riddle, Oregon, nearly doubled, accounting for the largest single share of the increase. According to the USBM estimates for 1991, the value of the combined metals and industrial minerals grew by 54 percent to $131 million; of this, the value of industrial minerals grew an estimated 39 percent. The value of produced rock materials, sand, gravel, and crushed stone decreased slightly, by 6 percent, to $139 million.

EASTERN OREGON

The Bonnanza placer mine (mine site 2 [for all active mine sites see Figure 2 and Table 2]) on Pine Creek in Baker County, remains the state's largest gold producer. The company's successful reclamation efforts were honored by the Oregon Department of Geology and Mineral Industries (DOGAMI) with one of the two Outstanding Operator awards presented in 1991 (Figure 3). Bonnanza expected to exhaust its deposit by 1991; it now foresees continued operations into 1992.

Ash Grove Cement West, Inc., near Baker City, remains eastern Oregon's largest mineral producer (mine site 9). In 1991, Ash Grove produced 475,000 tons of clinker for cement, down 5 percent from 1990, and 220,000 tons of crushed limestone, the same as in 1990. The company continues to employ 105 workers, remaining a stable and sizable employer for eastern Oregon. *(Text continued on page 62)*

Table 1. *Summary of mineral production value (in millions of dollars) in Oregon for the last 20 years. Data for 1991 derived from U.S. Bureau of Mines annual preliminary mineral-industry survey and Oregon Department of Geology and Mineral Industries natural-gas statistics.*

	Rock materials[1]	Metals and industrial minerals[2]	Natural gas	Total
1972	54	22	0	76
1973	55	26	0	81
1974	75	29	0	104
1975	73	33	0	106
1976	77	35	0	112
1977	74	35	0	109
1978	84	44	0	128
1979	111	54	+	165
1980	95	65	12	172
1981	85	65	13	163
1982	73	37	10	120
1983	82	41	10	133
1984	75	46	8	129
1985	91	39	10	140
1986	96	30	9	135
1987	102	52	6	160
1988	130	48	6	184
1989	131	55	4	190
1990	148	85	4	237
1991	139	131	4	274

[1] Includes sand, gravel, and stone.

[2] For 1991, this includes cement; clays, including bentonite; copper-zinc; diatomite; gemstones, including Oregon sunstone; gold-silver; nickel; perlite; pumice; quartz; silica sand; talc, including soapstone; and zeolites.

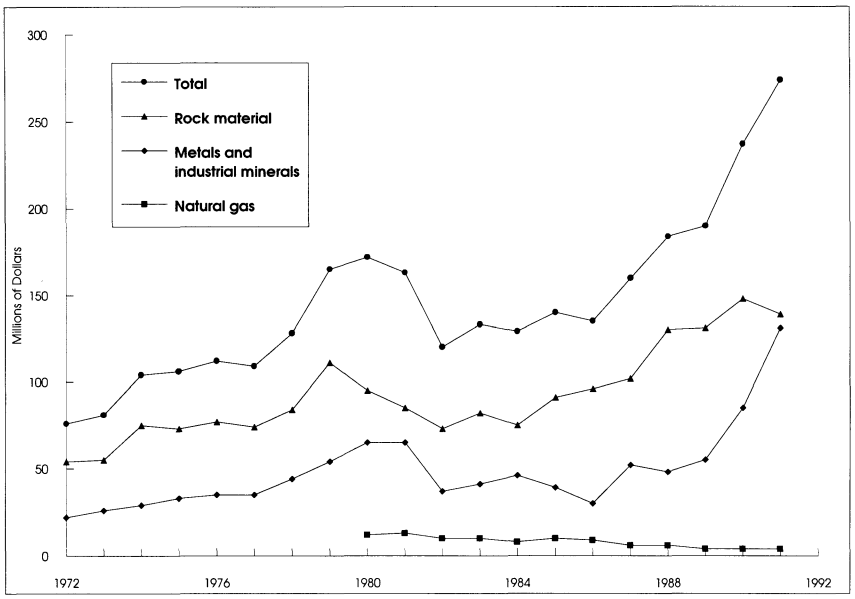
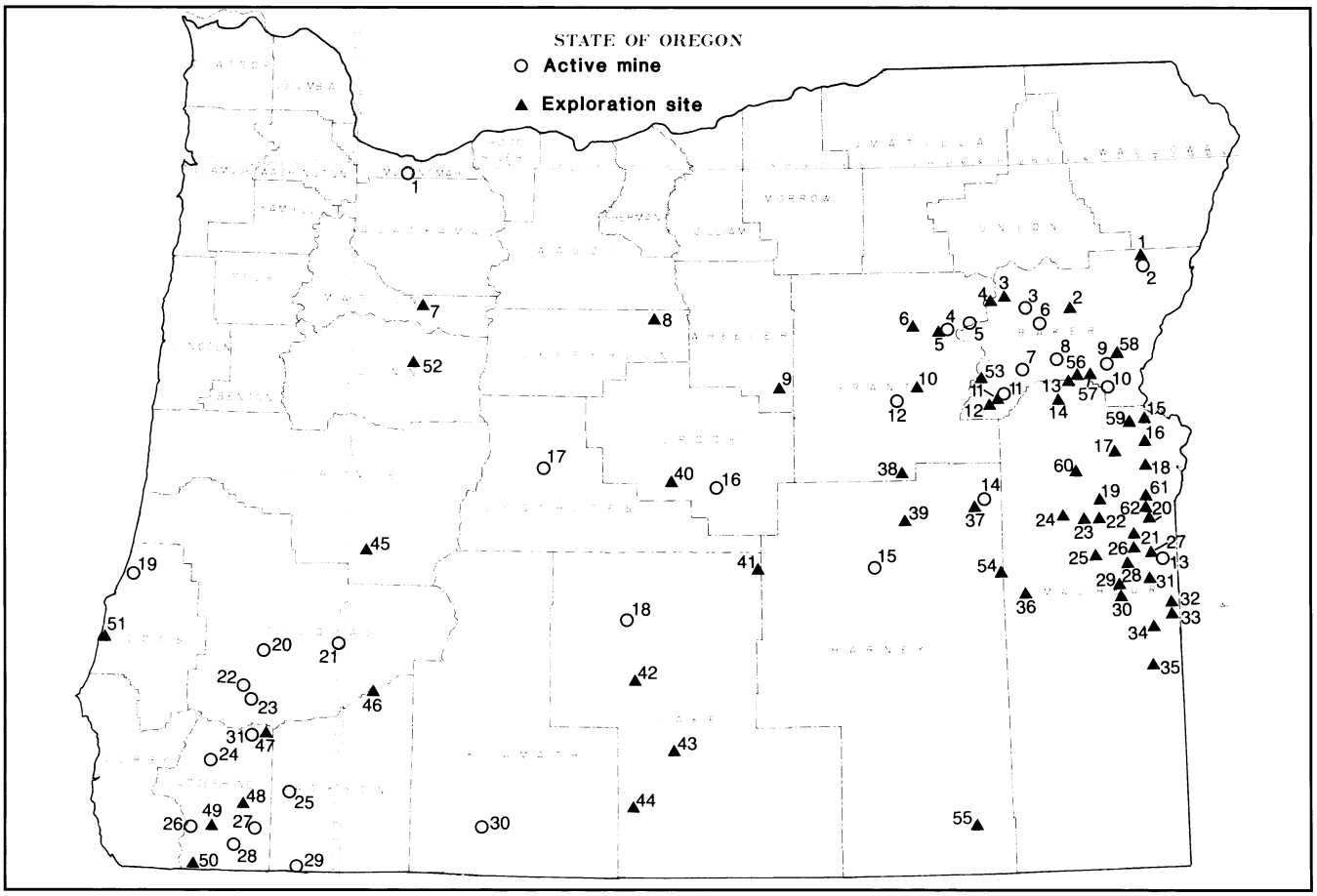


Figure 1. Summary of mineral production value in Oregon for the last 20 years. Data from Table 1.



EXPLANATION

Active Mines and Areas

1. Columbia Brick Works
2. Bonnanza Mine (placer gold)
3. Deer Creek (placer gold)
4. Big Creek (placer gold)
5. Greenhorn area (placer gold)
6. Elk Creek (placer gold)
7. Pine Creek (placer gold)
8. Dooley Mountain (perlite)
9. Ash Grove Cement West (cement and crushed limestone)
10. Rye Valley/Mormon Basin (placer gold)
11. Lower Grandview Mine (placer gold)
12. Canyon City Placers (placer gold)
13. Teague Mineral Products (bentonite and clinoptilolite)
14. Eagle-Picher Industries (diatomite)
15. Ponderosa Mine (Oregon sunstone)
16. Central Oregon Bentonite/Oregon Sun Ranch (bentonite clay)
17. Cascade Pumice/Central Oregon Pumice
18. Oil-Dri Production (diatomite)
19. CooSand (silica sand)
20. Oregon Portland Cement (limestone)
21. Quartz Mountain (silica)
22. Nickel Mountain (nickel)
23. Silver Peak (copper, zinc, gold, silver)
24. Galice area (placer gold)
25. Bristol Silica and Limestone (silica)
26. Josephine Creek area (placer gold)
27. Jones Marble quarry (agricult. limestone)
28. Sucker Creek area (placer gold)
29. Steatite of Southern Oregon (soapstone)
30. Klamath Falls Brick and Tile
31. Coyote Creek (placer gold)

Exploration Sites and Areas

1. Cornucopia Mine (lode gold)
2. White Swan—U.P. (lode gold)
3. Bourne (gold, silver)
4. Herculean Mine (gold and base metals)
5. Mammoth (gold, silver, copper)
6. Susanville (lode gold)
7. Bornite (copper, gold, silver)
8. Red Jacket (lode gold)
9. Spanish Gulch (lode gold)
10. Prairie Diggings (lode gold)
11. Record and Grouse Creek (gold, copper)
12. Grouse Creek (copper, silver)
13. Racey property (lode gold)
14. Cow Valley Butte (lode gold)
15. Kerby/East Ridge (lode gold)
16. Tub Mountain area (lode gold)
17. Hope Butte (lode gold)
18. Vale Butte (lode gold)
19. H claims (lode gold)
20. Calavera (lode gold)
21. Grassy Mountain (lode gold)
22. Harper Basin (lode gold)
23. BCMX (lode gold)
24. Gold Creek area (lode gold)
25. Freeze (lode gold)
26. Burnt Mountain area (lode gold)
27. Camp Kettle (lode gold)
28. Dry Creek Buttes area (lode gold)
29. Jessie Page (lode gold)
30. Red Butte (lode gold)
31. South Owyhee Ridge area (lode gold)
32. Bannock (lode gold)
33. Mahogany (lode gold)
34. Mahogany Gap and Storm (lode gold)
35. Jordan Valley area (lode gold)
36. Stockade area (lode gold)
37. Drewsey area (lode gold)
38. Baboon Creek (limestone)
39. Idol City area (lode gold)
40. Bear Creek Butte (lode gold)
41. Glass Butte (lode gold)
42. Summer Lake area (lode gold)
43. Paisley area (lode gold)
44. Quartz Mountain (lode gold)
45. Bohemia District (lode gold)
46. Prospect Silica (silica)
47. Martha Mine (lode gold)
48. Marble Mountain (limestone)
49. Eight Dollar Mountain (nickel laterite)
50. Turner-Albright (copper, zinc, gold)
51. Oregon Resources (black sands)
52. Quartzville (lode gold)
53. Pole Creek (lode gold)
54. Buck Mountain (lode gold)
55. Flagstaff Butte area (lode gold)
56. Cave Creek (lode gold)
57. Gold Ridge Mine (lode gold)
58. Gold Hill Mine (lode gold)
59. Birch Creek (lode gold)
60. White Mountain (diatoms)
61. Chalk Butte/Big Red (lode gold)
62. Shell Rock Butte (lode gold)

Figure 2. Mining and mineral exploration sites in Oregon in 1991, excluding sand, gravel, and stone. Active mines are keyed to Table 2; exploration sites are keyed to Table 3.

Table 2. *Active mines in Oregon, 1991 (Numbers are keyed to Figure 2)*

No.	Mine name	Company	Commodity	Location	Remarks
1	—	Columbia Brick Works	Brick	Sec. 14, T. 1 S., R. 3 E. Multnomah County	24,000 yards of bentonite mined; 22.7 million bricks fired.
2	Bonnanza	Bonnanza Mining Company	Placer gold	Sec. 3, T. 7 S., R. 45 E., Baker County	—
3	Deer Creek	Cammtex International, Inc.	Placer gold	Sec. 30, T. 9 S., R. 38 E., Baker County	—
4	Big Creek	—	Placer gold	T. 10 S., R. 34 E., Grant County	—
5	Greenhorn area	—	Placer gold	Tps. 9, 10 S., R. 35 E., Baker and Grant Counties	—
6	Elk Creek	—	Placer gold	Tps. 9, 10 S., R. 39 E., Baker County	—
7	Pine Creek	—	Placer gold	T. 12 S., R. 38 E., Baker County	—
8	Dooley Mountain	Supreme Perlite Company	Perlite	Tps. 11, 12 S., R. 40 E., Baker County	Estimated 1,500 tons mined in 1991.
9	—	Ash Grove Cement West, Inc.	Cement, crushed limestone	Sec. 11, T. 12 S., R. 43 E., Baker County	Produced 475,000 tons of clinker (cement) and 220,000 tons of crushed "sugar rock."
10	Rye Valley/ Mormon Basin area	—	Placer gold	T. 13 S., Rs. 42, 43 E., Baker County	—
11	Lower Grandview	Earth Search Sciences	Lode gold	Sec. 6, T. 14 S., R. 37 E., Baker County	Reverted to exploration status exploratory drilling.
12	Canyon City Placers	Cammtex International, Inc.	Placer gold	T. 13 S., R. 32 E., Grant County	Abandoned.
13	—	Teague Mineral Products	Bentonite, zeolite	Secs. 28, 29, T. 23 S., R. 46 E., Malheur County (and nearby Idaho)	First shipment to Japan in last quarter.
14	Eagle-Picher	Eagle-Picher Industries, Inc.	Diatomite	Tps. 19, 20 S., Rs. 35, 36 E., Malheur and Harney Counties	200,000 yards mined for 1991.
15	Ponderosa Mine	—	Oregon sunstone	T. 23 S., R. 30 E., Harney County	—
16	—	Central Oregon Bentonite Co.	Bentonite	Sec. 4, T. 19 S., R. 21 E., Crook County	8,844 tons mined in fiscal 1991.
17	—	Cascade Pumice Co./Central Oregon Pumice Co.	Pumice	Tps. 17, 18 S., R. 11 E., Deschutes County	—
18	—	Oil-Dri Production Company	Diatomite	Secs. 14, 21, 23, T. 26 S., R. 16 E., Lake County	Mined 95,670 tons; processed 22,990 tons.
19	—	CooSand Corporation	Silica sand	Sec. 34, T. 24 S., R. 13 W., Coos County	Estimated 20,000 cubic yards mined.
20	Roberts Mountain	Mountain Valley Resources	Limestone	Sec. 20, T. 28 S., R. 5 W., Douglas County	Estimated 4,700 tons mined in 1991.
21	Quartz Mountain	Quartz Mountain Silica	Silica	Sec. 2, T. 28 S., R. 1 W., Douglas County	Began year's production at end of 3rd quarter.
22	Nickel Mountain	Glenbrook Nickel Company	Nickel	Secs. 28, 29, T. 30 S., R. 6 W., Douglas County	Estimated mine production 900,000 tons laterite; smelter production 16 million lb contained nickel.
23	Silver Peak Mine	Formosa Resources, Inc.	Copper, zinc, gold	Sec. 23, T. 31 S., R. 6 W., Douglas County	Shipped 3,000 tons of concentrates to Japan.
24	Galice area	—	Placer gold	Tps. 34, 35 S., R. 8 W., Josephine County	—
25	—	Bristol Silica and Limestone Co.	Silica	Sec. 30, T. 36 S., R. 3 W., Jackson County	Investment by Pacific Suma.
26	Josephine Creek area	—	Placer gold	Tps. 38, 39 S., R. 9 W., Josephine County	—
27	Jones Marble quarry	—	Limestone	Sec. 31, T. 38 S., R. 5 W., Josephine County	Closed.
28	Sucker Creek area	—	Placer gold	Tps. 39, 40 S., Rs. 6, 7 W., Josephine County	—
29	—	Steatite of Southern Oregon	Soapstone	Secs. 10, 11, T. 41 S., R. 3 W., Jackson County	Estimated 210 tons mined for 1991.
30	—	Klamath Falls Brick and Tile Co.	Brick	Sec. 19, T. 38 S., R. 9 E., Klamath County	3 million bricks in 1991 (6,000 tons).
31	Coyote Creek	Jack Smith	Placer gold	T. 33 S., Rs. 5, 6 W., Josephine County	—

Table 3. *Exploration sites in Oregon, 1991 (Numbers are keyed to Figure 2)*

No.	Mine name	Company	Commodity	Location	Remarks
1	Cornucopia Mine	UNC Corporation	Lode gold	Sec. 27, T. 6 S., R. 45 E., Baker County	—
2	White Swan	Kennecott	Lode gold	Tps. 9, 10 S., Rs. 41, 42 E., Baker County	Drilled 12 holes; dropping Virtue, keeping Gold Powder.
3	Bourne	Cracker Creek Gold Mining Co.	Gold, silver	T. 8 S., R. 37 E., Baker County	J.R. Simplot Resources dissolved precious-metals section.
4	Herculean Mine	Cable Cove Mining Company	Gold, base metals	Sec. 22, T. 8 S., R. 36 E., Baker County	Leased to Technical Metals, Inc.
5	Mammoth	Formation Capital Corporation	Gold, silver, copper	Secs. 8, 17, T. 10 S., R. 34 E., Grant County	Geophysics, mapping, and sampling.
6	Susanville	Cradle Mtn. Resources/ Amer. Copper& Nickel	Lode gold	Tps. 9, 10 S., Rs. 32, 33 E., Grant County	Property dropped by both partners.
7	Bornite	Plexus, Inc.	Copper, gold	Sec. 36, T. 8 S., R. 4 E., Marion County	Expect construction to begin in 1993.
8	Red Jacket	Bond Gold Exploration, Inc.	Lode gold	T. 9 S., R. 17 E., Jefferson County	Drilled six holes and terminated project.
9	Spanish Gulch	ASARCO, Inc.	Lode gold	T. 13 S., Rs. 24, 25 E., Wheeler County	Returned to Placer Gold Development.
10	Prairie Diggings prospect	—	Lode gold	Sec. 33, T. 13 S., R. 32 E., Grant County	No activity.
11	Record/Grouse Creek prospects	Manville Corporation	Gold, copper	T. 14 S., Rs. 36, 37 E., Baker County	Geophysics for assessment.
12	Grouse Creek prospect	Golconda Resources, Ltd.	Copper, silver	Secs. 24, 25, T. 14 S., R. 36 E., Baker County	Returned to Manville.
13	Racey property	ICAN Minerals, Ltd.	Lode gold	Tps. 12, 13 S., Rs. 40, 41 E., Malheur County	Billiton ceased operations; ICAN conducted end-of-year drilling campaign.
14	Cow Valley Butte	Cambior USA, Inc.	Lode gold	T. 14 S., R. 40 E., Malheur County	Drilled 13 holes for 7,400 ft; project terminated.
15	Kerby/ East Ridge	Malheur Mining Company	Lode gold	Secs. 22, 27, T. 15 S., R. 45 E., Malheur County	No activity.
16	Tub Mountain area	Atlas Precious Metals, Inc.; Euro-Nevada Mining Corporation; Echo Bay Exploration, Inc.	Lode gold	Tps. 16, 17 S., R. 45 E., Malheur County	Atlas holding; Euro-Nevada abandoned its property; Echo Bay properties reverted to Malheur Mining.
17	Hope Butte	Horizon Gold Shares, Inc.	Lode gold	Sec. 21, T. 17 S., R. 43 E., Malheur County	Chevron Resources dropped out; project back to exploration status.
18	Vale Butte	Atlas Precious Metals, Inc.	Lode gold	Secs. 28, 29, T. 18. S., R. 45 E., Malheur County	Drilled nine holes and abandoned property.
19	H claims	U.S. Gold	Lode gold	Secs. 2, 10, 11, T. 20 S., R. 42 E., Malheur County	Assessment work.
20	Calavera	Atlas Precious Metals, Inc.	Lode gold	T. 21 S., R. 45 E., Malheur County	Leased from Euro-Nevada.
21	Grassy Mountain	Atlas Precious Metals, Inc.	Lode gold	Sec. 8, T. 22 S., R. 44 E., Malheur County	Obtained water supply; focused on permit acquisition.
22	Harper Basin	Atlas Precious Metals, Inc.	Lode gold	T. 21 S., R. 42 E., Malheur County	Assessment by Atlas; American Copper and Nickel Company, Inc., dropped out.
23	BCMX	American Copper and Nickel Company, Inc.	Lode gold	Secs. 10, 11, 14, 15, T. 21 S., R. 41 E., Malheur County	ACNC dropped out.
24	Gold Creek area	Manville Corporation	Lode gold	Secs. 3, 4, 10, T. 21 S., R. 40 E., Malheur County	Mapping.
25	Freeze	Western Mining Corporation	Lode gold	T. 23 S., R. 42 E., Malheur County	Completed drilling with intent of dropping.
26	Burnt Mountain area	Noranda Exploration, Inc.; Echo Bay Exploration, Inc.; Sunshine Precious Metals	Lode gold	Tps. 22, 23 S., Rs. 44, 45 E., Malheur County	Noranda withdrawing; Echo Bay dropped Lucky Lady; Sunshine Precious Metals drilled and dropped Lucky G.
27	Camp Kettle	ASARCO, Inc.	Lode gold	T. 23 S., R. 45 E., Malheur County	Reconnaissance.
28	Dry Creek Buttes area	Manville Corporation/ASARCO, Inc.; Noranda Explor., Inc.	Lode gold	Tps. 23, 24 S., Rs. 43, 44 E., Malheur County	ASARCO geophysics applied to Manville assessment; Noranda dropped some, acquired other properties.
29	Jessie Page (Quartz Mountain)	MK Gold	Lode gold	Sec. 6, T. 25 S., R. 43 E., Malheur County	Chevron dropped minerals-exploration groups.
30	Red Butte	Cyprus Mineral Company	Lode gold	Secs. 26, 27, 34, 35, T. 25 S., R. 43 E., Malheur County	Hand-trenching assessment.

Table 3. *Exploration sites in Oregon, 1991 (continued)*

No.	Mine name	Company	Commodity	Location	Remarks
31	South Owyhee Ridge area	Manville Corp.; Noranda Explor., Inc.; Euro-Nevada Minerals; Atlas Precious Metals	Lode gold	Tps. 24, 25 S., R. 45 E., Malheur County	Noranda continued minimal work at Goldfinger and SR claims; Katey drilled by Atlas.
32	Bannock	Atlas Precious Metals and Manville Corp.	Lode gold	Sec. 11, T. 26 S., R. 46 E., Malheur County	Atlas drilled three holes on lease.
33	Mahogany	Cyprus Minerals and Manville Corp.	Lode gold	Secs. 25, 26, T. 26 S., R. 46 E., Malheur County	Cyprus drilled one hole to satisfy assessment.
34	Mahogany Gap and Storm	Phelps Dodge	Lode gold	Secs. 18, 19, 30, T. 27 S., R. 45 E., Malheur County	Evaluation complete
35	Jordan Valley area	Manville Corp.; Battle Mountain Explor. Co.; Nerco Explor. Co.	Lode gold	T. 29 S., R. 45 E., Malheur County	Battle Mountain reclaimed; Manville let Hillside lapse; Nerco dropped Anderson in late 1990.
36	Stockade area	BHP-Utah International/Carlin Gold; Phelps Dodge	Lode gold	Tps. 25, 26 S., R. 38 E., Malheur County	BHP-Utah returned property to Carlin Gold; PD drilled nine holes and terminated project.
37	Drewsey area (Red Butte/Pine Creek)	Battle Mountain Exploration Company	Lode gold	T. 20 S., R. 35 E., Harney County	Battle Mountain reclaimed Pine Creek.
38	Baboon Creek	Chemstar Lime, Inc.	Limestone	T. 19 S., R. 32 E., Grant County	Reverted to Blue Mountain Mining.
39	Idol City area	Golden Chest	Lode gold	Tps. 20, 21 S., R. 32 E., Harney County	—
40	Bear Creek Butte	Coeur Exploration, Inc.; Independence	Lode gold	Tps. 18, 19 S., R. 18 E., Crook County	Drilled by Coeur, returned to Independence and terminated.
41	Glass Butte	—	Lode gold	Tps. 23, 24 S., R. 23 E., Lake County	Reclaimed in 1990; no activity in 1991.
42	Summer Lake area	N.A. Degerstrom, Inc.; Tracy Gold Corp.	Lode gold	Sec. 14, T. 30 S., R. 16 E., Lake County	Returned to Tracy Gold Corporation in late 1990.
43	Paisley area	N.A. Degerstrom, Inc.; Atlas Precious Metals	Lode gold, perlite	T. 34 S., Rs. 18, 19 E., Lake County	Degerstrom returned properties to Tracy Gold Corporation; Atlas tested perlite.
44	Quartz Mountain	Pegasus Gold, Inc.; Quartz Mtn. Gold Corp.; Wavecrest Resources	Lode gold	Secs. 26, 27, 34, 35, T. 37 S., R. 16 E., Lake County	8,000 ft of drilling in 1991; final feasibility study due early 1992.
45	Bohemia District	Bond Gold Exploration, Inc.	Lode gold	T. 22 S., Rs. 1, 2 E., Lane County	Bond Gold left; exploration by unnamed company.
46	Prospect Silica	Mountain Valley Resources	Silica	T. 30 S., R. 2 E., Jackson and Douglas Counties	Exploration plan approved by Forest Service.
47	Martha Mine	Cambior USA, Inc.	Lode gold	Sec. 28, T. 33 S., R. 5 W., Josephine County	Cambior drilled 11 holes for 6,900 ft and returned property to Dragon's Gold.
48	Marble Mountain	Campman Calcite Company	Limestone	Sec. 19, T. 37 S., R. 6 W., Josephine County	Mined 900-ton test batch.
49	Eight Dollar Mountain	Doug Smith/ Lynn Wagner	Nickel laterite	T. 38 S., R. 8 W., Josephine County	Permitting of complex land situation.
50	Turner-Albright	Cominco American Resources, Inc.	Copper, zinc, gold	Secs. 15, 16, T. 41 S., R. 9 W., Josephine County	Exploring.
51	Seven Devils area	Oregon Resources	Black sands	T. 27 S., R. 14 W., Coos County	Ambitious shallow-drilling program: 549 holes
52	Quartzville	Placer Dome	Lode gold	T. 11 S., R. 4 E., Linn County	Drilled five holes; total about 2,800 ft.
53	Pole Creek	Placer Dome	Lode gold	Sec. 4, T. 13 S., R. 36 E., Baker County	Drilled five holes for total of about 2,500 ft.
54	Buck Mountain	Teck Resources/ Carlin Gold	Lode gold	T. 24 S., Rs. 36, 37 E., Harney and Malheur Counties	Drilled 16 holes in last quarter of 1991.
55	Flagstaff Butte area	Noranda Exploration	Lode gold	Sec. 5, T. 39 S., R. 37 E., Harney County	Drilled three holes for total of 2,100 ft.
56	Cave Creek	Nerco	Lode gold	T. 12 S., R. 42 E., Baker County	Drilled 10 holes; holding property.
57	Gold Ridge Mine	Golconda Resources, Ltd.	Lode gold	Sec. 16, T. 12 S., R. 43 E., Baker County	Drilled 22 holes for total of about 7,500 ft; holding property.
58	Gold Hill Mine	Golconda Resources, Ltd.	Lode gold	Sec. 1, T. 12 S., R. 43 E., Baker County	Drilled three holes for total of about 750 ft; holding property.
59	Birch Creek	Western Epithermal	Lode gold	Secs. 20, 21, T. 15 S., R. 44 E., Malheur County	Drilled four holes for total of about 1,700 ft; returning property.
60	White Mountain	White Mountain Mining	Diatoms	T. 18 S., R. 41 E., Malheur County	Applied for exploration permit.
61	Chalk Butte/Big Red	Ron Johnson, Battle Mountain Exploration	Lode gold	Sec. 15, T. 20 S., R. 45 E.; T. 20 S., R. 44 E., Malheur County	Big Red was drilled and terminated; Battle Mountain holding Chalk Butte.
62	Shell Rock Butte	Western Epithermal	Lode gold	Secs. 12, 13, T. 21 S., R. 44 E.; secs. 5-8, 17, 18, T. 21 S., R. 45 E., Malheur County	Geophysics and geochemistry; drill targets identified.

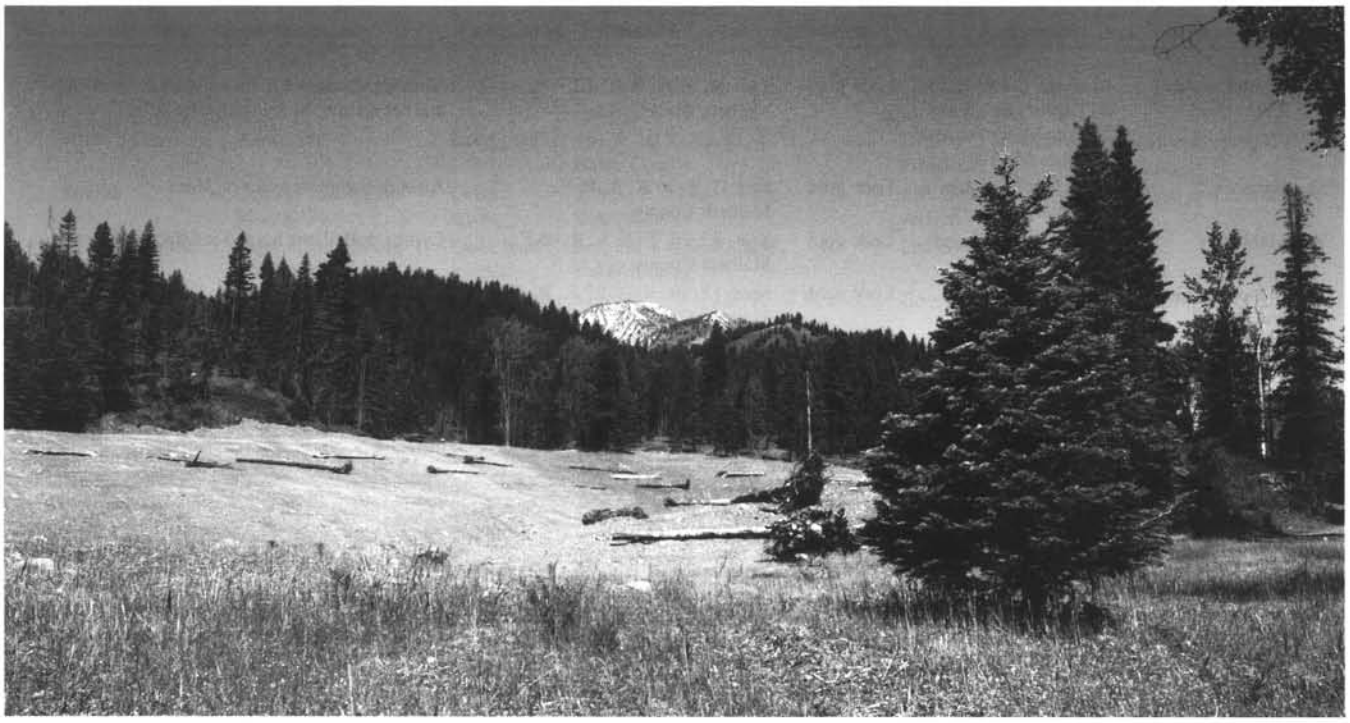


Figure 3. For its proficient reclamation at its Pine Creek operations, Bonnanza Mining Company was awarded DOGAMI's 1991 Operator of the Year Award for eastern Oregon. This was formerly a pit for placer operations.

Eastern Oregon producers continued to be major contributors to the state's industrial-minerals production. Eagle-Picher Industries (mine site 14) in Harney and Malheur Counties reported mining 200,000 yards of diatomite. Oil-Dri Production Company (mine site 18) in Lake County processed 22,990 tons of diatomite. Central Oregon Bentonite (mine site 16) in Crook County reported mining 8,800 tons of bentonite. Klamath Falls Brick and Tile (mine site 30) fired 3 million bricks from 6,000 tons of clay. Cascade Pumice and Central Oregon Pumice (mine site 17) in Deschutes County continued to dominate the nation's pumice production.

WESTERN OREGON

At Riddle, Glenbrook Nickel Company (mine site 22; see also Figure 4) produced an estimated 16 million pounds of contained nickel, nearly doubling the 1990 levels. Nine hundred thousand tons of laterite grading 1.25-1.5 percent nickel were mined from Nickel Mountain and provided 90 percent of the smelter feed in 1991. In addition, Glenbrook received its first shipment of 20,000 metric tons of test ore grading 2.4 percent nickel from New Caledonia. Glenbrook expects regular shipments of New Caledonian ore to begin in 1992. Glenbrook will produce 30 million pounds of nickel annually at peak capacity.

Formosa Exploration, Inc., in 1991 began mining zinc and copper ore from a kuroko-type massive-sulfide deposit at its Silver Peak Mine (mine site 23) near Riddle. In November, Formosa shipped its first 3,000 tons of concentrates to Japan. At year's end, operations at Silver Peak were on standby, with 28,000 tons having been mined.

In Multnomah County, Columbia Brick Works (mine site 1) mined 24,000 yards of bentonitic clay to produce nearly 23 million bricks, enough for about 570 brick houses.

Campman Calcite Company re-opened operations at the Marble Mountain Mine (exploration site 48 [for all exploration sites see Figure 2 and Table 3]) southwest of Grants Pass. A 900-ton sample was mined for shipment to Holly Sugar in Chico, California. Company owners have high hopes that Marble Mountain, which had operated from 1917 on for 50 years, would become a major limestone producer in southwestern Oregon. Planned production of up to 500,000 tons annually would help offset declining employment and tax revenues in an area beset by declining timber harvests. The reaction of local residents, however, was less than enthusiastic.

LEGISLATIVE ACTIONS

In 1991, the Oregon legislature passed two bills of major significance to the mining industry, especially precious-metals exploration: a moritorium on offshore mineral exploration, Senate Bill SB499, and the chemical process mining or cyanide heap-leaching bill, House Bill HB2244.

HB2244 governing chemical-process mining was a consensus bill with nobody happy about every aspect. The bill specified that the Oregon Department of Geology and Mineral Industries (DOGAMI) would have the lead coordination role and that multiple permits from several state agencies would remain. DOGAMI finished its rule writing on November 1, the provisions of which were hammered out and agreed to by a coalition of representatives from industry, environmental groups, and government. Early in 1992, the Oregon Mining Council (OMC) persuaded the Environmental Quality Commission (EQC) to select an independent consultant to review regulations proposed by the Oregon Department of Environmental Quality (ODEQ) for consistency with state statutes and standards. This has delayed final approval of regulations proposed by ODEQ that would affect mining operations using cyanide.

EXPLORATION HIGHLIGHTS

Exploration companies in Oregon continued to concentrate on gold. While the mood of industrial-mineral and aggregate producers remained relatively positive and unchanged from the year before, the mood of explorationists grew more somber. Anxiety over regulation reportedly contributed to the decline in exploration in Oregon, but the convulsions experienced by the precious metals industry were not restricted by state lines. Gold prices

remained soft worldwide. Several companies were rocked by staff reductions and office closures; a few companies terminated their U.S. precious-metals exploration staffs altogether, including Billiton, Chevron, and Simplot. More companies terminated Oregon projects in 1991 than initiated projects, at a rate of about 2 to 1. About half of these companies left Oregon altogether, most citing an uncertain regulatory future in the state. The other half retained a foothold in the state and looked to see if the projects of Atlas (Grassy Mountain) and Plexus (Bornite) would indicate a trend for future success.

EASTERN OREGON

In Eastern Oregon, large-scale epithermal gold deposits remained the exploration target of choice. The eyes of the mining industry were on Atlas Precious Metals and its Grassy Mountain project in Malheur County (exploration site 21). A number of exploration companies adopted a wait-and-see attitude; others dropped out. Atlas developed its water supply and focused on permit acquisition at Grassy Mountain. In addition, Atlas continued to acquire and drill other properties in 1991.

A number of 1990 properties were dropped in 1991 with no subsequent activity. Cradle Mountain Resources and American Copper and Nickel both dropped the Susanville Prospect (exploration site 6) in Grant County. ASARCO dropped Spanish Gulch (exploration site 9) in Wheeler County.

Several properties in Malheur County were dropped. Cambior USA, Inc., dropped Cow Valley Butte (exploration site 14). Atlas dropped Vale Butte (exploration site 18), and American Copper and Nickel dropped BCMX (exploration site 23). Phelps Dodge completed its evaluation and terminated its Mahogany Gap and Storm projects (exploration site 34) and drilled 5,000 ft in the Stockade area (exploration site 36) before abandoning the project. Western Mining drilled and intended to drop Freeze (exploration site 25). None of these properties attracted subsequent attention.

Noranda and Sunshine Precious Metals withdrew from the Burnt Mountain area (exploration site 26); Sunshine had drilled two holes on its Lucky G claims. Nearby, luck ran out for the Echo Bay Lucky Lady, a property credited with intriguing anomalies but a discouraging proximity to Owyhee Dam. These Burnt Mountain properties remained unattended at the end of 1991.

Bond Gold reclaimed exploration sites at its Red Jacket property (exploration site 8) in Jefferson County. Independence Mining terminated its Bear Creek Butte project (exploration site 40) in Crook County, which had been drilled without success by Coeur Exploration. Degerstrom turned back its interests in the Summer Lake area (exploration site 42) in Lake County.

The following companies reported terminating their exploration programs in Oregon: American Copper and Nickel, Billiton, Bond Gold, Cambior, Chevron Resources, Coeur Exploration, Degerstrom, Echo Bay, Independence, Simplot, Teck Resources, and Western Mining, USA.

Chevron Resources reportedly terminated all of its precious-metal exploration groups in the U.S. in 1991, except for its interest in developing platinum-group metals of the Stillwater complex in Montana. Chevron Resources property interests in Oregon were acquired by Cyprus Minerals, except for Jessie Page (exploration site 29), which was acquired by MK Gold, and Hope Butte (exploration site 17), which reverted to Horizon GoldShares.

Figure 4. Glenbrook Nickel Company doubled its production at its Riddle ferronickel plant in 1991 over that of the previous year, helping to propel the value of Oregon's mineral industry to its fastest single year of growth since 1979.

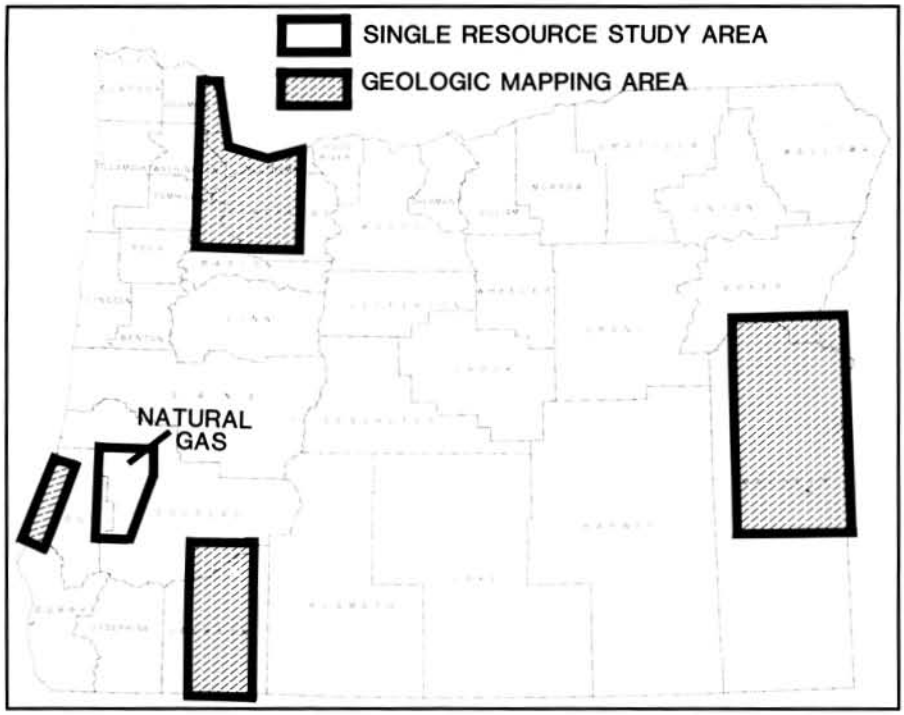


Figure 5. Areas of mapping by the Oregon Department of Geology and Mineral Industries.

Pegasus Gold committed itself to one more year at the Quartz Mountain prospect (exploration site 44) in Lake County but noted anxiety about the low grade and refractory nature of the deposit. The company reported two main ore zones containing a resource of about 55 million tons of 0.03 oz/ton gold. A final feasibility study is expected to be completed in the first half of 1992.

In contrast to the numerous departures of gold exploration companies, several new drilling programs were launched. Late in 1991, BHP-Utah began a 4,000-ft drilling program at its Quartz Mountain Basin project in the Dry Creek Buttes area south of Vale (exploration site 28). Teck Resources and Carlin Gold ventured together, temporarily, to drill at Buck Mountain (exploration site 54) in Harney and Malheur Counties. Noranda drilled three holes at its Flag property in Harney County (exploration site 55). Golconda Resources drilled a total of 25 holes at its Gold Ridge Mine (exploration site 57) and Gold Hill Mine (exploration site 58) properties in Baker County. Nerco drilled 10 holes and was retaining the property at Cave Creek in Baker County (exploration site 56).

Companies continued to extend the life of old projects. Although Billiton closed up shop, ICAN Minerals was planning an end-of-the-year drilling campaign at the Racey property in Malheur County (exploration site 13). A number of companies, among others, Atlas, ASARCO, Cyprus, Manville, and Noranda continued to apply varying levels of work to retain many different properties in eastern Oregon. Phelps Dodge retained a broad reconnaissance interest in Oregon.

Returning to Eastern Oregon in 1991 were Kennecott Exploration Company, who drilled two properties near the White Swan Mine (exploration site 2) in Baker County, and Placer Dome, who drilled at Pole Creek (exploration site 53), also in Baker County.

WESTERN OREGON

Exploration in western Oregon in 1991 was highlighted by the Plexus, Inc., Bornite project in Marion County (exploration site 7). The project has revealed a volcanic-hosted breccia pipe containing 3.5 million tons of bornite and chalcopyrite ore grading 2.2 percent copper. Coarse gold is also present, although average grades are low. Plexus completed its feasibility study in 1991 and began focusing on permit acquisition; final development will be tailored to meet permit criteria. Plexus plans to mine underground to obviate public resistance to open-pit mining. Mining rates are anticipated to be between 1,000 and 1,200 tons per day. Company officials expressed confidence in their ability to mine profitably while meeting regulatory conditions. The project has received favorable press in spite of its relative proximity to major population centers in the Willamette Valley. Initial construction is anticipated for the spring of 1993.

Following Plexus into the Western Cascades, Placer Dome descended upon a new project, Quartzville (exploration site 52) in Linn County. The target is silicic, volcanic-hosted epithermal gold. After having drilled five holes for a total of 2,800 ft, Placer Dome was holding its property.

In western Coos County (exploration site 51), Oregon Resources Corporation began and completed an ambitious shallow-drilling program to define the extent of onshore black sands. Over 16,000 ft in 549 holes were completed. Company officials reported that the results of a $3.5-million, three-and-a-half-year exploration program were favorable. Development to production status will require an additional $20 million.

Farther south in Josephine County, the Cambior USA, Inc., project at the Martha Mine (exploration site 47) ended in disappointment after 11 holes were drilled for a total of 6,900 ft in 1991. Cambior was unable to meet its corporate criterion of 1 million tons of 0.3 oz/ton gold in this difficult vein-gold terrane. Meanwhile, Cominco American Resources, Inc., continued to explore quietly along its Turner-Albright copper, zinc, and gold prospect in southern Josephine County (exploration site 50).

DOGAMI ACTIVITIES

Geologic mapping and mineral-resource assessment are major roles of the Oregon Department of Geology and Mineral Industries (DOGAMI), in addition to its regulatory role. DOGAMI's baseline geologic data are important to a wide variety of users, including the mineral industries. In Malheur, Baker, Jackson, and Douglas Counties, activities are directed toward geologic mapping and mineral resource assessment of the Boise and Medford 1° by 2° sheets (Figure 5). Mapping in the Portland metropolitan area and in coastal areas is directed toward earthquake-hazard assessment. Mapping in the Tyee Basin of Douglas and Coos Counties is directed toward natural-gas potential. In addition, DOGAMI provides single-resource inventories such as the state-wide pumice study expected to be published in 1992. Recently released, the Mineral Information Layer of Oregon by County (MILOC) is the most extensive available compilation of mineral resources within the state of Oregon. It consists of a computer database containing more than 7,600 mineral and aggregate sites with extensive descriptions. Current agency projects are further summarized in the report *Mission, Goals, and Activities, 1991-1997* published in 1990 and available from the agency's Portland office.

ACKNOWLEDGMENTS

The author thanks the many geologists and corporate officers that shared information for this report. □

Green apophyllite, zeolites, and quartz in Polk County, Oregon

by Jon Gladwell, 3235 SE 56th, Portland, Oregon 97206-2007

ABSTRACT

Fine green apophyllite, heulandite, and stilbite crystals have been found in a road cut near the confluence of Canyon and Rickreall Creeks in the Socialist Valley 7½-minute quadrangle in Polk County, Oregon (Figure 1). These same minerals, as well as quartz, calcite, mordenite, and other species, are also present in a barrow pit on an access road 0.1 mi west of the road cut. The sites are located on land belonging to Boise Cascade Corporation and are accessible only during approximately one month in the fall, when the company allows deer-hunting access.

DESCRIPTION AND DISCUSSION

In October of 1990 several members of the Pacific Mineral Society (Kris Dennis, Gary Hinkle, and Dan Rokosz) were conducting reconnaissance work in the Dallas, Oregon, area. At a rather weathered road cut, Dennis suggested stopping to look briefly at the cliff face and small talus slope. Rokosz found a baseball-sized nodule lined with stilbite and pearly white heulandite crystals in the debris that had weathered from the cliff. Upon closer inspection, several small, radial clusters of medium-green apophyllite crystals perched on the heulandite were noted. Further search of the scree revealed additional heulandite but no apophyllite. Inspection of the overhanging cliff face revealed a number of cavities ranging in size from 2 in. to 18 in. in largest dimension lined with heulandite crystals. No additional apophyllite was found at this point.

Soon after returning from this expedition, these gentlemen notified the author as well as other members of the Pacific Mineral Society of their findings. The author and members of the Society made several collecting trips in rapid succession, until the gate providing access to the area was closed and locked at the conclusion of the 1990 hunting season. During this period (less than a month), several hundred fine heulandite specimens were collected. However, only two or three green apophyllites of significant size were discovered, in addition to about a dozen microspecimens.

After the gate was locked, the author contacted Boise Cascade Corporation on behalf of the Society and obtained a special permit that allowed members access to the area during a five-month period in the winter and early spring. The permit was issued for the purpose of collecting sufficient specimens for study and characterization of the deposit for the historical record. During the period allowed by the permit, additional specimens were found, including approximately six more green apophyllites (Figure 2). Also, another small outcrop of pale-tan heulandite crystals was found higher up the hill, immediately west of the road cut. Prospecting in the area revealed an abandoned barrow pit west of the road cut. Cavities containing fine mordenite, colorless apophyllite, stilbite, heulandite, and quartz crystals and chalcedony rinds were found in abundance. A few small masses of green apophyllite were also found, but no crystals were recovered.

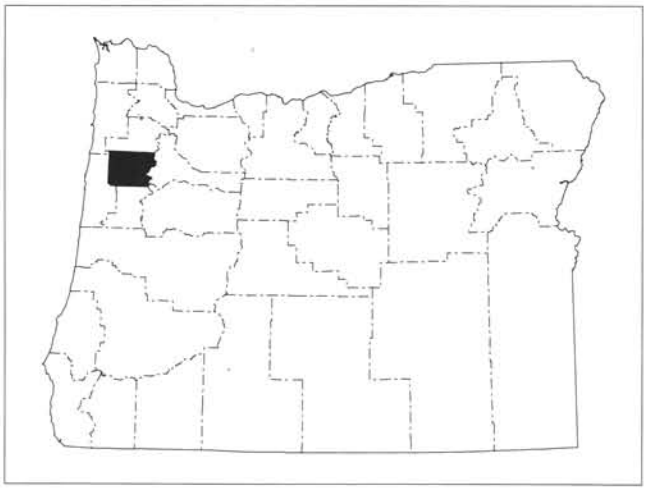


Figure 1. General location of study area. Map showing Oregon counties shows Polk County in black.

Figure 2. An opened concretion showing green apophyllite crystals on white heulandite crystals.

The study area lies along the northern bank of Rickreall Creek, due west of Dallas in Polk County, Oregon, 0.5 mi east of the confluence of Rickreall Creek with Canyon Creek, and is included in the Dallas/Polk County watershed. Access is regulated and restricted by Polk County, Boise Cascade, and the landowners along the creek. The public is generally not granted access to the watershed area except during hunting season, when vehicles are permitted past the gate but must stay on the main road. Residents of the area report that the Polk County Sheriff's Department has issued citations (resulting in stiff fines) to unauthorized visitors.

The bedrock in the area has been mapped as the lower Eocene Siletz River Volcanic Series (Snavely and Baldwin, 1948) and has since been renamed the "Siletz River Volcanics." The Siletz River Volcanics are described as "a series of basaltic flows, breccia, and pillow lavas, together with tuffaceous sedimentary beds" and are exposed "in the valleys of Rickreall, Salt, Gooseneck, Gold, Rowell, and Sunshine Creeks and in the main valley and tributaries of the Siletz River" (Baldwin, 1964). Sedimentary bedding layers are found in many sections. The lithology of the area reveals that most of the Siletz River Volcanics are composed of basaltic breccia whose fragments range from 1 to 6 in. in diameter. Some mudflow and pyroclastic material is present, and some rather well-defined flows occur as well. The unweathered basalt fragments found in the breccia are embedded in a matrix of finer particles and palagonite. The rock is occasionally cut by calcite veinlets and is usually zeolitized. Random pillow structures occur within the breccia but are seldom concentrated in any particular flow. Zeolitic mineralization does not occur throughout the basalt groundmass as it does in the breccias. The Siletz River Volcanics are largely submarine, as indicated by the pillow lavas

and (fossiliferous) calcareous sedimentary rock associated with the volcanic rocks.

At the road cut, the volcanic terrane has produced a series consisting of sedimentary beds (consisting primarily of sandstone and siltstone), followed by ash flows and breccias, and capped by basalt flows. In the case of the cavities where the fine crystals were found, it has been postulated that these cavities were originally calcareous concretions that nucleated around a carbonate/apatite particle. Over time, silica particles continued to be cemented by dissolved calcite, as they were buried under accumulating sea-floor sediments. At some point, depletion of calcium ions in the interstitial fluids allowed a change from a calcite "cement" to one consisting predominantly of silica (J.J. Gray, personal communication, 1991). Later hydrothermal alteration caused the "leaching away" of the calcite "cement" in the nuclei of the concretions. A cavity was thus formed in the center of many concretions (see Figure 3), which became the place for the development of the secondary zeolitization process, including growth of the green apophyllite crystals.

Figure 3. A concretion in place with a small hole showing white heulandite.

Although all of the species described are worthy of collecting and display, it is the green apophyllite crystals at the road cut that make this locality particularly special. The apophyllite is generally found in radiating clusters and approaches an inch in diameter in the larger specimens. The color ranges from pale sea green to fine emerald. The crystals are exceptionally clear and often are enhanced by a white base of underlying heulandite. Rosettes perched directly on the gray to black country rock take on a duskier hue.

At the barrow pit, fine specimens consisting of mordenite-lined cavities up to 24 in. or more across have been collected. Oftentimes, tiny microcrystals of quartz are impaled on the mordenite hairs. Large white stilbite and heulandite crystals, often up to an inch in length, are associated with the mordenite. In some cases, mineralization commenced with a layer of blue chalcedony, which makes aesthetically pleasing specimens. Occasionally, the mordenite has been lightly stained with an amorphous iron oxide, which also enhances the specimen.

A small exposure of pale-tan heulandite crystals (the coloring due to a slight iron oxide stain) was also noted just a few hundred feet due west of the road cut, higher up the slope. These crystals are up to an inch in size and rather more weathered than those found in the road cut or barrow pit.

WARNING

Unfortunately for collectors, Boise Cascade has not been inclined to allow additional collecting in the area. At the road cut, the already dangerous overhang was further weakened by collecting efforts (see Figure 4) and, at this time, presents a serious and profound risk of falling rock. Exploratory work done at the conclusion of the permit period included efforts to spall off the most dangerous breccia overhang, with only limited success. **It must be emphasized that the road cut area presents an extreme hazard to collectors. Boise Cascade does not allow collecting at any of these sites.**

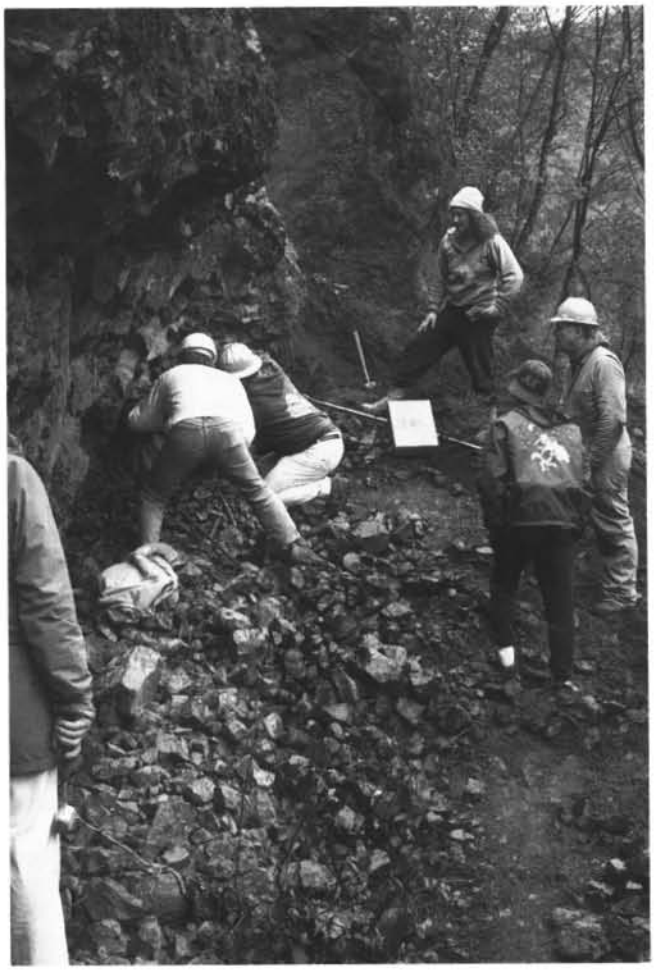


Figure 4. A sedimentary interbed overlain by basalt and containing crystal-bearing concretions is being mined by members of the Pacific Mineral Society. Note hazardous basalt overhang.

ACKNOWLEDGMENTS

The author wishes to express his gratitude to Toussaint Clay; Kris Dennis; Christopher and Ric Gibson; Gary Hinkle; Alex, Bonnie, and Karen Huang; Bill and Patrick Leach; Mickey Marks; Dan Rokosz; Bill Tompkins; Ray Schneider; and other members of the Pacific Mineral Society for their consistent support. Jerry J. Gray of the Oregon Department of Geology and Mineral Industries (DOGAMI) provided on-site explanations and advice and generously gave hours of his time to explain the geology of the area. Beverly Vogt of DOGAMI provided valuable production assistance and on-site photography. Dan Rokosz provided the excellent specimen photography. Finally, the author and the members of the Pacific Mineral Society are greatly indebted to Bill Dryden and Boise Cascade Corporation for permission to collect at the sites and for encouragement in noting these sites for the historical record.

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Amateur paleontologist thanks the professionals

Melvin S. Ashwill of Madras, Oregon, was the recipient of the prestigious Strimple Award for 1991, awarded by the Paleontological Society for outstanding contributions of an amateur to the science of paleontology. Although his acceptance speech is printed in the Journal of Paleontology, *we consider it worthwhile to share it with the readers of* Oregon Geology. *(eds.)*

Acceptance statement delivered by Melvin S. Ashwill to the Paleontological Society annual business luncheon at the Geological Society of American annual meeting in San Diego, California, October 22, 1991.

Mr. President, paleontologists of America and elsewhere.

Very briefly, I want to thank the Paleontological Society and the foresighted Strimple family for this award. I feel deeply honored. I am also very appreciative of the care and effort expended on my behalf by those who made and supported my nomination. Thank you, particularly, Steve Manchester and Ian Gordon.

I want to seize these precious few moments that I am allowed to stand before this body to tell the professional paleontologists of the world something that they know, but can bear hearing repeated—how much their help means to an amateur paleontologist. I know every one of you has helped numbers of amateurs, and gained their gratitude. However, I want these remarks to go on record as an assessment of the value of the working partnership of amateur and professional paleontologists historically. Let me mention only a smattering of those amateurs who have benefitted from the help of professionals.

More than a century ago in my neck of the woods, central Oregon, a preacher with a strong interest and some background in natural history named Thomas Condon needed help in identifying fossils. He sent a packet of fossil bones to Othniel Marsh at Yale [University]. Dr. Marsh's eyes must have widened when he found among the specimens bones of a new genus—the Eocene ancestor of the horse. Marsh published his famous paper on horse evolution and also helped Condon by not only identifying material, but by supplying him with technical papers that were of great help to the remotely located preacher. Edward Cope, Joseph Leidy, and others likewise helped Condon. This help, along with self education prepared him, so that when the University of Oregon first opened its doors, Condon was the entire geology department!

Young Charles Sternberg, as a farmer in Kansas, discovered a rich deposit of fossil leaves. Leo Lesquereux of the United States Geological Survey helped him with indentifications. Later, he got help with vertebrate fossils from Edward Cope, even spending a winter as a guest at the Cope home in New Jersey. Sternberg went on to found a veritable dynasty of paleontologists.

Back in my neck of the woods again in recent times, a talented amateur paleontogist named Douglas Emlong scoured the Miocene rocks around Newport, Oregon, for marine mammal fossils. He was immensely successful, and his contributions to science are significant. Significant also was the professional help and encouragement he received form Arnold Shotwell, Clayton Ray, and others. Tragically, Emlong is no longer with us, but another outstanding amateur paleontologist named Guy Pierson walks in his footsteps. Pierson has also put previously unknown fossil marine mammals in the hands of professionals. He, again, has been helped by some of the same people who worked with Emlong, as well as by staff members at the Los Angeles County Museum of Natural History.

As a retired music teacher, pecking on the rocks in the desert of central Oregon, I have often found myself holding a fossil in my hands that I could not identify. The corps of professional paleontologists, each member with tremendous demands on his or her time, has been unstinting in its aid.

I mentioned earlier the mentoring of Steve Manchester; in addition, listen to a partial list of paleontologists who have generously helped me: Frank Carpenter, Bruce Tiffney, Greg Retallack, Clayton Ray, David Taylor, Jack Smiley, Herb Meyer, Jane Gray, Howard Schorn, Bill Rember, Jack Wolfe, Ted Cavender, Robin Burnham, Leo Hickey, Sidney Ash, Ted Downs, Raymond Rye, Richard Thoms, Ted Fremd, and Bill Orr. In my area of work, it's a kind of "Who's Who," isn't it?

If you are an amateur in Madras, Oregon, you are three and a half hours of driving time away from the nearest science library. Guess from where help arrived in the literature quarter? My shelves hold current reprints that would have cost me thousands of dollars if I had purchased them. They were gifts from Hickey, Wolfe, Retallack, Tiffney, Ray, Burnham, Manchester, and others. The data in this literature have been of incalculable value to me.

I must share with you a remarkable story that capsulizes my points regarding professional help to amateurs:

While collecting fossil leaves at one of my favorite localities, my daughter Leslie found a striking pseudofossil. The imprint on the rock seemed to be that of an insect. One could plainly make out head, thorax, segmented abdomen, and assorted legs.

I mailed one counterpart of the imprint to the Museum of Natural History at Harvard. I also mailed a cover letter to Frank Carpenter. Carpenter at the time was at the apex of a brilliant career, and had been referred to as "the dean of paleoentomologists". The demands on his time can be imagined.

I have a letter from Carpenter in which he patiently laments that "it is unfortunate" that the specimen was not directed to the Museum of Comparative Zoology, as there are a number of museums on the campus dealing with natural history. None of us music teachers in central Oregon could have thought there would be a need for more than one! Carpenter went to great lengths to inquire about the missing package.

I mailed the counterpart. In due time it came back with a letter from Dr. Carpenter. Instead of berating an amateur who had wasted his time, he calmly stated: "I, too, thought this was a fossil insect until I put it under the microscope and saw root hairs coming from the 'legs'!"

I close with a salute to you on behalf of the thousands of amateur paleontologists worldwide. I tip my hat and thank you, the corps of professional paleontologists, for your generous help. You can never know how much it has meant to us. □

Earth science resource guide offered

The Academy of Natural Sciences of Philadelphia has published a new reference book for earth science educators, the *Resource Guide to Earth Science.*

The guide presents brief discussions of introductory earth science topics (Planet Earth—Plate Tectonics—Minerals and Rocks—Volcanoes—Earthquakes—Weathering and Erosion—Geologic Time), each with many helpful illustrations. Most of the chapters include several activities with detailed methodological instructions. A final chapter provides an extensive list for further study: publications, periodicals, field trip ideas, and national organizations and other sources of earth science information. (Unfortunately, the book appeared too early to reflect the changed address of the Oregon Department of Geology and Mineral Industries.)

Single copies of the first printing of the 75-page, spiral-bound *Resource Guide* are available free while supplies last. They may be requested in writing on school or organization letterhead paper and should be addressed to Scott Stepanski, Education Department, Academy of Natural Sciences, 1900 Ben Franklin Parkway, Philadelphia, PA 19103-1195. □

Summary of 1992 activities, Oregon Department of Geology and Mineral Industries

Focus	Activity/project	Contact persons	Objective
Geologic hazards	Earthquake hazard inventory	George Priest Ian Madin Matthew Mabey (503) 731-4100	Provide ground response maps for urban and coastal areas; seismic velocity data from cooperative bore holes; and leadership or technical assistance for earthquake scenarios, paleoseismology, active faults, workshops, and policy-centered mitigation. Partners and cooperators include USGS, METRO, PSU, U of O, OSU, ODOT, WWSC, EMD, and SSPAC.
	Coastal erosion	George Priest Dennis Olmstead Mark Neuhaus (503) 731-4100	Continue digital analysis of coastal erosion as a pilot project using historic shoreline data; evaluate results, integrate geologic considerations into model and cooperate in outreach efforts. Partners and cooperators will include FEMA, LCDC, OCZMA, and OSU.
Geologic regulation	Surface mined land reclamation	Gary Lynch Allen Throop Frank Schnitzer Doug Gallipeau (503) 967-2039	Provide for safe and environmentally sound surface mining, leading to beneficial second use in cooperation with other agencies including local government. Includes aggregate, metal mines, cyanide heap leach mines, and exploration. Cooperation with local government is being revised through rule making and revision of State Agency Coordination Agreement. Coordination with federal agencies delineated in memorandum of understanding.
	Drilling for oil, gas, and geothermal resources	Dennis Olmstead Dan Wermiel (503) 731-4100	Provide for conservation of resource, protection of environment, safety, and second beneficial use of land plus equitable distribution of revenues where necessary. Authority includes exploration, drilling, production, and reclamation. Governing Board functions as Oil and Gas Commission. Coordination with federal agencies defined in memorandum of understanding.
Geologic mapping and data collection	Northwest Oregon	George Priest (503) 731-4100	Guide and prepare geologic mapping in northwestern Oregon with emphasis on quadrangles in the Portland area, East Vancouver sheet, etc., and with emphasis on facilitating or attracting mapping efforts by cooperators in support of agency objectives.
	Southwest Oregon	Tom Wiley Frank Hladky (503) 476-2496	Conduct geologic mapping on a cooperative basis in the east-central Medford 1° x 2° sheet. Emphasis is on the Medford valley. Partners and cooperators include U of O and USGS.
	Southeast Oregon	Mark Ferns (503) 523-3133	Conduct geologic quadrangle mapping of the east half of the Boise 1° x 2° sheet for the purposes of guiding wilderness discussion, enhancing the local economy, and delineating geologic hazards. Cooperators and partners include the USGS, PSU, and the Oregon Lottery Commission. Current emphasis is on infill mapping in anticipation of a 1:100,000-scale final map product in 1993.
Public information	The Nature of Oregon Information Center	Beverly Vogt (503) 731-4444	Operate a multidisciplinary, multi-agency outlet for natural resource and outdoor recreation related information located in the new state office building for distribution of information to the public in the Portland metropolitan area for the purposes of general public education, tourism enhancement, and public service. Cooperators include natural resource agencies, Oregon Productivity Fund, and USGS.
	Oregon Geology, publications, and library	Beverly Vogt (503) 731-4100	Release agency and cooperative geologic information to a broad public in a timely and cost effective manner with publications, a subscription-based periodical, and a technical library coordinated with the State Library System.

Summary of 1992 activities, Oregon Department of Geology and Mineral Industries (continued)

Focus	Activity/project	Contact persons	Objective
Economic geology	Mineral data base for GIS, planning and policy guidance	Jerry Gray (503) 731-4100	Maintain a PC oriented database of 8,000 mines, prospects, and occurrences based on all USGS, BLM, MLR, and agency unpublished data bases designed for dBase 3+. Retrieval utilizes a variety of fields including location. Cooperators include USGS, BLM, and USFS. Applications include local planning, basin planning, and resource overviews.
	Industrial minerals	Ron Geitgey (503) 731-4100	Conduct statewide assessments and regional evaluations of industrial minerals for purposes of rural diversification. Current emphasis is on initial stages of clay studies and dimension stone studies. The need for aggregate studies is being monitored.
	Energy resources	George Priest Jerry Black (503) 731-4100	Complete final report for 1-km-deep scientific drill hole at Santiam Pass with geothermal implications, serve as source of geotechnical advice for geothermal energy, and continue natural gas assessment of southern Coast Range (Tyee Basin) with emphasis on resource targeting through reconnaissance mapping and transect development. Cooperators include USDOE, Oxbow Energy Co., BPA, landholders, DSL, Oregon Lottery, OSU, USFS, and BLM.
	Rock and mineral laboratory	Gary Baxter Chuck Radasch (503) 229-6966	Provide quantitative analytical data in support of agency programs through a cooperative lab facility focused on unique tasks with emphasis on sample preparation, quality control, correct sampling, and proper interpretation of results. Includes curation of samples and voluntary drill cores.
Selected planning	Water	Dan Wermiel (503) 731-4100	Link agency geologic mapping and data with state water quality and water quantity planning efforts through referrals and delivery of publications.
	Local government	Dennis Olmstead Dan Wermiel (503) 731-4100; also, technical assistance by regional geologists at Baker City (503) 523-3133, Grants Pass (503) 476-2496, and Portland (503) 731-4100	Oversee agency planning involvement and link planning efforts to necessary agency data bases with emphasis on periodic review and plan amendments. Roll in areas of growing need, including updated State Agency Coordination Agreement and Goal 5, is under study.
	Offshore coordination	Dennis Olmstead (503) 731-4100	Contribute to state offshore policy development through participation in OPAC.

Acronyms:

BLM	Bureau of Land Management	ODOT	Oregon Dept. of Transportation
BPA	Bonneville Power Administration	OPAC	Ocean Policy Advisory Council
DSL	Division of State Lands	OSU	Oregon State University
EMD	Emergency Services Division	PSU	Portland State University
FEMA	Federal Emergency Management Administration	SSPAC	Seismic Safety Policy Advisory Commission
GIS	Geographic Information System	U of O	University of Oregon
LCDC	Land Conservation and Development Commission	USDOE	U.S. Department of Energy
METRO	Metropolitan Service District	USFS	USDA Forest Service
MLR	Mined Land Reclamation	USGS	U.S. Geological Survey
OCZMA	Oregon Coastal Zone Management Association	WWSC	Western Washington State College

MINERAL EXPLORATION ACTIVITY

MAJOR MINERAL EXPLORATION ACTIVITY

County, date	Project name, company	Project location	Metal	Status
Baker 1990	Cracker Creek Mine Bourne Mining Corp.	T. 8 S. R. 37 E.	Gold	Expl
Baker 1991	Aurora Ridge Western Cons. Mines	T. 10 S. Rs. 35.5, 36	Precious metals	Expl
Baker 1991	Cave Creek Nerco Exploration	Tps. 11, 12 S. R. 42 E.	Gold	App
Baker 1991	Gold Hill Golconda Resources	T. 12 S. R. 43 E.	Gold	App
Baker 1991	Gold Powder Kennecott Expl. Co.	Tps. 9, 10 S. Rs. 41, 42 E.	Gold	Expl
Baker 1991	Gold Ridge Mine Golconda Resources	T. 12 S. R. 43 E.	Gold	Expl
Baker 1992	Pole Creek Placer Dome U.S.	T. 13 S. R. 36 E.	Gold, silver	Expl
Baker 1992*	Bigelow prospect Yellow Eagle Mining	T. 7 S. R. 45 E.	Gold	Expl
Coos 1991	Seven Devils Oreg. Resources Corp.	Tps. 2, 7 S. R. 4 W.	Chromite, zircon	Expl com
Crook 1988	Bear Creek Independence Mining	Tps. 18, 19 S. R. 18 E.	Gold	Expl
Curry 1992*	Mindoro project Mindoro Corporation	T. 36 S. R. 12½ W.	Precious metals	Expl
Grant 1991	Buffalo Mine American Amex	T. 8 S. R. 35½ E.	Gold	App
Grant 1991	Canyon Mtn. Cammtex International	T. 13 S. R. 32 E.	Gold	Expl
Grant 1992	Standard Mine Bear Paw Mining	T. 12 S. R. 33 E.	Gold, copper	Expl
Harney 1990	Pine Creek Battle Mtn. Exploratn.	T. 20 S. R. 34 E.	Gold	Expl
Harney 1991	Flagstaff Butte Noranda Exploration	Tps. 3, 9 S. R. 37 E.	Gold	App
Harney 1992*	Celatom Mine Eagle-Picher Minerals	Tps. 19, 20 S. Rs. 35-37 E.	Diatoms	App
Jackson 1991*	Al Sarena Project Fischer-Watt Gold Co.	T. 31 S. R. 2 E.	Gold	App
Josephine 1992*	Eight Dollar Mountain Doug Smith	T. 38 S. R. 8 W.	Gold	Expl
Lake 1988	Quartz Mountain Wavecrest Resources.	T. 37 S. R. 16 E.	Gold	Expl
Lake 1990	Glass Butte Galactic Services	Tps. 23, 24 S. R. 23 E.	Gold	Expl
Lake 1991	8th Drilling Series Wavecrest Resources	T. 37 S. R. 17 E.	Gold	Expl
Linn 1991	Hogg Rock Oreg. St. Highw. Div.	T. 13 S. R. 7½ E.	Rock	App
Linn 1991	Quartzville Placer Dome U.S.	T. 11 S. R. 4 E.	Gold, silver	App
Malheur 1988	Grassy Mountain Atlas Precious Metals	T. 22 S. R. 44 E.	Gold	Expl, com
Malheur 1988	Harper Basin Project Amer. Copper and Nickel	T. 21 S. R. 42 E.	Gold	Expl
Malheur 1988	Jessie Page M.K. Gold Co.	T. 25 S. R. 43 E.	Gold	Expl
Malheur 1988	Kerby Malheur Mining	T. 15 S. R. 45 E.	Gold	Expl, com
Malheur 1989	Hope Butte Chevron Resources	T. 17 S. R. 43 E.	Gold	Expl, com
Malheur 1990	Ali/Alk Atlas Precious Metals	T. 17 S. R. 45 E.	Gold	Expl

MAJOR MINERAL EXPLORATION ACTIVITY (continued)

County, date	Project name, company	Project location	Metal	Status
Malheur 1990	Cow Valley Butte Cambiex USA, Inc.	T. 14 S. R. 40 E.	Gold	Expl
Malheur 1990	Freezeout Western Mining Corp.	T. 23 S. R. 42 E.	Gold	Expl
Malheur 1990	Goldfinger Site Noranda Exploration	T. 25 S. R. 45 E.	Gold	Expl
Malheur 1990	Grassy Mtn. Regional Atlas Precious Metals	T. 22 S. R. 44 E.	Gold	Expl
Malheur 1990	KRB Placer Dome U.S.	T. 25 S. R. 43 E.	Gold	App
Malheur 1990	Mahogany Project Cyprus Minerals	T. 26 S. R. 46 E.	Gold	App
Malheur 1990	Racey Project Ican Minerals, Ltd.	T. 13 S. R. 41 E.	Gold	Expl
Malheur 1990	Sand Hollow Noranda Exploration	T. 24 S. R. 43 E.	Gold	Veg
Malheur 1990	Stockade Mountain BHP-Utah Internatl.	T. 26 S. Rs. 38, 39 E.	Gold	Expl
Malheur 1990	Stockade Project Phelps Dodge Mining	Tps. 25, 26 S. R. 38 E.	Gold	Expl
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Malheur 1991	Deer Butte Atlas Precious Metals	T. 21 S. R. 45 E.	Gold	App
Malheur 1991	Harper Basin Atlas Precious Metals	T. 21 S. R. 42 E.	Gold	App
Malheur 1991	Quartz Mtn. Basin BHP-Utah Intl., Inc.	T. 24 S. R. 43 E.	Gold	App
Malheur 1991	Rhinehardt Site Atlas Precious Metals	Tps. 18, 19 S. R. 45 E.	Gold	Expl
Malheur 1991	Sagebrush Gulch Kennecott Exploration	Tps. 21, 22 S. R. 44 E.	Gold	App
Malheur 1991	White Mountain D.E. White Mtn. Mining	T. 18 S. R. 41 E.	Diatoms	App
Marion 1990	Bornite Project Plexus Resources	T. 8 S. R. 3 E.	Copper	App com

Explanations: App=application being processed. Expl=Exploration permit issued. Veg=Vegetation permit. Com=Interagency coordinating committee formed, baseline data collection started. Date=Date application was received or permit issued. *=New site

MLR office moves

The Mined Land Reclamation Office has moved to larger quarters adjacent to the old location. The new address is 1536 Queen Avenue, SE, Albany, OR 97321. The telephone number, 967-2039, remains unchanged. A fax line will be added in the near future.

Major mineral exploration activity

No major changes in mineral activity have taken place since the March issue of *Oregon Geology*. A summary of all significant exploration activity in Oregon is presented elsewhere in this issue.

Regulatory issues

A contract is being negotiated between the Department of Environmental Quality and TRC Environmental Consultants, Inc., of Englewood, Colorado, to evaluate technical aspects of operational and closure standards of chemical process mines. The final report from TRC is expected by July 1992. □

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