

OREGON GEOLOGY

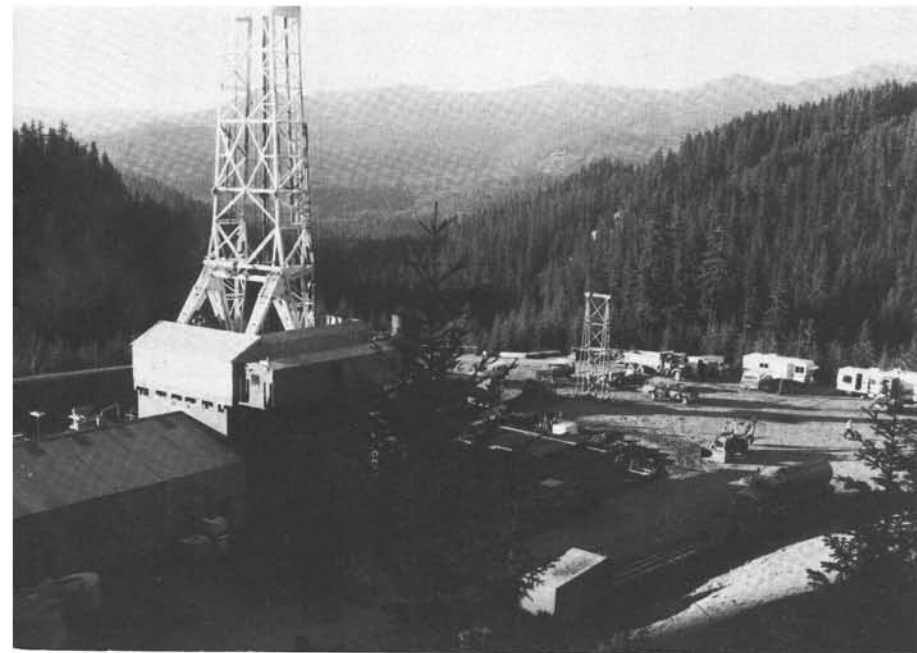
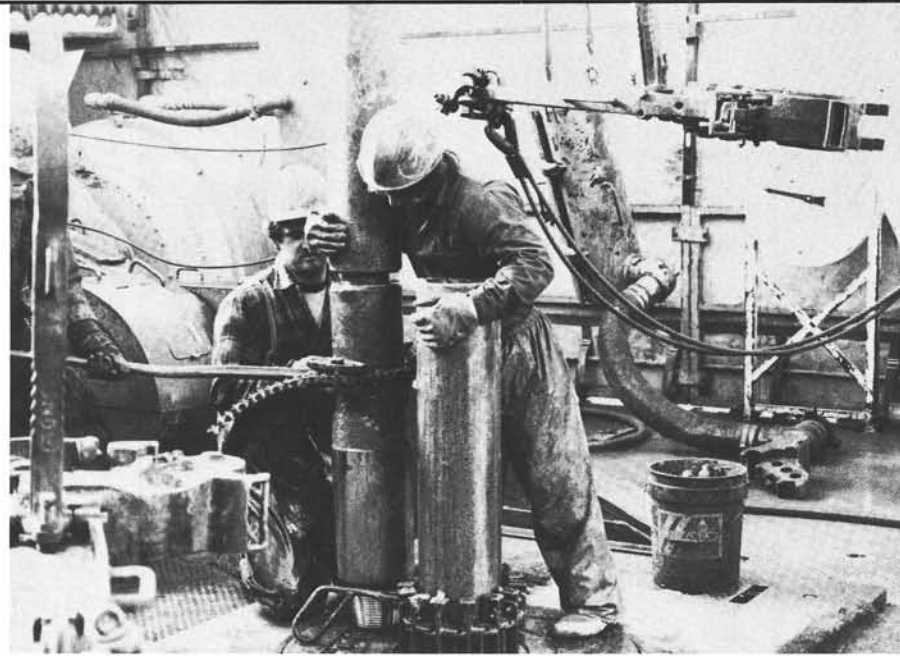
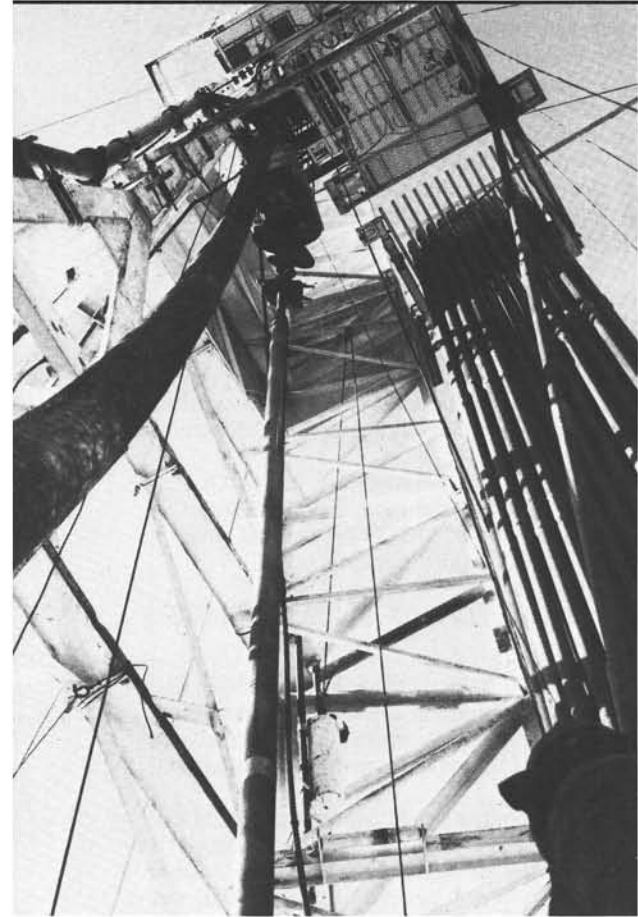
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Main Office: 1005 State Office Building, Portland 97201, phone (503) 229-5580.

Baker Field Office: 2033 First Street, Baker 97814, phone (503) 523-3133.

Howard C. Brooks, Resident Geologist

Grants Pass Field Office: 312 S.E. "H" Street, Grants Pass 97526, phone (503) 476-2496.

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COVER PHOTO

Sunoco's geothermal test well, drilled during fall of 1981, southeast of Breitenbush Hot Springs, Western Cascades. Article beginning on next page summarizes geothermal activity in Oregon during 1981.

DOGAMI publishes new geologic map of eastern Oregon mining area

A new geologic map by the Oregon Department of Geology and Mineral Industries (DOGAMI) covers the Mt. Ireland quadrangle, a traditional mining area on the border between Baker and Grant Counties.

The two-color map, *Geology and Mineral Resources Map of the Mt. Ireland Quadrangle, Baker and Grant Counties, Oregon*, was prepared by M.L. Ferns, H.C. Brooks, and J. Ducette and appears in DOGAMI's Geological Map Series as Map GMS-22. At a scale of 1:24,000, it delineates ten different bedrock and surficial geologic units and indicates quartz veins and mineralized fault zones. In addition, the map identifies 76 mine or prospect locations and describes them in a separate table.

Gold and silver from quartz vein and placer deposits have been the main mineral products of the quadrangle which covers most of the Cable Cove mining district and parts of the Cracker Creek and Granite districts. In addition to gold and silver, small amounts of lead, zinc, and copper have been recovered as by-products from the complex sulfide ores. Low-grade chromite deposits also occur in the area. Using historic values for gold and silver at the time of mining, total production value of the quadrangle has been about \$1.2 million. Most of that production came from mines along the Bald Mountain-Ibex vein.

DOGAMI Map GMS-22 is available now at the Oregon Department of Geology and Mineral Industries, 1005 State Office Building, Portland, OR 97201. The purchase price is \$5.00. Orders under \$20.00 require prepayment. □

USGS guidebook describes volcanic areas in northwest U.S.

A limited number of U.S. Geological Survey (USGS) Circular 838, *Guides to Some Volcanic Terranes in Washington, Idaho, Oregon, and Northern California*, are still available at the Portland office of the Oregon Department of Geology and Mineral Industries.

The 189-page book contains field trip guides for (1) Columbia River basalt between Lewiston, Idaho, and Kimberly, Oregon; (2) the area between Kimberly and Bend, Oregon; (3) central High Cascades, Bend, Sisters, McKenzie Pass, and Santiam Pass, Oregon; (4) Newberry Volcano, Oregon; (5) High Lava Plains, Brothers Fault Zone to Harney Basin, Oregon; (6) Fort Rock-Christmas Valley Basin, Oregon; (7) Medicine Lake Highland, Oregon-California; (8) Captain Jack's Stronghold, Lava Beds National Monument, California; and (9) the northern and western margins of the Medicine Lake Highland.

USGS Circular 838 is available free of charge to the public. A limited number of copies are available, one to a customer and over the counter only, at the business office of the Oregon Department of Geology and Mineral Industries, 906 State Office Building, in Portland. Free copies may be obtained by mail from the USGS, 604 S. Pickett St., Alexandria, VA 22304. □

CONTENTS

Geothermal exploration in Oregon, 1981	63
Oil and gas news	68
BLM State Office changes location	68
December 3, 1981, fireball	69
Geologic map of parts of Polk and Yamhill Counties placed on file	70
Ocean hot spring still producing metals off Oregon coast	70

Geothermal exploration in Oregon, 1981

by George R. Priest, Gerald L. Black, Neil M. Woller, and William L. King, Oregon Department of Geology and Mineral Industries

ABSTRACT

Geothermal leasing and drilling in Oregon continued to increase in 1981 (Figure 1*). Drilling of a deep well near Breitenbush Hot Springs by Sunoco Energy Development Co. and discovery of steam at Newberry Crater by the U.S. Geological Survey (USGS) have greatly stimulated interest in the Oregon Cascades. Accelerated drilling and leasing should occur in the Cascades in 1982.

The highlight of activity in eastern Oregon centered around the Vale Known Geothermal Resource Area (KGRA), where GONRG, Inc., and Union Oil have done exploration. GONRG plans to install a 40-kW freon-cycle wellhead generator at Vale Hot Springs, and Union Oil drilled a 3,853-ft test well into the Cow Hollow heat-flow anomaly.

LEVEL OF DRILLING IN 1981

During 1981, the number of geothermal wells drilled and permits issued dropped slightly below the 1980 level (Figures 2

and 3). Drilling occurred on four of the seven wells which were permitted for depths greater than 2,000 ft (Table 1*). A total of at least 127 temperature-gradient wells was drilled to depths less than 2,000 ft (Table 2*). The overall emphasis of drilling appeared to be shifting from eastern Oregon toward the Cascades (Figure 1).

EXPLORATION IN EASTERN OREGON

The level of exploration in eastern Oregon was similar to 1980, the highlight being a 3,853-ft well drilled by Union Oil in the Cow Hollow heat-flow anomaly south of Vale. Results from this hole are confidential. Shallow temperature-gradient drilling was also completed at Reinhart Butte adjacent to Vale by Technology International, Inc., and R.D. and R.T. Butler;

* Locations of areas discussed in text are shown in Figure 1; detailed information on all deep wells and prospect wells appears in Tables 1 and 2, respectively.

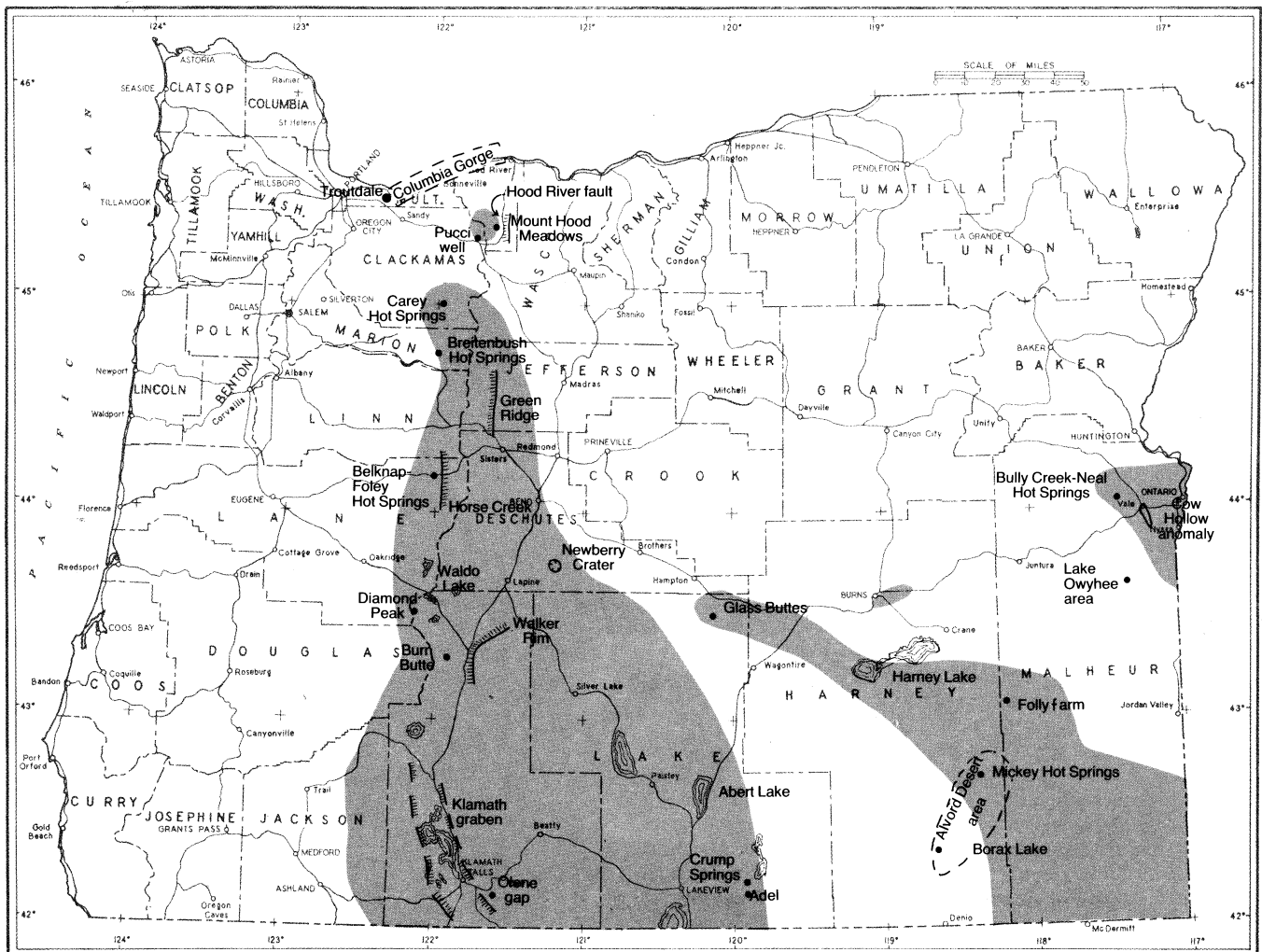


Figure 1. Location map. Some major fault scarps which have caused subsidence in the High Cascades heat-flow anomaly are shown with hachures on downthrown side. Areas with heat flow over 100 mW/m² shown in gray. (After Blackwell and others, 1978; Black and others, in preparation.)

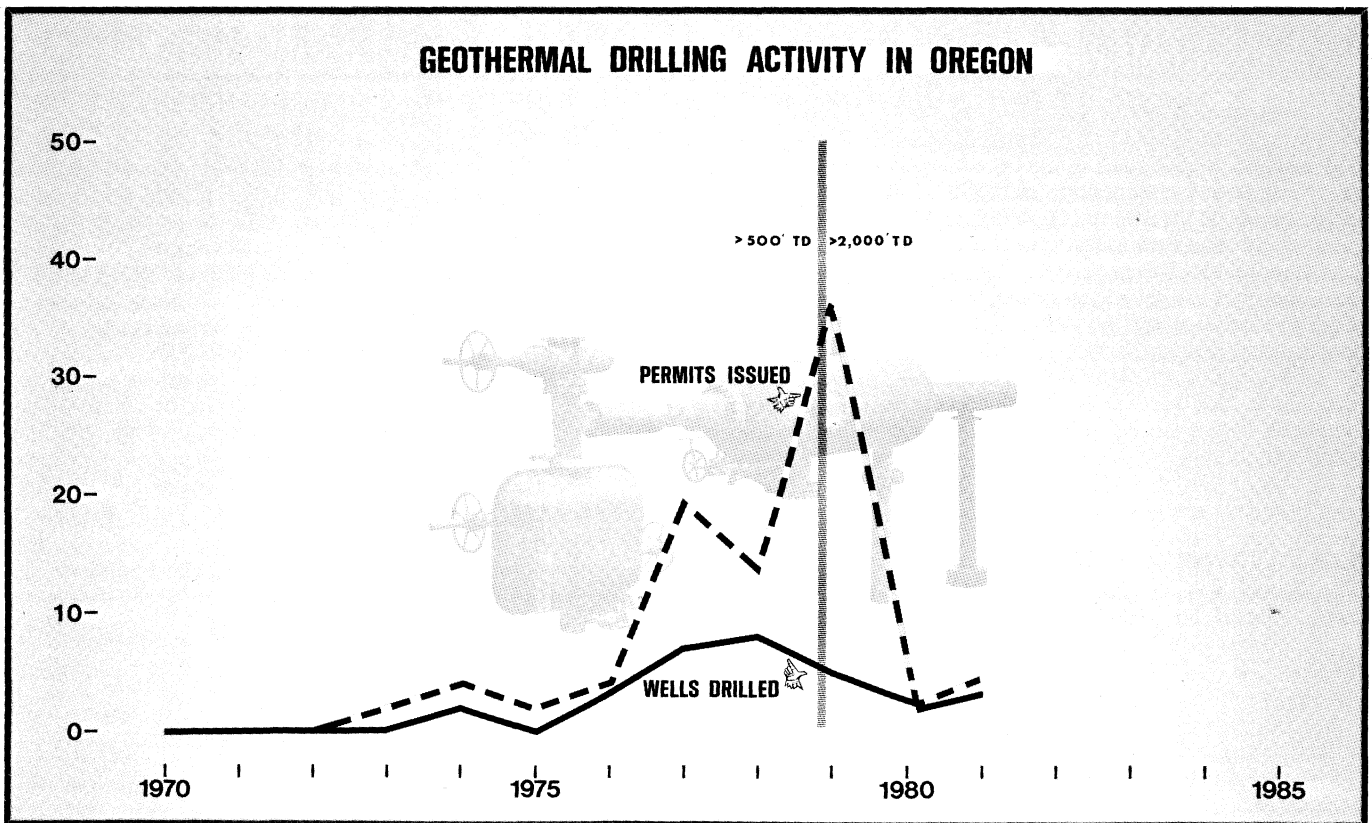


Figure 2. Geothermal well drilling in Oregon. Vertical line indicates time when definition of geothermal well was changed to a depth greater than 2,000 ft.

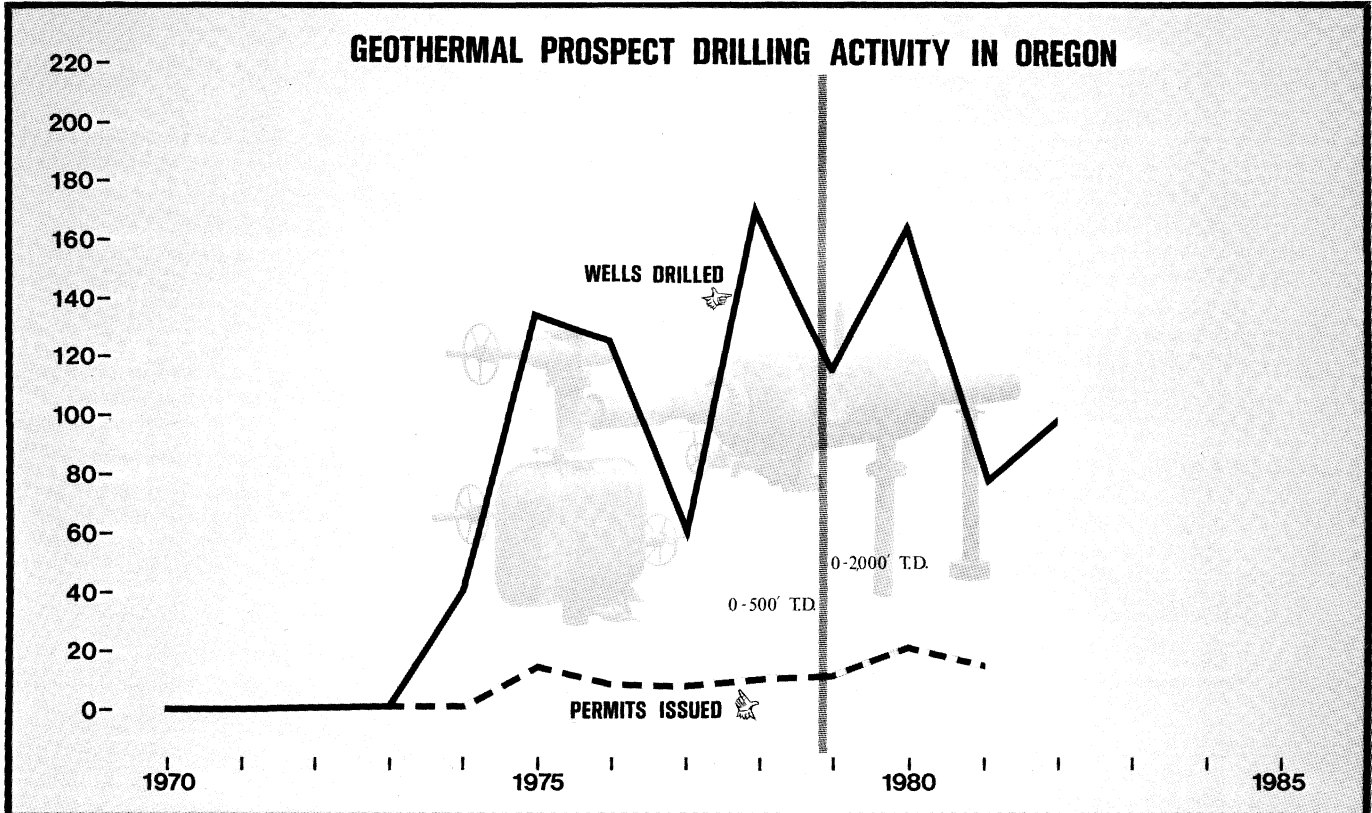


Figure 3. Geothermal prospect-well drilling in Oregon. Vertical line indicates time when definition of prospect well was changed to a depth less than 2,000 ft.

Table 1. Geothermal permits and drilling activity for wells greater than 2,000 ft in depth

Permit no.	Operator and well name	Location	Status
45	U.S. Geological Survey Newberry Crater 2	SW¼ sec. 31 T. 21 S., R. 13 E. Deschutes County	Abandoned at 3,057 ft.
55	U.S. Geological Survey Mount Hood Meadows	SW¼ sec. 3 T. 3 S., R. 9 E. Hood River County	Deepened to 1,975 ft.
84	Northwest Geothermal Corp. Municipal Land 1	NE¼ sec. 15 T. 39 S., R. 20 E. Lake County	Location.
85	Sunoco Energy Development Co. Breitenbush 58-28	SE¼ sec. 28 T. 9 S., R. 7 E. Marion County	Suspended, confidential.
86	Union Oil of California Well 47-10	SW¼ sec. 10 T. 19 S., R. 45 E. Malheur County	Suspended at 3,853 ft.
87	Union Oil of California Well 83-4	NE¼ sec. 4 T. 19 S., R. 45 E. Malheur County	Location.
88	Union Oil of California Well 35-4	SW¼ sec. 4 T. 19 S., R. 45 E. Malheur County	Location.

Table 2. Geothermal permits and drilling activity for wells less than 2,000 ft in depth (prospect wells)

Permit no.	Operator and well name	Location	Issue date and status
49	Technology International, Inc.	Vale area, Malheur County	December 1980; drilled four gradient holes to 300 ft.
67	Hunt Energy Corporation	Lake Owyhee area, Malheur County	June 1980; drilled nine holes to 500 ft.
68	Oregon Department of Geology and Mineral Industries	Mount Hood National Forest, Hood River County	June 1980; location, three gradient holes.
73	Oregon Department of Geology and Mineral Industries	Upper Hood River Valley, Hood River County	November 1980; location, four gradient holes.
76	R.D. and R.T. Butler	Vale area, Malheur County	March 1981; drilled two gradient holes to 200 ft.
77	AMAX Exploration, Inc.	Bully Creek area, Malheur County	April 1981; drilled nine gradient holes to 330 ft, one gradient hole to 1,010 ft.
78	Union Oil of California	Western Cascades, Clackamas, Deschutes, Hood River, Jefferson, Lane, Linn, and Marion Counties	June 1981; drilled eighteen gradient holes to 500 ft.
79	Oregon Department of Geology and Mineral Industries	Harney Basin, Harney County	June 1981; re-entered old well to monitor subsurface temperature.
80	Phillips Petroleum Company	North-central Cascades, Clackamas, Lane and Marion Counties	June 1981; drilled 13 gradient holes to 500 ft.
81	Anadarko Production Company	Borax Lake area, Harney County	July 1981; drilled four gradient holes to 500 ft.

Table 2. Geothermal permits and drilling activity for wells less than 2,000 ft in depth (prospect wells)—Continued

Permit no.	Operator and well name	Location	Issue date and status
82	Francana Resources	Glass Buttes area, Lake County	July 1981; drilled three gradient holes to 1,300 ft.
83	Oregon Department of Geology and Mineral Industries	Troutdale-Columbia Gorge area, Hood River and Multnomah Counties	July 1981; drilled six gradient holes to 500 ft.
84	Chevron Resources	Belknap area, Lane County	August 1981; drilled six gradient holes to 970 ft.
85	Chevron Resources	Mount Hood Nationa. Forest, Marion and Clackamas Counties	August 1981; drilled six holes to 500 ft.
86	Hunt Energy Corporation	Adel area, Lake County	September 1981; drilled nineteen gradient holes to 500 ft.
87	Anadarko Production Company	Alvord Springs area, Harney County	September 1981; drilled three gradient holes to 500 ft.
88	Oregon Department of Geology and Mineral Industries	Burns area, Harney County	October 1981; drilled one gradient hole to 575 ft.
89	John W. Hook and Associates	Bend area, Deschutes County	October 1981; five gradient holes.
90	Hunt Energy Corporation	Lakeview area, Lake County	October 1981; drilled nine gradient holes to 500 ft.
91	Renewable Energy, Inc.	Vale Butte, Malheur County	December 1981; location, one gradient hole.

at Lake Owyhee by Hunt Energy Corp.; at Bully Creek and in the Adel area by AMAX Exploration, Inc.; near Borax Lake by Anadarko; and at Glass Buttes by Francana Resources, who drilled three 1,300-ft gradient holes.

EXPLORATION IN THE CASCADES

Exploration activity in the Oregon Cascades increased dramatically in 1981. Discovery of steam at Newberry Crater and drilling of a deep hole near Breitenbush Hot Springs should encourage similar high levels of exploration in 1982.

Newberry Crater

Discovery of temperatures of 509° F (265° C) and steam in the bottom of the 3,057-ft diamond-drill hole drilled by the USGS at Newberry Crater was the big news in the Oregon Cascades (Sammel, 1981). This discovery will probably increase interest in not only the Newberry area but also the rest of the Cascades in Oregon, Washington, and northern California. The hole clearly showed that a high-temperature geothermal system can go undetected by drilling programs aimed at depths of less than 2,000 ft in youthful volcanic terranes (e.g., see temperature log in Sammel, 1981). Consequently, the number of deep wells drilled in the Pliocene and younger volcanic rocks of the High Cascades can be expected to increase in coming years.

Shallow temperature-gradient drilling by industry

The Oregon Department of Geology and Mineral Industries (DOGAMI) completed much of its drilling program along

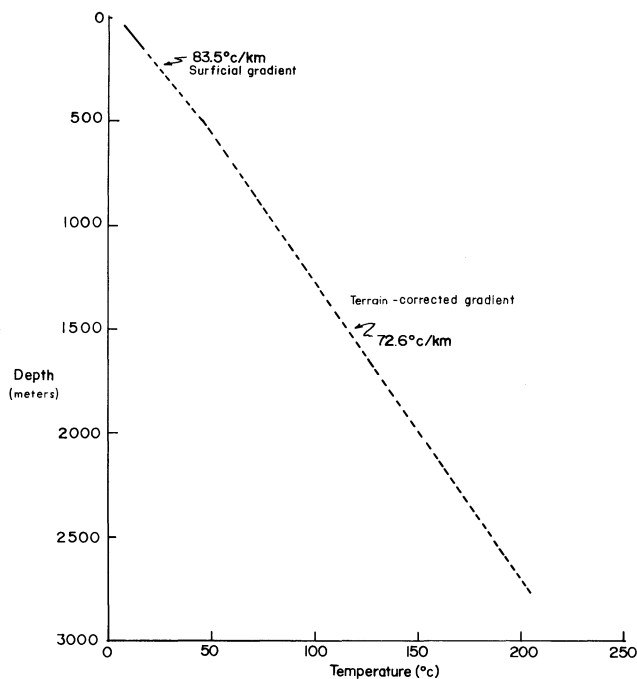


Figure 4. Terrain-corrected temperature-depth plot for the Devils Creek hole (NE¼ NE¼ sec. 11, T. 10 S., R. 7 E.) drilled by DOGAMI in 1979. Dashed line shows the gradient projected beyond the drill depth of 500 ft down to 9,000 ft. Actual temperature at 9,000 ft may be somewhat lower because of probable increase of thermal conductivity with depth.

the western boundary of the High Cascade heat-flow anomaly in 1980. The 1981 publication of temperature gradients obtained in the program (Blackwell and others, 1981) and earlier heat-flow data (Blackwell and others, 1978) stimulated major shallow drilling programs by industry in the north-central Cascades. Union Oil, Phillips Petroleum, and Chevron Resources all conducted extensive shallow drilling programs.

The Breitenbush deep well

Sunoco Energy Development obtained a permit for a 9,000-ft test well and drilled it during the fall of 1981 on Devils Creek, southeast of Breitenbush Hot Springs. The hole was completed to an undisclosed depth after a few months of drilling. A gradient of 83.5° C/km was found in a nearby 500-ft hole drilled by DOGAMI in 1979, also on Devils Creek. Because late Miocene basalts encountered in the DOGAMI hole provided excellent drilling, it is likely that the Sunoco hole encountered few problems and probably reached close to the projected 9,000-ft depth, which would make it the deepest hole in the Cascades. If the surficial gradient of the above-mentioned DOGAMI hole held up at depth, about 200° C could have been encountered at 9,000 ft (Figure 4). It is not known if significant fluids were encountered in the Sunoco hole, but chemical geothermometry of Breitenbush Hot Springs indicates possible reservoir temperatures of about 149° C (Brook and others, 1979). Fluids would probably have to circulate to about 6,560 ft to reach this temperature near the Sunoco site.

USGS drilling at Mount Hood

The USGS deepened its Mount Hood Meadows drill hole and flow-tested the 4,000-ft Pucci chairlift deep well. The Mount Hood Meadows well was deepened from 1,165 to 1,975

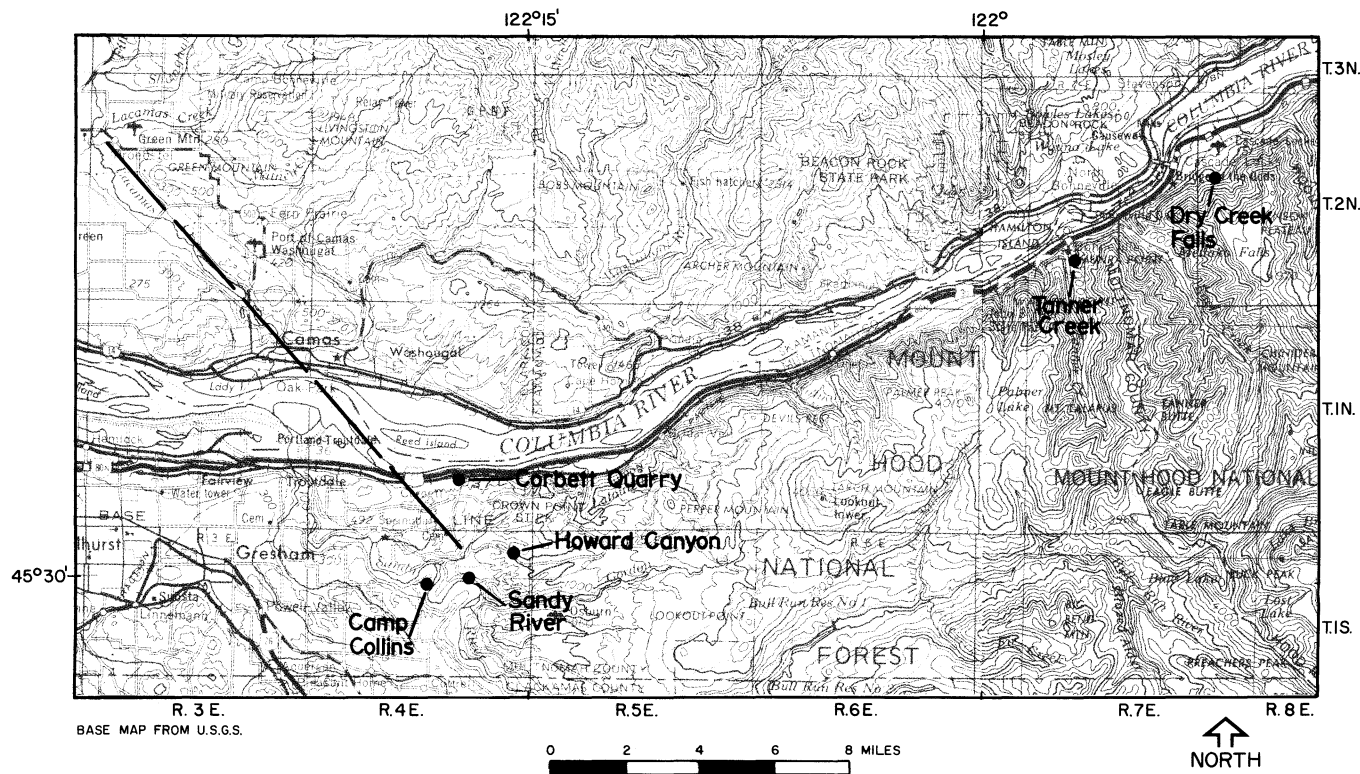


Figure 5. Locations of six shallow temperature-gradient holes drilled by DOGAMI in Troutdale-Columbia Gorge area in 1981. Tanner Creek—NE¼ NW¼ sec. 10, T. 2 N., R. 7 E.; Corbett Quarry—SW¼ SE¼ NE¼ sec. 27, T. 1 N., R. 4 E.; Howard Canyon—NW¼ SW¼ NE¼ sec. 1, T. 1 S., R. 4 E.; Sandy River—SW¼ SW¼ NE¼ sec. 11, T. 1 S., R. 4 E.; Dry Creek Falls—SE¼ SW¼ NE¼ sec. 16, T. 2 N., R. 8 E.; YMCA Camp Collins—NE¼ NE¼ NW¼ sec. 10, T. 1 S., R. 4 E. Lamacas fault zone is shown as dashed line.

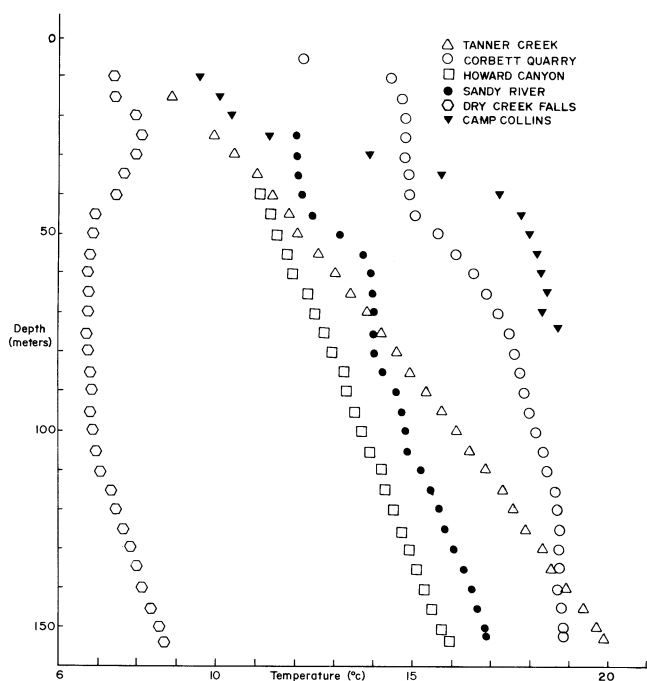


Figure 6. Temperature-depth plots for Troutdale-Columbia Gorge holes drilled in 1981 by DOGAMI. Dry Creek Falls temperature was measured before hole had stabilized.

ft and yielded a very good gradient of 81.7° C/km in the lower 650 ft of the well. The Pucci flow test recovered 110 gpm of water from a thermal zone with estimated temperature of 80° C (USGS news release, August 13, 1981). Unfortunately, the hole caved in below the casing, so further development for heating Timberline Lodge would require redrilling of all or part of the well.

DOGAMI drilling

Utilizing U.S. Department of Energy (USDOE) funds, DOGAMI completed six shallow temperature-gradient wells in the area extending from Troutdale into the Columbia Gorge (Figure 5). Preliminary temperature-depth curves for the holes are shown in Figure 6. No major temperature anomalies or thermal fluids were discovered in the holes near the Lamacas fault zone in the Troutdale (Corbett-Camp Collins) area, but anomalous gradients were encountered in the Columbia Gorge holes. Especially interesting is the Tanner Creek hole, which has a gradient of 77° C/km.

The USDOE-sponsored drilling program in the Oregon Cascades will terminate in the summer of 1982 with the drilling of several shallow temperature-gradient wells in the Ashland area in southwestern Oregon. This drilling program will be aimed at both discovering geothermal fluids adequate for direct use and defining the western margin of the High Cascade heat-flow anomaly.

GEOTHERMAL PUBLICATIONS

Several geothermal and geophysical publications related to geothermal exploration in Oregon were released by DOGAMI in 1981 (Table 3).

LEASING

The statistics on geothermal leasing activity in 1981 are summarized in Table 4. Issuing of leases continued mostly in areas of noncompetitive leasing on U.S. Bureau of Land Man-

Table 3. DOGAMI geothermal publications released in 1981

Open-File Reports

- 0-80-2-10 Preliminary geology and geothermal resource potential of [areas below], by D.E. Brown and others:
 - 0-80-2 Belknap-Foley area: 58 p., 1 map.
 - 0-80-3 Willamette Pass area: 65 p., 1 map.
 - 0-80-4 Craig Mountain-Cove area: 68 p., 1 map.
 - 0-80-5 Western Snake River Plain: 114 p., 4 maps.
 - 0-80-6 Northern Harney Basin: 52 p., 4 maps.
 - 0-80-7 Southern Harney Basin: 90 p., 8 maps.
 - 0-80-8 Powell Buttes area: 117 p., 1 map.
 - 0-80-9 Lakeview area: 108 p., 2 maps.
 - 0-80-10 Alvord Desert area: 57 p., 2 maps.
- 0-80-11 Engineering and air and mud drilling data, DOGAMI well Old Maid Flat 7A: 1 sheet, folded into 16 p.
- 0-80-12 Geothermal gradient drilling, north-central Cascades of Oregon, by W.L. Youngquist: 47 p., 2 gamma-ray logs.
- 0-80-14 Progress report on activities of the low-temperature resource assessment program 1979-1980, D.A. Hull, principal investigator: 79 p.
- 0-81-2 Geophysical logs, Old Maid Flat well 7A, Clackamas County, Oregon: Folded log copies, 2 parts:
 - 0-81-2A Shallow drilling (96-1,190 ft), 3 logs.
 - 0-81-2B Deep drilling (96-5,952 ft), 9 logs.
- 0-81-3 Geothermal gradient data for Oregon, by Blackwell and others: 3 parts:
 - 0-81-3A Data for 1978, 63 p.
 - 0-81-3B Data for 1979, 98 p.
 - 0-81-3C Data for 1980, 374 p.

Special Papers

- 9 Geology of the Breitenbush Hot Springs quadrangle, Oregon, by C.M. White: 26 p., 1 map.
- 12 Geologic linears of the northern part of the Cascade Range, Oregon, by R. Venkatakrisnan and others: 25 p., 5 maps.
- 13 Faults and lineaments of the southern Cascades, Oregon, by C.F. Kienle and others: 23 p., 1 map (2 sheets).

Geological Map Series

- GMS-15 Free-air gravity anomaly map and complete Bouguer gravity anomaly map, Cascade Mountain Range, northern Oregon, by R.W. Couch and others: 2 maps, scale 1:250,000.
- GMS-16 Free-air gravity anomaly map and complete Bouguer gravity anomaly map, Cascade Mountain Range, southern Oregon, by R.W. Couch and others: 2 maps, scale 1:250,000.
- GMS-17 Total-field aeromagnetic anomaly map, Cascade Mountain Range, southern Oregon, by R.W. Couch and others: 1 map, scale 1:250,000.

Table 4. Geothermal leases in Oregon, 1981

Types of leases	Numbers	Acres	Relinquished leases	
			Numbers	Acres
Federal leases, active (new in 1981)				
Noncompetitive, USBLM	33	47,395	21	34,419
Noncompetitive, USFS	0	0	3	3,200
KGRA, USBLM	2	4,190	1	119
KGRA, USFS	0	0	0	0
Total	35	51,585	25	37,738
Federal leases pending (total since 1974)				
Noncompetitive, USBLM	46	135,352		
Noncompetitive, USFS	487	957,926		
KGRA, USBLM	0	0		
KGRA, USFS	0	0		
Total	533	1,093,278		
State (total since 1974)				
Total leases active in 1981	13	9,463		
Total applications pending	2	320		
Private (total since 1974)				
Total leases active (est.)	No data	200,000		

OIL AND GAS NEWS

agement (USBLM) lands. As the U.S. Forest Service (USFS) begins to issue more leases, the number of active leases in the Cascades should increase considerably in the next few years.

In order to stimulate exploration, the Federal government will reoffer KGRA lands for competitive bidding and declassify lands now classified as KGRA's when no bids are received after several sales. A lease sale will be held on June 15, 1982, for about 107,800 acres on USFS and USBLM lands in the Summer Lake KGRA and on USBLM lands in the Alvord, Crump Geyser, Klamath Falls, and Vale KGRA's (Jackie Clark, USBLM, Portland Office, 1982, personal communication).

New areas which have been the focus of recent lease applications are the Cultus Lake, Devils Lake, Green Ridge, and Powell Buttes areas. Some areas continue to be ignored by industry even though, for geological reasons, they appear to have high potential. Areas which, in the writer's opinion, deserve more attention are (1) the Walker Rim; (2) the northeast and west sides of the Klamath graben; (3) the western margin of the south-central High Cascades province, especially at lineaments that may be fault zones which have caused major subsidence of the High Cascade axis (examples are areas due north of Diamond Peak, such as the escarpment on the west side of Waldo Lake and southern extensions of the Horse Creek fault zone mapped by Flaherty, 1981); (4) all areas of the High Cascade axis not within wilderness or national parks (essentially all of these areas in the southern Oregon High Cascades are unleased at present); (5) Burn Butte, north of Crater Lake; (6) the Follyfarm area north of the Alvord Desert; (7) the Harney Lake area; and (8) the Abert Lake area (Figure 1).

POSSIBLE FREON BINARY GENERATOR AT VALE

GONRG, Inc., of Ontario, Oregon, is planning to install a 40-kW freon-cycle, binary-fluid electrical generator at Vale Hot Springs. The small wellhead generator should be installed early in the summer of 1982, if financial backing is secured. The generator will utilize 60 gpm of 230° F water from a 200-ft well near the hot springs; 150 gpm of 55° F water will be necessary for cooling the working fluid (R.T. Butler, 1982, personal communication).

The project is strictly a research-and-development effort at present but may pave the way for a larger generating plant (perhaps 1 MWe) which could utilize the full potential of the shallow thermal waters. Should this project prove successful, it could mean that a large number of shallow geothermal systems that have water in the 190°-250° F range could be cheaply exploited for electrical power production. Areas with measured temperatures within or near this range are Breitenbush Hot Springs, Carey (Austin) Hot Springs, Belknap-Foley Hot Springs, Klamath Falls-Olene Gap, Mickey Hot Springs, Borax Lake, Lakeview, Crump Springs, Neal Hot Springs, and the Collohan well at Paisley (Figure 1).

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- Black, G.L., Blackwell, D.D., and Steele, J.L., in preparation, Heat flow of the Oregon Cascades, in Priest, G.R., and Vogt, B.F., eds., Geology and geothermal resources of the Cascades of Oregon: Oregon Department of Geology and Mineral Industries Special Paper 15.
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- Blackwell, D.D., Hull, D.A., Bowen, R.G., and Steele, J.L., 1978, Heat flow of Oregon: Oregon Department of Geology and Mineral Industries Special Paper 4, 42 p.
- Brook, C.A., Mariner, R.H., Mabey, D.R., Swanson, J.R., Guffanti, M., and Muffler, L.J.P., 1979, Hydrothermal convection systems with reservoir temperatures $\geq 90^\circ$ C, in Muffler, L.J.P., ed.,

Columbia County

Reichhold Energy Corporation's Crown Zellerbach 32-26, located in sec. 26, T. 5 N., R. 4 W., near Pittsburg, was plugged and abandoned April 20, 1982. Total depth was 6,501 ft. Reichhold has one additional location in sec. 26, Crown Zellerbach 34-26, projected to a total depth of 6,000 ft.

Reichhold is currently redrilling Columbia County 13-1 in sec. 1, T. 6 N., R. 5 W. The original hole was completed August 15, 1981, as a gas well flowing 2.6 MMCFD. Total depth was 3,076 ft. Mechanical problems on the original hole necessitated this redrill operation.

Douglas County

Florida Exploration Company of Houston is drilling ahead on well 1-4, sec. 4, T. 21 S., R. 6 W. Florida has applied to drill three additional wells in Douglas County, one of which was previously reported in the May issue of *Oregon Geology*.

Malheur County

Z&S Construction Company of Kimball, Nebraska, spudded Recla 1 on April 29, 1982, in sec. 9, T. 19 S., R. 44 E., approximately 6 mi southwest of Vale. Projected total depth is 6,000 ft.

Recent permits

Permit no.	Operator, well, API	Location	Status
214	Florida Exploration Co. USA 1-22 019-00016	SE¼ sec. 22 T. 26 S., R. 8 W. Douglas County	Application
215	Florida Exploration Co. Eagles View Management 1-26 019-00017	NW¼ sec. 26 T. 20 S., R. 6 W. Douglas County	Application
216	Nahama & Weagant Klohs 1 071-00003	NE¼ sec. 6 T. 3 S., R. 2 W. Yamhill County	Application <input type="checkbox"/>

BLM State Office changes location

All units of the Bureau of Land Management's (BLM) Oregon State Office have been moved to the Lloyd Center Tower at 825 NE Multnomah Street, Portland, OR 97208, according to William G. Leavell, State Director for BLM.

Phone numbers at the new location are the same as when the agency occupied two leased buildings on Oregon and Holladay Streets, a few blocks south of the new office. Likewise, the mailing address remains the same: P.O. Box 2965, Portland, OR 97208. With recent reorganization and decentralization, fewer employees are assigned to the State Office than before the move to different quarters.

For additional information, contact the BLM Public Affairs Office, phone (503) 231-6274.

Assessment of geothermal resources of the United States—1978: U.S. Geological Survey Circular 790, p. 18-85.

Flaherty, G.M., 1981, The Western Cascade-High Cascade transition in the McKenzie Bridge area, central Oregon Cascade Range: Eugene, Oreg., University of Oregon master's thesis, 178 p.

Sammel, E.A., 1981, Results of test drilling at Newberry Volcano, Oregon—and some implications for geothermal prospects in the Cascades: Geothermal Resources Council Bulletin, v. 10, no. 11, p. 3-8.

December 3, 1981, fireball

by Richard N. Pugh, Science Teacher, Cleveland High School, Portland, Oregon 97202

Down through the ages, human beings have watched "falling stars," or meteorites, and have often attached great significance to such spectacular events. Scientists, however, take a much more practical view of meteorites. These objects, which fall to earth from orbits around the sun, may be fragments of broken-up planets or bits of the original material from which the earth was formed. Studies of these meteorites, thus, provide insight into the composition of our earth as well.

Meteorites have a variety of compositions, ranging from "irons," which are primarily metallic iron alloyed with nickel, to "stones," which consist of silicates and resemble ultramafic rocks in composition. Because irons are more durable and more unusual looking, they are found more often and appear more frequently in museum collections. Descriptions of observed falls suggest, however, that stony meteorites are more common. We are printing the following article, which describes what may have been the falling of a stony meteorite into the Willamette Valley, in the hopes that bits of the meteorite may be found, thus adding to the body of information about the earth on which we live.

At 10:21, Pacific Standard Time, December 3, 1981, a meteoroid entered the earth's atmosphere over south-central Washington. The angle of entry was approximately 45° to the earth's surface. The direction of flight was south-southwest. The bolide (fireball), which illuminated an area of approximately 3,000 sq mi of the northern Willamette Valley, may have produced meteorites as well.

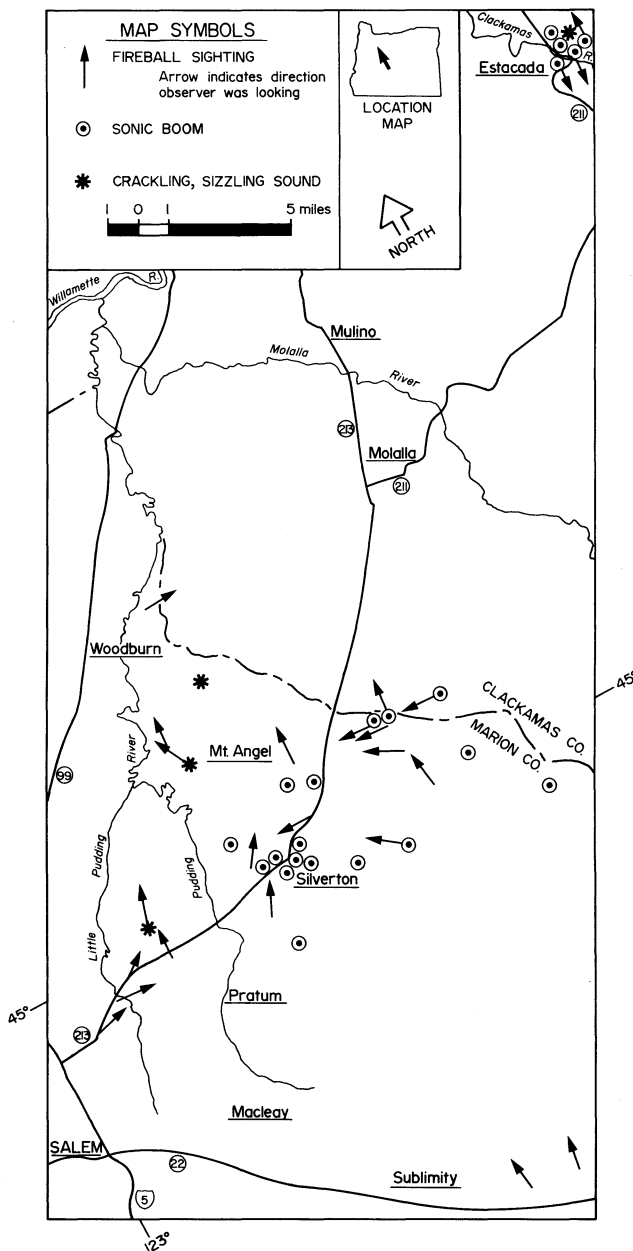
Over 100 people have already reported sightings and sound effects to the author. The fireball was seen as far east as Boardman, Oregon; as far north as Prosser, Washington; as far west as Astoria, Oregon; and as far south as Reedsport, Oregon. The observers east of the Cascades reported a kelly-green fireball, while the majority of the observers west of the Cascades saw a blue-white fireball. Most observers in western Oregon saw the fireball through a thin cloud layer or fog, and they reported the fireball to be the size of a full moon and somewhat brighter. The author estimates the fireball had a brightness of a magnitude of -13 (the moon has a magnitude of -12.7).

Sonic booms were heard from Portland in the north to Pratum in the south, and from Scotts Mills in the east to Salem in the west. The heaviest sonic booms occurred in the Scotts Mills-Silverton area. The sonic boom was reported to have rattled dishes and windows and in several cases to have knocked pictures askew on walls. The sonic booms were heard 1-1½ minutes after the fireball disappeared.

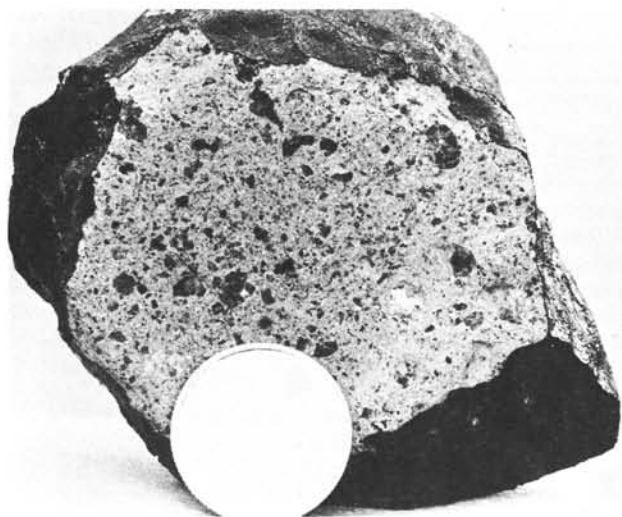
There were at least four reports of sizzling, crackling sounds heard at the same time as the fireball was seen. These sounds are unexplained, but they have been reported associated with other fireballs. These sounds are usually heard by those under the path of the fireball.

Several observers reported seeing the bolide disrupt over Estacada, with the larger fragments continuing down range toward the Silverton area. One person stated that the fireball exploded like a skyrocket. In the Silverton area, however, most observers reported a single object. This may be because most reporters were looking toward the north with the fireball coming toward them, which would make multiple fragments difficult to observe. One person in the Silverton area reported a large fireball with two smaller ones following it. Those people west of Silverton, at the end of the path of the fireball, observed the bolide moving slowly, coming almost straight downward, and then disappearing. Most of these observers heard no sound at all. It is not uncommon to have a cone of silence in front of a fireball. The meteoroid ceased producing light just west of Silverton.

By mapping the position of the observers and the direction from which they saw the fireball, I have concluded that the larger fragments could have landed as far south as Pratum,



Map showing areas where fireball was observed and most sound effects were heard. Path of the fireball was to the south-southwest.



The Washougal meteorite, a stony meteorite that is the only meteorite that was seen to fall and was then recovered in the Pacific Northwest. It is also the only stony meteorite recovered in the Northwest. It fell at 7:35 a.m., P.S.T., July 2, 1939, after a fireball exploded over Portland, Oregon. It is currently in the University of Oregon Museum collection. Round object is dime for scale.

Four Corners, and Macleay, just north of Highway 22. There could be smaller fragments of meteorite as far north as Estacada.

Since most of the meteorites entering the earth's atmosphere are stony, and since stony meteorites are brittle and tend to break up, it would seem reasonable to assume that this event was a stony meteorite that also disrupted, producing an elliptical area of impact. The larger fragments should be found southwest of Silverton, and the smaller fragments should be found around Mount Angel and perhaps as far north as Molalla and Estacada.

The meteorites will have a black or brown fusion crust on the exposed surface and will probably show rust due to our heavy rains. Flow lines and shallow depressions may be evident on the fusion crust.

The meteorites may have penetrated the ground a foot or two. Smaller fragments may be found in gutters or beside buildings where they rolled off roofs. Larger meteorites may have penetrated roofs.

Only four meteorites have been found in Oregon, and all of them were iron meteorites. It is hoped that some of the fragments from this fireball may be recovered. The finder of any specimens should contact the author at Cleveland High School, 3400 SE 26th Avenue, Portland, OR 97202, phone (503) 233-6441.

SUGGESTED READING

- Buchwald, V.F., 1975, Handbook of iron meteorites: Berkeley, Calif., University of California Press, v. 1, p. 27, 31-32.
 Heide, F., 1957, Meteorites: Chicago, Ill., University of Chicago Press, p. 12, 25-27.
 McKinley, D.W.R., 1961, Meteor science and engineering: New York, McGraw-Hill, p. 25-26, 141.
 Nininger, H.H., 1972, Find a falling star: New York, Paul S. Ericksen, Inc., p. 3, 78. □

- Nature cannot be commanded except by being obeyed.
 — Sir Francis Bacon (1561-1626)

Geologic map of parts of Polk and Yamhill Counties placed on open file

A new preliminary geologic map of the Ballston 7½-minute quadrangle in western Oregon has been placed on open file by the Oregon Department of Geology and Mineral Industries (DOGAMI).

Preliminary Geologic Map of the Ballston Quadrangle, Oregon, DOGAMI Open-File Report 0-82-2, was prepared by former Department staff member Michael E. Brownfield at a scale of 1:24,000. The blue-line map shows seven bedrock and surficial geologic units of Eocene and Pleistocene-Holocene age and includes a geologic cross section.

The Ballston quadrangle is situated on the border between Polk and Yamhill Counties, roughly within the triangle formed by McMinnville, Sheridan, and Dallas. The investigation of the quadrangle was part of a regional study of the northern Coast Range. It serves to link previous geologic mapping in the Willamette Valley with the new mapping project and will enable geologists to relate Willamette Valley geology to the geology of the central Oregon Coast Range.

Open-File Report 0-82-2 is now available at the Oregon Department of Geology and Mineral Industries, 1005 State Office Building, Portland, OR 97201. The purchase price is \$3.00. Orders under \$20.00 require prepayment. □

Ocean hot spring still producing metals off Oregon coast

A plume of water containing the highest concentrations of manganese yet reported is still rising from an active submarine hydrothermal spring on the deep-sea Pacific floor 270 nautical mi west of Newport, Oregon. The discovery was first reported last September by researchers from the U.S. Geological Survey (USGS) Western Regional Center, Menlo Park, California, and from the University of Washington, Seattle, Washington. The initial announcement reported the occurrence of a series of metal deposits containing up to 60 percent by weight zinc and having significant amounts of silver, copper, and cadmium.

The stream of mineral-carrying water is being discharged by one of many submarine springs that have deposited large deposits of zinc- and silver-rich metals in an area of recent volcanic activity along the deep-sea Juan de Fuca Ridge, according to William R. Normark, USGS marine geologist and chief scientist on the discovery cruise by the USGS research ship *S.P. Lee*.

Followup laboratory analyses of water samples taken in the area by James Murray of the University of Washington have demonstrated the continuing activity and high metal content of the plumes above the vent. Murray reported water samples recovered from the vent area had dissolved manganese values that are greater than 100 times the normal background levels and that are the highest ever reported from water above hydrothermal vents.

Manganese carried in minute quantities in submarine hydrothermal discharge is known to be a reliable tracer of the hot vent water that deposits the rich metal deposits. At this location, very high manganese values were measured in a series of water samples from the sea floor and at several levels up to 500 ft above the sea floor. The persistent high values to that altitude indicate that this string of water samples was taken in a vertically rising plume of water from one of the vents.

The scientists from the USGS will return to the vent area in the fall of 1982. □

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