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The Ore Bin

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PROGRESS REPORT ON HEAT-FLOW STUDY OF THE BROTHERS FAULT ZONE, CENTRAL OREGON

Richard G. Bowen,¹ David D. Blackwell,² Donald A. Hull,³
and Norman V. Peterson³

Introduction

The natural flow of heat toward the surface of the Earth is a function of the presence of heat in the Earth's crust and mantle. The measurement of heat flow is a direct method for determining where there may be a subsurface concentration of heat energy. To be suitable for commercial utilization, there must be, in addition to a concentration of high heat, either water or steam in sufficient quantity and at high enough temperature to do useful work. For producing electrical power, a minimum temperature of 150°C (302°F) is required. For heating or for industrial process use, temperatures of 90° to 150°C (194° to 302°F) are necessary.

To determine the commercial viability of the prospect in the anomalous area, it is necessary to drill a well into the reservoir and evaluate its temperature and producing capabilities. This evaluation can only be made through the costly process of drilling exploration wells to depths of 5,000 to 7,000 feet or even greater.

Heat-flow determinations and temperature gradients, such as those made by the Department and described in this report, guide the other exploratory tools in ultimately locating the site for drilling.

Certain areas of Oregon have geologic conditions that suggest the possible presence of higher than normal heat flow. One of these areas extends along the Brothers fault zone in central Oregon. This major regional lineament is the type of feature along which geothermal resources tend to be concentrated. It was selected for study by the Oregon Department of Geology and Mineral Industries as part of a continuing investigation of Oregon's geothermal resource potential.

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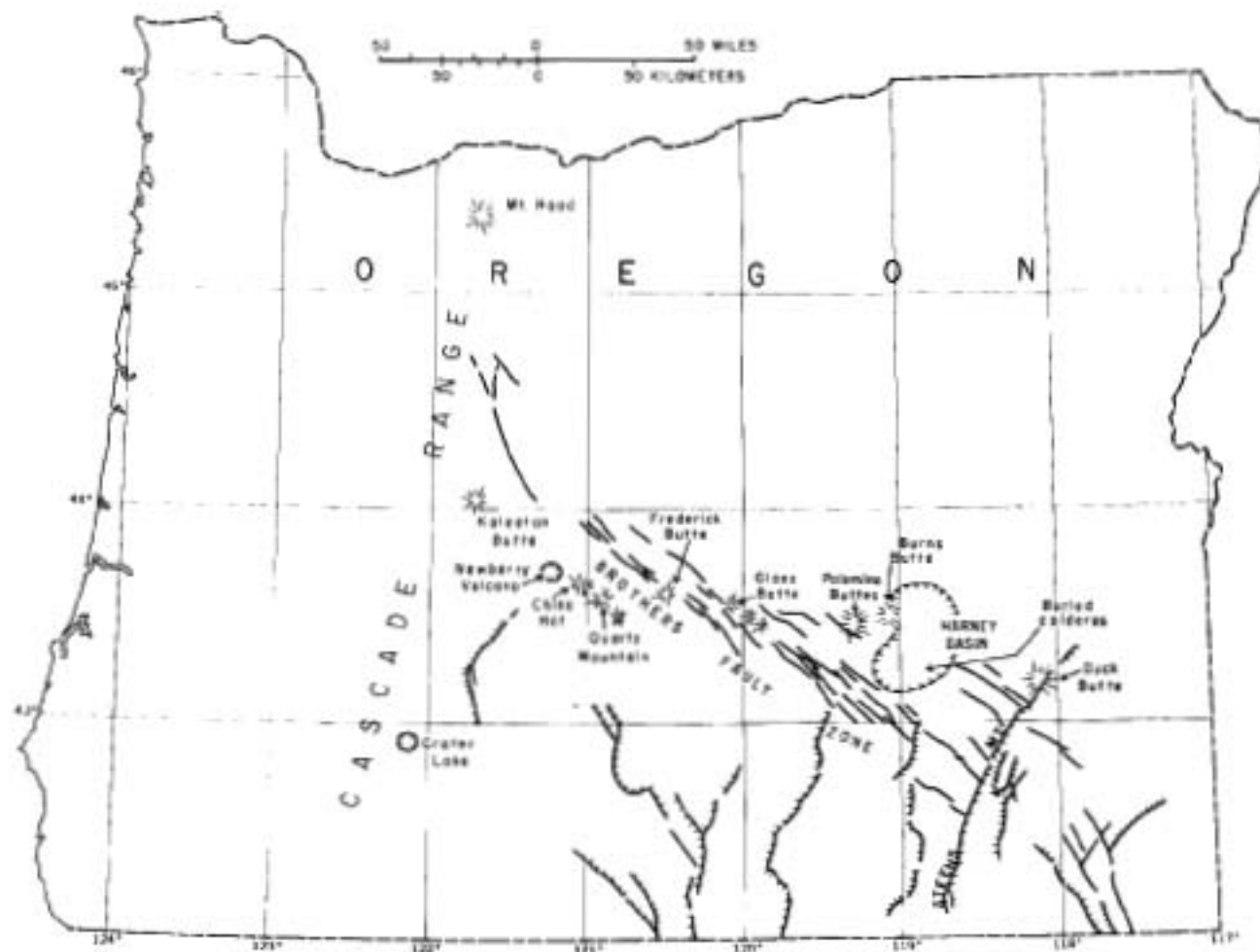


Figure 1. Extent of Brothers fault zone and location of silicic volcanic domes

Our research to determine heat flow associated with the Brothers fault zone was begun on July 1, 1975 and will continue in 1976. The study is made possible by Geothermal Research Grant No. 14-08-0001-G-200 from the U.S. Geological Survey.

The preliminary results of our investigations are presented here as a progress report for the use of government, industry, and research groups. Additional drilling to measure heat flow along the westward and possible eastward extensions of the Brothers fault zone is planned for the 1976 field season.

Regional Geology

The Brothers fault zone extends east-southeast from the Cascade Range on the west to the Steens Mountains on the east (see Figure 1). The zone at the surface is seen as a series of parallel, partly en-echelon, high-angle, normal faults. Walker (1969) suggests that "The normal faults of the zone and the many volcanic vents along the zone represent only the surface manifestations of deformation of a large, deeply buried structure, the exact nature of which is not known. The pattern of normal faults within and near the Brothers fault zone and the relation of many small monoclinial folds to the faults suggest, however, that the zone overlies a deeply buried fault with lateral displacement; the normal faults denote only adjustment of surface and near-surface volcanic and tuffaceous sedimentary rocks."

Recent work by Stewart and others (1975) has indicated that the Brothers fault zone is colinear with, and possibly an extension of, a structural zone extending as far southeast as central Nevada and termed the Oregon-Nevada lineament. Further detail on the Brothers fault zone is provided by Lawrence (1974) in a study of ERTS-1 imagery. He interprets the Brothers fault zone as a zone of right-lateral tear faulting which forms the northern boundary of the Basin and Range geologic province across much of central Oregon.

The regional geology in the vicinity of the Brothers fault zone has been mapped by Walker and others (1967) and Greene and others (1972). The fault zone traverses a sequence of volcanic and sedimentary rocks ranging in age from Miocene to Holocene. The volcanic rocks are predominantly basalt flows and silicic ash-flow tuffs. The sedimentary rocks are fluvial and lacustrine tuffaceous sandstones, siltstones, and claystones occurring as thin interbeds between lava flows and occasionally as thicker accumulations where lakes were formed. Associated with the ash-flow tuffs, along the Brothers fault zone and in a broad area to the south, are silicic volcanic domes ranging in composition from rhyolite to rhyodacite. Age dates obtained by Walker (1974) and MacLeod and others (1975) show that the domes and related ash flows decrease progressively in age from Harney Basin westward to the Cascade Range. This information has led Walker (1974) and MacLeod and others (1975) to postulate that silicic intrusive bodies sufficiently

young to be heat sources for geothermal systems are more likely located near the western part of the zone.

Geothermal Data

The procedure for determining heat flow consists of three steps: 1) drilling a hole, 2) measuring the temperature gradient in the hole with a thermistor probe, and 3) determining in the laboratory the thermal conductivity of the rock from drill-core or cutting samples. Heat flow is computed as the product of the temperature gradient and the thermal conductivity.

In order to expedite the development of information on geothermal prospects in central Oregon, our information on temperature gradients along the Brothers fault zone is released at this time. Measurements of thermal conductivity are continuing to be refined, and heat-flow calculations will be published in a later paper.

During the present study, 28 holes were drilled to variable depths; the deepest was 67 meters (220 feet). Twenty-one holes gave useful information, and only these are recorded on Table 1.

Moving ground water presents one of the most serious obstacles to getting representative geothermal gradients because it transmits heat more readily than does rock conduction. The holes drilled in the sedimentary rocks, in the ash-flow tuffs, and in silicic domes generally provide linear gradient data because these formations are either above the regional ground-water level or are sufficiently impervious to prevent water circulation. In two of the unreported holes, BR75-2 and BR75-3, ground-water movement masked the true gradients, and in the remaining unreported holes (BR75-8, 15, 19, 20, and 26) drilling and completion problems prevented the gathering of useful gradients. These were mainly in basalt, where brecciation, cinders, or poorly consolidated interflow sediments occurred at flow contacts.

Figure 2 shows where holes were drilled along five traverses oriented northeast-southwest approximately perpendicular to the trend of the Brothers fault zone. Holes were drilled at intervals of about 6 to 32 kilometers (4 to 20 miles) along the traverse lines with locations dependent upon lithology, access, tree cover, topography and ownership. The traverse lines were spaced about 40 kilometers (25 miles) apart.

Geothermal gradients are tabulated in Table 1. Terrain corrections have not been made to the gradient data but hole sites were selected to be free of major topographic influences and corrections for most gradients would be less than 5 percent.

Holes were drilled in a variety of rock types as shown in Table 1. The thermal conductivity of the sedimentary rocks ranges from about 2.0 to 3.0 mcal*/cm sec °C with the sandstone and siltstone usually about 2.6 ± 0.4 and the claystone 2.3 ± 0.3 in the same units. The thermal conductivity of the volcanics ranges from 2.5 to 5.0 for the basalt and 3 to 5 for the silicic

*mcal = millicalorie

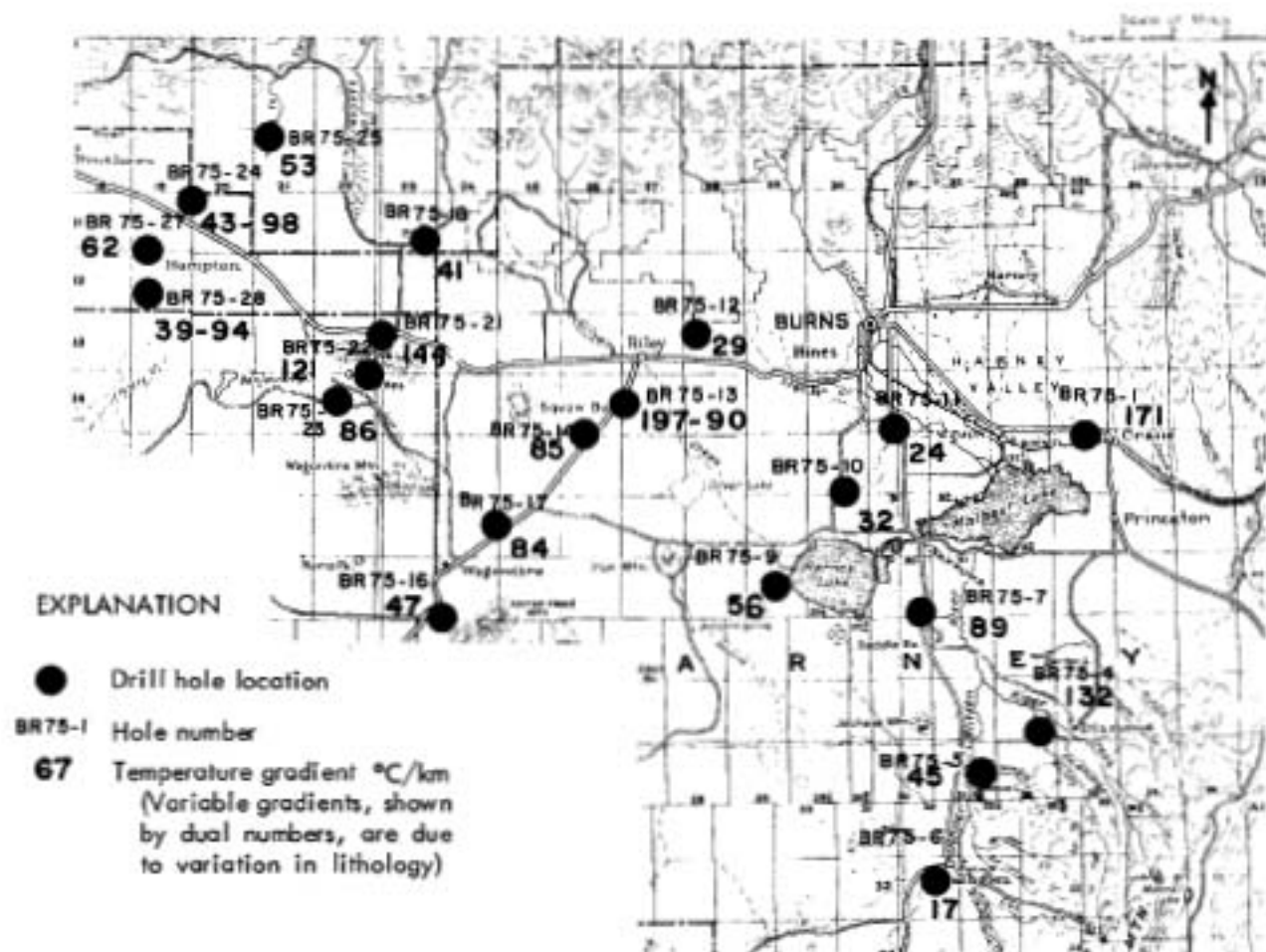


Figure 2. Temperature gradients measured in holes drilled along Brothers fault zone.

Table 1. Geothermal gradient measurements along the Brothers fault zone, central Oregon

Hole	Location	Depth meter (feet)	Average** gradient (°C/km)	Lithology
BR75-1*	NW¼ sec. 3, T. 25 S., R. 33 E.	28 (92)	171	Tuffaceous siltstone and sandstone
BR75-4	SE¼ sec. 34, T. 29 S., R. 32 E.	52 (171)	132	Welded tuff
BR75-5	NW¼ sec. 23, T. 30 S., R. 31 E.	31 (102)	45	Tuffaceous sandstone
BR75-6	NW¼ sec. 16, T. 32 S., R. 32 E.	61 (200)	17	Basalt
BR75-7	SW¼ sec. 36, T. 27 S., R. 30 E.	52 (171)	89	Claystone and sandstone
BR75-9	NE¼ sec. 21, T. 27 S., R. 29 E.	47 (154)	56	Welded tuff
BR75-10	NW¼ sec. 3, T. 26 S., R. 30 E.	31 (102)	32	Sandstone and claystone
BR75-11	NW¼ sec. 4, T. 25 S., R. 31 E.	61 (200)	24	Sandstone and siltstone
BR75-12	NE¼ sec. 18, T. 23 S., R. 28 E.	61 (200)	29	Welded tuff
BR75-13	NE¼ sec. 24, T. 24 S., R. 26 E.	61 (200)		
		20-40 (49-131)	197	Basalt and tuff
		40-61 (131-200)	90	Rhyodacite
BR75-14	SW¼ sec. 4, T. 25 S., R. 26 E.	27 (89)	85	Basalt
BR75-16	NW¼ sec. 4, T. 28 S., R. 24 E.	31 (102)	47	Welded tuff
BR75-17	NE¼ sec. 24, T. 26 S., R. 24 E.	60 (197)	84	Tuff
BR75-18	SW¼ sec. 26, T. 21 S., R. 23 E.	61 (200)	41	Basalt
BR75-21	SW¼ sec. 18, T. 23 S., R. 23 E.	62 (203)	144	Rhyolite
BR75-22	SE¼ sec. 2, T. 24 S., R. 22 E.	62 (203)	121	Tuffaceous sandstone
BR75-23	NE¼ sec. 20, T. 24 S., R. 22 E.	60 (197)	86	Sand and silt
BR75-24	SE¼ sec. 12, T. 21 S., R. 19 E.	62 (203)		
		20-30 (49-98)	43	Basalt and tuff
		30-60 (98-197)	98	Tuffaceous sandstone and pumice
BR75-25	NW¼ sec. 7, T. 22 S., R. 21 E.	59 (194)	53	Andesite
BR75-27	SW¼ sec. 5, T. 22 S., R. 19 E.	39 (128)	62	Basalt
BR75-28*	NE¼ sec. 32, T. 22 S., R. 19 E.	49 (161)		
		20-35 (49-115)	39	Rhyodacite
		35-49 (115-161)	94	Pumice and cinders

*Holes may not have reached thermal stability; non-linear gradient due in part to drilling disturbance.

**Terrain corrections have not been made.

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ash-flow tuff. Regional heat flow is assumed to be $2.0 \mu\text{cal}^*/\text{cm}^2 \text{ sec}$ (Blackwell, 1969), thus the thermal conductivity values given above suggest that "normal" gradients would be on the order of $77^\circ \pm 10^\circ\text{C}/\text{km}$ for the sandstone and siltstone, $87^\circ \pm 10^\circ\text{C}/\text{km}$ for the claystone, and between 40° and $80^\circ\text{C}/\text{km}$ for the volcanic rocks.

Holes BR75-21 in rhyolite(?) and BR75-22 in tuffaceous sandstone are located on the north and south flanks of Glass Buttes and have higher than normal gradients of 144° and $120^\circ\text{C}/\text{km}$ respectively, thus extending the Glass Buttes geothermal anomaly described by Bowen and others (1975).

Higher than normal gradient values were also detected in holes BR75-1, 4, 13, and 14. Hole BR75-1 is located in siltstone and sandstone approximately 1.1 km (0.7 miles) south of Crane hot springs (Bowen and Peterson, 1970). Hole BR74-4 was drilled in welded tuff 7 km (4.5 miles) west-south-west of Diamond. Hole BR75-13 was drilled in an interlayered sequence of basalt, tuff, and rhyodacite adjacent to U.S. Highway 395 at a point about 8 km (5 miles) south of Riley Junction. Hole BR75-14 was drilled in basalt adjacent to Highway 395, 16 km (10 miles) south of Riley Junction.

The holes at the west end of the study area (BR75-24 and 28), for which two gradients are reported, appear to show the effects of differing rock conductivity. In both instances, the upper parts of the holes were in lava flows - basalt in BR75-24 and rhyodacite in BR75-28; the deeper portions of the holes, showing the higher gradients, were in tuffaceous sediments and pumice respectively.

Holes drilled in basalt show a broad range of gradient values including suspiciously low values, e.g., BR75-6 with a very uniform gradient of approximately $17^\circ\text{C}/\text{km}$, indicating that heat flow is influenced by ground-water movements at some depth below the bottom of the hole. Holes BR75-10 and 11 in the Harney Basin both give low gradient values that do not represent regional geothermal gradients but indicate moving ground waters.

Conclusions

During the present study, holes were drilled in a variety of rock types, and linear gradients were measured in all of these lithologies. Basalts present potential problems in that 1) they may act as ground-water aquifers, and 2) basalt sequences in this area contain interlayered unconsolidated sediments and cinders which cause drilling problems. The widespread silicic ash-flow sheets present good drilling conditions, but they are relatively thin ranging in thickness up to 64 m (210 feet), and the gradient data from the ash flows cannot reliably be projected to any great depth. The rhyolitic to dacitic complexes seem to be the best units for heat-flow holes, but they are widely and irregularly spaced.

The data gathered thus far in this study indicate that the Brothers fault zone is the locus of several areas of anomalously high geothermal

* μcal - microcalorie

gradients, and in most traverses the gradients decrease with distance away from the zone. However, until the thermal conductivity measurements can be refined and heat-flow values assigned to the zone, and until more heat-flow data are gathered in the regions to the north and south of the Brothers fault zone, a firm conclusion as to the relative heat flow cannot be made. The magnitude and distribution of the geothermal gradient anomalies thus far located by the drilling, which extended as far west as Fredrick Butte, show no correlation with the westerly decreasing ages of silicic intrusives as reported by Walker (1974) and MacLeod and others (1975). Forthcoming heat-flow calculations may help to better define the magnitude of the anomalies located along the Brothers fault zone and perhaps will show other portions of the zone to have higher than normal heat flow.

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OPEN FILE REPORTS ISSUED

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Bauxite Report: The Department has released Open-file Report No. O-76-3, "Ferruginous Bauxites of the Pacific Northwest," by John H. Hook, Consulting Geologist. The report is an outgrowth of data obtained for the U.S. Bureau of Mines Minerals Availability System program, which is an inventory of minerals important to the nation.

The report shows distribution of the ferruginous bauxite deposits and gives information on geology, theories of origin of the ore, quality and quantity of ore, methods for mining and processing, and ways to reduce environmental impact of development.

The report can be consulted at the Department's Portland office or purchased for \$2.00.

Temperature Gradient Data: The Department has released Open-file Report No. O-76-2, "Geothermal Gradient Data, Brothers Fault Zone, Central Oregon." The report includes temperature logs and graphs of data collected in 1975 during the Department's geothermal resources study of the Brothers fault zone. Copies are available from the Department's Portland office for \$2.00.

U.S. Geological Survey

Columbia Plateau: "Geologic Interpretation of an Aeromagnetic Map of West-central Columbia Plateau, Washington and Oregon," by D. A. Swanson, T. L. Wright, and I. Zietz, has been placed on open file (No. 76-51) by the U.S. Geological Survey. The map area lies in south-central Washington, extending into Oregon approximately to Pendleton, and is underlain principally by the Yakima Basalt, the youngest formation in the Columbia River Group. Aeromagnetic data reveal hidden structures, dikes, and lava-filled valleys in the Yakima Basalt. The 28-page report and the aeromagnetic map (29"x30") can be seen at the Department's Portland office or purchased from the USGS Library, 345 Middlefield Road, Menlo Park, California 94025.

Heat-flow Data: "Heat-flow Data from Southeastern Oregon," by J. H. Sass, S. P. Galanis, Jr., R. J. Munroe, and T. C. Urban, has been released on open file (No. 76-217) by the U.S. Geological Survey. Areas of heat-flow study include Burns, Catlow Valley, Diamond Craters, Foster Lake, Alvord Valley, and Standard Oil Co.'s Blue Mountain well. Copies of the 52-page report can be consulted at the Department's Portland and Baker offices or purchased from the Department's Portland office for \$4.00.

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USGS REPORTS MINERALS NEEDED FOR ENERGY GOALS

The U.S. Geological Survey has published a report that presents estimates of basic materials needed by five major energy industries in order for the U.S. to achieve self-sufficiency in energy production. Assistant Secretary of the Interior Jack W. Carlson says the goal "cannot be reached unless vast amounts of a wide variety of metals, minerals, or mineral products are available to the energy industry."

U.S.G.S. Director Vincent McKelvey said the preliminary report emphasizes that the nation's economy is based on minerals and energy and that "expanded domestic production of energy will require expanded use of other minerals, some of which are in short supply from domestic sources. Unless domestic exploration is strongly encouraged, we can be certain that by the end of this century these dependency ratios will increase markedly."

The report contains estimates of the basic materials needed by the primary energy industries during the next 10 to 15 years; for example, 335 million tons of concrete, 187 million tons of iron, 15.3 million tons of aluminum, 3.76 million tons of copper, 418 tons of silver, and 45 tons of boron.

Copies of the report entitled "Non-fuel Minerals and Materials Needed by the Energy Industry - A Preliminary Report" are available in the open files of U.S.G.S. libraries.

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BLM RELEASES ENVIRONMENTAL STUDY

The U.S. Bureau of Land Management (BLM) has released for public comment an environmental analysis record (EAR) for the Bully Creek Geothermal Interest Area. The analysis covers a 100-square-mile area just west of Vale, Oregon in Malheur County. Included within the 66,000-acre area is the Bully Creek Reservoir.

BLM prepared the study because of the recent interest from national energy companies to lease parts of the area for geothermal development. Currently BLM has 14 lease applications pending. If approved, these leases could be issued this summer. Additional environmental studies will be made for each specific site prior to actual development.

The EAR describes the general environment of the area and the resources found within. It details what will happen if geothermal leasing is allowed and the long-term effects of development. The document identifies one alternative to leasing - no leasing.

Copies of the EAR are available for public inspection at the Department field office in Baker and at all BLM offices. A limited number of copies are available at the Oregon State BLM office, Portland, at a cost of \$2.00 each. Comments on the EAR may be made by writing District Manager, BLM, Box 700, Vale, Oregon 97918.

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SENATE PASSES BLM ORGANIC ACT

The Senate, by a 78 to 11 roll-call vote February 25, passed S. 507, the Bureau of Land Management Organic Act after amending the measure reported by the Interior and Insular Affairs Committee.

There was one major change in the Committee bill as reported. S. 507 increased to 60 percent from 37.5 percent the share of Federal mineral leasing receipts going to the state where the minerals are found. The bill, as reported, would allow state and local governments to use the additional 22.5 percent to provide services and facilities needed to take care of expanding populations that energy development projects are expected to draw; the existing 37.5 percent could be utilized only for building schools and roads. The Senate voted to remove the latter restrictions.

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FISHER NOMINATED ASSISTANT SECRETARY OF INTERIOR

Dr. William L. Fisher has been nominated as Assistant Secretary for Energy and Minerals, subject to Senate confirmation. The post would give him supervision over the Bureau of Mines, U.S. Geological Survey, Mining Enforcement and Safety Administration, Office of Minerals Policy Development, and others. He joined Interior as a deputy assistant secretary for energy and minerals in April 1975 and became acting assistant secretary on January 14.

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MINERAL RESOURCES CONFERENCE IN APRIL

Problems of the present and some projections for the future will be the theme of the First Oregon Mineral Resources Conference to be held April 20, 1976 at the Sheraton Hotel, Portland, R. W. deWeese, Chairman of the Mineral Resource Committee, announced. Conference sponsors are Portland Chamber of Commerce, Oregon Concrete and Aggregate Producers Association, and Associated Oregon Industries. Allen Overton, President of American Mining Congress, will keynote the morning session, followed by Thomas Faulkie, Director of U.S. Bureau of Mines. Mr. Dale Gronsdaahl, Vice President of Caterpillar Tractor Co., will address the noon luncheon. The afternoon program will feature two panel discussion on the outlook for the mineral resources in Oregon as viewed by industry and by members of the Oregon Legislature and the Executive Department. Closing speaker will be James N. Purse, President of Hanna Mining Co. Registration for the conference can be made through the Portland Chamber of Commerce, 824 S.W. 5th Ave., Portland, Oregon 97204; 228-9411.

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AGE OF HOWARD 2 MONTHS, ME 10

The tumult and the shouting dies,
The captains and the kings depart -

---but it was grand while it lasted. Who could have guessed that a tongue-in-cheek offer to provide genealogical services for Pet Rocks would find column space even in a small-town weekly? The idea was sent to Phil Brogan, a columnist for the Oregonian, who sent the story to the paper. The Oregonian front-paged it; the wire services moved it nationally; and in one week newspapers, radio, and television all over the country picked it up.

Then the Pet Rock owners began coming in, wanting to KNOW their rock: "How old is it?" "Where did it come from?" "How did it get that way?" Of course we had no form to record this information, but geologists and their secretaries are good improvisers and in a few hours we had a supply of certificates, a rubber stamp that said "GENUINE," and a square of black velvet for the Pet Rock to rest on during the consultation. All this, plus a brochure on rocks and minerals of Oregon, for \$1.00.

As the media did its work across the country, Pet Rocks arrived from nearly every state in the union. They came in envelopes, mailers, little fancy boxes, tubes, and big fancy boxes - by parcel post or first class, and some even Registered with "return receipt requested." Most people included a news clipping - as if they doubted the offer was real. Quite a few letters arrived with the clipping and a dollar - but no rock. We are experts, but working up a genealogy on an unseen rock described as "round and gray" exceeds our not inconsiderable abilities.

Our low public profile has now been elevated a bit. Most Pet-rock owners had never heard of the Department and were amazed to learn that we cared about rocks, landslides, volcanic eruptions, sand and gravel, fossil fuels, even about vacation places.

The public, we found, value an escape from reality for a buck and were glad to learn about rocks, minerals and geologic phenomena along with it. We learned some psychology with our Pet Rock Genealogy caper, too. Most of the letters were clever, some straight business, others rather chatty, but the one we liked the best came from Secaucus, New Jersey, which, after the usual request that the rock, named Howard, be returned promptly and unharmed, ended with, "Age of Howard 2 months, age of me 10."

Ralph S. Mason, Pet Rock Genealogist

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PET ROCK GENEALOGY - Send \$1.00, your rock, and return postage to
Oregon Dept. of Geology, 1069 State Office Bldg., Portland 97201

AVAILABLE PUBLICATIONS

(Please include remittance with order; postage free. All sales are final - no returns. Upon request, a complete list of Department publications, including out-of-print, will be mailed.)

BULLETINS

26. Soil: Its origin, destruction, preservation, 1944: Twenhofel	\$0.45
33. Bibliography (1st suppl.) geology and mineral resources of Oregon, 1947: Allen	1.00
35. Geology of Dallas and Valsetz quadrangles, Oregon, rev. 1964: Baldwin	3.00
36. Papers on Tertiary foraminifera: Cushman, Stewart & Stewart	vol. 2-1.25
39. Geology and mineralization of Morning mine region, 1948: Allen and Thayer	1.00
44. Bibliography (2nd suppl.) geology and mineral resources of Oregon, 1953: Steere	1.00
46. Ferruginous bauxite deposits, Salem Hills, 1956: Corcoran and Libbey	1.25
49. Lode mines, Granite mining district, Grant County, Oregon, 1959: Koch	1.00
52. Chromite in southwestern Oregon, 1961: Ramp	5.00
53. Bibliography (3rd suppl.) geology and mineral resources of Oregon, 1962: Steere, Owen	3.00
57. Lunar Geological Field Conf. guidebook, 1965: Peterson and Groh, editors	3.50
60. Engineering geology of Tualatin Valley region, 1967: Schlicker and Deacon	7.50
61. Gold and silver in Oregon, 1968: Brooks and Ramp	7.50
62. Andesite Conference Guidebook, 1968: Dole	3.50
64. Geology, mineral, and water resources of Oregon, 1969	3.00
65. Proceedings of the Andesite Conference, 1969: McBirney, editor (photocopy)	10.00
66. Geology and mineral resources of Klamath and Lake Counties, 1970	6.50
67. Bibliography (4th suppl.) geology and mineral industries, 1970: Roberts	3.00
68. Seventeenth biennial report of the Department, 1968-1970	1.00
69. Geology of the southwestern Oregon Coast, 1971: Dott	4.00
70. Geologic formations of western Oregon, 1971: Beaulieu	2.00
71. Geology of selected lava tubes in the Bend area, 1971: Greeley	2.50
72. Geology of Mitchell quadrangle, Wheeler County, 1972: Oles and Enlows	3.00
73. Geologic formations of eastern Oregon, 1972: Beaulieu	2.00
75. Geology, mineral resources of Douglas County, 1972: Ramp	3.00
76. Eighteenth biennial report of the Department, 1970-1972	1.00
77. Geologic field trips in northern Oregon and southern Washington, 1973	5.00
78. Bibliography (5th suppl.) geology and mineral industries, 1973: Roberts and others	3.00
79. Environmental geology inland Tillamook Clatsop Counties, 1973: Beaulieu	7.00
80. Geology and mineral resources of Coos County, 1973: Baldwin and others	6.00
81. Environmental geology of Lincoln County, 1973: Schlicker and others	9.00
82. Geol. Hazards of Bull Run Watershed, Mult. Clackamas Counties, 1974: Beaulieu	6.50
83. Eocene stratigraphy of southwestern Oregon, 1974: Baldwin	4.00
84. Environmental geology of western Linn Co., 1974: Beaulieu and others	9.00
85. Environmental geology of coastal Lane Co., 1974: Schlicker and others	9.00
86. Nineteenth biennial report of the Department, 1972-1974	1.00
87. Environmental geology of western Coos and Douglas Counties, Oregon, 1975	9.00
88. Geology and mineral resources of upper Chetco River drainage, 1975: Ramp	4.00

GEOLOGIC MAPS

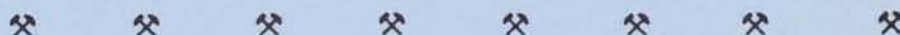
Geologic map of Oregon west of 121st meridian, 1961: Wells and Peck \$2.00; mailed -	2.50
Geologic map of Oregon (12" x 9"), 1969: Walker and King	0.25
Geologic map of Albany quadrangle, Oregon, 1953: Allison (from Bulletin 37)	1.00
Geologic map of Galice quadrangle, Oregon, 1953: Wells and Walker	1.50
Geologic map of Lebanon quadrangle, Oregon, 1956: Allison and Felts	1.50
Geologic map of Bend quadrangle, and portion of High Cascade Mtns., 1957: Williams	1.50
GMS-1: Geologic map of the Sparta quadrangle, Oregon, 1962: Prostka	2.00
GMS-2: Geologic map, Mitchell Butte quadrangle, Oregon: 1962	2.00
GMS-3: Preliminary geologic map, Durkee quadrangle, Oregon, 1967: Prostka	2.00
GMS-4: Gravity maps, Oregon onshore & offshore; [set only]; at counter \$3.00, mailed	3.50
GMS-5: Geology of the Powers quadrangle, 1971: Baldwin and Hess	2.00
GMS-6: Preliminary report, geology of part of Snake River Canyon, 1974: Vallier	6.50

[Continued on back cover]

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Second Class Matter
POSTMASTER: Form 3579 requested



Available Publications, Continued:

SHORT PAPERS

- 18. Radioactive minerals prospectors should know, 1955: White and Schafer \$0.30
- 19. Brick and tile industry in Oregon, 1949: Allen and Mason 0.20
- 21. Lightweight aggregate industry in Oregon, 1951: Mason 0.25
- 24. The Almeda mine, Josephine County, Oregon, 1967: Libbey 3.00
- 25. Petrography, type Rattlesnake Fm., central Oregon, 1976: Enlows in prep

MISCELLANEOUS PAPERS

- 1. Description of some Oregon rocks and minerals, 1950: Dole 1.00
- 2. Oregon mineral deposits map (22 x 34 inches) and key (reprinted 1973): 1.00
- 5. Oregon's gold placers (reprints), 1954 0.50
- 6. Oil and gas exploration in Oregon, rev. 1965: Stewart and Newton 3.00
- 7. Bibliography of theses on Oregon geology, 1959: Schlicker 0.50
(Supplement) Bibliography of theses, 1959 to Dec. 31, 1965: Roberts 0.50
- 8. Available well records of oil and gas exploration in Oregon, rev. 1973: Newton . . 1.00
- 11. A collection of articles on meteorites, 1968 (reprints from The ORE BIN) 1.50
- 12. Index to published geologic mapping in Oregon, 1968: Corcoran 0.50
- 13. Index to The ORE BIN, 1950-1974. 1.50
- 14. Thermal springs and wells, 1970: Bowen and Peterson 1.50
- 15. Quicksilver deposits in Oregon, 1971: Brooks 1.50
- 16. Mosaic of Oregon from ERTS-1 imagery, 1973: 2.50
- 18. Proceedings of Citizens' Forum on potential future sources of energy, 1975 2.00

OIL AND GAS INVESTIGATIONS

- 1. Petroleum geology, western Snake River basin, 1963: Newton and Corcoran 3.50
- 2. Subsurface geology, lower Columbia and Willamette basins, 1969: Newton 3.50
- 3. Prelim. identifications of foraminifera, General Petroleum Long Bell No. 1 well . . . 2.00
- 4. Prelim. identifications of foraminifera, E. M. Warren Coos Co. 1-7 well: Rau . . . 2.00

MISCELLANEOUS PUBLICATIONS

- Landforms of Oregon: a physiographic sketch (17" x 22"), 1941 0.25
- Mining claims (State laws governing quartz and placer claims) 0.50
- Oregon base map (22" x 30"). 0.50
- Geologic time chart for Oregon, 196110
- Postcard - geology of Oregon, in color 10¢ each; 3 - 25¢; 7 - 50¢; 15 - 1.00
- The ORE BIN - Annual subscription (\$8.00 for 3 yrs.) 3.00
- Available back issues, each 25¢; mailed 0.35
- Accumulated index - see Misc. Paper 13

GOLD AND MONEY SESSION PROCEEDINGS

- Second Gold and Money Session, 1963 [G-2] 2.00
- Third Gold and Money Session, 1967 [G-3] 2.00
- G-4 Fifth Gold and Money Session, Gold Technical Session 5.00