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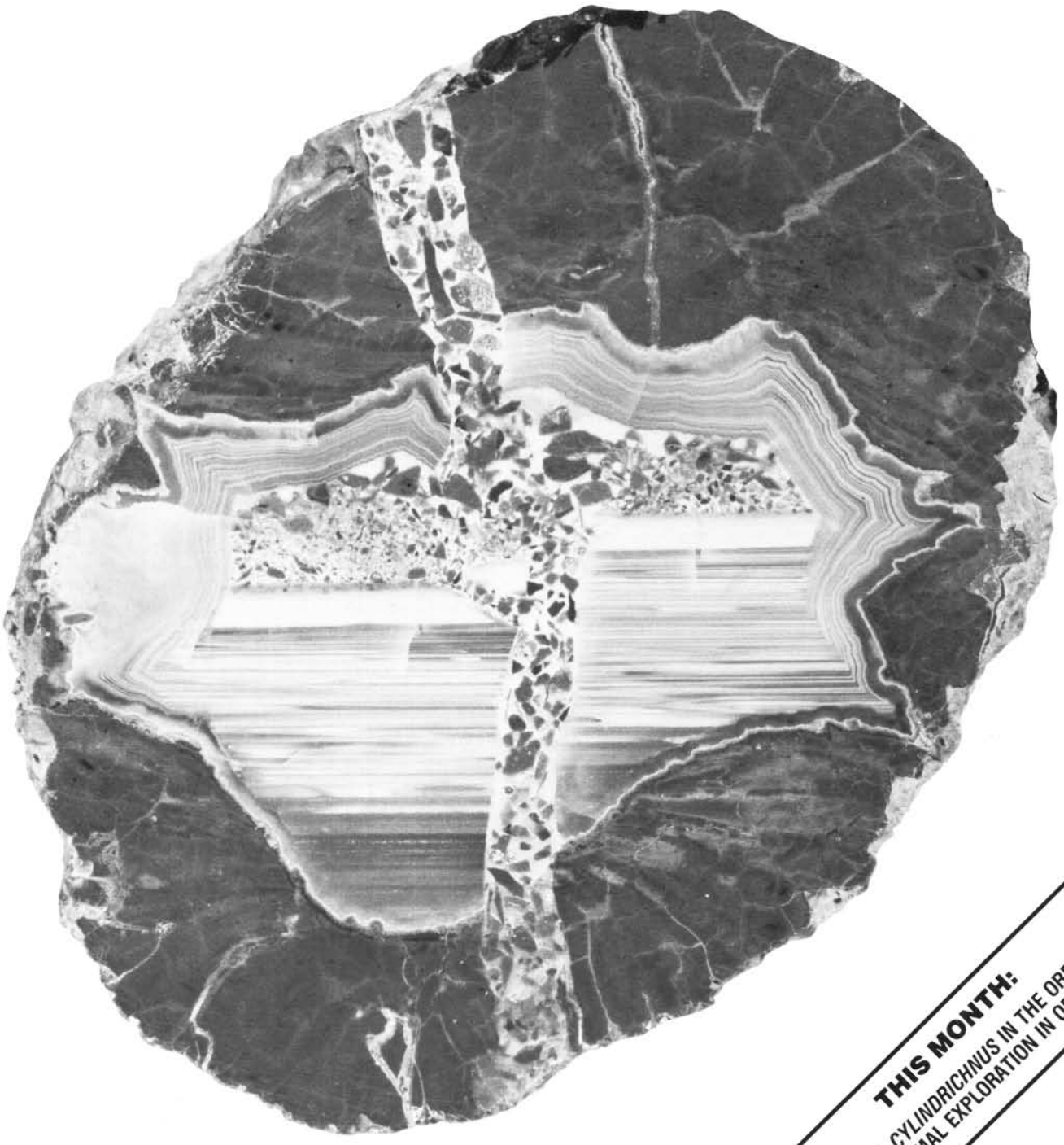

**THIS MONTH:**

THE TRACE FOSSIL *CYLINDRICHNUS* IN THE OREGON OLIGOCENE
and GEOTHERMAL EXPLORATION IN OREGON, 1983

# OREGON GEOLOGY

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## COVER PHOTO

Unusual "thunder egg" (rock structure formed in welded tuffs and rhyolites, of spherical or ellipsoidal shape, containing cores of chalcedony and sometimes quartz) from central Oregon. This cut specimen, which was recently donated to the Portland State University Department of Geology, records a late-stage fracturing event during which jaspery breccia entered the thunder egg from below (note triangular fragment of white agate in center of photo). Photo and description courtesy John E. Allen, Emeritus Professor, Department of Geology, Portland State University.

# OIL AND GAS NEWS

**Mist Gas Field**

As mentioned in the annual summary report published in the April issue of this magazine, the Mist Gas Field has begun to produce water in three of the wells. Reichhold Energy Corporation has performed remedial work on one of the wells, Paul 34-32, in an attempt to prevent the water from entering the perforations. No results are known at this time. The contractor was A.M. Jannsen Well Drilling Company.

Water from the well Paul 34-32 is hauled to the well Columbia County 13-1 for disposal. □

## PSU lectures announced

The spring term lecture series of the Portland State University Department of Geology is scheduled to conclude with seminar speakers from the Seattle area. The final three lectures, presented in cooperation with PSU's Environmental Sciences and Hydrology Programs, are listed below and will be held at 3:00 p.m. in Room 250, Cramer Hall, on the PSU campus in Portland.

May 23 – *Gravity changes and surface deformation on strato-volcanoes*, by Al Eggers, University of Puget Sound.

May 29 – *Estimates of flood and sedimentation hazards around active volcanoes*, by Thomas Dunne, University of Washington.

May 30 – *Hillslope runoff processes and their significance*, by Thomas Dunne, University of Washington. □

## USGS revises hazard warning system

New criteria and terms have been adopted by the U.S. Geological Survey (USGS) for issuing formal statements to government officials and the public about geologic hazards such as earthquakes, volcanic eruptions, and landslides.

In the future, any formal statement issued by the director of the USGS concerning a geologic hazard will be called a hazard warning and will address a condition "that poses a significant threat to public health and safety and for which near-term public response would be expected," according to USGS Director Dallas L. Peck.

The previous system had three categories of hazard statements – notice of potential hazard, hazard watch, and hazard warning. Peck explained that "if a potential hazard is not apt to occur in the near future or doesn't suggest that the public should do something different than [continue] normal activity, then we don't want to generate excessive concern from the public, news media, and public officials over the hazard with a formal hazard warning."

"Understandably, a hazard warning tends to create some anxiety within a community," Peck said. The new system, in his words, "will help eliminate situations in which USGS statements might cause unwarranted public concern over potential hazards that present low risk to the public."

The new system will continue earlier provisions for forwarding information to local and state officials about lesser geologic or hydrologic hazards or hazards that may require longer-range actions. □

## CONTENTS

# The trace fossil *Cylindrichnus* in the Oregon Oligocene

*by William N. Orr and Paul R. Miller, Geology Department, University of Oregon, Eugene, Oregon 97403*

## INTRODUCTION

A trace fossil is the track, trail, or burrow of a prehistoric organism. Because an animal could potentially leave an infinite number of tracks, the reader might think trace fossils would greatly outnumber ordinary fossils in the geologic record. However, the probability of preserving a track in soft sediment, as opposed to the hard shell of a mollusc, for example, precludes an overabundance of trace fossils in the record. To the geologist, trace fossils are more useful as indices of particular paleoenvironments than as biostratigraphic markers. Unlike most other fossils, trace fossils are rarely reworked from older sediments into younger.

Marine shallow water intervals of the Oligocene informally designated "Butte Creek Beds" in Marion County, Oregon, have yielded trace fossil specimens assignable to the genus *Cylindrichnus*.

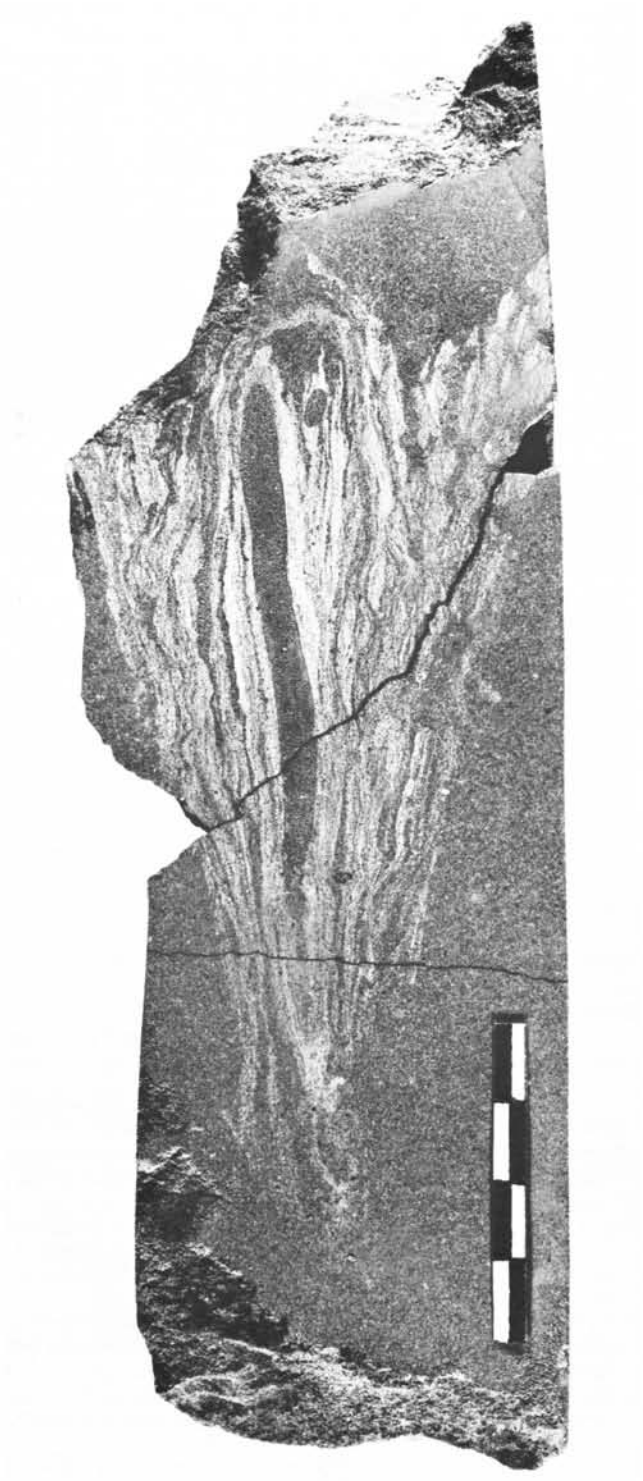
To date there are less than a half-dozen published reports of trace fossils in Oregon, and this is the first record of *Cylindrichnus*.

## DESCRIPTION

Preserved in an upright, concave upward position, these cone-shaped specimens are a series of tall, tapering, cone-in-cone, sand and clay sheaths surrounding a central sand-filled tube. Subconical clay sheaths fade into the sand at both the proximal and distal ends, with a maximum height of 120 mm. Maximum cone diameter on the dorsal margin (at the distal lip) is 60 mm. The central sand-filled tube averages 4 mm in diameter. As many as 20 to 30 light-colored separate clay sheaths make up and are responsible for the high visibility of this trace fossil. These clay sheaths are not part of the stratigraphic laminae of the entombing sandstones. Unlike many previously described cone-shaped trace fossils, Oregon specimens flare out at the open end and show no constriction of the cone or truncation by the overlying sedimentary sequence. The clay sheaths are commonly rippled or rugose as a by-product of preconsolidation settling of the sediments. Fossils are preserved in a near-shore infra-littoral tuffaceous sand/silt (Orr and Faulhaber, 1975; Orr and Miller, 1983). Upper Oligocene mollusc-dominated invertebrate faunas at the same interval bear all the characteristics of an undisturbed biococenosis paleoenvironment (Orr and Miller, 1981, 1982).

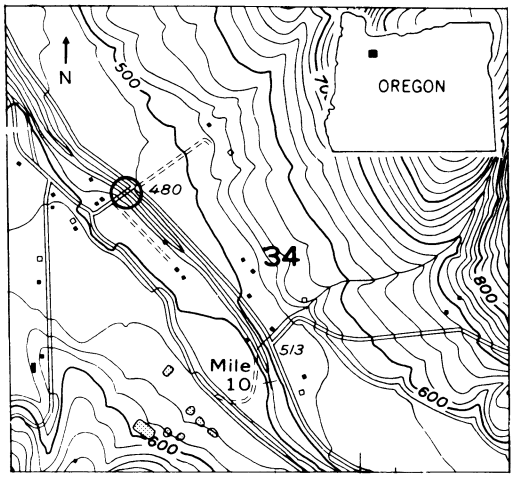
## DISCUSSION

Examination of the trace fossil literature reveals considerable diversity with respect to the taxonomic status of cone-shaped trace fossils. Oregon specimens conform well in shape to the genus *Cylindrichnus* first described by Toots (1962), but Toots' specimens were only half as large as ours. Chamberlain (1978) distinguishes *Cylindrichnus* from a similar form *Rosselia* by the size disparity and thinner, tapering shape of the former. Oregon specimens are not truncate at the distal end, as Chamberlain notes is often the case for *Cylindrichnus*. Frey and Howard (1970) use the genus *Asterosoma* as part of a gradational sequence for *Cylindrichnus*. A similar form, *Anemonichnus* (Chamberlain and Clark, 1973) is reported by those authors from the late Paleozoic rocks in Utah. Those authors note that the latter form is similar to extant anemone burrows reported by Shinn (1968). Howard's (1966) report of *Cylindrichnus* from the Cretaceous of Utah compares well with our specimens. A similar but, with respect to symmetry, quite distinct form, *Conostichnus* (Lesquereux, 1876), from upper Paleozoic rocks in southern Oklahoma, was demonstrated by Chamberlain (1971) to represent the probable trace fossil of a burrowing coelenterate. The same author has shown that a succession of



*Vertically sawed section of tuffaceous sandstone of "Butte Creek Beds," Oregon Western Cascades, displaying* Cylindrichnus *sp. wrinkled clay sheaths around central and sand-filled tube. Scale is in centimeters.*

spiraling motions by a burrowing organism could produce the cone-in-cone structure of the similar trace fossil *Rosselia*. Chamberlain considered *Conostichnus* to be the trace fossil of a permanent shelter, whereas *Rosselia* may represent the by-product of a sediment processor such as a worm. Several authors have also suggested that a cone-in-cone structure may represent the vertical track of an organism keeping pace with sedimentation.




*Map (scale 1:24,000) showing sec. 34 (see "LOCALITY" in text), where the trace fossil* Cylindrichnus *was found. Circle indicates exact location of Abiqua Road (north of creek), approximately 3.5 mi southeast from intersection with State Highway 213 and, via 213, approximately 6.5 mi east of Silverton.*

## LOCALITY

The trace fossil *Cylindrichnus* was found in the northwest corner of sec. 34, T. 6 S., R. 1 E., in Marion County. The fossils were taken from exposures of siltstone and sandstone in the bed of Abiqua Creek beneath the bridge where the Abiqua Creek road crosses the creek. This locality is stratigraphically within the designated "Unit II" of Orr and Miller (1983). The stratigraphy of the "Butte Creek Beds" has been described by Orr and Miller (1983).

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# Publications received

*From time to time, we print information about new books that we have received in the Department's Portland library. These books are available from the publisher or may be ordered from local bookstores.*

**Mount St. Helens, An Annotated Bibliography**, by Caroline D. Harnly and David A. Tyckoson (1984; hardbound; 261 pages, 5½×8½; Scarecrow Press, Inc., P.O. Box 656, Metuchen, NJ 08840; $17.50): The authors, who are reference librarians, have compiled a collection of 1,700 annotated citations from journals, technical reports, conference proceedings, trade newspapers, dissertations, maps, and books covering both the technical and popular literature on the eruption of Mount St. Helens from March 1980 through December 1982. The references are divided into ten broad categories: general Mount St. Helens information; geological studies; atmospheric and climatic studies; chemical and physical studies; effects on agriculture; biological and environmental effects; medical and health effects; business, commercial, and economic implications; industrial and engineering aspects; and social and cultural aspects. An author index and chapters listing special maps, dissertations, books, and material on Mount St. Helens before the 1980 eruption are also included.

**Contributions to the Tectonics and Geophysics of Mountain Chains** (Geological Society of America Memoir 158), edited by Robert D. Hatcher, Jr., Harold Williams, and Isidore Zietz (1983; hardbound; 8½×11; 228 pages plus 9 oversize plates in a rear pocket; Geological Society of America, Inc., Publications Sales, Department 58, P.O. Box 9140, Boulder, CO 80301; $42.50): This volume grew out of a GSA Penrose Conference held in Helen, Georgia, in May 1980, where geologists and geophysicists from academic institutions, government, and industry addressed some of the complex problems of orogenic terranes. The papers presented in this volume develop ideas either generated by the conference or presented there. Topics covered by the 15 papers in the book include regional geology and tectonics of the Appalachian orogen; comparisons with the Caledonides, Mauritanides, Alps, and the North American Cordillera; the application of mechanical principles to structural problems; and the utilization of reflection seismology to interpret tectonics of mountain chains. The text is illustrated with numerous maps and figures; one of the plates is a two-color map, and the rest are one color.

**The Role of Heat in the Development of Energy and Mineral Resources in the Northern Basin and Range Province** (Geothermal Resources Council Special Report No. 13) (1983; hardbound; 8½×11; 384 pages; Geothermal Resources Council, P.O. Box 1350, Davis, CA 95617; $30 plus $3.50 handling and mailing): This publication contains 27 papers, including five papers on the northern Basin and Range province, six papers on active hydrothermal systems, four on thermogenics and hydrocarbon resources, six on fossil hydrothermal systems, and six on regional geophysics of the northern Great Basin. The publication is a product of a symposium co-sponsored by the Geothermal Resources Council and the American Association of Petroleum Geologists and convened in Reno, Nevada, in May 1983. □

# Geothermal exploration in Oregon, 1983

*by George R. Priest, Oregon Department of Geology and Mineral Industries*


## ABSTRACT

Drilling continued at a very low level in 1983 and was chiefly centered on Newberry volcano and the central High Cascades. The total acreage of leased geothermal lands in Oregon increased by 45 percent in 1983, primarily because of the release of large tracts of pending leases in Deschutes National Forest and new leases to California Energy in Winema National Forest. For the first time in the history of geothermal leasing in Oregon, the acreage leased by the U.S. Forest Service (USFS) exceeded the acreage leased by the U.S. Bureau of Land Management (BLM). This was caused primarily by the release of part of the large backlog of pending USFS leases but also reflected continued investor confidence in Newberry volcano and the Cascades. The nearly 50-percent decrease in BLM leased acreage may in part reflect the fact that developers are trading off former holdings at Basin and Range sites for Cascade sites in order to stay under the current acreage ceiling of 20,480 acres.

The geothermal group of the Oregon Department of Geology and Mineral Industries (DOGAMI) published Special Paper 15, a comprehensive summary of the geology and geothermal resources of the Central Cascades. A similar report on Newberry volcano was released as an open-file report. In addition, DOGAMI assisted Sandia National Laboratories in drilling a well at Newberry caldera.

New life will be pumped into the Oregon Institute of Technology (OIT) and the DOGAMI geothermal programs in 1984 by a planned $530,000 grant from the U.S. Department of Energy (USDOE). Most of the money will go to OIT to revive recently canceled services such as the institute's newsletter and free technical transfer program. The money will not be enough, however, for new research drilling by DOGAMI.


## LEVEL OF GEOTHERMAL EXPLORATION

The level of geothermal exploration in 1983 was similar to the low level which characterized 1982. The continuing power surplus and the low cost of competing energy sources such as coal, oil, and hydropower have all combined to depress the market for geothermal energy. With no current market incentive, developers are reluctant to sink large amounts of capital into drilling and other expensive exploration techniques. Only the largest companies, such as Union Oil of California, can afford to invest in capital-intensive near-term exploration for long-term payoffs expected when the current energy surplus disappears.

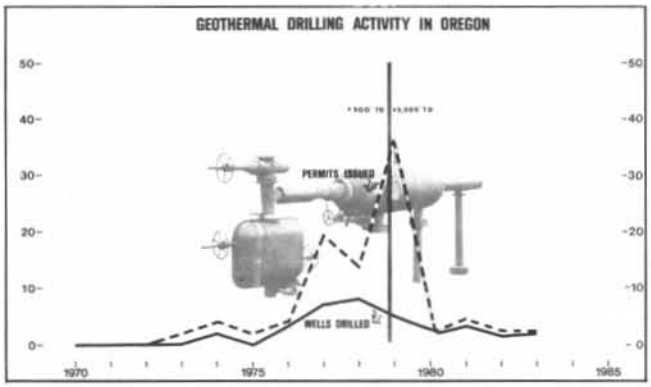


*Figure 1. Geothermal well drilling in Oregon. Vertical line indicates time when definition of geothermal well was changed to a depth greater than 2,000 ft.*

## DRILLING ACTIVITY

Drilling activity continued to be low, although more permits for deep test wells were processed in 1983 than in 1982 (Tables 1 and 2, Figures 1 and 2). Only three groups were involved in significant geothermal drilling in Oregon during 1983. Union Oil of California (Table 2) drilled three 2,000-ft prospect wells in the Newberry-High Cascades area. Occidental Geothermal, Inc. (Table 1) drilled on the west flank of Newberry volcano, just outside the caldera. After the 1983 field season, the company revised the target depth of its drilling permit from 3,000 ft to 4,500 ft. Finally, Sandia National Laboratories (Table 1, Orvail Buckner Drilling) drilled a rotary-drill hole to 1,390 ft in Newberry caldera, near the U.S. Geological Survey (USGS) Newberry 2 site (see Black and others, 1984, for location of the Newberry 2 well).

*Table 1. Permits for geothermal wells (greater than 2,000 ft in depth)*

| Permit number | Operator, well, API number | Location | Status, proposed total depth (ft) |
|---|---|---|---|
| 94 | John W. Hook and Assoc., Inc. USA-Site A 017-90003 | SE¼ sec. 34 T. 20 S., R. 8 E. Deschutes County | Application; 4,000. |
| 95 | John W. Hook and Assoc., Inc. USA-Site B 017-90004 | SW¼ sec. 17 T. 20 S., R. 8 E. Deschutes County | Application; 4,000. |
| 96 | Orvail Buckner Drilling RDO-1 017-90005 | SW¼ sec. 31 T. 21 S., R. 12 E. Deschutes County | Abandoned at 1,390 ft; 5,000. |
| 97 | Occidental Geothermal, Inc. Well No. 72-03 017-90006 | NE¼ sec. 3 T. 22 S., R. 12 E. Deschutes County | Suspended; orig. 3,000, now 4,500. |

The emphasis on the Cascades and on Newberry volcano, which began in 1981, continued in the drilling activity of 1983. All of the holes drilled were in these two areas. Newberry volcano remained the most popular target, but the High Cascade Range, particularly the area just south of the silicic South Sister volcano and the area between Mount Jefferson and Green Ridge, were also attracting drilling interest.

A major increase in drilling activity around the flanks of the Mount Mazama volcano (Crater Lake) is expected for 1984. California Energy Company, Inc., has a very large block of unitized

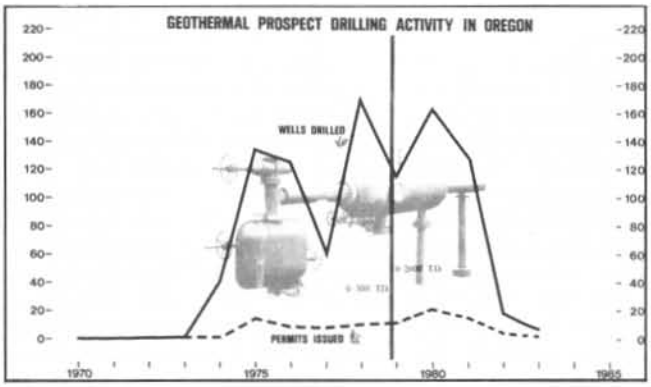


*Figure 2. Geothermal prospect-well drilling in Oregon. Vertical line indicates time when definition of prospect well was changed to a depth less than 2,000 ft.*

Table 2. *Permits for geothermal prospect wells (less than 2,000 ft in depth)*

| Permit number | Operator | Location | Issue date, status |
|---|---|---|---|
| 94 | Union Oil of California | Eight locations in the Western Cascades, Deschutes, Lane, and Linn Counties | March 1983; drilled three holes to 2,000 ft. |

leases covering most areas adjacent to the Crater Lake National Park. Unitized lease blocks must, by law, have a substantial amount of development every year. A large capital investment by California Energy, probably including extensive drilling, can thus be expected this summer.

## LEASING

For the first time in the history of geothermal leasing in Oregon, USFS active-leased acreage now exceeds BLM acreage (Figure 3, Table 3). In 1983, the USFS granted large numbers of leases in the Winema and Deschutes National Forests, causing a 235-percent increase in the acreage of active noncompetitive geothermal leases on USFS lands (Figure 3, Table 3). The 45-percent increase in the total acreage of federal lands leased for geothermal resources in Oregon was caused in large part by this release of USFS noncompetitive leases which had been pending for years. If 284 USFS leases still pending are also released, then another sharp increase in the numbers of active leases may be expected. The logjam of pending leases on USFS lands has been a major impediment to geothermal development in the Cascades for years. It now looks as though it is finally beginning to break.

According to current statutes, the BLM can increase the acreage limitation of 20,480 acres to as much as 51,400 acres as of December 20, 1985. If BLM increases the limit to the maximum that it is allowed, leasing could be dramatically affected in future years.

At the present time, holders of prime leases in such areas as Newberry volcano, for example, are being forced to give up other lease blocks in order to stay below the 20,480-acre limit. This limitation may, in part, explain the nearly 50-percent decrease in active leases on BLM lands (Figure 3, Table 3), as holders of southeast Oregon Basin and Range leases (chiefly BLM lands) traded off those leases for the newly available Newberry and Cascade areas (chiefly USFS lands).

Some companies such as California Energy are avoiding the acreage limitation by unitizing hundreds of thousands of acres. As mentioned above, however, the accelerated development mandated on unitized lands requires substantial capital outlay in the first few years. This can prove to be an unacceptable risk for smaller companies.

The shift from BLM to USFS leases reflects a fundamental change in the emphasis of the geothermal industry in Oregon. Prior to 1980 and 1981, Basin and Range targets were predominant, but the discovery of high-temperature resources at Meager Creek in the British Columbia Cascades and a similar discovery at Newberry volcano demonstrated to explorationists the tremendous potential of the Cascades. It became apparent from the results at Newberry that high-temperature reservoirs could exist in youthful volcanic areas without significant hot-spring activity. This conclusion implied that, even though most of the High Cascade Range lacks significant hot springs, large, undetected reservoirs could still exist almost anywhere. This caused a rush to lease Cascade lands, especially lands next to silicic volcanic centers such as Crater Lake and the South Sister.

Thus there is hope that Oregonians may some day see electricity produced from geothermal plants harnessing Cascade heat sources. If so, geothermal energy may prove in the future to be a very important alternative to electrical generation by coal and nuclear energy.

## KGRA LEASE SALES

On September 23, 1983, the BLM opened and read bids on 3,658.6 acres of land in the McCredie Hot Springs Known Geothermal Resource Area (KGRA). Gaslight Corporation was the only bidder and acquired 360 acres for $720. The company reportedly intends to develop a resort at McCredie Hot Springs.

Table 3. *Geothermal leases in Oregon, 1983*

| Types of leases | Numbers | Acres |
|---|---|---|
| Federal active leases: | | |
| Total, 1/1/1983 | 259 | 449,316 |
| Changes during 1983: | | |
| Noncompetitive, BLM | −70 | −112,147 (−46%) |
| Noncompetitive, USFS | +172 | +320,735 (+235%) |
| KGRA, BLM | −4 | −8,645 (−14%) |
| KGRA, USFS | +2 | +2,933 (+43%) |
| Subtotal | +100 | +202,876 (+45%) |
| Total, 12/31/1983 | 359 | 652,192 |
| Federal leases relinquished: | | |
| Noncompetitive, BLM | 68 | 112,137 |
| Noncompetitive, USFS | 9 | 16,459 |
| KGRA, BLM | 4 | 8,645 |
| KGRA, USFS | 1 | 2,133 |
| Federal leases pending (total since 1974): | | |
| Noncompetitive, BLM | 5 | No data |
| Noncompetitive, USFS | 284 | No data |
| State leases (total since 1974): | | |
| Total active in 1983 | 11 | 22,404 |
| Total applications pending in 1983 | 0 | 0 |
| Private leases (total since 1974): | | |
| Total active in 1983 | No data | 200,000 (est.) |

## DOGAMI RESEARCH

The DOGAMI geothermal research group was reduced to one staff member during most of the 1983 field season because of continually dwindling government support for the program. However, during the fall of 1983, DOGAMI employed two additional geologists: one to serve in an 18-month regional geothermal resource study sponsored by the Bonneville Power Administration (BPA), and one to assist with the drilling done by Sandia National Laboratories in Newberry caldera.

The BPA study is a cooperative effort involving state agencies in Oregon, Washington, Idaho, and Montana and will result in a summary of the resource base and development possibilities of all potential geothermal resources in the BPA service area. The emphasis of the BPA study is on potential electrical-load offsets that could be realized from geothermal energy. The study will be used by planners at BPA to evaluate the contribution of geothermal energy to the region's future electrical-power needs.

The Sandia project was intended to investigate the deep parts of the Newberry geothermal system, and the drill hole was originally aimed at reaching about 5,000 ft. However, serious problems with the cement job in the upper casing string, coupled with artesian fluids at moderately high (170° C) temperature, caused the hole to be abandoned at 1,390 ft. For information on the temperatures in the well, see Black and others (1984). Sandia National Laboratories is also preparing a report on the drilling history and data from the well (Jim Dunn, personal communication, 1983).

The DOGAMI geothermal staff also initiated a long-term research project aimed at assessing the geothermal potential of the

central Oregon Cascade Range. This program will investigate structure, heat flow, and hydrothermal resources in the area from Mount Jefferson to Crater Lake. Much work has already been done in previous programs, but there are still large gaps in the geologic mapping and, particularly, in the heat-flow data base. As a first step, mapping of the North Santiam area in the vicinity of Mount Jefferson was begun by the writer during the summer of 1983. In addition, a task force of researchers interested in the Cascades was organized by DOGAMI at the 1983 fall meeting of the American Geophysical Union in San Francisco. The task force, which consists of USGS, university, and DOGAMI personnel, is preparing a scientific plan for surface surveys and deep drilling in the central Oregon Cascade Range. Researchers interested in becoming involved in preparation or review of the scientific plan are encouraged to contact the following people who are coordinating various aspects of the proposed investigation:

- Hydrothermal and hydrologic studies—Terry E.C. Keith, Edward A. Sammel, and Robert H. Mariner, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025, phone (415) 323-8111.
- Geophysical studies—Richard W. Couch and G. Steven Pitts, Department of Geophysics, School of Oceanography, Oregon State University, Corvallis, Oregon 97331, phone (503) 754-4430; and David D. Blackwell, Geothermal Laboratory, 253 Heroy Building, Southern Methodist University, Dallas, Texas 75275, phone (214) 692-2745.
- Geologic studies—George R. Priest, Oregon Department of Geology and Mineral Industries, 1005 State Office Building, Portland, Oregon 97201, phone (503) 229-5580; and Edward M. Taylor and Gary Smith, Department of Geology, Oregon State University, Corvallis, Oregon 97331, phone (503) 754-2484.

In 1984, the geothermal research group will finish the previously mentioned geologic map of the North Santiam area and begin mapping a similar-sized area to the south. The goal of this mapping program is to eventually complete detailed mapping of the structural boundary between the High Cascade and Western Cascade Range from the North Santiam River to the Rogue River.

## DOGAMI GEOTHERMAL PUBLICATIONS

Two new geothermal publications and an *Oregon Geology* paper were completed in 1983 and released by DOGAMI in January 1984:

1. Priest, G.R., and Vogt, B.F., eds., 1983, *Geology and Geothermal Resources of the Central Oregon Cascade Range*: DOGAMI Special Paper 15, 123 p., 3 plates (price $11).
2. Priest, G.R., Vogt, B.F., and Black, G.L., eds., 1983, *Survey of Potential Geothermal Exploration Sites at Newberry Volcano, Deschutes County, Oregon*: DOGAMI Open-File Report O-83-3, 174 p., 8 maps (price $20).
3. Black, G.L., Priest, G.R., and Woller, N.M., 1984, *Temperature Data and Drilling History of the Sandia National Laboratories Well at Newberry Caldera*: DOGAMI, *Oregon Geology*, v. 46, no. 1, p. 7-9 (price $.75 over the counter, $1 mailed).

Special Paper 15 summarizes the results of six years of geologic and geothermal research funded by the USDOE. It includes new geologic maps, radiometric dates, geochemical analyses, and a complete summary of heat-flow data for the central Cascades.

In 1982, a preliminary version of Special Paper 15 was released for review as Open-File Report O-82-7 (Priest and Vogt, 1982). Special Paper 15 is not, however, identical with the earlier report. It has been extensively revised and contains geologic data collected during an additional field season in the Waldo Lake-Willamette Pass area. A new geologic map of the entire Waldo Lake 15-minute quadrangle is the result of this additional field season of work.

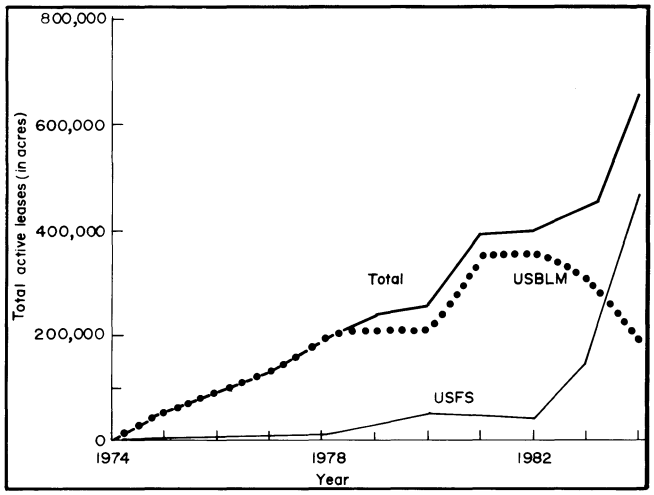


*Figure 3. Change of pattern of active geothermal leases on federal lands in Oregon from the inception of leasing in 1974 through December of 1983.*

Owing to budgetary constraints, two maps included in Open-File Report O-82-7 were omitted from Special Paper 15. The maps, an index map to geologic mapping in the Cascades and a 1:250,000-scale map showing the heat-flow data base for the entire Cascade Range, are, however, available as Open-File Report O-84-4 (Priest and others, 1984). Most of the data given on the geologic index map can also be obtained from an index to theses and dissertations in Oregon, DOGAMI Special Paper 11 (Neuendorf and others, 1982), and the index to published geologic mapping in Oregon, DOGAMI map set GMS-14 (Schumacher, 1981). However, only Open-File Reports O-82-7 and O-84-4 show the actual boundaries of unpublished Cascade thesis maps.

Open-File Report O-83-3 (item 2, above) is the final report for a BPA-funded study aimed at evaluating and updating the current data base on geothermal resources at Newberry volcano. A soil-mercury survey of the entire volcano was conducted by DOGAMI as part of this study (Priest and others, 1983a). In this survey, 1,641 samples were collected from an area covering 500 sq mi of the volcano. The survey showed large mercury anomalies associated with both the caldera and the south and east flanks of the volcano (Figure 4). Also included in the report were new interpretations and models for available geophysical data. The series of gravity and aeromagnetic maps included in the report should prove valuable to explorationists. All of the available geographic, geologic, geophysical, and geochemical data were utilized to develop a drilling program which could put constraints on the geothermal potential of the flanks of the volcano.

The *Oregon Geology* article on the Sandia National Laboratories well (item 3, above) summarizes the results of several temperature logs of the 1,390-ft well. When compared at equivalent depths to the USGS Newberry 2 well, the Sandia well has much higher temperatures. This is remarkable when one considers that the two wells are only 1,500 ft apart. Black and others (1984) concluded that the Sandia well may have encountered the same flow of hot water that occurred in Newberry 2 at a depth of 1,300-1,400 ft but that the Sandia well is closer to the source of the fluids, which probably emanate from the caldera ring-fault system.

## NEW USDOE FUNDING ANNOUNCED

In a Washington, D.C., news release of December 14, 1983, Senator Mark Hatfield announced that $530,000 will be given to Oregon from a total of $2 million allocated by the USDOE to assist the western states in geothermal research. Of that amount, about $342,000 is expected to go to OIT for continuation of the services the institute provides (Paul Lienau, personal communication,

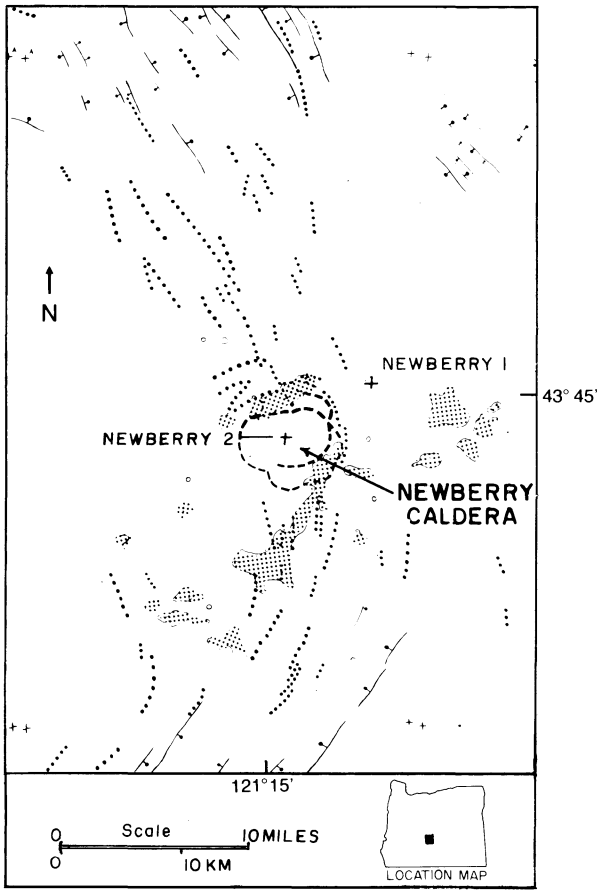


*Figure 4. Geologic structures and soil-mercury anomalies in the Newberry volcano area. Shaded areas = soil-mercury anomalies; thin solid lines = faults; dashed lines = caldera ring fractures; dotted lines = fissures and associated volcanic vent alignments; + = USGS drill holes. The area is covered by the geologic map of MacLeod and others (1982). Figure taken from Priest (1983).*

1984), about $150,000 will be made available to DOGAMI, and the balance is being held in reserve. OIT had previously received $70,800 of federal support in 1983 for technology transfer.

These new USDOE funds will help to restore some Oregon geothermal research programs, which had all but disappeared in recent years. The funds will also substantially revitalize the OIT program. OIT offers technological assistance to developers of low-temperature geothermal resources. The funding to DOGAMI will be inadequate for the aggressive drilling and mapping programs which have characterized its research in the past, but the support will allow a modest amount of temperature logging of water wells as well as some geologic mapping.

It is to be hoped that this new support for state programs from USDOE signals an important change in funding priorities. The level of funding for all state-coupled geothermal research has steadily declined over the last three years.

## OIT GEO-HEAT UTILIZATION CENTER

During 1983, the OIT Geo-Heat Utilization Center offered a limited program of technical assistance to developers interested in utilization of low- to moderate-temperature geothermal resources. The Center completed a feasibility analysis for a district heating system for the City of Vale and has continued to monitor the Lakeview low-temperature electrical generation project operated by Wood and Associates. Computer programs simulating electrical generation from Freon-based binary wellhead generators are being developed as part of the Lakeview project. The Geo-Heat Center also completed a district heating analysis guide. The guide and the Lakeview and Vale work were funded under subcontracts from the Oregon Department of Energy (ODOE).

The Center cooperated with the USGS, the Lawrence Berkeley Laboratory, and Stanford University during hydrologic testing of the Klamath Falls geothermal system. The pump test was supervised by Edward A. Sammel of the USGS and is discussed below in the USGS section of this report.

The previously mentioned USDOE support will allow OIT to expand its services. There will be free feasibility analysis and consulting for developers, amounting to as much as 64 hours per site, if the initial proposal to USDOE is approved (Paul Lienau, personal communication, 1984). A referral service identifying organizations that can be contacted for particular information and services will also be offered. A quarterly bulletin, monthly newsletter, library, and tour program will be available to the public. A speaker's bureau for geothermal conferences will also be part of the services. The new USDOE program will be operated for 18 months under the upcoming contract.

## OREGON DEPARTMENT OF ENERGY (ODOE)

In 1983, ODOE supported some OIT activities, subcontracted a number of studies to OIT (mentioned above), provided direct technical assistance to the City of Vale, provided public information, and responded to inquiries on geothermal energy and development from the public. ODOE also participated in the above-mentioned regional geothermal assessment project funded by BPA, working closely with DOGAMI on compilation of the Oregon data.

ODOE reviewed applications for state tax credits for geothermal heating development, processing eight applications for direct use and forty-five applications for ground-water heat pumps in 1983. A 25-percent tax credit, up to a maximum of $1,000, is offered for individual residences for the year of the installation. A 35-percent tax credit apportioned over as much as five years is offered to businesses.

ODOE now has a new geothermal program manager. David Brown, who left the position on December 15, 1983, to join a private consulting firm, has been replaced by Alex Sifford, formerly of Eliot Allen and Associates, Salem. Sifford has extensive experience in geothermal energy work from his association with Eliot Allen and from a previous position as geothermal program manager for the State of Idaho.

## U.S. GEOLOGICAL SURVEY (USGS)

Geothermal research in Oregon by the USGS was sharply curtailed because of budget cuts. A few projects, however, were completed in 1983 or are still continuing.

According to Walter D. Mooney (personal communication, 1984), a 60-km east-west seismic refraction line was completed across Newberry volcano in the fall of 1983. Five shots along the line and two shots offset to the east were recorded at stations spaced 500 m apart. Although the data have not yet been reduced, magma bodies as small as 2 to 3 km in diameter down to depths of 10 km beneath the volcano should be detectable at this station spacing. The offset shots were done to explore the crust-mantle boundary.

Edward A. Sammel (USGS), in cooperation with Lawrence Berkeley Laboratory, conducted a pump test of the Klamath Falls hydrothermal system between July 5 and August 26, 1983. The test was preceded in June by tracer tests conducted by Stanford University. Important conclusions from the testing were presented at a public meeting in Klamath Falls on January 25, 1984. It was found that (1) temperatures did not change during the test; (2) the cone of depression encountered no major hydrologic barriers; (3) drawdown was very significantly decreased in all wells when reinjection was employed; (4) the thermal waters are tens of thousands of years

old and receive essentially no local recharge. Mixing calculations by A.H. Truesdell (USGS) indicated that (5) the deep thermal water has equilibrated with an extensive volume of rock and has an estimated minimum reservoir temperature of 180° C. Finally, (6) the entire shallow hydrothermal system responds as one relatively simple system with two distinct types of permeability, a fracture-controlled system with rapid flow and a system controlled by intergranular permeability with slower flow (E.A. Sammel, personal communication, 1984).

Extensive reconnaissance-level geologic mapping by G.W. Walker, N.S. MacLeod, and D.R. Sherrod continued in the Cascades. This project is aimed at completing the Roseburg and Salem 1°×2° quadrangle maps, which will eventually be combined into a new compilation map covering the western half of Oregon.

Information from previous USGS field work at Newberry volcano and the Cascades was published chiefly in USGS open-file reports and as short papers in conferences. The following are some of the more important papers which were published in 1983 or are in press for 1984:

1. Summary papers were published on the geology (Bacon, 1983a,b) and the heat flow and limnology (Williams and von Herzen, 1983) of Crater Lake.

2. Keith and others (1984) interpreted the hydrothermal alteration mineralogy of the Newberry 2 drill hole. Bargar and Keith (1984) presented the full data set from the hole in an open-file report.

3. Data from time-domain electromagnetic soundings (Fitterman, 1983a,b) and Schlumberger soundings (Bisdorf, 1983) of Newberry volcano were released as open-file reports.

4. The hydrology of Newberry volcano was summarized in two papers (Sammel, 1983; Sammel and Craig, 1983).

5. A major paper summarizing results of a seismic refraction line from Mount Hood to Crater Lake will soon be published in the Journal of Geophysical Research (Leaver and others, 1984).


### ACKNOWLEDGMENTS

Edward A. Sammel (USGS), Walter D. Mooney (USGS), Paul Lienau (OIT Geo-Heat Utilization Center), and Alex Sifford (ODOE) provided the information about the geothermal programs of their organizations. Special thanks must go to Jacki Clark who every year is kind enough to provide complete statistics on BLM and USFS leases.


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## GRC annual meeting announced

The 1984 annual meeting of the Geothermal Resources Council will be held August 26-29 at the MGM Grand Hotel in Reno, Nevada.

The three-day meeting will include a technical program consisting of oral and poster presentations, special sessions, commercial and educational events, luncheons, special events, a guest program, and both pre- and post-meeting field trips.

There will also be a display of the winning entries in the fifth annual photograph contest. Winning photos automatically become candidates for use as a cover on the GRC Bulletin. Entries for this contest must be submitted by July 6, 1984, to the Geothermal Resources Council, 111 G Street, Suite 29, or P.O. Box 1350, Davis, CA 95617-1350. Use this address, or phone (916) 758-2360, also to obtain further information about the contest or the annual meeting. □

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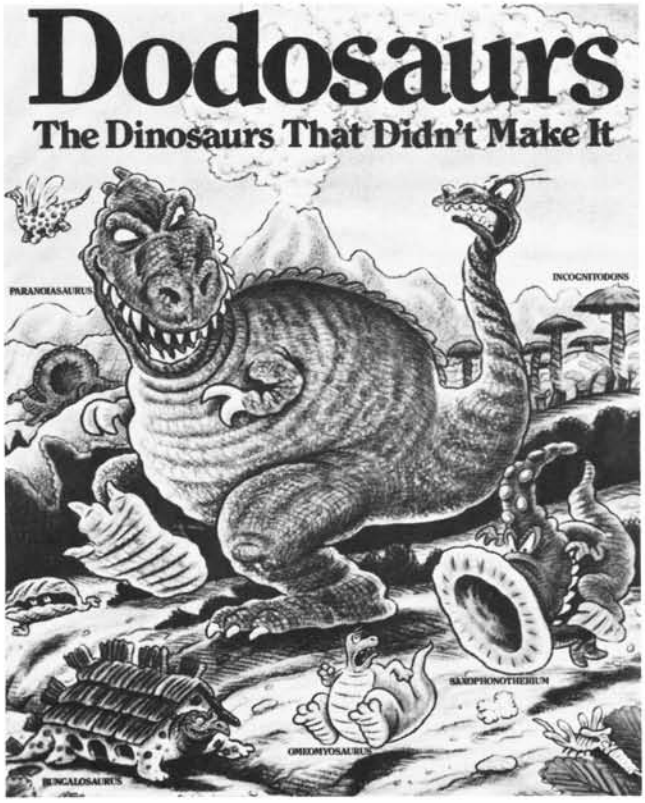
# BOOK REVIEW

*by Ralph S. Mason, former State Geologist*

**Dodosaurs. The Dinosaurs That Didn't Make It**, by Rick Meyerowitz and Henry Beard, New York, Harmony Books, 1983, 63 p. $7.95.

Deadly serious, truly scientific publications are easy to review, even though they may be deadly dull. Science is usually quantifiable and dependable, and scientific writers rarely stray very far from home base. *Dodosaurs*, on the other hand, is none of these. The author, who is a cofounder of the Harvard *Lampoon*, and the illustrator, who has also done artwork for the *Lampoon*, *Time*, and *Newsweek*, have apparently thrown their bonnets over the windmill, as the saying goes, kicked over the traces, and taken off into the wild blue yonder in a flying machine constructed of pure whimsy and powered by 180-spoof fuel. And there you have it.




*Part of jacket design for* Dodosaurs, *featuring the giant Paranoiasaurus, whose carnivorous front end posed a constant threat to his herbivorous rear end and who is surrounded here by, in the foreground, such smaller creatures as a Clamphibian, a Bungalosaurus, the ever-fearful Omeomyosaurus, a Saxophonotherium, and, in the background, a herd of Incognitodons (no, that's not a forest!), a Kaleidoscophus, and a Polychromodon.*

The naturalist-author Gerald Durrell once claimed he had a zoo in his suitcase. These guys not only have a zoo in a book but have invented a whole new geologic time chart and geographic area to accommodate their wildly imaginative prehistoric denizens. Unlikely animals glare at one in full color from every page, while the rather sparse text tries to explain how, when, and where they lived, but skillfully avoids why. The Dodosaurs, according to the author, lived on a land mass called Extragaea during the Moronic, Idiotic, and Preposterous geologic periods. The Dodosaurs belonged to a separate class of animals, the Ineptiles, some of whom had tired blood, assured their own oblivion by sporting self-defeating physical conformations such as having two tails and no head, two heads and no tail, and everything, or nothing, in between. For instance the Chopstichthyosaur was outfitted with, you guessed it, chopsticks for eating, while the Triunclogosincus looked suspiciously like that necessary household appliance, the "plumber's helper."

How do you treat a book such as this? Take it seriously, finding deeply hidden truisms visible only to the select few, or play it for laughs, chuckle at the witticisms and funny drawings, and then put it down and get back to perusing the *Wall Street Journal*? Maybe a bit of both. Believe it or not, there is quite a bit of sound historical geology tucked away in the text, but it is overshadowed by the absurdities created and flaunted everywhere in this large-format book. At first blush, *Dodosaurs* looks like a fanciful picture book

*The authors of* Dodosaurs, *pondering a model of the majestic Blunderdon ("almost ninety feet from the tip of its tail to the tip of its tail"): "Considering its monumental defects, if it were alive today, it would almost certainly be dead." (Illustration by Rick Meyerowitz, © 1983)*

for primary kids, and doubtless they would laugh all the way through the merry menagerie. Adults will smile at the nutty nomenclature, but the loudest guffaws will undoubtedly arise from the professional geology community, since the memory of not-so-funny-at-the-time boners by other professionals (remember the Piltdown Hoax?) may be revived here. And lastly, some of those same experts will ask themselves reproachfully "Why didn't I think of this before they did?" This brings us to the close of the Preposterous. □

## Workshop on geothermal economics announced

The Geothermal Resources Council and the U.S. Department of Energy are sponsoring a workshop on geothermal economics and related institutional factors, May 21-23, 1984, in Palm Springs, California. The workshop fee is $100.

The workshop is intended primarily for those actively involved in the development of geothermal energy and, in particular, those developing funding programs for power plants. It is recommended also for geologists, reservoir and design engineers, attorneys, accountants, economists, and employees of financial houses.

For information and registration, call (800) 525-3587 (in Colorado 337-4809) on weekdays between 9:00 a.m. and 8:00 p.m. (Mountain Time), or write to GRC-Convention Center, 2323 S. Troy, Suite 105B, Aurora, CO 80014. □

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