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AN EXTINCT EVODIA WOOD FROM OREGON

By Irene Gregory*

Introduction

During the early Eocene in Oregon, approximately 35 million years ago, a relatively level lowland reached from the base of the Blue Mountains in northeastern Oregon to the Pacific Ocean, which at that time extended into western Oregon. Since the Coast and Cascade Ranges had yet to develop, the entire area was influenced by ocean currents and had a subtropical climate largely free from frost.

Fossil plant remains in the Eocene Clarno Formation indicate the area to have been forested with many kinds of broad-leaf evergreen trees that today also are typical of such subtropical climates. Among them were magnolia, palm, Cedrela, Persea (avocado), Ficus (fig), Sabal (palmetto), Anona, and Meliosma. Since Eocene time, as a result of climatic changes, many of these trees have become extinct as natives in this hemisphere.

The genus Evodia can be included among trees which were native to Oregon during Eocene times but which are extinct in the western hemisphere.

A group of petrified woods collected from the Eocene Clarno Formation includes specimens identified as Evodia. Well-preserved and undistorted by earth pressures, the specimens have retained the finest anatomical details, so the diagnostic features necessary for identification are virtually as definitive as those in living wood (Figure 1).

Character and Distribution of Living Evodia

Evodia belongs to the family Rutaceae, a large group of shrubs and trees (with a few herbs) whose members occur throughout the world, primarily in subtropical and tropical areas. Their woods are characterized by small

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* Mrs. J.M. Gregory is a paleobotanist specializing in fossil wood anatomy.

(often minute) to medium vessels, typically grouped in multiples (often radial strings) and having a distinct oblique arrangement. Most are dense and hard Evodia, which is light and soft, is aberrant among rutaceous woods.

As a living wood today, the genus Evodia includes approximately 45 species of trees and shrubs, most of which are aromatic. Their range is restricted to an area reaching from Madagascar through India and Malaya to the Polynesian Islands and Australia.

Several different timber species of Evodia are harvested, especially in Malaya, for use in making tea boxes, looms, posts, matches, and other such articles. E. micrococca of Australia (called White Evodia or Silver sycamore) is a fine-textured white wood valued for cabinetwork. Some species of Evodia have wood so bitter that no insect will attack it; thus it is valued for its durability. One Chinese species, the Bee-bee Tree (E. danielii), has been introduced in North America as a decorative garden tree. Blooming profusely in mid-summer with large eight-inch clusters of flowers, it has been named for its particular attraction to bees.

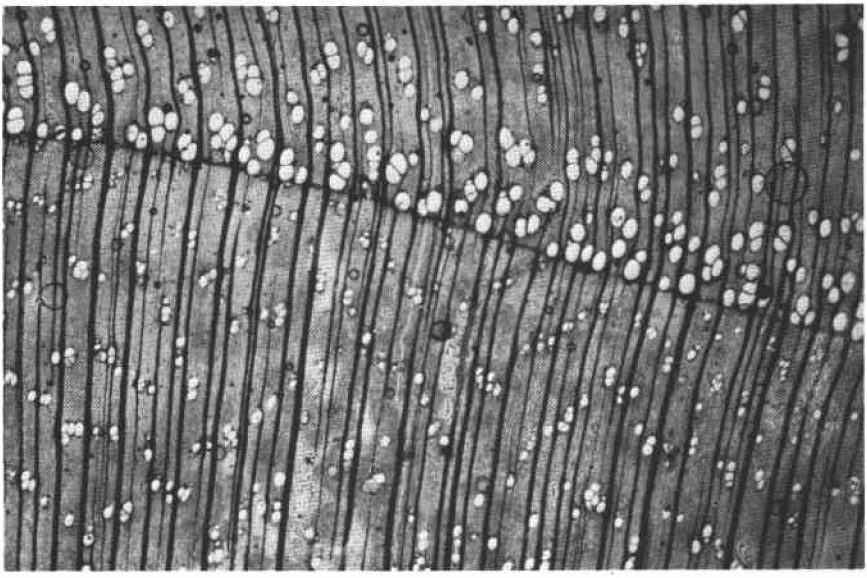
Records of Fossil Evodia

Reports of Evodia in the fossil record are few. Evodioxylon oweni (Carruthers) is reported from the Miocene and Cretaceous of eastern Africa (Chiarugi, 1933). Leaves of a fossil species, E. miosinica Hu and Chaney, are reported from the Miocene Shangwang flora of Shantung, China; the compound leaves (seven to 12 leaflets) show a marked resemblance to those of E. danielii described by Chaney and Hu (1940). Another list of plant fossils from the Miocene of Oregon includes a specimen tentatively identified as Evodia wood, although its anatomy is not described (Eubanks, 1966).

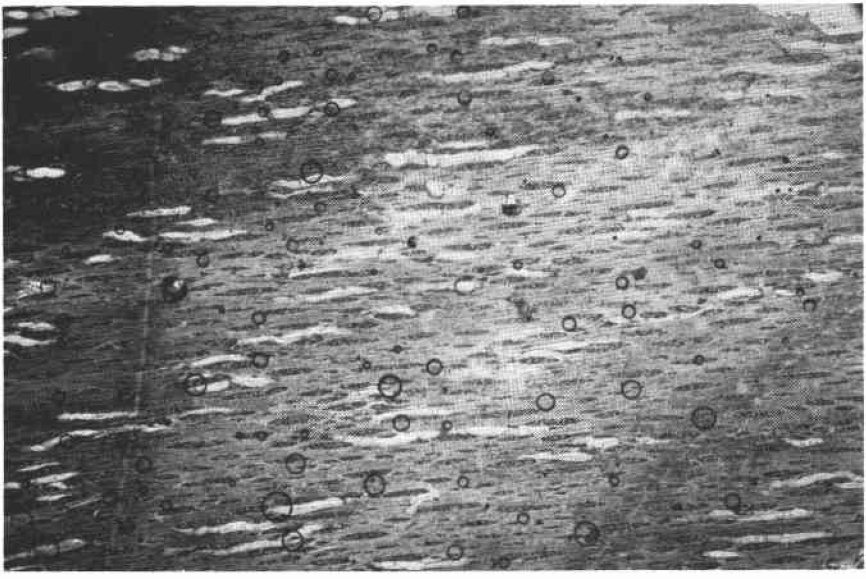
Geologic Background

The central Oregon locality in which the Evodia specimens occur has been mapped as Clarno Formation (Waters, 1968). The Clarno Formation has been described as composed almost entirely of andesitic volcanic material - chiefly lavas, mudflows, breccias, and tuffs, including some water-laid sediments. The formation overlies older marine rocks of Paleozoic and Mesozoic age. The Clarno sediments contain abundant fossil plant remains, mainly subtropical in nature, occuring in lenses of volcanic ash that accumulated in shallow lake bottoms and small ponds, either by direct ash falls or by erosion and redeposition of such material.

The somewhat orderly stratification of specimens in the Evodia locality indicates that the material may represent such a lake-bottom accumulation. The wood specimens, closely packed in the volcanic tuff, are highly silicified, with well-preserved cell structure and wood grain.



A



B

Figure 1. Photomicrographs of thin sections cut from fossil Evodia of Oregon.

A. Transverse section.
B. Tangential section.

Systematic Description

Family: Rutaceae
Genus: Evodia Forst.
Evodia gadijirian nov. sp.

Figure 1, A and B

Growth rings: Present; distinct to the naked eye. Marked by a uniseriate row of larger early-wood pores and thin but definite line of terminal parenchyma.

Vessels: Medium-sized to very small in the late wood. Open, with rare inclusions of gum. Solitary, but chiefly in radial rows of two or three, which at times are aligned tangentially. Rarely in nests of five to 12. Early-wood vessels are more numerous, more closely spaced, and larger, with a somewhat ring-porous arrangement. Up to 14 per millimeter. Vessel segments are thin walled, long. Perforations simple; oblique. Tyloses not observed.

Parenchyma: (A) Terminal; distinct to eye, forming a sharply-defined four- to eight-seriate line along which the single row of early-wood vessels of the next ring are aligned; thin-walled. (B) Paratracheal; one to two cells wide between vessels and between vessels and rays where they are contiguous. Rarely several cells grouped in the space between vessels. Frequently very small globules of gum are present; here, as in other parts of the wood, the gum has not taken on the coloration of the minerals in the host rock, but rather remains its natural amber color.

Fibers: Non-libriform, coarse, thin-walled; wide lumen. Not aligned in rows, but arranged to fill in large areas between rays and vessels.

Rays: Not distinct to naked eye. Very variable in size. 1- to 8-seriate, heterogeneous; up to 26 cells and 550 microns high. Small globules of gum are present.

Affinities

The minute anatomical details of the fossil Evodia wood closely resemble those of the living woods of this genus. Species correlation is more difficult to make; but because of the excellent preservation of the fossil wood structure, we can see its close comparison with E. fraxinifolia, extant in the eastern Himalayas and northern Burma.

Minor differences in the anatomy of the two woods are observed. These provide the basis for separating the fossil species from the living Evodia for the establishment of a proposed new fossil species, E. gadijirian.

Differences include:

A. Notably larger vessel nests in the fossil species.
   Vessel nests: Up to 12 per nest in fossil species.
   Up to several only in living E. fraxinifolia.

B. Rays up to twice as tall in the fossil species.
   Rays: Up to 550 microns high in the fossil species.
   Up to 225 microns high in the living E. fraxinifolia.

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NEW TOPOGRAPHIC MAPS FOR EASTERN OREGON

Eastern Oregon is gradually getting topographic map coverage. During the past few years the U.S. Geological Survey has been issuing many new maps and has more in preparation. Most of the new maps are 7½-Minute quadrangles at a scale of 1:24,000 (one inch equals 2,000 feet). They show towns, roads, trails, streams, and topographic contours in color. Some of the areas that are receiving map coverage are the central west half of Malheur County, the old 30' Sumpter and Ironside Mountain quadrangles in Baker and Grant Counties, and the northern part of the old Dayville 30' quadrangle in Crook and Grant Counties.

The Oregon Department of Geology and Mineral Industries maintains a file of topographic maps, and stationery and sporting goods stores in most cities in Oregon carry topographic quadrangle maps of their particular regions.

* * * * *

M'KELVEY URGES CURB ON WASTE

Addressing the Conference on National Materials Policy at Henniker, New Hampshire recently, USGS Director Dr. V.E. McKelvey said there is a "collision" between our ever-rising demands and our dwindling supplies of low-cost resources.

". . . we are dependent on foreign sources for more than half our supply of 20 important minerals, a number of which are critical to some of our basic industries," McKelvey said, continuing, "I do not consider it at all likely that we shall ever be fully self sufficient in all minerals. The random nature of their distribution and the fact that we occupy only 7 percent of the Earth's land area while consuming 30 percent of its mineral production is enough to convince me that we shall always be dependent on other countries for part of our mineral supply. The real problem is how to avoid becoming even more dependent than we now are as we continue to deplete our known domestic sources."

McKelvey warned that "we shall face extensive shortages by the end of this century unless prompt and effective actions are taken to avoid them." He noted that volumes of known resources await the development of technology that will allow their profitable extraction. He recommended the substitution of abundant materials for scarcer ones. "Recycling used materials, especially metals," McKelvey said, "not only saves energy, but also reduces the amount of trash that must be disposed of at the taxpayers' expense." He cited conservation, stating, "We cannot view shortages as merely a problem of supply. Without a sane and sensible policy toward consumption, it is impossible to balance the supply-demand equation, no matter how much emphasis is given to supply."

"There is the fundamental approach of discovering new deposits of minerals, which entails not only new tools and concepts for exploration, but also new places to look," McKelvey went on. "The great challenge to minerals exploration remains the hidden deposit. . . .The petroleum industry has been highly successful in its ability to locate structural traps at great depth, but the mining industry to date has been nowhere nearly as successful in discerning environments where ore bodies may be found."

Although such new techniques as mapping information provided by remote sensing devices are helping in the search for concealed deposits, these achievements represent only gradual improvements over our past capabilities, the USGS chief believes.

"I am optimistic that if we devote searching, imaginative, and driving effort to the task, we can succeed in satisfying our resource needs far into the future," McKelvey concluded.

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AN EOCENE FORAMINIFERAL FAUNA FROM BANDON, OREGON*

Regina L. Link
25 Lexington Drive, Urbana Illinois 61801

Introduction

An Eocene foraminiferal fauna was recovered from siltstones exposed in two small outcrops in Bandon, Oregon. The primary significance of the fauna is its age; although the rocks beneath the terrace deposits were assigned to the late Eocene Coaledo Formation by Baldwin (1965), they were overlooked by Ehlen (1960), who considered the terrace deposits at Bandon to be underlain by the Otter Point Formation, of latest Jurassic age. The faunal evidence presented here agrees with both the age and the formation originally assigned by Baldwin.

Materials and Methods

The samples studied came from two outcrops in the SW$\frac{1}{4}$ sec. 30, T. 28 S., R. 14 W., across Highway 101 from the Bandon fire department and library buildings, southwest of the intersection of Highway 101 and Chicago Avenue. Outcrop 1, near the sidewalk, is an inconspicuous portion of the north end of the bank. It strikes N 70 E and dips 12° S. Several yards to the northwest, strata of Outcrop 2 are exposed in the sides of a small gully and are unconformably overlain by Pleistocene terrace deposits. Outcrop 2 beds strike N 84 E and dip 41° S. The rocks in both outcrops are apparently in place.

The rock is dark-grey siltstone which becomes orange upon weathering. Outcrop 2 is deeply weathered. Fresh specimens from both outcrops resist breakdown; the rock must be boiled for several hours before it can be sieved and picked. After air-drying in the laboratory for several months, however, the rock disintegrates in hot water in a few minutes; boiling for an hour produces almost complete mechanical breakdown. The microfossils seem to better withstand the air drying process. After boiling, the samples were wet-sieved and dried before picking.

Material from Outcrop 1 was collected in 1964. When studied in 1970, approximately 600 cubic centimeters of this sample yielded several thousand specimens representing a well-preserved and moderately diverse fauna. Outcrop 2 was sampled in 1969, and the material was processed soon afterward.

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* Senior thesis at University of Oregon Honors College

It yielded only a few dozen specimens. This disparity may be due in part to the problems encountered in processing the material soon after it is collected. Future work on samples collected from Outcrop 2 may show the poor fauna to be an artifact [in microscopy, a result not indicative of actual conditions].

Faunal Age and Affinities

The foraminifera are of late Eocene age. Some of the species have been recorded only from the upper Eocene; all others, with one exception, have late Eocene as part of their ranges. One species, Bolivina marginata adelaidana, has previously been recorded only from the Miocene and Pliocene on the West Coast.

Table 1. Comparison of the Bandon fauna to four other upper Eocene faunas from western Oregon.

	B	LC	H	T	UC[1]
Dentalina communis	x	x			
Eponides ellisorae	x	x			
Gyroidina cf. soldanii	x	x			
Planulina haydoni	x	x			
Robulus articulatus texanus	x	x			
Bolivina basisenta oregonensis	x			x	
Plectofrondicularia packardi	x		x		
Plectofrondicularia yokesi	x			x	
Bulimina schencki	x		x		x
Plectofrondicularia oregonensis	x	x	x		
Plectofrondicularia searsi	x	x		x	
Bolivina basisenta	x		x	x	x
Cassidulina globosa	x	x	x	x	
Nonion applini	x	x	x		x
Robulus inornatus	x	x	x	x	x
Globobulimina pacifica oregonensis	x	x	x	x	x

[1]B = Bandon, UC = Upper Coaledo, LC = Lower Coaledo, H = Helmick Hill, T = Toledo

The faunal relationships between the Bandon strata and four other upper Eocene western Oregon formations are shown in Table 1. The faunas of the latter four formations were described by Cushman and others (1947). The Bastendorff Shale is not represented in the table because consistency in faunal identifications is not certain. The available information (Allen and Baldwin, 1944, Appendix B) indicates no close relationship between the Bastendorff and Bandon faunas. Only four species, two of which are ubiquitous in the Oregon Eocene, are held in common by the two.

The faunas from Outcrops 1 and 2 were essentially similar. No planktonic or arenaceous foraminifera were found.

Annotated Faunal Checklist

Family Lagenidae

Robulus Montfort, 1808: Individuals of this genus make up about 40 percent of the fauna.

Robulus inornatus (d'Orbigny): The material assigned to this species in the literature shows a wide range of variation. The Bandon material most closely resembles that of Cushman and others (1947).

Robulus articulatus (Reuss) var. texanus (Cushman and Applin): The Bandon material is similar to that of Cushman and others (1947) in size, but the sutures are bifurcated as illustrated by Mallory (1959).

Robulus alato-limbatus (Gümbel): This species is less common than R. inornatus or R. articulatus texanus.

Dentalina d'Orbigny, 1826.

Dentalina communis d'Orbigny: The material appears identical to that illustrated by Cushman and others (1947).

Dentalina sp: While in overall shape and size this species is similar to Dentalina dusenburyi, the costae are too few and too heavy to permit definite assignment to that species.

Family Nonionidae

Nonion Montfort, 1808.

Nonion applini Howe and Wallace: At Bandon the tests of this species are invariably filled with an unidentified black substance.

Family Heterohelicidae

Plectofrondicularia Liebus, 1903.

Plectofrondicularia searsi Cushman, Stewart, and Stewart: At Bandon the costae of this species are longer than is usual, posing some difficulty in distinguishing it from Plectofrondicularia packardi multilineata.

Plectofrondicularia packardi Cushman and Schenck: This is the most common of the Plectofrondicularia species in the Bandon fauna. It occurs in typical form.

Family Heterohelicidae (continued):

Plectofrondicularia packardi multilineata Cushman and Simonson: This variety of P. packardi also occurs in typical form at Bandon.

Plectofrondicularia oregonensis Cushman, Stewart, and Stewart: This species has not been widely recorded outside Oregon.

Plectofrondicularia vokesi Cushman, Stewart, and Stewart: This species is rare in the Bandon material.

Plectofrondicularia sp: This species is represented by only a few broken specimens. The test is less compressed and the costae are heavier than in the other species of Plectofrondicularia recorded here.

Family Buliminidae

Bulimina d'Orbigny, 1826.

Bulimina schencki Beck: The Bandon material displays about the same range of variation as the illustrations in Beck (1943), Cushman and others (1947), and Mallory (1959).

Globobulimina Cushman, 1927.

Globobulimina pacifica Cushman var. oregonensis Cushman, Stewart, and Stewart: Most specimens found were somewhat damaged, but the well-preserved individuals closely resemble the holotype of Cushman and others (1947).

Buliminella Cushman, 1911.

Buliminella cf. bassendorfensis Cushman and Parker: Because of the broad, somewhat compressed apertural end of the test, there is some doubt about the assignment of this species.

Bolivina d'Orbigny, 1839.

Bolivina basisenta Cushman and Stone: This species occurs in typical form and is common in the Bandon material.

Bolivina basisenta oregonensis Cushman, Stewart, and Stewart: Bolivina basisenta and B. basisenta oregonensis also occur together in the Toledo Formation.

Bolivina marginata Cushman var. adelaidana Cushman and Kleinpell: This species previously has been recorded only from Miocene and Pliocene rocks on the West Coast.

Family Rotaliidae

Gyroidina d'Orbigny, 1826.

Gyroidina cf. soldanii d'Orbigny: This material closely resembles that illustrated by Cushman and others (1947), but differs in the more angular ventral portion of the final chamber.

Gyroidina cf. soldanii d'Orbigny var? No illustrations of this variety could be found. It forms a distinct variety in the Bandon sample, making up about 6 percent of the species. It differs from the ordinary variety

(above) in its increased dorso-ventral flattening, larger umbilicus, and slightly inflated chambers in the latter portion of the test.

Eponides Montfort, 1808.

Eponides ellisorae Garrett: At Bandon this species has seven chambers in the adult whorl, as does the holotype of Garrett (1939). In apertural view, however, it more closely resembles the material illustrated by Cushman and others (1947), which has nine chambers in the adult whorl.

Family Cassidulinidae

Cassidulina d'Obigny, 1826.

Cassidulina globosa Hantken: This widely recorded species is also common at Bandon. Here it is almost spherical and most resembles the material from the Lower Coaledo Formation.

Family Anomalinidae

Planulina d'Orbigny, 1826.

Planulina cf. haydoni Cushman and Schenck: This species appears identical to that illustrated from the Lower Coaledo Formation. It is fairly common in the Bandon material.

Summary

The Bandon fauna seems to be closely related to the Lower Coaledo Formation assemblage. The absence of planktonic and arenaceous foraminifera indicates a moderately shallow bay without exposure to open ocean.

Acknowledgements

This study was undertaken at the suggestion of Ewart Baldwin, who supplied a rock sample collected in 1964, when the Bandon roadcut was fresh. William N. Orr criticized the manuscript and confirmed most of the faunal identifications.

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NEW EDITION OF GEOLOGY OF OREGON FOR SALE

"Geology of Oregon," by Ewart M. Baldwin, Professor of Geology at the University of Oregon, has been issued in a revised edition. First printed in 1959, the book was revised in 1964. The latest edition, like the others, is organized according to physiographic provinces. The text incorporates new concepts in geologic thought, and the book contains many new illustrations. A lively new cover drawing by Harold Cramer Smith depicts a hungry preditor on the verge of a prehistoric dinner.

The new "Geology of Oregon" is for sale at bookstores for $5.95.

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USGS OPEN-FILE REPORTS RELEASED

All open-file reports listed below may be consulted in the Department Library in the Portland office. Notations indicate where reproducible copies are available.

"Principal facts for gravity observations near McDermitt, Nevada," by Donald Plouff. U.S. Geol. Survey open-file report 76-599. 21 p. Reproducible copy at USGS Library, 345 Middlefield Rd., Menlo Park, CA 94025.

"Principal facts for gravity observations in the Charles Sheldon Antelope Range, Nevada-Oregon," by Donald Plouff, S.L. Robbins, and K.D. Holden. U.S. Geol. Survey open-file report 76-601. 22 p. Reproducible copy at USGS Library, 345 Middlefield Rd., Menlo Park, CA 94025.

"Lithium reconnaissance of southern Oregon," by J.R. Davis and A.L. Meier. U.S. Geol. Survey open-file report 76-666. 7 p.

"Station location map and audio-magnetotelluric data-log for Summer Lake Known Geothermal Resource Area, Oregon," by R.M. Senterfit and D.A. Dansereau. U.S. Geol. Survey open-file report 76-514. 6 p. and map. Reproducible copy at USGS, Room 678, U.S. Court House, Spokane, WA 99201.

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MINERAL SYMPOSIUM ANNOUNCED

The Pacific Northwest Chapter (Region 12) of the Friends of Mineralogy is sponsoring the Second Annual Mineral Symposium, to be conducted at the Sheraton Motor Inn, Portland on October 2. The topic will be, "The Gems and Minerals of Pegmatites."

Among the speakers will be Frederick Pough and W.L. Roberts. Activities will include a mineral auction, swapping, and dealer displays. Write for further information and registration forms to: Robert J. Smith, Friends of Mineralogy, Box 197 Mailroom, Seattle University, Seattle, Washington 98122.

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KEASEY FOSSILS DESCRIBED

"Bathyal gastropods of the family Turridae in the early Oligocene Keasey Formation in Oregon, with a review of some deep-water genera in the Paleogene of the eastern Pacific," by Carole S. Hickman, is published as volume 70, number 292, Bulletins of American Paleontology. The 119-page booklet discusses the stratigraphy, paleoenvironment, and fauna composition of the Keasey Formation and describes the specimens examined, including many species. Seven plates of photographs illustrate the fossils.

Copies of the bulletin are for sale by Paleontological Research Institute, 1259 Trumansburg Road, Ithaca, New York 14850. Price is $5.00.

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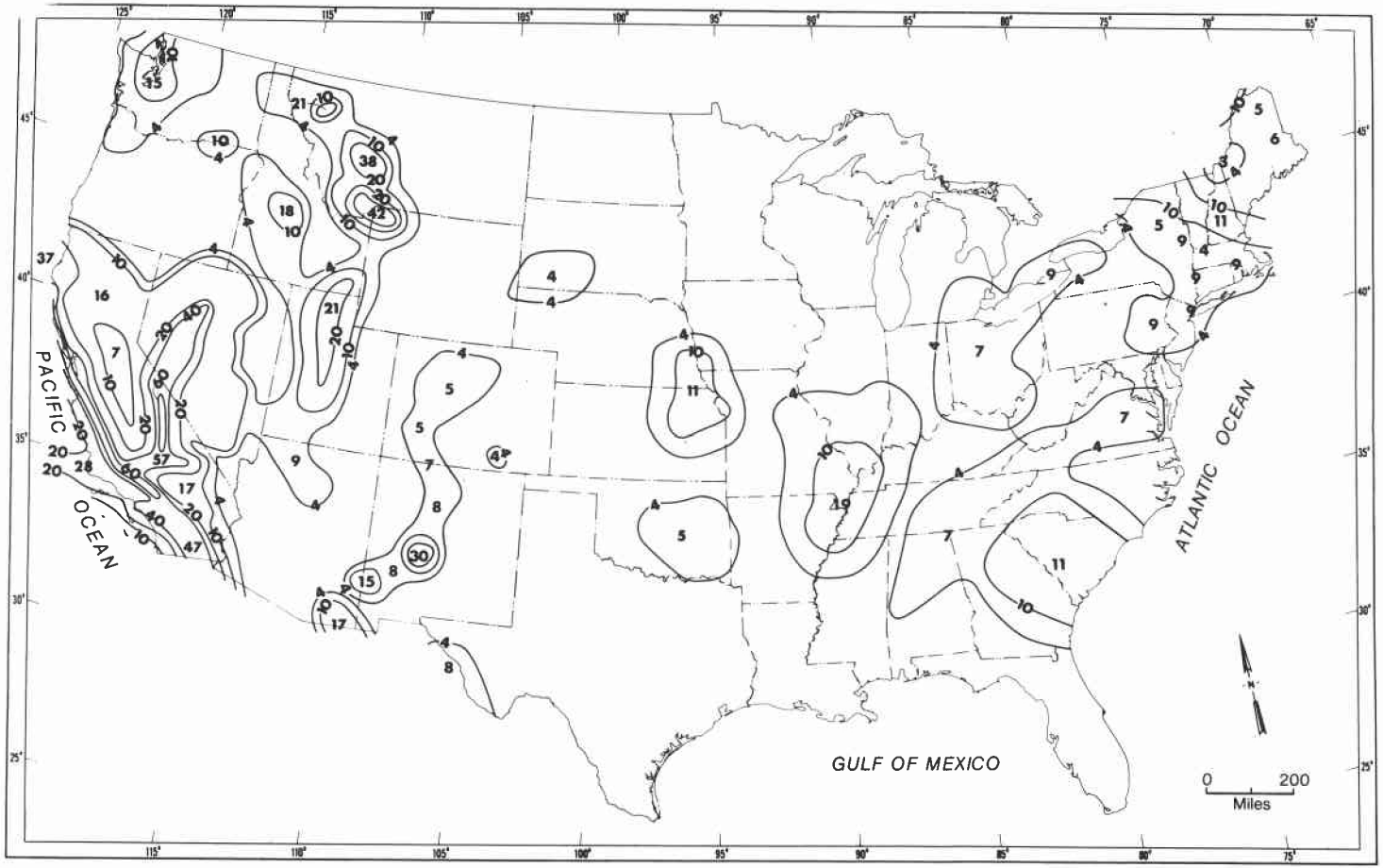
ROCKY MOUNTAIN GEOTHERMAL SECTION FORMED

The Geothermal Resources Council, organized in 1971 to encourage research, exploration, and development of geothermal energy, has announced the formation of the Rocky Mountain Section. Increased activity in geothermal investigations in the Rocky Mountain region led to the formation of the new section.

Officers of the Rocky Mountain Section are: Dr. L. Trowbridge Grose, Professor of Geology at the Colorado School of Mines, president; Glen Campbell, Gulf Mineral Resources, vice president; and Edgar A. Pash, U.S. Fish and Wildlife Service, secretary/treasurer.

The Section hopes to promote more frequent association among members in the Rocky Mountain region as well as expand awareness of the GRC and its functions. Luncheon meetings are held on the last Thursday of each month at the Petroleum Club Building, 16th and Broadway, Denver, Colorado. Interested persons are invited to participate.

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Map of the United States showing the expectable levels of earthquake hazards.

USGS MAPS QUAKE PROBABILITIES

The U.S. Geological Survey has prepared a new report and map for the conterminous (48) United States appraising the potential ground shaking produced by earthquakes. This represents the first attempt to show expectable levels of earthquake shaking hazards on a national basis.

Contour lines on the map (see opposite page) express in percentages of the force of gravity the maximum amount of horizontal acceleration (shaking) likely to occur at least once in a 50-year period. Contours at 4, 10, 20, 40, and 60 percent of gravity are shown. All contours are expressed at the 90 percent probability level.

The areas of greatest hazard from earthquake shaking include parts of California, Nevada, Washington, Montana, Wyoming, Utah, Idaho, New Mexico, Arizona, Missouri, Arkansas, Tennessee, Kentucky, and Illinois. States with least hazard are Florida, Louisiana, Wisconsin, Minnesota, and North Dakota.

Accelerations are those estimated to occur on solid rock. Because the surface materials in many areas of the United States are not solid rock, the maximum acceleration at a particular location may be quite different from that shown on the map.

The acceleration map provides a quick method for evaluating the relative earthquake hazard throughout the country. For example, during a 50-year period, accelerations of 10 percent of gravity may be expected at least once in portions of New England, while many areas of California can expect to experience accelerations of 60 percent of gravity at least once during the same period.

In earthquake-prone regions, buildings must be designed to resist substantial horizontal forces in addition to the normal vertical forces of gravity. Buildings adequately designed to accomodate vertical forces of gravity and horizontal forces of strong winds may not be able to withstand the horizontal shaking produced by earthquakes.

USGS scientists emphasize that exposure to damage from seismic shaking is steadily increasing because of continuing urbanization in earthquake-prone regions and the increasing complexity of lifeline systems such as power, water, transportation, and communication networks. Data in the new report and map can be helpful in assessing earthquake hazards, developing earthquake resistant designs, and making insurance studies to estimate potential earthquake losses.

The preliminary report and map, "A Probablistic Estimate of Maximum Acceleration in Rock in the Contiguous United States," by S.T. Algermissen and D.M. Perkins, printed as USGS Open-File Report 76-416, are available for inspection at USGS libraries. The Department also has a copy for visitors to examine.

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KEEP IN TOUCH!

Of course you notify the Post Office when you are going to move. Perhaps you think with satisfaction, "Now we won't miss any mail." Not so!

Unless you notify the Department (see address below your address on The ORE BIN cover) direct, your ORE BIN winds up in some other bin, and nobody gets to enjoy reading it. Later, the Department will receive a copy of the cover, with your new address handwritten on it, in exchange for a 25-cent coin (the price of the magazine!).

So, if you have moved or are planning an address change, drop a 9-cent post card in the mail to let the Department know about it. Or, better, get a free Change of Address Kit from your Post Office or letter carrier and inform everybody of your whereabouts.

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RULE-MAKING POLICIES ESTABLISHED

All State agencies with regulatory responsibilities will be required by Oregon Administrative Law, passed by the 1975 Legislature, to formalize their rule-making policies through public notices, hearings, and notification lists. The Department comes under this regulation since it governs mined land reclamation, geothermal drilling, and oil and gas drilling in the State.

A public hearing is scheduled for 10:00 a.m. on October 5, 1976 in Room 678, State Office Building, Portland, to review the Department's rule-making policies before they are officially adopted.

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NORTHEASTERN OREGON STREAM SEDIMENT DATA AVAILABLE

In the May 1976 issue of The ORE BIN we announced that the Department's stream sediment sampling program for northeastern Oregon was complete and that the information was available for inspection. The tabulated data and 33 topographic maps are now printed as Open-file Report O-76-4 and are for sale at the Department's Portland office.

The report contains analyses of 1,005 samples collected from drainages of the Snake, Powder, and Burnt Rivers in Baker, Malheur, and Wallowa Counties and analyzed for copper, lead, zinc, and nickel. Locations of collecting sites are indicated on the topographic maps.

The 33 maps and tabulated data are sold only as an entire set. The price is $25.00.

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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. 2.00
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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Marine Science Drive
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Second Class Matter
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Available Publications, Continued:

SHORT PAPERS

18. Radioactive minerals prospectors should know, 1976: White, Schafer, Peterson . . $0.75
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 2.00

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: 17" x 22" pictorial relief map 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, 1961 10
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