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The ORE BIN
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# THE TRACE FOSSIL TISOA IN WASHINGTON AND OREGON

Robert W. Frey* and John G. Cowles**

## Introduction

Recently we described and interpreted some specimens of the trace fossil Tisoa from the Tertiary of Washington (Frey and Cowles, 1969), the first reported occurrence of this fossil burrow in North America. Specimens were collected near Megler, Washington, along a bluff facing the Columbia River (Figure 1); the fossils weathered out of the Lincoln Creek Formation. Distinct variations in trace fossil morphology were observed, representing differences in behavior of the animals responsible for the burrows.

Figure 1. The Megler locality, Pacific County, Washington. (On Columbia River, approximately 400 feet east of boundary between sections 8 and 9, T. 9 N., R. 9 W.)

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Tisoa has since been identified at various other places in Washington, but until very recently all of our attempts to locate specimens in Oregon opposite the Megler locality had failed. The fossil is now known from the Astoria Formation (early Miocene).

Considering the potential environmental, paleoecological, and paleontological significance of trace fossils generally (Frey, 1970, 1971), further searches should be undertaken in Oregon and Washington, aimed at documenting variations in, and the stratigraphic and facies distributions of, this fossil burrow.

## Characteristics of Tisoa

Megler specimens of Tisoa typically consist of two parallel tubes contained within elongate calcareous concretions (Figure 2A, B), which are thus very similar to specimens reported from other countries (Häntzschel, 1962, Figure 137.4; 1965). The concretions collected by us are of assorted sizes but are invariably less than 15 cm in length and 7 cm in diameter. The enclosed tubes are generally 1 to 1.4 cm in diameter, and they run the full length of the host concretion; distances between adjacent tubes range from 2.5 to 7 mm (Frey and Cowles, 1969, Figure 1). Individual tubes are commonly lined with diagenetic pyrite, and the pairs of tubes may also be encircled by a thin layer of pyrite (Figure 3C, D). These tubes, evidently remaining open for a time during deposition of Lincoln Creek sediments, were eventually filled with a variety of detrital and diagenetic minerals.

Actually, rare specimens from Megler show that the "normal" twin tubes are in reality fragments of the upper part of a single U-shaped tube (Figure 3A), conceivably as much as a meter in original length (Häntzschel, 1962, p. W218). U-shaped fragments are less common now than "normal" specimens because (1) the break-up of the original structure produced more fragments of the upper part than of the basal part (Figure 4C), and (2) the basal part may have been less well constructed by the burrowing animal originally (Frey and Cowles, 1969, p. 19).

Rare Megler specimens also show that the tubes are not invariably straight (Figure 4A) and that the twin tubes may branch into additional pairs of tubes (Figure 4B). Furthermore, single-tube varieties of Tisoa are fairly common at this locality (Figure 2C); although these are identical to "normal" specimens in all other respects, no evidence for an original second tube has been observed.

Peculiarly, many of the tisoans observed at various places in Washington, other than Megler, consist predominantly of the single-tube variety, and at some localities the "normal" twin tubes are apparently very rare. Weldon W. Rau (1968, personal communication) wrote us that:

> "Although we frequently find concretions with a single tube of some sort in the middle, I do not recall ever seeing any like your specimens with the double tube. Those I have

enclosed (by mail) are not particularly good specimens but are a sample from outcrops where I saw hundreds and possibly thousands. They were all oriented with the long axis normal to bedding. They range from a few inches up to possibly 8 inches in length. They all seem to have evidence of a crude tube through the middle."

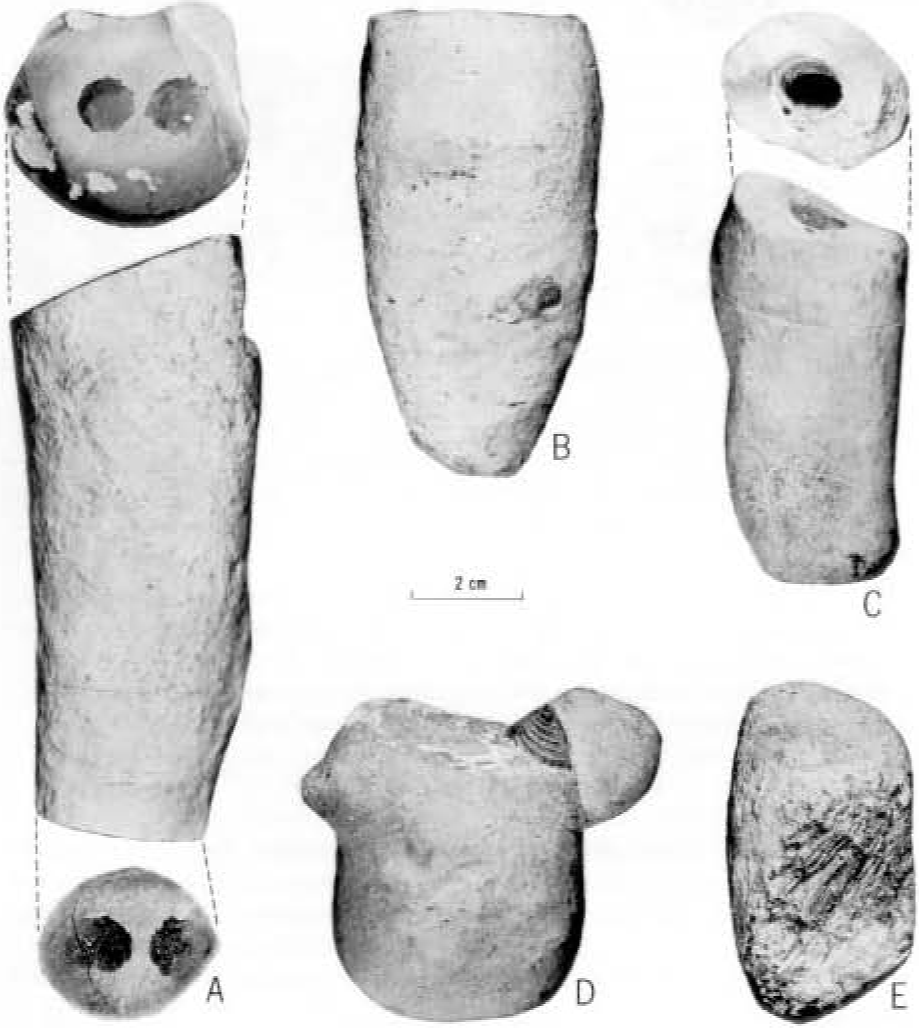


Figure 2. Tisoans from Megler. A, B. Typical double-tube specimens. C. Typical single-tube specimen. D. Bivalve Lucinoma cf. L. acutilineata (Conrad) embedded in tisoan concretion. E. Fish fin on side of tisoan concretion.

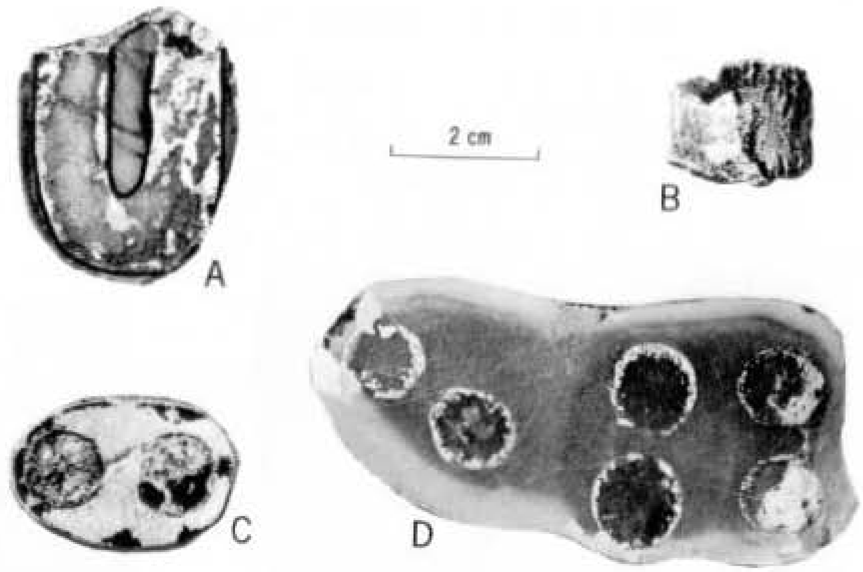


Figure 3. Tisoans from Megler. A. Longitudinal section through U-shaped tube (outlined in ink). B. Longitudinal view of tube fragment, mostly weathered out of its concretion, showing scratch marks. C. Transverse view of tisoan having pyrite concentrations around tubes and circumference of concretion. D. Transverse section through concretion containing three pairs of tubes, each lined with pyrite (cf. Figure 4B).

The morphological variations and interrelationships among local and regional assemblages of Tisoa thus clearly need additional study. Such work may eventually show that the genus is too broadly conceived and that it could realistically be split into two genera, although we would certainly discourage taxonomic splitting if possible (see Frey, 1971, p. 103-104).

## Interpretation of Tisoa

The wall linings seen in many tisoan tubes suggest that the burrowing animal reinforced its domicile with organic secretions, which later reacted biogeochemically and thus helped concentrate secondary minerals such as pyrite (see Frey, 1971, p. 101-102). These alterations and the formation of enveloping concretions took place early in diagenesis, as suggested by a nearly intact fish fin and a closely articulated clam found embedded in tisoan concretions (Figure 2D, E); otherwise, bioturbation and other sedimentary and diagenetic processes probably would have disarticulated and scattered these fossil remains.

On the basis of morphology, requisite behavior, and the presence of small scratch marks on certain burrow walls (Figure 3B), we interpret Tisoa

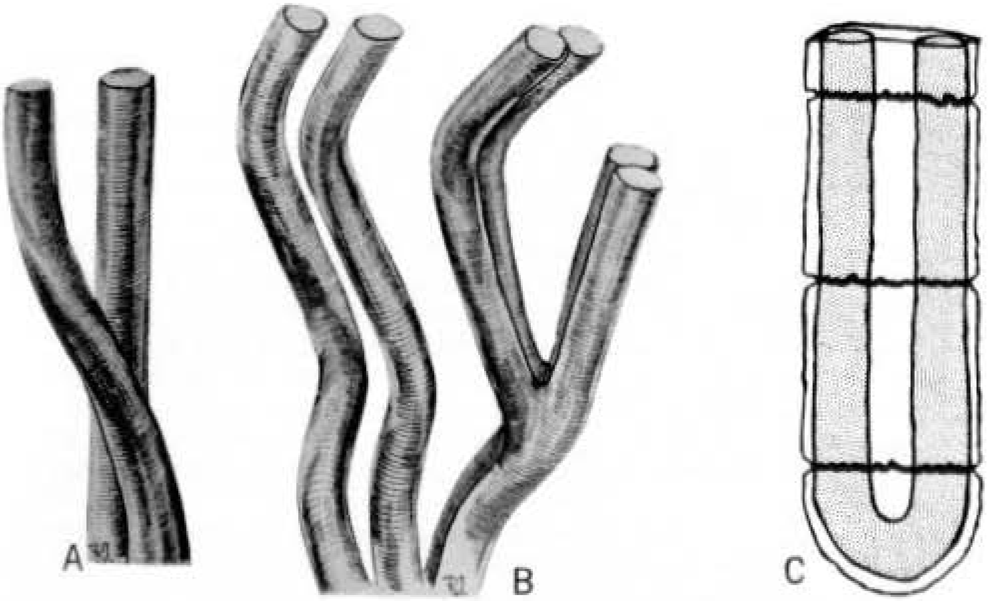


Figure 4. Reconstructions of Megler tisoans. A. Spiraled tubes. B. Branched tubes (cf. Figure 3D). C. Hypothetical specimen illustrating how several short, double-tube tisoans may be derived from a single long, U-shaped tube.

as the dwelling burrow of a shrimp- or amphipod-like arthropod (Frey and Cowles, 1969, p. 20). None of our burrow specimens contain arthropod remains, and virtually none of the fossil arthropods reported by Weaver (1942) are likely candidates; yet arthropod remains are rarely found even in well-documented Holocene and fossil arthropod burrows (Bromley, 1967, p. 170-172).

A possible exception among invertebrates reported by Weaver are such decapods as Callianassa knapptonensis (Rathbun, 1926, p. 112-113, Pl. 38, Figure 4), collected from the Oligocene near Megler. By analogy with the Holocene shrimp C. californiensis (Warme, 1967), C. knapptonensis conceivably could have constructed tisoan burrows having smooth exteriors, rather than the more popularly known knobby exteriors of Holocene C. major burrows and Ophiomorpha (Weimer and Hoyt, 1964). Callianassa californiensis does not, of course, make U-shaped burrows having closely appressed limbs, but certain other features of the burrow are somewhat comparable.

Overall, the burrowing habits reflected by Megler tisoans are more like that of the Holocene amphipod Corophium volutator (see Häntzschel, 1939), although the tisoan organism must have been substantially larger in size.

## Distribution of *Tisoa*

*Tisoa* was previously known only from foreign localities, including the Oligocene of Tunisia, Cretaceous of Russia, and Jurassic of France and Madagascar (Häntzschel, 1962, p. W218). Hartmut U. Wiedemann (1970, personal communication) informed us that he has also observed the trace fossil in Jurassic marls near Aalen, Württenberg, Germany. Specimens from all of these localities consist predominantly of the twin-tube variety.

We have collected additional specimens southeast of Megler, especially on the western slope of K M Mountain, half a mile or more below the summit, along U.S. Highway 101. Weldon W. Rau (1968, 1971, personal communications) notes having seen *Tisoa*-like concretions in several other places, including the structures mentioned in his report on the Quinault Formation (Rau, 1970, p. 10). We examined a few of his specimens and found them extremely similar to those from Megler. Specimens from all of these localities consist mostly (or perhaps wholly) of the single-tube variety however.

In contrast, we have not personally located any unequivocal tisoans in Oregon. On the Oregon side of the Columbia we collected certain of the fossils and other concretions associated with *Tisoa* at Megler but no unmistakable evidence of *Tisoa* itself. Recently, however, Sam Boggs of the University of Oregon informed us (1971, personal communication) that he has collected a few specimens from an area along Youngs River near Astoria; we examined some of these specimens (from the Astoria Formation) and indeed found them to be single- and double-tube varieties of *Tisoa*, the latter being rare.

We strongly suspect that continued searching will eventually yield many additional specimens from Oregon, which will help establish further the morphological variation and overall distribution of this trace fossil in the Pacific Northwest.

## Conclusions

Additional observations on the morphology and distribution of *Tisoa* are needed. Primary consideration should be given to the documentation of behavioral, biostratigraphic, and facies relationships of the different varieties of this trace fossil in Oregon and Washington. Only with this kind of information at hand can the full paleontological and environmental significance of *Tisoa* be evaluated.

## Acknowledgments

We are grateful to Weldon W. Rau, Washington Department of Natural Resources, Ewart M. Baldwin, University of Oregon, and Richard E.

Thoms, Portland State University, for their comments and suggestions concerning this manuscript, and to Sam Boggs, University of Oregon, for sending us specimens of Tisoa collected by him in Oregon.

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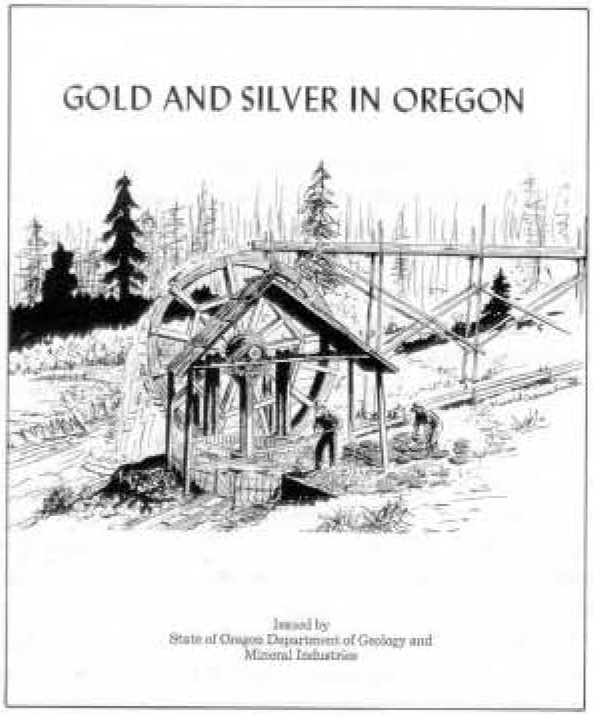
## POPULAR GOLD BULLETIN REISSUED




The Department's Bulletin 61, "Gold and Silver in Oregon," by Howard C. Brooks and Len Ramp, has been reprinted and is again available from the Department's offices in Portland, Baker, and Grants Pass. The price is the same: $5.00.

The bulletin was originally published in 1968 and went out of print in a very few months. Because of the great demand, it has been reprinted in its entirety. It contains a wealth of information about gold and silver in the state that was previously scattered through a great number of published and unpublished records.

The gold bulletin is organized in three parts: Part I contains a general discussion of the economics of gold and silver and a review of the production, history, and geologic occurrences of these metals in Oregon; Part II describes the principal gold-mining areas in eastern Oregon, particularly those in the "Gold Belt of the Blue Mountains;" and Part III describes the principal gold-mining areas in the Klamath Mountains and Western Cascades in western Oregon. In all, some 500 lode and placer mines and prospects are discussed.

The337-page publication contains mine maps, index maps of mining areas, production statistics, historical information and photographs. The volume serves as a guide to future exploration and development.

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# A NEW LOOK AT MODERN MINING

Ralph S. Mason*

Mining in Oregon began with the discovery of gold at Jacksonville in 1851. That same year gold was also discovered at Griffin Gulch, not far from Baker. The next quarter of a century saw a full-fledged gold rush in Oregon. Placer gold, found in the streams and later in the adjacent banks, formed the basis for this tremendous activity, which brought thousands of people to the state, provided a wilderness society with an abundance of wealth, and established the first semblance of a legal structure. It is significant that Oregon became a state long before much of the territory lying to the east, mainly because of the search for gold.

The abuses perpetrated by the early-day miners are common knowledge. However, miners were not alone. The farmer, the stockman, the logger -- all moved to Oregon because of the land. Many brought injurious practices with them and left wreckage behind. The prospect of limitless land and an abundance of natural resources made conservation of any kind uneconomic and unheard of.

Once the easily obtainable stream placers were exhausted, miners turned first to the gold-bearing stream banks and later to the rich veins cropping out on the hillsides. To work the banks required capital and in many instances water for the hydraulic giants. Ditches to supply the water were dug by hand, often in record time, in mountainous unsurveyed areas. The Auburn Canal, the Rye Valley Ditch, the Sparta Ditch, and the Eldorado Ditch were completed in the 1860's and '70's. The Eldorado Ditch, incidentally, was 100 miles long, an engineering feat which would be of major proportions even today with earth-moving machinery. To mine underground required even more financing and for the first time the large mining companies appeared. The completion of the transcontinental railroads in the 1880's signalled the beginning of a period of intensive mining and milling, which was to continue, with some fluctuations, until World War II and the ill-advised government order L-208, which permanently closed nearly all of the state's metal mines. Gold dredging in Oregon began in earnest about 35 years ago. In 1938 there were 12 dredges active in eastern Oregon; in 1939 the state had 15 floating dredges and 13 nonfloating washing plants. Gold dredging came to an abrupt halt with World War II, and only a few attempts have been made to revive it since.

Of all the mining activity in the state during the past 121 years, none has been subjected to more criticism than gold dredging. Admittedly there

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were abuses, but the outcry has been largely based on an emotional rather than a factual basis. In 1939, a total of .0015 percent of the state's crop land was dredged. Translated, this amounts to only 70 acres. It has been estimated that if all of the potential dredgeable ground should be dredged it would amount to .04 percent of the state's crop land.

Land abuse and stream pollution are always related. The relationship is sometimes obvious, as in some dredging where water is muddied and silt introduced into the stream. In other instances, the tie between land abuse and stream pollution is not so readily apparent. An over-cropped farm or a hillside stripped of trees will eventually pollute the streams with topsoil and silt. The big difference is that pollution from dredging occurs at the time of the operation, but pollution from poor farming or logging takes place during periods of heavy rain when the muddy water is assumed to be due to "natural" causes.

Today the mining industry presents a far different picture from that of 50 years ago. Mining companies have largely replaced the individual operator who was primarily interested in immediate return rather than a long-term investment. The high cost of setting up any type of industry today requires a long period for amortization - and the assurance that it will be permitted to stay in business. The mining industry is particularly vulnerable to this situation, with amortization periods of 20 years or more required for most large-scale operations.

Mining has recognized that it must accept its share of community responsibility, just as manufacturers and logging companies have done. Any well-established business realizes that good public relations are a "must." Mining companies also have learned that it is good business to police their own ranks rather than to have punitive and restrictive legislation forced upon them. A few examples of present-day mining company reclamation practices illustrate this point. In the southeastern United States, areas which have been mined for bauxite by ALCOA have been reseeded to trees which are tended as carefully as our own tree farms in the Northwest.

Here in Oregon, Reynolds Metals Co. is also in the tree farm business -- before they have started to mine bauxite. In Washington and Columbia Counties, where this company owns a considerable acreage of land underlain by ferruginous bauxite, a two-fold program of restoration and timber cutting is underway. Much of this land had been cut over, was brush covered, and was nonproductive when purchased by the company. Incidentally, much of this area was made unproductive by bad cutting practices of early loggers.

Some of the Reynolds' land has reseeded naturally, and trees are being harvested on an individual basis with care exercised to prevent damage to surrounding trees. In other areas, the land has been reforested and some of the trees are approaching marketable size. Several planted areas are designed for Christmas tree production. No clear cutting is permitted and the entire region of approximately 5000 acres is being managed on a sustained yield basis. Several test pits opened to a depth of 10 feet or more 20 years ago are now obscured by trees. As a direct result of this program, soil erosion and stream pollution have been reduced and the land is esthetically enhanced.

Sand and gravel operators have found that unsightly gravel pits can be landscaped and made into attractive home sites featuring a lake with swimming and boating facilities. Currently in the Salem area, Walling Sand and Gravel Co. is converting mined-out gravel pits into public-use areas. In addition to picnic facilities, the company has arranged with the Oregon Game Commission to have the ponds occupying the former pits stocked with legal-size fish. The response from the public has been enthusiastic. As a side venture the company obtained plans for duck-nest platforms, which were erected in a secluded location within the pit, and several pairs of migratory birds have nested there.

The reclamation work of Porter Brothers in Bear Valley, Idaho, is well known. In northern California, as long as 30 years ago Harmes and Larson dredged and then leveled and resoiled 100 acres along Horse Creek. In this instance it is interesting to note that the cost of doing the reclamation work was exactly double the original value of the land.

Most surface-stripped land can be reclaimed and water pollution held to a minimum. The mining industry is willing and eager to do it, but the sad fact remains that all too often the land owner is more interested in immediate gain from rents and royalties on his mineral deposit than in a long-term investment. Clearly something must be done.

The problems are these:

1. The failure by large segments of the people to recognize that mining is an essential industry, indispensable to our way of life and to our very existence. What sets modern man apart from his ancestors is his use of metals and minerals.
2. Although mining operations on state and federal lands are controlled by existing legislation and present mining practices, there has been a real problem where the operation was on privately-owned land. The landowner has needed to be educated in the value of his land after mining, not just for himself but for the economy of the community. Hopefully the new reclamation law will help correct this.
3. Mining is not the only industry that has environmental problems, and the matter should be viewed in its entirety. Basically, stream pollution and land abuse are the by-products of civilization, and the record dates back 7000 years.
4. There is a need for realization that any regulatory measures to control mining activity must be drawn with care lest the industry be destroyed. Over the past 30 years most of the legislation related to mining has been of a restrictive nature, in sharp contrast to a great number of laws passed to help nearly every other phase of our economy.

The Mined Land Reclamation Act for the state of Oregon, which went into effect July 1, 1972, is designed to rectify many of the problems related to the increasing demand for minerals, particularly aggregate. In some areas there is a diminishing supply of these non-renewable resources, plus steadily shrinking areas where mineral resources may be obtained, and a growing awareness by the public generally that far better use must be made of all our land. Briefly the new law requires aggregate producers and miners who mine more than 10,000 cubic yards or disturb more than two acres of land annually to provide a performance bond, a mining plan, a reclamation plan, and evidence that the operation and the proposed use following cessation of mining meet with the approval of the appropriate local government. Visual screening, where necessary, will be required; water pollution will be controlled; and when the mining operation is completed the site must be left in a suitable condition for a planned subsequent use.

This new law closely parallels one now in force in the State of Washington. It is hoped that the experience reported from Washington will be repeated here in Oregon. Our sister state has been getting excellent cooperation from aggregate operators, state and federal agencies, and local governments. Some Washington operators, too small to come under the law, have voluntarily agreed to abide by the regulations, no doubt considering that it is good public relations to do so.

Gold miners of the early days had it easy. They could dig gravel, remove the gold, and leave the pits and piles of tailings behind, because in those days gold mining was the major source of income in the remote regions where gold was found, and no one really cared about the appearance of the environment. Nowadays, gravel deposits are being mined for another purpose - aggregate. Billions of tons of sand and gravel, plus large amounts of limestone, gypsum, and clay, go into the concrete for freeways, bridges, office buildings, shopping centers, apartment houses, condominiums, forecourt fountains, and a hundred other concrete uses that have come with the rise in our standard of living and increase in population. As a result, pits and piles of gravel can be seen across the land. Strictures are being placed on industry to curtail the environmental effects created by these and all other mining operations. This reclamation will cost large amounts of money and the added expense must be passed on ultimately to the consumer, who willingly or grudgingly will pay more for commodities in order to maintain or improve his life style. Thus, in the final analysis, the consumer is as much a contributor to the environmental consequences of mining as is the miner himself.

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## WEISSENBORN HONORED FOR SPOKANE SERVICE

Albert E. Weissenborn, head of the U.S.G.S. office in Spokane for many years, has been awarded the Interior Department's 1972 Distinguished Service Award. Interior Secretary Rogers C. B. Morton made the presentation at a Washington, D.C. ceremony in June.

"Since joining the Geological Survey in 1943," the citation reads, "Mr. Weissenborn has rendered exceptional service in mineral resource programs of the Department of the Interior.

"As regional geologist for the Pacific Northwest, he established and maintained liaison with state and federal agencies, representatives of the mineral industry, professional organizations and other groups in the field of mineral resources.

"As executive officer for the Defense Minerals Exploration Administration Pacific Northwest field team, he skillfully directed a large mineral exploration program in Montana, Idaho, Oregon, Washington and Alaska.

"Mr. Weissenborn is internationally acclaimed as an expert technical advisor on mineral development programs and has served with distinction in this capacity in Liberia, Dahomey, Guyana, Saudi Arabia, and Turkey."

"Mineral and Water Resources in Oregon," a 462-page booklet originally issued for the Congressional Committee on Interior and Insular Affairs and subsequently published as Oregon Department of Geology and Mineral Industries Bulletin 64, was under the direction of Mr. Weissenborn.

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## GEOTHERMAL REPORT FOR WASHINGTON ON OPEN FILE

The Washington Department of Natural Resources' Division of Mines and Geology has "open-filed" a <u>Report on Geothermal Ground Noise Measurements in Washington State</u>. Copies are available for examination at:

Dept. of Natural Resources, Div. of Mines and Geology
335 General Admin. Bldg., Olympia, Wash. 98504
Dept. of Geology and Mineral Industries
1069 State Office Bldg., Portland, Ore. 97201
California Division of Oil and Gas
1416 9th St., Rm. 1316-35, Sacramento, Calif. 95814

Data were gathered at 83 stations, all in the vicinity of either thermal springs or Pliocene-to-Recent volcanism. The report includes 14 pages of text plus references, tables, maps, with plots of power spectra for the Klamath Falls, Oregon, and Klickitat and Tum Tum Mountain, Washington areas.

* * * * *

## GEOTHERMAL STUDY CONTRACT AWARDED DEPARTMENT

The U.S. Bureau of Mines is funding a continuation of the geothermal study being conducted by the Oregon Department of Geology and Mineral Industries. The contract calls for the Department to continue the geologic studies, begun several years ago, by N. V. Peterson and E. A. Groh to determine areas of greatest geothermal potential. In addition to the geologic studies, geothermal gradients and heat flow measurements will be made.

This study is a part of the plan outlined by R. W. deWeese, member of the Department's Governing Board, at the hearing on geothermal drilling regulations held in Klamath Falls on February 29, 1972. The plan evolved because Oregon and the rest of the Pacific Northwest lack identified resources with potential to supply some of the increasing demand for energy. Since materials to supply fossil fuel and nuclear power plants would have to be imported into the area at high cost and potential environmental hazard, geothermal resources, with their proven low cost and minimal environmental impact, appear to be the most attractive energy source for this region. Eastern Oregon abounds in indications of large geothermal reservoirs, and this is the region that will be given first attention in the study that will begin the joint state-federal development proposed by deWeese. The Bureau of Mines contract, amounting to $76,000, will provide sufficient funds for the Department to continue the structural geologic studies related to geothermal areas and carry out a program of geothermal temperature measurements.

The basic physical property sought in exploring for geothermal fluids is available heat. Because water is only the carrier of this heat energy, measurements of heat flow from the earth provide a direct exploration tool for the location of usable geothermal energy. Information on geothermal gradient and heat flow will add a new dimension to the knowledge of the presently known thermal manifestations, such as hot springs.

Three distinct types of gradient and heat-flow measurements will be made to locate areas of high heat flow and to develop exploration techniques that might be applied to large areas at a minimal cost. The program will start with the locating of previously drilled holes or the drilling of new holes to a depth of 20 meters, at which depth the bottom of the hole will be unaffected by annual temperature variations resulting from the flow of solar heat. These wells will be instrumented with temperature-recording devices at several levels to monitor changes in temperature over a year, a full cycle of solar heating. The holes will be located in various geographic and climatic zones in the state in order to determine what portion of the heat flow from the ground surface to the atmosphere is dependent upon variations of the solar heating cycle and what part is dependent upon heat radiated from the interior of the earth. Data from the monitor wells can then be applied to shallow wells to obtain heat-flow determinations rather than drilling the 150- to 200-meter holes normally used for heat-flow measurements.

During the period that the monitor wells are being located, a series of shallow (3-meter) holes will be drilled and geothermal gradients will be measured over an interval of 1 meter to locate anomalously high gradients. The amount of temperature variation sought in these holes will be very minute but well within the capabilities of available instrumentation. Normal temperature gradient amounts to 30°C/km or 0.03°C per meter; within geothermal areas gradients run as high as 200° to 250°C/km or 0.2 to 0.25°C per meter. The low thermal conductivity of the tuffaceous sediments and lake beds of eastern Oregon, where the shallow-hole survey will be conducted, will make it easy to determine an apparent increase in the temperature wherever areas of high heat flow are found.

At the end of the shallow-drilling program, four or five of the anomalies will be drilled to a depth of 150 to 200 meters to determine the heat flow by conventional methods in order to confirm results obtained from the shallow holes. All of the holes will be drilled under conditions specified by the Department's geothermal drilling regulations and will be abandoned by backfilling and plugging. Prior to taking measurements the holes will be cased with plastic pipe and capped as a safety measure for grazing animals that might otherwise step into the holes and be injured.

The study this summer will begin with the drilling of shallow-gradient and monitor holes in the Vale-Owyhee upland region of Malheur County. The contract with the Bureau of Mines covers the studies for 15 months, after which time a report will be prepared and made available. Supervision of the project will be by Richard Bowen, Department economic geologist. Two geology graduates, Alan Preissler and Richard Kent, have been hired by the Department to perform the drilling. Consultant on the heat-flow studies is Dr. David Blackwell of the Geology Department of Southern Methodist University, Dallas, Texas. Dr. Blackwell has been working on heat-flow determinations in the Northwest for several years and has outlined the general method of operation for this study.

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## WILLIAM T. PECORA

Our Department has just received word of the untimely passing of Undersecretary of the Interior William T. Pecora. Dr. Pecora spent many years as a geologist for the U.S. Geological Survey, and in 1965 was promoted to Director. His most notable work in Oregon was the investigation of nickeliferous laterite deposits near Riddle. These deposits were subsequently developed by the M. A. Hanna Company into the nation's only nickel mine. President Nixon nominated Pecora as Undersecretary on April 20, 1971, and the Senate confirmed the post the following month. Secretary of the Interior Rogers C. B. Morton stated that "Few men possessed the leadership qualities which Dr. Pecora showed in the quest for balance and harmony in resource development and conservation."

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## CHANGES IN DEPARTMENT PERSONNEL

The most recent addition to the staff of the Department of Geology and Mineral Industries is Robert C. Sauve of Vancouver, Washington. His position is that of Spectroscopist-Assayer. Bob Sauve attended Clark College and Portland State University, majoring in chemistry. He was employed by Reynolds Aluminum Co. for 19 years before joining the Department in February 1972. He replaces Thomas C. Matthews, Spectroscopist, and Wm. Kahn, Chemist.

Thomas C. Matthews, now retired from the Department, is associated with the Dayton Travel Agency, which has headquarters in Seattle. Tom joined the Department in October 1966 and during his nearly 26 years as Spectroscopist performed thousands of analyses of rocks, ores, trace elements, rare earths, metallurgical materials, and substances from crime laboratories. William Kahn joined the staff in September 1967 and was employed as Chemist-Assayer for 4½ years. He is now sales representative with Penrose Realty in Tigard.

Other changes in staff in recent years that we have failed to note in The ORE BIN include Rudolph P. Zobl, who was accountant from November 1953 until his retirement in December 1970. His position has been filled by Clifford Speaker, who joined the staff in December 1970.

Miriam Roberts (Mrs. Ted) was Editor-Librarian for the Department between August 1960 and January 1971, when she moved to Eugene, Oregon. Previously her position had been held for 17 years by Mrs. Lilliam Owen, who produced the early issues of The ORE BIN on an ancient multilith machine which she held together by shear will power. After Miriam's retirement, Sally Lillis was Editor-Librarian for 6 months, and the position is now filled by Carol Brookhyser (Mrs. Robert), who joined the staff in June 1971. Previously, Carol was a publications editor for National Institutes of Health.

Employed on a part-time basis as a secretary is Barbara Jacob (Mrs. Laurance), who has been with the Department in its Portland office since January 1971. In the Grants Pass office, Ruth Pavlat (Mrs. Howard) has been secretary since the retirement of Arline Jacques in October 1970.

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## GEOLOGIC FORMATIONS OF EASTERN OREGON PUBLISHED

"Geologic Formations of Eastern Oregon (east of longitude 121°30')" by John D. Beaulieu, has just been released by the Department as Bulletin 73. This is a companion to Bulletin 70, "Geologic Formations of Western Oregon" also by Beaulieu, providing a complete compendium for the state. Information about each geologic formation includes original description, distribution, lithology, contacts at base and top of unit, age, and references. Included are index maps, correlation charts, and an extensive bibliography. Bulletin 73 is available at Portland, Baker, and Grants Pass offices for $2.00.

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AVAILABLE PUBLICATIONS

(Please include remittance with order. Postage free. All sales are final and no material is returnable. Upon request, a complete list of the Department's publications, including those no longer in print, will be mailed.)

## BULLETINS

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| 8. | Feasibility of steel plant in lower Columbia River area, rev. 1940: Miller | 0.40 |
| 26. | Soil: Its origin, destruction, preservation, 1944: Twenhofel . . . . . | 0.45 |
| 33. | Bibliography (1st supplement) of geology and mineral resources of Oregon, 1947: Allen . . . . . . . . . . . . . . . . . . | 1.00 |
| 35. | Geology of Dallas and Valsetz quadrangles, Oregon, rev. 1963: Baldwin | 3.00 |
| 36. | Vol. 1. Five papers on western Oregon Tertiary foraminifera, 1947: Cushman, Stewart, and Stewart . . . . . . . . . . . . | 1.00 |
| | Vol. 2. Two papers on foraminifera by Cushman, Stewart, and Stewart, and one paper on mollusca and microfauna by Stewart and Stewart, 1949 | 1.25 |
| 37. | Geology of the Albany quadrangle, Oregon, 1953: Allison . . . . . | 0.75 |
| 39. | Geology and mineralization of Morning mine region, Grant County, Oregon 1948: R. M. Allen & T. P. Thayer. . . . . . . . . . . | 1.00 |
| 46. | Ferruginous bauxite deposits, Salem Hills, Marion County, Oregon, 1956: Corcoran and Libbey . . . . . . . . . . . . . . . | 1.25 |
| 49. | Lode mines, Granite mining dist., Grant County, Ore., 1959: Koch . . | 1.00 |
| 52. | Chromite in southwestern Oregon, 1961: Ramp . . . . . . . . . | 3.50 |
| 53. | Bibliography (3rd supplement) of the geology and mineral resources of Oregon, 1962: Steere and Owen . . . . . . . . . . . | 1.50 |
| 57. | Lunar Geological Field Conference guide book, 1965: Peterson and Groh, editors . . . . . . . . . . . . . . . . . . | 3.50 |
| 58. | Geology of the Suplee-Izee area, Oregon, 1965: Dickinson and Vigrass . | 5.00 |
| 60. | Engineering geology of the Tualatin Valley region, Oregon, 1967: Schlicker and Deacon . . . . . . . . . . . . . . . . | 5.00 |
| 62. | Andesite Conference Guidebook, 1968: Dole, . . . . . . . . . | 3.50 |
| 63. | Sixteenth Biennial Report of the State Geologist, 1966-68 . . . . . . | Free |
| 64. | Geology, mineral, and water resources of Oregon, 1969 . . . . . . | 1.50 |
| 66. | Reconnaissance geology and mineral resources, eastern Klamath County & western Lake County, Oregon, 1970: Peterson & McIntyre | 3.75 |
| 67. | Bibliography (4th supplement) geology & mineral industries, 1970: Roberts | 2.00 |
| 68. | The Seventeenth Biennial Report of the State Geologist, 1968-1970 . . | Free |
| 69. | Geology of the Southwestern Oregon Coast W. of 124th Meridian, 1971: R. H. Dott, Jr. . . . . . . . . . . . . . . . . | 3.75 |
| 70. | Geologic formations of Western Oregon, 1971: Beaulieu . . . . . . | 2.00 |
| 71. | Geology of selected lava tubes in the Bend area, 1971: Greeley . . . . | 2.50 |

## GEOLOGIC MAPS

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| Geologic map of Oregon west of 121st meridian, 1971: . . . . . . . . . | 2.15 |
| (over the counter) . . . . . . . . . . . | 2.00 |
| Geologic map of Oregon (12" x 9"), 1969: Walker and King . . . . . . . | 0.25 |
| Geologic map of Albany quadrangle, Oregon, 1953: Allison (also in Bull. 37) . | 0.50 |
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| GMS-3: Preliminary geologic map, Durkee quad., Oregon, 1967: Prostka . . | 1.50 |
| GMS-4: Gravity maps of Oregon, onshore & offshore, 1967: [Sold only in set] flat, $2.00; folded in envelope, $2.25; rolled in map tube . . . | 2.50 |
| GMS-5: Geology of the Powers quadrangle, 1971: Baldwin and Hess . . . . | 1.50 |

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| 1. | Petroleum geology of the western Snake River basin, Oregon-Idaho, 1963: Newton and Corcoran | 2.50 |
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