OREGON GEOLOGY

published by the

Oregon Department of Geology and Mineral Industries

VOLUME 44, NUMBER 7 JULY 1982

OREGON GEOLOGY
(ISSN 0164-3304)

VOLUME 44, NUMBER 7 JULY 1982

Published monthly by the State of Oregon Department of Geology and Mineral Industries (Volumes 1 through 40 were entitled *The Ore Bin*).

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

Baker Field Office: 2033 First Street, Baker 97814, phone (503) 523-3133.
Howard C. Brooks, Resident Geologist

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

Mined Land Reclamation Program: 1129 S.E. Santiam Road, Albany 97321, phone (503) 967-2039.
Paul F. Lawson, Supervisor

Subscription rates: 1 year, $4.00; 3 years, $10.00. Single issues, $.40 at counter, $.75 mailed.
Available back issues of *The Ore Bin*: $.25 at counter, $ .75 mailed.

Address subscription orders, renewals, and changes of address to *Oregon Geology*, 1005 State Office Building, Portland, OR 97201.

Send news, notices, meeting announcements, articles for publication, and editorial correspondence to the editor, Portland office. The Department encourages author-initiated peer review for technical articles prior to submission. Any review should be noted in the acknowledgments.

Second class postage paid at Portland, Oregon.
Postmaster: Send address changes to *Oregon Geology*, 1005 State Office Building, Portland, OR 97201.

COVER PHOTO

Eastward-dipping lower Coaledo outcrops near Coos Bay, Oregon. Photo shows Gregory Point with Cape Arago lighthouse at lower left, Cape Arago at upper right. Article beginning on next page presents data acquired from recent oil and gas exploratory drilling in the region that suggest revisions in the stratigraphic understanding of the Eocene Coaledo Formation. (Photo courtesy of Ward Robertson, Coos Bay, Oregon)

DOGAMI releases geothermal open-file reports

Geothermal-gradient data: The Oregon Department of Geology and Mineral Industries (DOGAMI) has released 1981 geothermal-gradient data for Oregon and placed them on open file as Open-File Report 0-82-4. The 430-page report contains temperature-gradient measurements taken by the DOGAMI geothermal staff in about 100 drill holes throughout the state. It includes a large number of new measurements in the Cascades and in eastern Oregon. The computer-produced report contains data tables and temperature-depth plots as graphic summaries for each of the drill holes.

Open-File Report 0-82-4, *Geothermal-Gradient Data, 1981*, was compiled by D.D. Blackwell, G.L. Black, and G.R. Priest, under contract to the U.S. Department of Energy, and is available for $15 from the Oregon Department of Geology and Mineral Industries, 1005 State Office Building, Portland, OR 97201.

Low-temperature geothermal-resource assessment: DOGAMI has completed its low-temperature geothermal-resource assessment of thirteen major prospects throughout the state, and the final report of this U.S. Department of Energy-sponsored project has been released as Open-File Report 0-82-5, *Oregon Low-Temperature Resource Assessment Program: Final Technical Report.*

The 53-page report summarizes assessment results for each of the following areas: Corbett-Moffets and Parkdale (Multnomah and Hood River Counties), Milton-Freewater (Umatilla County), La Grande (Union County), Belknap-Foley and Willamette Pass (Lane County), Powell Buttes (Crook County), Lakeview (Lake County), northern and southern Harney Basin and Alvord Desert (Harney County), and Western Snake River Plain and McDermitt (Malheur County). The raw data obtained in the three-year investigation have already been made available in earlier DOGAMI publications.

Low-temperature geothermal resources produce temperatures up to 90° C (194° F) and are considered mainly for direct use of hot geothermal water. The report points out that direct use of such hot water depends on its proximity to larger population centers for economic feasibility and is difficult in some low-population areas in the Cascades and eastern Oregon. However, new technologies are being tested now which will allow generation of electric power even from low-temperature resources. The report also confirms the very favorable geologic setting of the state for geothermal potential in general. The information gained in the completed program will aid the discovery of more and perhaps larger and hotter geothermal resources.

Open-File Report 0-82-5 sells for $5 and is also available from the Portland office of the Oregon Department of Geology and Mineral Industries. Prepayment is required for orders under $50. □

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Subsurface stratigraphic correlations of the Eocene Coaledo Formation, Coos Bay basin, Oregon

by Richard D. Robertson, Northwest Exploration Company, P.O. Box 5800 T.A., Denver, Colorado 80217

INTRODUCTION

In 1980, Northwest Exploration Company (NWE) of Denver, Colorado, drilled three oil and gas exploratory wells in the Coos Bay basin on the southern Oregon coast. All three wells penetrated the Eocene Coaledo Formation. Data acquired from these and other test holes revealed stratigraphic relationships within the Coaledo which are not evident in the frequently studied sea-cliff outcrops on the western side of the basin.

The Coaledo Formation, where exposed at the coast between Cape Arago and Yoakam Point (Figure 1), is approximately 6,600 ft thick. Turner (1938) divided the formation into three members. The upper and lower members are primarily sandstone, and the middle member is primarily mudstone. Open marine, marginal marine, and nonmarine facies are all represented. The Coaledo is overlain by the Bastendorff Formation and the Bastendorff by the Tunnel Point sandstone (Figure 2). A stratigraphic cross section using well data has been constructed across the basin in order to relate the coastal outcrops to the basin interior (Figure 3, Table 1).

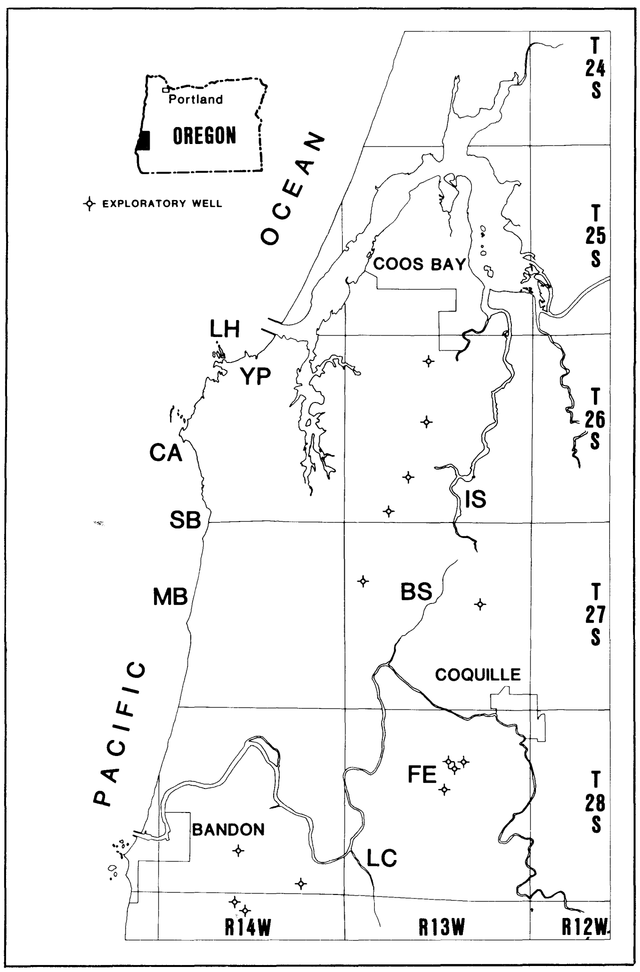

Figure 1. Index map of study area. LH = Cape Arago lighthouse; YP = Yoakam Point; CA = Cape Arago; SB = Sacchi Beach; MB = Merchants Beach; IS = Isthmus Slough; BS = Beaver Slough; FE = Fat Elk; LC = Lampa Creek.

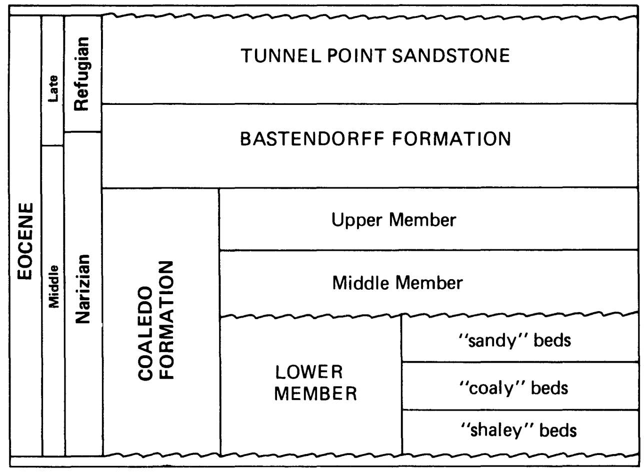

Figure 2. Stratigraphic chart for the Coaledo Formation, Coos Bay basin, Oregon.

The base of the Coaledo has been debated over the years. At Cape Arago, 1,700 ft of lower Coaledo sandstone rests on 650 ft of mudstone and shale. The base of the argillaceous sequence is concealed by faulting. Some authors have included the shaley beds within the lower Coaledo (Baldwin, 1966, 1974; Baldwin and Beaulieu, 1973; Dott, 1966). Other workers have considered the base of the Coaledo to be the base of the sandstones and have assigned the underlying beds to the Pulaski (Turner, 1938), Umpqua (Allen and Baldwin, 1944), Arago (Weaver, 1945), Flournoy (Baldwin, 1975), and Elkton Formations (Rooth, 1974; Ryberg, 1978). This writer believes that these shaley beds correlate with similar rocks which are found inland in the subsurface and which appear to be a part of the lower Coaledo.

Coals are present in both the upper and lower members of the Coaledo. Lower Coaledo coals are not developed along the coast at Cape Arago; however, 2 mi south of the Cape near Sacchi Beach, two thin coals are exposed. Eastward in the subsurface, the coaly beds thicken dramatically. In the central part of the basin, the lower Coaledo coaly beds have a gross thickness exceeding 2,100 ft.

The lower Coaledo sandstones exposed along the coast are continuous inland to the central part of the basin, where 1,100 ft of inner neritic and brackish-water sandstones are present above the coaly beds.

Up until this time, the Coaledo Formation was thought to have been deposited in an area of relatively sustained sedimentation. Dipmeter data from drill holes, however, suggest the existence of an unconformity between the lower Coaledo and overlying members inland from the present-day coast (Figure 4).

The writer wishes to thank Northwest Exploration Company of Denver, Colorado, for permitting the presentation of

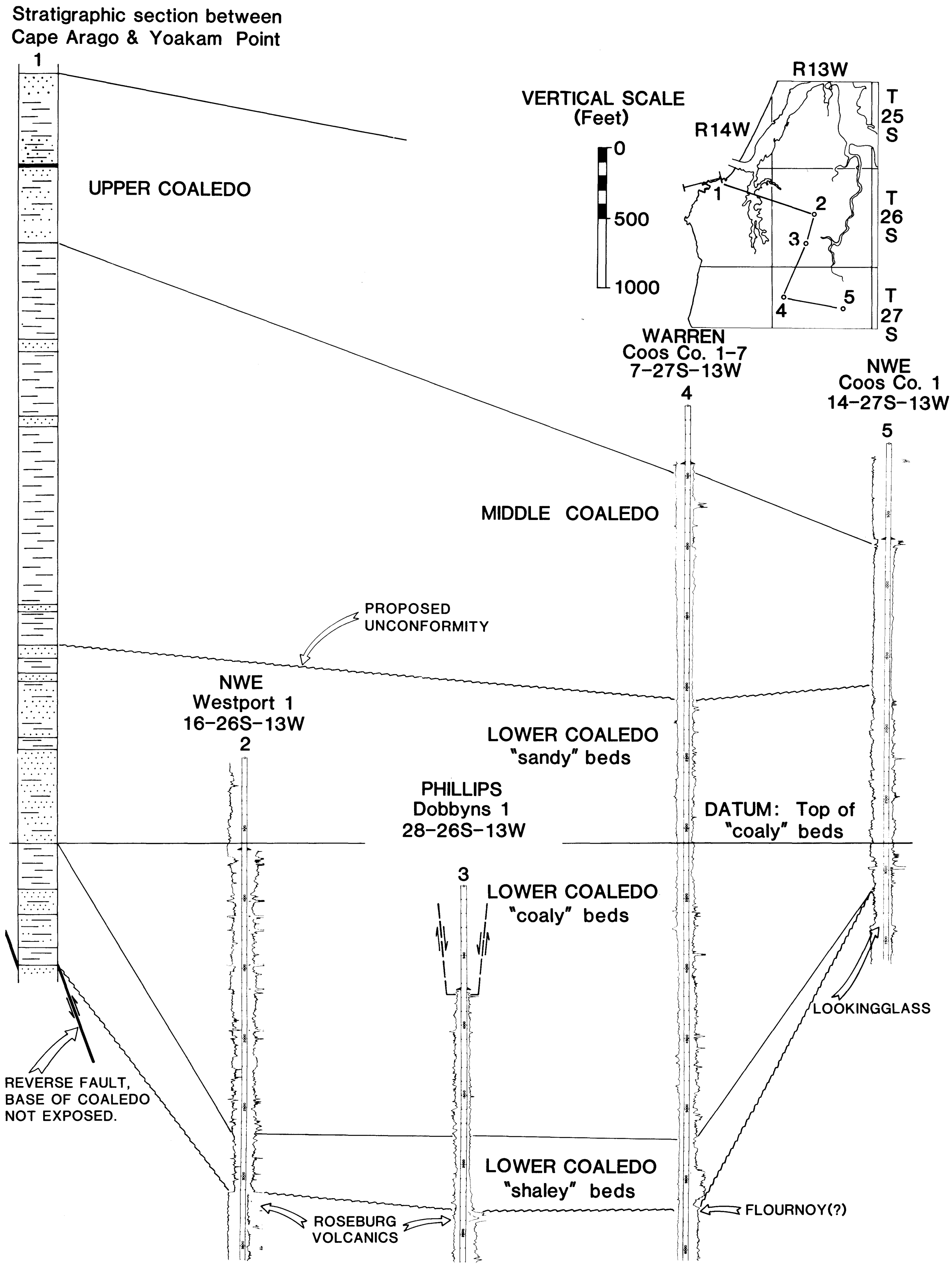

Figure 3. Subsurface stratigraphic correlations of the Coaledo Formation, Coos Bay basin, Oregon.

Table 1. *Locations of exploratory wells mentioned in text.*

NWE Westport 1	SW SE Sec. 16, T26S R13W
PHILLIPS Dobbyns 1	NW SW Sec. 28, T26S R13W
WARREN Coos Co. 1-7	SW SE Sec. 7, T27S R13W
NWE Coos Co. 1	NE SW Sec. 14, T27S R13W
NWE Fat Elk 1	NW SW Sec. 15, T28S R13W

these data. Subsurface data are essential to geological understanding in structurally and stratigraphically complex areas, yet too often such data have been unavailable in the Pacific Northwest. The writer also wishes to thank Ewart M. Baldwin for reviewing the manuscript.

AGE AND CORRELATION

An abundance of paleontological data is available from the Coaledo Formation (Detling, 1946; Cushman and others, 1947a,b; Bird, 1967; Rooth, 1974; McKeel, 1980). The unit is endowed with a diverse faunal assemblage. The microfauna indicates that the entire Coaledo correlates with the benthonic foraminiferal Narizian Stage of Mallory (1959). Traditionally, the Narizian Stage has been regarded by West Coast workers as late Eocene in age. More recently the Narizian Stage has come to be regarded as middle Eocene in age (Poore, 1980).

The Coaledo is but one of several contemporaneously deposited stratigraphic units in the Pacific Northwest. Correlative units include the Spencer Formation in the Willamette Valley and the Cowlitz Formation in northwestern Oregon and southwestern Washington.

PRE-COALEDO UNCONFORMITY

Allen and Baldwin (1944) suggested that a regional unconformity existed at the base of the Coaledo Formation. Overwhelming evidence for such an unconformity can be cited today. The most striking hiatus occurs in a small outcrop in the town of Bandon. Lower Coaledo sediments are in juxtaposition with the Jurassic Otter Point Formation (Link, 1970). Less striking, the Westport 1 and Dobbyns 1 wells encountered lower Coaledo sediments resting on the Paleocene Roseburg volcanics. In the NWE Coos County 1 well, the Coaledo is underlain by the lower Eocene Lookingglass Formation. In the NWE Fat Elk 1 well and numerous outcrops east of Coos Bay, the Coaledo overlies the lower middle Eocene Flournoy Formation.

STRATIGRAPHY

Lower Coaledo

Within the lower member of the Coaledo Formation, three basin-wide informal stratigraphic subdivisions can be recognized. They are, in ascending order, the shaley beds, the coaly beds, and the sandy beds (Figures 2 and 3).

Shaley beds: The shaley beds crop out in North and South Coves at Cape Arago, at Sacchi Beach, and at Merchants Beach. The top of the shaley beds at the coast is considered to be the base of the first overlying massive sandstone. The shaley beds, as described in the introduction, have been included by some authors in various other formations. Inland in the subsurface, the unit is recognized in the Westport 1, Dobbyns 1, and Warren Coos County 1-7 wells, where its thickness is 426, 530, and 500 ft, respectively. The microfauna of the shaley beds in the above three wells and at the Merchants Beach locality is Narizian (Bird, 1967; McKeel, 1980, and 1980, personal communication). The fauna described from the Sacchi Beach locality has both Narizian and Ulatisian affinities (Bird, 1967). The microfauna of North and South Coves is indeterminate with respect to age (Rooth, 1974). The fauna of the shaley beds in the Dobbyns 1 well appears to represent deposition in a cold-water, outer neritic environment (McKeel, 1980). Lithologically, the shaley beds consist of shale and mudstone, with lesser amounts of fine-grained sandstone and laminated siltstone. In the coastal outcrops, the shaley beds also contain spectacular channels. Erratic dipmeter attitudes in the shaley beds in the Warren Coos County 1-7 well may be indicative of similar channeling inland.

Coaly beds: The coaly beds of the lower Coaledo are not particularly well developed at Cape Arago, consisting of only a few thin carbonaceous lenses. Two mi south of the Cape near Sacchi Beach, the coaly beds are more evident. Lower Coaledo coals were mined inland at Lampa Creek as well as at several other localities. A 420-ft-thick coaly section along Lampa Creek contains seven individual coal beds (Allen and Baldwin, 1944). The coaly beds thicken eastward from the coast. In the Westport 1 and Warren Coos County 1-7 wells, the coaly beds have a thickness of 1,880 and 2,115 ft, respectively. The Dobbyns 1 well, drilled in 1944, is somewhat enigmatic since the coaly beds are only about 1,020 ft thick. Marginal marine rocks are reported between 450 and 650 ft in the well (McKeel, 1980). It is believed that the well cut a normal fault at 779 ft (the top of the coaly beds) that shortens the coaly section. The NWE Fat Elk 1 well began drilling in the coaly beds and encountered 840 ft of coal-bearing section before topping lower middle Eocene sandstones. The NWE Coos County 1 penetrated 305 ft of coal-bearing section.

The top of the coaly beds is recognized by the transition from coal-bearing nonmarine sediments to overlying marginal marine sediments. In the Westport 1 and the Warren Coos County 1-7 wells, the transition is also marked by the occurrence of a very coarse-grained, conglomeratic sandstone containing volcanic pebbles. The rocks immediately above the coaly beds in the Westport 1 and and NWE Coos County 1 wells contain a very shallow water fauna consisting of the foraminiferal genus *Elphidium* plus gastropod fragments and sponge spicules. In the central part of the basin, the coaly beds contain up to ten individual coal beds plus numerous thin carbonaceous zones. Electrical logs indicate the individual coal beds range between 2 and 10 ft in thickness.

Sandy beds: The sandy beds of the lower Coaledo are best exposed in the sea cliffs between Cape Arago and the Cape Arago lighthouse. Ryberg (1978) measured 1,365 ft of predominantly fine- to medium-grained, cross-bedded, and laminated sandstone along the coast. In the Warren Coos County 1-7 and the NWE Coos County 1 wells, the thickness of the sandy beds is 1,010 and 1,130 ft, respectively. Lithologically, the top of the sandy beds in both outcrop and the subsurface is abrupt. Faunally, the change is also distinct. The

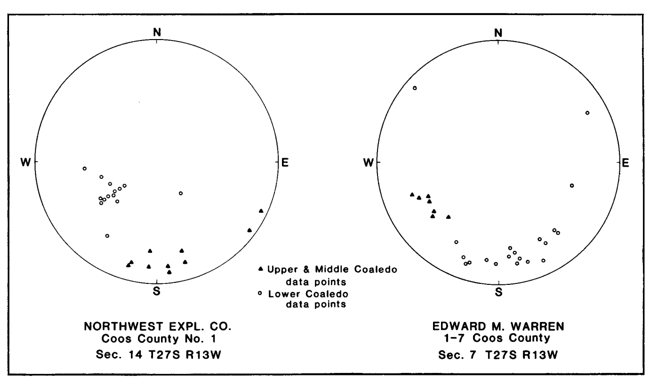

Figure 4. Stereographic plot on lower hemisphere of dipmeter attitudes.

top of the lower Coaledo sandy beds contains inner neritic to brackish-water forms, while the overlying middle Coaledo contains outer neritic to upper bathyal forms.

Middle Coaledo

The middle member of the Coaledo Formation is exposed at the coast between Yoakam Point and the Cape Arago lighthouse. The unit consists of 2,710 ft of thinly bedded, dark-gray mudstone and siltstone (Ryberg, 1978). The middle Coaledo thins eastward. Both the Warren Coos County 1-7 and the NWE Coos County 1 wells penetrated the unit in its entirety. In the wells, the observed thickness was 1,605 and 970 ft, respectively. The middle Coaledo microfauna present in the Coos County 1 well indicates a very rapid transgressive phase to middle bathyal depths, followed by a much slower regressive phase to middle neritic depths. This suggests the middle Coaledo shoreline at one time may have been a considerable distance eastward of the present-day outcrop limits.

Upper Coaledo

Only one oil and gas test well has penetrated a significant amount of the upper Coaledo. The NWE Coos County 1 cut 710 ft of upper Coaledo before reaching the middle member. Fifteen upper Coaledo coal core holes have been described from the Isthmus Slough-Beaver Slough area south of Coos Bay (Duncan, 1953). By correlating the deepest observed coals in the core holes with the deepest upper Coaledo coals encountered in the Coos County 1 well, a composite stratigraphic section can be extrapolated for the upper Coaledo along the eastern side of the basin. Core hole 7-10 (SW ¼ sec. 10, T. 27 S., R. 13 W.) appears to have penetrated 160 ft of Bastendorff Formation before reaching the Coaledo, providing an upper limit to the composite stratigraphic section. The thickness of the upper Coaledo in the eastern part of the basin is about 2,000 ft. This is considerably thicker than the 1,280 ft measured at Yoakam Point on the coast (Ryberg, 1978). There is only one coal bed present at Yoakam Point, while inland there are up to twelve individual coal beds. The westward thinning of the upper Coaledo, the decrease in number of coals, and the complementary westward increase in thickness of the middle Coaledo suggest the middle and upper members of the Coaledo are different facies of the same regressive depositional cycle.

LOWER/MIDDLE COALEDO UNCONFORMITY

In the coastal section near the Cape Arago lighthouse, the lower and middle members of the Coaledo appear to be conformable. Between the two units, however, there is an abrupt change in paleobathymetry, suggesting substantial vertical movement during Coaledo deposition (Rooth, 1974). Inland in the subsurface, there is evidence for an angular unconformity between the two members. Figure 4 is a stereographic plot of dip attitudes from the two wells for which dipmeter data are available. In both wells, the upper- and middle-member data points fall in one cluster, while the lower-member data points fall in a second cluster. While data from only two wells are not conclusive, there is other supporting evidence.

At Fat Elk, 2 mi southwest of the town of Coquille, surface mapping (Baldwin and Beaulieu, 1973) indicates an anticline cored by lower Coaledo and flanked by middle and upper Coaledo. Drilled on the crest of the structure, the NWE Fat Elk 1 well encountered only 840 ft of lower Coaledo, and then only the coaly beds. The sandy beds are not evident on the surface flanks of the structure. The Fat Elk anticline possibly was growing during Coaledo time, resulting in nondeposition of the lower Coaledo shaley beds and either truncation or nondeposition of the lower Coaledo sandy beds.

All three members of the Coaledo Formation are mappable separately in the western and southern portions of the basin. East of Coos Bay, it has been necessary to map the Coaledo as a single unit (Baldwin and Beaulieu, 1973), due, in part, to the eastward pinch out of the middle Coaledo shale and mudstone marker beds and possibly to truncation and onlap of the lower Coaledo by the middle and upper members. The Coaledo sandstone outcrops exposed east of Coos Bay may be entirely upper Coaledo.

CONCLUSIONS

The Coos Bay basin is a sedimentary basin in the true sense, with subsidence concurrent with sedimentation. The frequently studied coastal Coaledo outcrops on the western side of the basin are not representative of the entire formation. The basin axis and thickest sedimentary section appear to be east of the present-day coastline.

The lower member of the Coaledo has been subdivided into three informal units recognizable in the subsurface and in outcrop. In ascending order they are the shaley beds, the coaly beds, and the sandy beds.

The Coaledo Formation represents two predominantly regressive episodes of sedimentation separated by an unconformity. The lower Coaledo was deposited during the first episode, and the middle and upper members were deposited during the second. Perhaps further investigations will reveal an unconformity between the upper Coaledo and overlying Bastendorff Formation, with the Bastendorff and Tunnel Point sandstone representing a third sedimentary episode.

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(Coaledo Formation, *continued on p. 82)*

Finding formations fit for firing

by Ralph S. Mason, former State Geologist

The practice of ceramics has always depended on two basic elements: clay and fuel. The art and the industry of ceramics were born when primitive fire builders discovered that the clay right under their campfires not only turned red but became exceedingly hard. In the centuries that followed this important discovery, the use of fired clay increased and proliferated steadily throughout most of the world.

To be economically viable, clay working must be conducted at a place where there is a source of easily dug clay and a relatively cheap source of fuel. Modern improvements in transportation, both for bulk materials such as clay and for energy such as gas, oil, coal, and electricity, have blurred this historic relationship somewhat, but the low unit value of raw clay still greatly restricts the distance it can be moved from pit to kiln. It is mainly for such economic reasons that history, even pre-history, is firmly on the side of the craft potter who finds and digs his own clay.

Two hundred years ago, itinerant craft potters supplied households with ware made from clay found nearby and fired with wood cut at the site. By and large, settlements tended to locate near streams which provided a ready means of transportation in a land devoid of good roads. The flood plains on which the buildings were erected also supplied clay deposits, composed of clay particles that had been transported and deposited by water. These clays were rather of the common type, but they were readily available; the crude and not very durable wear produced from them was in character with the rough living conditions of the times.

The early-day potter rarely upgraded the clay he dug, since he had little equipment for doing so, and the market was content with the unbeneficiated product. Modern craft potters, however, have a variety of methods at their disposal for improving raw clays and glaze materials. Treatment may include crushing and screening, blunging and decantation, magnetic separation, and blending. But even today, some potters prefer to work with a low-grade clay and to produce ware of refined quality just by applying their skills.

The modern craft potter who wants to dig his own clay has both advantages and disadvantages over his earlier colleagues. On the plus side, the potter has access to a much wider area to look for suitable material, thanks to good roads and the automobile. He also has a great deal of information available in the form of reports and maps, helping him to winnow the potentially good sites from the poor ones. Another plus is a wide choice of digging and drilling equipment which can take much of the drudgery out of searching for and mining the clay.

The disadvantages of digging clay for your own pots pretty much center on the fact that most potters live and work in populated areas where there are many restrictions to prospecting and mining. With patience and effort, however, a potter can locate areas where there is not only clay but also no serious prohibition to removing it. One other factor must be considered: Digging clay, even with the help of mechanical equipment, can be rather strenuous, and a careful assessment of one's physical capabilities should be made.

Populated areas have one feature that can actually help in the search for clay: holes. Civilized countries can almost be rated as to their level of development by the size and number of holes they create. Here is a sampling of holes and excavations that can aid a potter: post holes, power-pole holes, basements, road cuts, wells, graves, and ditches. Road cuts generally top the list in being useful, since we have miles of them and the access, in most cases, couldn't be better. The material that comes out of such holes is an excellent indicator of what lies below the surface. If the spoil pile beside a hole looks interesting, grab a sample and run a few field tests, like making a ball and a snake. If these look good, try gritting some material between your teeth. Your teeth, when they are your natural ones, are remarkably sensitive to particle sizes. (The modern porcelain substitute, unfortunately, is quite insensitive to another clay's properties.) A propane torch can be used to make a rough firing test for color and behavior at high temperatures.

Clays passing these tests should be collected and given further examination in the studio. Be sure to keep good records as to where you took your samples; attach labels, tags, or other markings.

There is no sense in looking for something that you know little about. "Know before you go," is excellent advice. Hunting for clay is much like hunting elephants—just as you look for elephants in elephant country, so you look for clay in "clay country." Therefore, before you go off into the countryside looking for some clay, get all the information you possibly can. Check out reports on clay deposits, soil types, and geology; obtain topographic, soil, and geologic maps. If you are unfamiliar with the various clay-forming processes, read a college-level physical geology text on the subject.

Here is a suggested program for obtaining the information you will need: First, determine how far afield you plan on prospecting. Second, buy some detailed maps of the areas you have decided on. The topographic maps published by the U.S. Geological Survey are excellent. They show roads, streams, elevations (by means of contour lines), buildings, dams, power lines, and a land net which shows the legal divisions into sections, townships, and ranges. These maps are sold at many stationery stores, outdoor recreation shops, and state departments of geology. Soil maps published by the U.S. Soil Conservation Service usually cover an entire county and show the distribution of the surface soils, describing each type. County agents and, sometimes, libraries have these maps. Third, go to the appropriate state geology department or state university library and read any reports they have on the geology of your region. If you are unfamiliar with some of the terms used in the publications, pick up a geology text at your bookstore or at the college co-op.

Proper tools are a must for any successful prospecting trip. Figure 1 shows a suggested list of items to take. Quite possibly some of them will not be needed for your work, and again you may find some additional tools necessary. After a trip or two, you can trim or expand your equipment to fit your needs. Most of the items shown in the illustration can be obtained at hardware stores, particularly shops serving farming communities. Be sure to take your Good Manners with you; they may be the most important tool in the sack.

You are finally ready for your first clay-prospecting trip. You have read reports, have bought some maps and tools, and are itching to go find a deposit of good clay. Now, book learning is essential, but a good practical example of just what a deposit looks like is mighty helpful. A visit to a commercial clay plant in the general area of your interest could be most instructive. There were literally hundreds of clay pits in operation in Oregon and Washington fifty years ago, and many of

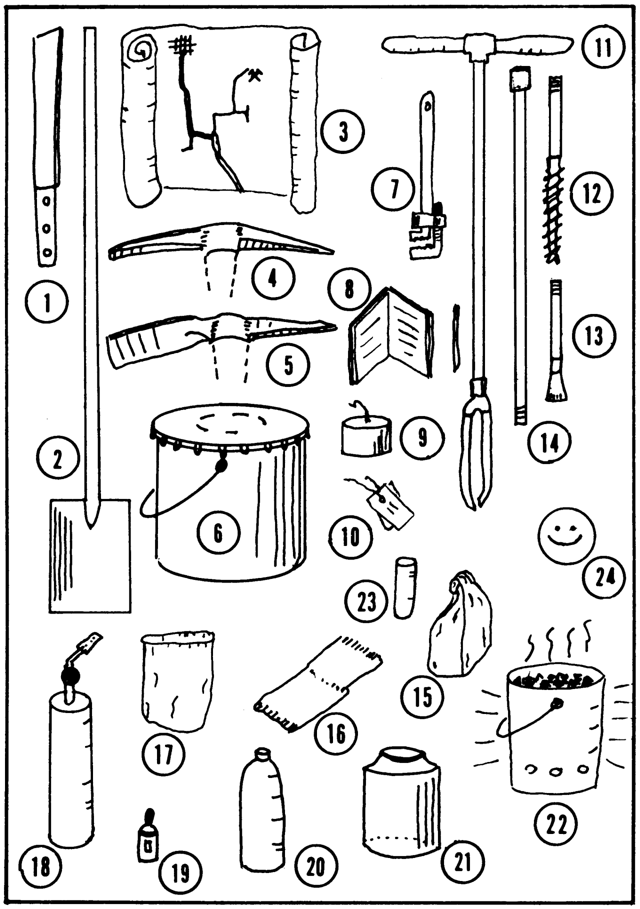

Figure 1. Typical equipment used for clay prospecting and field testing. (1) Corn knife. (2) Long-handled shovel. (3) Map. (4) Clay pick. (5) Mattock. (6) Plastic bucket with lid. (7) Stillson wrench. (8) Notebook, pencil. (9) String in container. (10) Labels. (11) Iwan-type soil auger. (12) Screw auger. (13) Chopping bit. (14) Extra length of pipe, 36 inches. (15) Sack lunch. (16) Old rags or towel. (17) Cloth or plastic sacks. (18) Propane burner. (19) Dropper bottle with 1:1 HCl acid. (20) Water bottle or canteen. (21) Glass gallon jar, wide-mouth. (22) Old bucket, hibachi, or barbeque. (23) Test tube. (24) Good Manners.

these were located in bottom land that was frequently flooded. Records of these operations are usually available in reports issued by either state, provincial, or federal agencies. Unfortunately, quite a few brick and tile plants have succumbed in recent years, but some of their clay pits are still accessible. Take a good look at the clay formation, the overburden, and the general setting in which the deposit is located. Chances are that similar conditions extend away from the pit and that some road cut in the vicinity can yield satisfactory clay.

The removal of some clay from such a spot should cause no problems, since cuts tend to slough down onto the road or drain ditch, and the clay removal does no harm. If in doubt about the propriety of digging along some road, you should talk to the roadmaster or his equivalent. For very small amounts of clay, it is better to let sleeping bureaucrats lie. Sometimes it is necessary to drill to get your samples. The Iwan-type soil auger works well in this service. Wear a sweatshirt or similar garment when drilling, since the auger handles are death on clothing with buttons. Also, do not keep anything in any pockets above your waist—the pocket contents seem to be attracted to the hole you are drilling, and retrieval can be difficult.

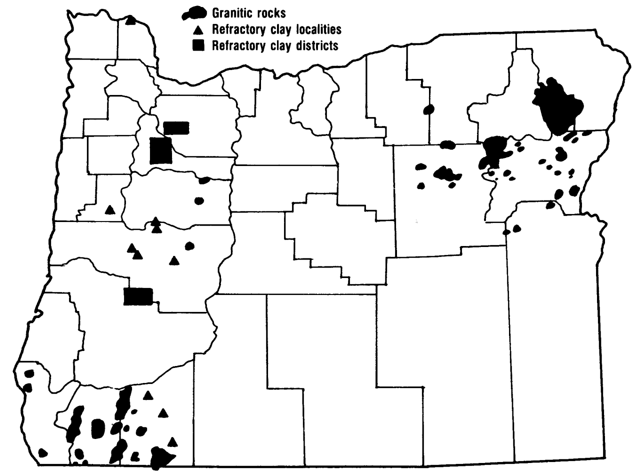

Figure 2. Areas of intrusive rocks and refractory clay districts and localities in Oregon.

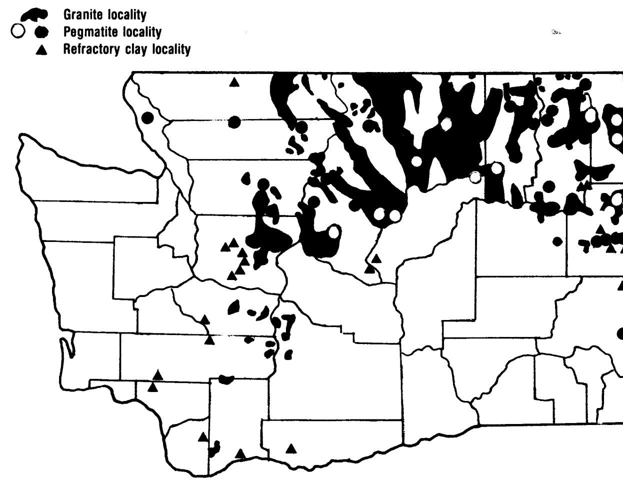

Figure 3. Areas of intrusive rocks and refractory clays in Washington.

Craft potters who are looking for clays of some higher grade, with a higher firing range and lighter color, may be interested in the refractory clay deposits scattered around the countryside, many of which are of the residual type. Unlike the transported clay deposits found on flood plains and along streams, the residual clays are directly associated with weathered granite and pegmatite and tend to occur in hilly or mountainous terranes.

In Oregon, granitic outcrops are found in the southwestern and northeastern corners of the state, somewhat removed from the population concentrations. In Washington, these same rock formations are more favorably located, extending across large areas of the northern half of the state. Figure 2 shows the distribution of the principal refractory clay localities and districts in Oregon. Also shown are the generalized areas of granitic rocks which, if sufficiently weathered, may form clay deposits of better-than-average quality. A report on the refractory clays of western Oregon by Wilson and Treasher (1938) is listed in the bibliography. Two somewhat similar publications by Wilson (1923) and Wilson and Goodspeed (1934) are also listed. Figure 3 shows the generalized localities for refractory clays, pegmatites, and granite in Washington. Before starting out for those granite-studded hills, please be advised that not all granites are weathered, and not all weathered granites are suitable for ceramic uses.

Finally, let me reiterate one bit of advice mentioned above: When you go out prospecting be sure and take your Good Manners with you. Good Manners open many doors that otherwise might be slammed tightly shut. Every square inch of the countryside is owned by somebody, and that somebody might take a very strong objection to your presence unless you conduct yourself most circumspectly. Remember that a low-iron clay is far less important than a lead-free body.

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Kelly, H.J., Strandberg, K.G., and Mueller, J.I., 1956, Ceramic industry development and raw-material resources of Oregon, Washington, Idaho, and Montana: U.S. Bureau of Mines Information Circular 7752, 77 p.

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Wilson, H., 1923, The clays and shales of Washington, their technology and uses: Seattle, Wash., University of Washington, Engineering Experiment Station Series Bulletin 18, 224 p.

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Wilson, H., and Treasher, R.C., 1938, Preliminary report of some of the refractory clays of western Oregon: Oregon Department of Geology and Mineral Industries Bulletin 6, 93 p.

For further references the reader may consult the several bibliographies in Ralph S. Mason's recent book, *Native Clays and Glazes for North American Potters. A Manual for the Utilization of Local Clay and Glaze Materials*, published in Portland by Timber Press (see review in *Oregon Geology* of February this year). □

Daylight fireball, December 16, 1981

At 11:06 a.m., Pacific Standard Time, December 16, 1981, a daylight fireball occurred over northwest Oregon and southwest Washington. The fireball was seen from Seattle, Washington, on the north, to Lincoln City, Oregon, on the south, and as far east as Portland, Oregon. This report is based on 21 sightings reported to the author.

The meteoroid apparently entered the atmosphere over the Cascade Mountains of southern Washington, coming down at an angle of 15° and heading west-southwest. Most observers reported the object to be about one-fourth the size of a full moon, with a flight time of 1½ to 5 seconds. The color of the fireball was blue-white to blue-green, with a long tail that changed color from yellow to orange to red. There were four reports of a vapor trail and one report of the fireball breaking up. There were two reports of a whistling sound but no reports of a sonic boom.

Since observers on the Oregon coast saw the fireball heading to the west, and since no sonic booms were reported by observers, it must be assumed that if the fireball produced any meteorites, they landed in the Pacific Ocean, where recovery is almost impossible.

Daylight fireballs are uncommon but seem to occur over Oregon once or twice a year. Readers sighting such phenomena are asked to contact the author at Cleveland High School, phone (503) 233-6441.

—Dick Pugh, Science Teacher, Cleveland High School, 3400 SE 26th, Portland, OR 97202

Volcanic hazards assessed for California's Long Valley-Mono Lake area

Future volcanic eruptions of moderate size, similar to those that have occurred frequently in the geologic past in the Long Valley-Mono Lake area, California, could seriously affect communities within about 50 mi of the area, according to a preliminary hazards assessment released by the U.S. Geological Survey (USGS), Department of the Interior. The area is just east of Yosemite National Park in east-central California. USGS scientists emphasized that no one was issuing a specific prediction of an immediate eruption in the area. No eruptions are known to have occurred within the past several centuries of historic records. Recent changes in earthquake patterns and other events, however, prompted the USGS to issue a notice of potential volcanic hazard for the Mammoth Lakes area, California, on May 26, 1982. This is the lowest of three levels of formal concern that can be issued by the earth science agency.

The hazards-assessment report was prepared in conjunction with the notice and was patterned after more detailed assessments that have been conducted by the USGS in other volcanic areas, such as Mount St. Helens, Washington; Mount Shasta, California; and Mount Hood, Oregon. The report, USGS Open-File Report 82-583, is titled *Preliminary Assessment of Potential Volcanic Hazards in the Long Valley-Mono Lake Area, East-Central California and Southwestern Nevada* and contains information on the possible kinds, scales, and consequences of eruptions that might be expected.

The volcanic-hazards notice was issued as a result of recently discovered intermittent swarms of earthquakes and spasmodic tremor and the outbreak of new steam vents in the area. Among other conclusions, these recent events suggest that a tongue of molten rock several miles below the land surface may be moving slowly upward.

The USGS notice states, "The ultimate consequences of this activity are uncertain. It is quite possible that no eruption will occur and that the magma will cool and solidify to form an intrusion at depth. If an eruption does occur, the possible consequences vary greatly in severity. The kinds of activity that might be expected include phreatic (steam) explosions, pumice and ash falls, pyroclastic flows, mudflows, and extrusion of a lava dome."

C. Dan Miller, a USGS geologist in Denver, Colorado, and principal author of the hazard assessment and an accompanying map, emphasized that the report is preliminary and based on the limited studies and data currently available. He said studies are now underway to provide a more comprehensive volcanic-hazard assessment for the area.

According to the preliminary hazards assessment, an explosive volcanic eruption of moderate volume in the Long Valley-Mono Lake area could send pyroclastic flows of hot-rock debris and gases surging over the land surface to distances of up to 12 mi from where the volcano vents. Such an eruption could also produce ash clouds that would deposit up to about 8 in. of ash at distances of about 20 mi from a vent and 2 in. of ash at distances of up to 50 mi.

Geologic studies show that volcanic eruptions of widely varying magnitude have occurred in the Long Valley-Mono Lake region during the last one million years, with the most recent eruption occurring sometime within the past 400 years. Miller said more eruptions can be expected in the future and that recent events indicate that an eruption could occur in the near future.

The USGS report and map concentrate on volcanic haz-

(**Volcanic hazards**, *continued on p. 82)*

OIL AND GAS NEWS

Columbia County

Reichhold Energy Corporation continues to drill in the Mist Gas Field after a successful redrill of Columbia County 13-1 in May. The most recent well is Columbia County 43-5, located in sec. 5, T. 6 N., R. 5 W., 1.5 mi from the nearest production. The total depth is 3,099 ft, but results from the logging of the well are not yet available.

Clatsop County

Exploration for oil and gas is once again taking place in Clatsop County after a hiatus of several months. Oregon Natural Gas Development Corp. is drilling Patton 32-9, a follow-up to its Johnson 33-33 well of last year, a dry hole. The new location is sec. 9, T. 7 N., R. 8 W., 3 mi east of Olney. ROVOR Drilling is the contractor, using the same rig that drilled the Johnson location, this time drilling to a proposed depth of 8,000 ft.

Douglas County

Florida Exploration Company continues to drill FEC 1-4 near the town of Drain. Difficulty with casing has slowed progress, with present depth of about 3,000 ft.

Malheur County

The Z & S Construction Company location reported on last month has been drilled to a total depth of 4,745 ft and abandoned as a dry hole. The company has not announced plans for further drilling in the county.

Northwest Association of Petroleum Landmen formed

On June 11, about 75 oil industry personnel, mostly landmen, met at Northwest Natural Gas Company headquarters in Portland for election of officers and adoption of bylaws. They were joined by Calvin Blue and Harry Sprinkle of the American Association of Petroleum Landmen. The elected officers include Kyle Huber, President; Garth Tallman, Vice-President; Ron Hordichok, Secretary; and Judith Hiserote, Treasurer. The Board of Directors consists of Kurt Humphrey, Alf Lausitzen, and Dolores Yates.

The purposes of the organization are to promote communication between members of the Association, government, community, and industry regarding energy issues; to educate the public about energy issues and about landmen; and to further the education of the petroleum landman.

There are over 100 members in this new organization.

Recent permits

Permit no.	Operator, well, API	Location	Status
217	Reichhold Energy Corp. Libel 21-15 009-00103	NW¼ sec. 15 T. 6 N., R. 5 W. Columbia County	Location ☐

(Coaledo Formation, *continued from p. 78)*

Ryberg, P.T., 1978, Lithofacies and depositional environments of the Coaledo Formation, Coos County, Oregon: Eugene, Oreg., University of Oregon master's thesis, 159 p.

Turner, F.E., 1938, Stratigraphy and Mollusca of the Eocene of western Oregon: Geological Society of America Special Paper 10, 130 p.

Weaver, C.E., 1945, Stratigraphy and paleontology of the Tertiary formations at Coos Bay, Oregon: Seattle, Wash., University of Washington Publications in Geology, v. 6, no. 2, p. 31-62. ☐

Last chance at old prices

Because of recent increases in publishing costs and postage, we find it has become necessary to raise the price of a subscription to *Oregon Geology*. Effective August 1, 1982, a one-year subscription to *Oregon Geology* will cost $6, a three-year subscription $15. At the same time, the prices of some of our other publications will be raised to cover the increased cost of mailing. The new prices will be printed on the back cover of the August *Oregon Geology*.

So, if you are thinking of renewing your subscription to *Oregon Geology* or buying some of our publications, July would be a good time to do it. ☐

Oregon High Desert Museum opens

After five years of planning and development, the Oregon High Desert Museum opened its doors to the public on May 29, 1982. Located 7 mi south of Bend on Highway 97, the museum features exhibits on the land and people of the High Desert, live-animal demonstrations, a forestry learning center, participatory activities for the public, traveling exhibits, outdoor trails, and special programs and classes on a variety of topics.

Summer hours are 9:00 a.m. to 5:00 p.m. daily through September 30. Winter hours are 9:00 a.m. to 4:00 p.m. daily starting October 1. The museum will be open every day except Thanksgiving, Christmas, and New Years Day.

Admission fee is $1 for adults, 50¢ for children 6 to 12 years of age. The museum phone number is (503) 382-4754. ☐

GSOC luncheon meetings announced

The Geological Society of the Oregon Country (GSOC) holds noon meetings in the Standard Plaza Building, 1100 SW Sixth Avenue, Portland, in Room A adjacent to the third floor cafeteria. Topics of upcoming meetings and speakers include:

July 16—*Preview of the President's Campout at Bend, Oregon (July 30-August 6)*: by President Ruth Hopson Keen. For more information about the campout, call 222-1430.

August 6—*Show and Tell*: Bring your favorite geologic specimens.

August 20—*Pictures of the President's Campout*: by Clair Stahl.

For additional information about the luncheons, contact Viola L. Oberson, Luncheon Chairwoman, phone (503) 282-3685. ☐

(Volcanic hazards, *continued from p. 81)*

ards from a possible moderate size explosive eruption with an ejected volume of as much as 0.25 mi³ of material. They also, however, show areas that could be severely affected by a catastrophic eruption similar to one that occurred in Long Valley about 700,000 years ago. That catastrophic eruption produced about 140 mi³ of ash and has not been equaled anywhere in the world during historic times. By comparison, the May 18, 1980, eruption of Mount St. Helens in southwestern Washington ejected only about 0.25 mi³ of ash.

Other authors of the report and map are Dwight R. Crandell, Donal R. Mullineaux and Richard P. Hoblitt, all USGS geologists in Denver, Colorado; and Roy A. Bailey, a geologist at the USGS National Center in Reston, Virginia.

Copies of USGS Open-File Report 82-583 may be purchased from the Open-File Services Section, Western Distribution Branch, U.S. Geological Survey, Box 25425, Federal Center, Denver, Colorado 80225. Prices are $2.50 for each paper copy and $1 for microfiche. ☐

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