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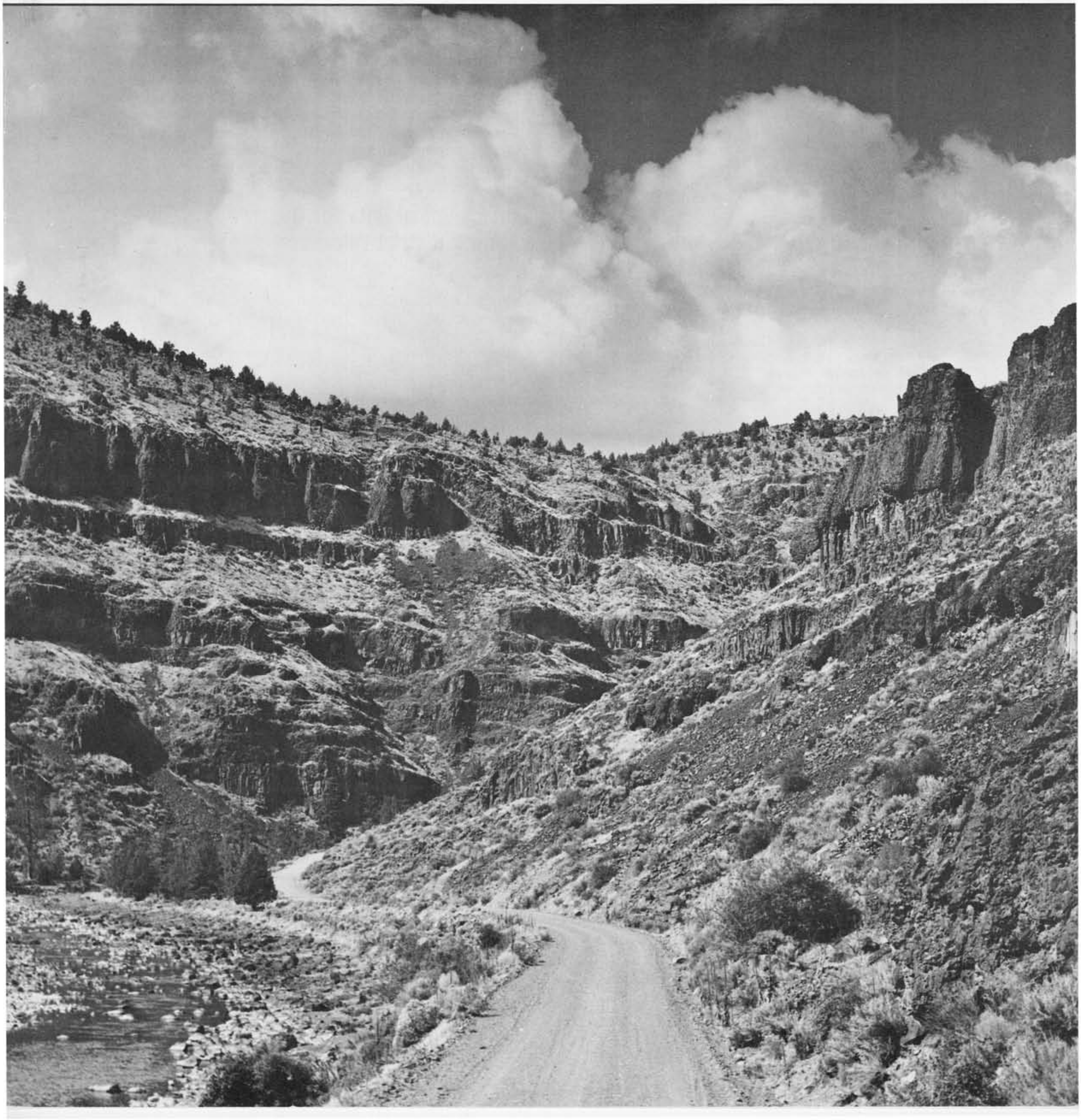

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COVER PHOTO

Crooked River canyon, east of Prineville, Oregon. Article beginning on p. 8 discusses thermal springs occurring near the confluence of the Crooked, Metolius, and Deschutes Rivers to the west of this area and west of Madras, Oregon. Photo courtesy of Oregon State Highway Commission.

Haagensen appointed to DOGAMI Governing Board; Rasmussen elected Chairman

Donald A. Haagensen, Portland, has been appointed by Governor Vic Atiyeh to the three-member Governing Board of the Oregon Department of Geology and Mineral Industries. He succeeds John Schwabe of Portland, whose term expired this fall. Schwabe served on the Board since September 19, 1977, and was the Board's Chairman since 1979.

Haagensen, an attorney with the Portland law firm of Schwabe, Williamson, Wyatt, Moore, and Roberts since 1977, received his bachelor of science degree from The College of Idaho, Caldwell (1967), and masters of science (1974) and law (1977) degrees from the University of Miami, Coral Gables, Florida.

At its December 8, 1981, meeting in Portland, the Board elected C. Stanley Rasmussen of Baker as its new Chairman. Rasmussen, who is Vice President and Oregon Electric Division Manager of CP National, has been a member of the Governing Board since fall of 1979. □

Geochemical data for Quartzville mining district released

Geochemical data for the Quartzville mining district in Linn County are available now in an open-file report recently released from the Oregon Department of Geology and Mineral Industries (DOGAMI). The Department has placed on open file Report 0-81-8, *Reconnaissance Geochemical Study of the Quartzville Mining District, Linn County, Oregon*, by Steven R. Munts.

The 14-page report includes tabulated results of analyses for lead, zinc, and copper for 27 samples of altered volcanic host rocks, 47 samples of granitic intrusive rocks, and 134 soil and sediment samples. The rock samples were also analyzed for molybdenum and silver. A sample location map (scale 1:12,000) is keyed to the sample numbers in the tables.

The Quartzville mining district is one of Oregon's well-known, older mining areas. Organized in 1864 and operated mostly in the 1860's and 1890's, it has been the object of intensive geologic investigation in recent years.

DOGAMI Open-File Report 0-81-8 is now available at the Oregon Department of Geology and Mineral Industries, 1005 State Office Building, Portland, OR 97201. The purchase price is $4.00. Orders under $20.00 require prepayment. □

Meteorite information requested

A fireball was sighted Thursday night, December 3, 1981, between 10:20 and 10:25 p.m. in the Estacada-Molalla area near Portland. Anyone with information about the event or the meteorite that caused it is asked to contact Dick Pugh, Cleveland High School. His phone number during the day is (503) 233-6441. □

CONTENTS

Problems in the regional stratigraphy of the Strawberry Volcanics

by Greg Wheeler, Department of Geology, California State University at Sacramento, Sacramento, Calif. 95819

ABSTRACT

Some portions of the Strawberry Volcanics of northeastern Oregon have lost petrographic and stratigraphic identity because intrusive and volcanic rocks that are not stratigraphic correlatives with the Strawberry Volcanics in the type locality have been included in the unit.

Flow units of the Strawberry Volcanics along the Middle Fork of the John Day River near Bates, Oregon, are basalt and andesitic basalt. These rocks are columnar jointed and have platy jointing perpendicular to the flow surface. A potassium-argon age of 9.96±0.24 m.y. (million years) and leaf fossils found in intercalated diatomite pods support a middle to late Miocene age for these rocks. Elsewhere, other rocks of the volcanic series have been dated at between 10 and 20 m.y.

Although many intrusive rocks in the Strawberry Volcanics outcrop area have previously gone unnoticed, they can be distinguished from stratigraphically significant flow rock by their metamorphosed and iron-stained contact zones; concentric, concave-outward joint patterns; and absence of some flow structures. A 40.06±1.06-m.y. age for the intrusive plug at Cow Camp, just east of Bates, Oregon, confirms the Eocene age of this intrusion. The Cow Camp plug is representative of many other intrusions which have been mapped as Strawberry Volcanics but which are actually equivalent in age to the Clarno Formation. Age determinants in other intrusions give an Oligocene age contemporaneous with John Day Formation volcanism. Some intrusions may be nearly contemporaneous with the flows of the Strawberry Volcanics which they intrude.

INTRODUCTION

Much of the 161,000 km² (62,100 mi²) of eastern Oregon is covered by Tertiary-age volcanic rock. Rocks mapped as Strawberry Volcanics cover approximately 2,500 km² (975 mi²), mostly in eastern Grant and western Baker Counties (Brown and Thayer, 1966; Robyn, 1977; Walker, 1977). The Canyon City 1°×2° quadrangle contains 80 percent of the mapped outcrops of the formation (Figure 1).

The rocks were first described by Thayer (1957) (Figures 1 and 2) at the type area at Strawberry Mountain, which is 27 km (17 mi) southeast of John Day, Oregon. The principal sources of the Strawberry Volcanics are two eruptive vent complexes in Unity Basin east of the type locality (Robyn, 1977, p. 144). The formation was originally described as "pale-gray, fresh basaltic to andesitic hypersthene-bearing lavas," with minor amounts of more silicic volcanic rock (Thayer, 1957, p. 237). Brown and Thayer (1966) included olivine basalt, dacite, and rhyolite in their descriptions of rocks mapped as Strawberry Volcanics in the Canyon City quadrangle. Thayer and Brown (1973, p. 492) described a 2,100-m (6,900-ft)-thick section of Strawberry Volcanics which is half rhyolite and half andesite in the Ironside Mountain quadrangle. Robyn (1978, p. 144) states that the Strawberry Volcanics are characteristically calc-alkaline andesites, but their composition ranges from high-alumina basalts to dacite. Thus the original petrographic description has been expanded to include many varieties of volcanic rock.

Thayer (1957, p. 239) considered the Strawberry Volcanics equivalent to the upper Miocene Columbia River Basalt of northeastern Oregon. Potassium-argon ages on rocks mapped as Strawberry Volcanics (reported in Wheeler, 1976, p. 68) within the Canyon City 1°×2° quadrangle (Brown and Thayer, 1966) range from late Miocene to Eocene. Robyn (1977) has proved that the majority of the Strawberry Volcanics were deposited between 15 and 20 m.y. ago but that volcanism began 20 m.y. ago and continued episodically until at least 10 m.y. ago.

This study was undertaken to help clarify the stratigraphic significance and petrographic identity of the Strawberry Volcanics. Three weeks were spent in reconnaissance mapping of the Strawberry Volcanics in the Canyon City 1°×2° quadrangle. Two more weeks were spent in detailed mapping and study of the northwestern outcrops of Strawberry Volcanics in the Bates 15-minute quadrangle, a part of the Canyon City 1°×2° quadrangle. The detailed study was a small part of a doctoral dissertation (Wheeler, 1976).

GENERAL CHARACTER

Strawberry Volcanics rocks in the Bates quadrangle are gray, with light-green mottling and thin, pinkish veins of

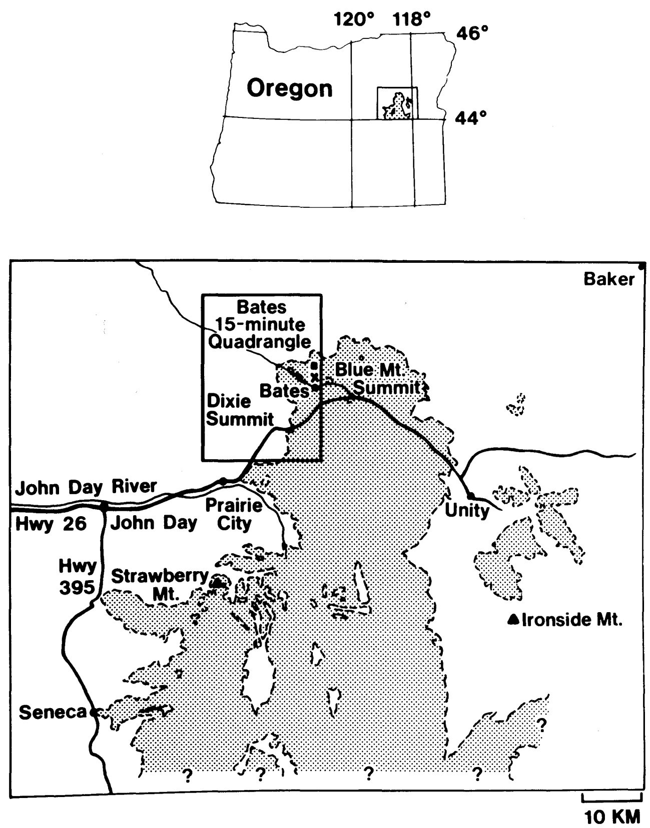

Figure 1. Map showing the extent of rock units included in the Strawberry Volcanics (stippled pattern). Solid black block marks Vinegar Hill, the collection locality of fossils listed in Table 1. X marks the collection locality of basaltic andesite dated 9.96±0.24 m.y. using potassium-argon whole rock analysis.

Figure 2. Basaltic to andesitic hypersthene-bearing lavas in the Strawberry Volcanics type section immediately west of Strawberry Lake on Strawberry Mountain.

altered iron minerals. Microscopic studies indicate the rock is 85 percent zoned plagioclase with An_{35} rims and An_{45} cores. Cumulophyric clots of plagioclase and augite are common. No olivine and only a trace of hypersthene were found. The lack of vesicles in most rock samples in this area indicates low gas content. This mineralogy is distinct from the hypersthene-rich basaltic andesites originally described by Thayer (1957, p. 237) as characteristic of the type Strawberry Volcanics.

Most of the basaltic andesite that crops out northwest of Bates, Oregon, has columnar jointing; in some areas, such as the east summit areas of two hills* in the east-central portion of the Bates 15-minute quadrangle, columns have fallen intact to form large "post-pile" deposits. Whether or not the columnar jointing is apparent, platy jointing perpendicular to flow surfaces is pervasive. Weathering of these resistant outcrops produces large quantities of rubble which cover the gentle slopes (Figure 3). The platy jointing found near Bates is not present in many of the outcrops studied further south. Individual flows of basaltic rock are much more distinct near Strawberry Lake than further to the north.

Leaf-bearing diatomite and diatomaceous tuffs occur interbedded with the columnar-jointed volcanic rocks on lower Vinegar Creek in the Bates 15-minute quadrangle and elsewhere in the northern part of the area mapped as Strawberry Volcanics. The Slide Creek flows at Vinegar Creek are considered by Robyn (1977, p. 17, 31) to be basal flows of the Strawberry Volcanics.

The dips of the beds are always gentle. Beds dip 13° to the southwest and strike northwesterly at Vinegar Creek. Similar low dips were measured on Strawberry Mountain. The aggregate thickness of flows appears to be less than 170 m (560 ft) near Bates, but the unit becomes thicker toward Strawberry Mountain. A 2,100-m (6,900-ft) section has been described in the Ironside Mountain 30-minute quadrangle (Thayer and Brown, 1973, p. 492).

CORRELATION AND AGE

The Strawberry Volcanics are unconformable over all older rocks of the region. Volcanic mudflows of the Clarno Formation underlie the Strawberry Volcanics along the northern and eastern edges of the area mapped. The Clarno Formation dips 10° to 20° more steeply than the Strawberry Volcanics. The contact between the two units is marked in many places by a soil horizon, baked zone, and considerable topographic relief along the old erosion surface. Steeply dipping pre-Tertiary rocks directly underlie the Strawberry Volcanics at some localities.

Brown and Thayer (1966) considered the Strawberry Volcanics equivalent to the Columbia River Group. The group is separated by a marked unconformity from the overlying Rattlesnake Formation of middle Pliocene and Pleistocene(?) age (Shotwell, 1956, p. 719) and includes the Mascall Formation. Brown and Thayer (1966) believed the Columbia River Group interfingers with the Strawberry Volcanics in the John Day River valley. The basalt flows of the Columbia River Group have recently been separated from the sedimentary units and are now called the Columbia River Basalt Group (Griggs, 1976, p. 6; Swanson and others, 1979, p. 15). Brown and Thayer (1966) stated that flows belonging to the Strawberry Volcanics interfinger with the early Pliocene lacustrine deposits in the Unity Basin (Shotwell, 1956). This interfingering relationship has been confirmed in remapping of the area by Robyn (1977, p. 7).

* One hill in sec. 5, T. 10 S., R. 35 E., can be identified on a topographic map by its elevation of 5,492 ft, the other hill in sec. 8, T. 10 S., R. 35 E., by an elevation of 4,765 ft.

Figure 3. Rubble along Vinegar Creek 1.5 km (1 mi) east of Bates, Oregon. The Strawberry Volcanics exhibit columnar joints truncated by platy jointing.

Thayer's conclusion that the Strawberry Volcanics were contemporaneous with the Columbia River basalt lavas was partially based on evidence obtained from exposures in cirques along the north side of Strawberry Mountain. There, according to Thayer, "basalts indistinguishable from known Columbia River basalt between Mt. Vernon and Picture Gorge" are intercalated with lower flows of the Strawberry Volcanics (Thayer, 1957, p. 237). However, the basalt flows at Strawberry Mountain are not continuous with Columbia River basalt units and are equally well interpreted as basaltic members of the Strawberry Volcanics. Thayer and Brown (1973, p. 492) describe basalt units such as these in Strawberry Volcanics along King and East Camp Creeks in the Ironside 30-minute quadrangle. Many such basalt flows are described by Robyn (1977).

The Strawberry Volcanics are not in contact with the Columbia River Basalt Group in the Bates quadrangle nor do they contact proved Columbia River Basalt Group or Mascall Formation rocks at any known outcrop (Brown and Thayer, 1966; Robyn, 1977; and personal field investigations).

Pods of intermixed diatomite and tuff between flows in the northwestern part of the mapped area probably formed in small ponds on the old flow surfaces. Many of these pods contain a wide variety and large quantities of leaf and seed fossils. Fossil plants collected 60 m (200 ft) stratigraphically below flows dated as 9.96 m.y. old (Wheeler, 1976, p. 68) from the NW¼ sec. 16, T. 11 S., R. 35 E., in the Bates quadrangle (Figure 1), were submitted to Charles Smiley of the University of Idaho. Smiley identified 21 plant species (Table 1) "of Miocene age but probably not as old as the Mascall." The flora "could well be as young as the lower Ellensburg (probably about 12 m.y.) or the upper Miocene Hog Creek of Idaho" (1977, written communication). Chaney (1959, p. 61) describes this fossil locality and others just to the east. He states that there is "no reason to question the conclusion that the leaf-bearing strata and the basalts below and above them were laid down with no perceptible break in time" (p. 62). Field observations of this author concur with those of Chaney. The fossil evidence yields an age significantly younger than the 15-m.y. age suggested by Robyn (1977, p. 17, 31) for these rocks.

Rocks mapped as Strawberry Volcanics have yielded a wide range of potassium-argon ages. Walker and others (1974) report an age of 12.2 ± 0.4 m.y. for a rhyolite which is 17 km (10 mi) southeast of Seneca and which has been mapped as Strawberry Volcanics. J.F. Sutter dates a "massive andesitic lava" near the summit of Strawberry Mountain as 14.2 m.y. old (A.R. McBirney, 1974, written communication). In contrast to these Miocene ages are the ages of 24.3 m.y. for an "andesitic lava 3.2 km (2 mi) south of the north boundary of Malheur National Forest on the main road south of Prairie City" and of 29.4 m.y. for a "basaltic andesite 3.5 km (2.2 mi) east of the road to High Lake on the road to Seneca" (McBirney, 1974, written communication). On the basis of potassium-argon whole rock analysis, Sutter dates a basaltic andesite sample collected by the author from near the base of the Strawberry Volcanics section at the Bates airstrip as 9.96 ± 0.24 m.y. old (Figure 1).

Table 1. *Strawberry Formation flora species list. Collected by G.R. Wheeler in Bates quadrangle, Oregon, NW¼ sec. 16, T. 11 S., R. 35 E. Species identifications by C.J. Smiley, University of Idaho, December 1972*

Conifers:
- *Picea lahontense* MacGinitie
- *Pinus tiptoniana* Chaney and Axelrod
- *Pseudotsuga* (or *Tsuga*) *sonomensis* Axelrod
- *Sequoia affinis* Lesquereux
- *Thuja dimorpha* (Oliver) Chaney and Axelrod

Dicots:
- *Acer bendirei* Lesquereux
- *Betula fairii* Knowlton
- *Castanea spokanensis* (Knowlton) Chaney and Axelrod
- *Cercidiphyllum crenatum* (Unger) Brown
- *Fagus* cf *idahoensis* Chaney and Axelrod
- *Fagus washoensis* LaMotte
- *Ostrya oregoniana* Chaney
- *Persea pseudocarolinensis* Lesquereux
- *Populus lindgreni* Knowlton
- *Populus voyana* Chaney and Axelrod
- *Quercus dayana* Knowlton
- *Quercus eoprinus* Smith
- *Quercus simulata* Knowlton
- *Salix knowltoni* Berry
- *Sassafras* cf *columbiana* Chaney and Axelrod
- *Zelkova oregoniana* (Knowlton) Brown

INTRUSIVE ROCKS

Failure to distinguish extrusive from intrusive rocks explains, in part, the wide range of potassium-argon ages attributed to the Strawberry Volcanics. Some intrusive rock units included with the Strawberry Volcanics may be nearly contemporaneous with the flow units. However, the Oligocene ages of

Figure 4. An andesite plug in the Clarno Formation along Camp Creek, sec. 25, T. 10 S., R. 32 E.

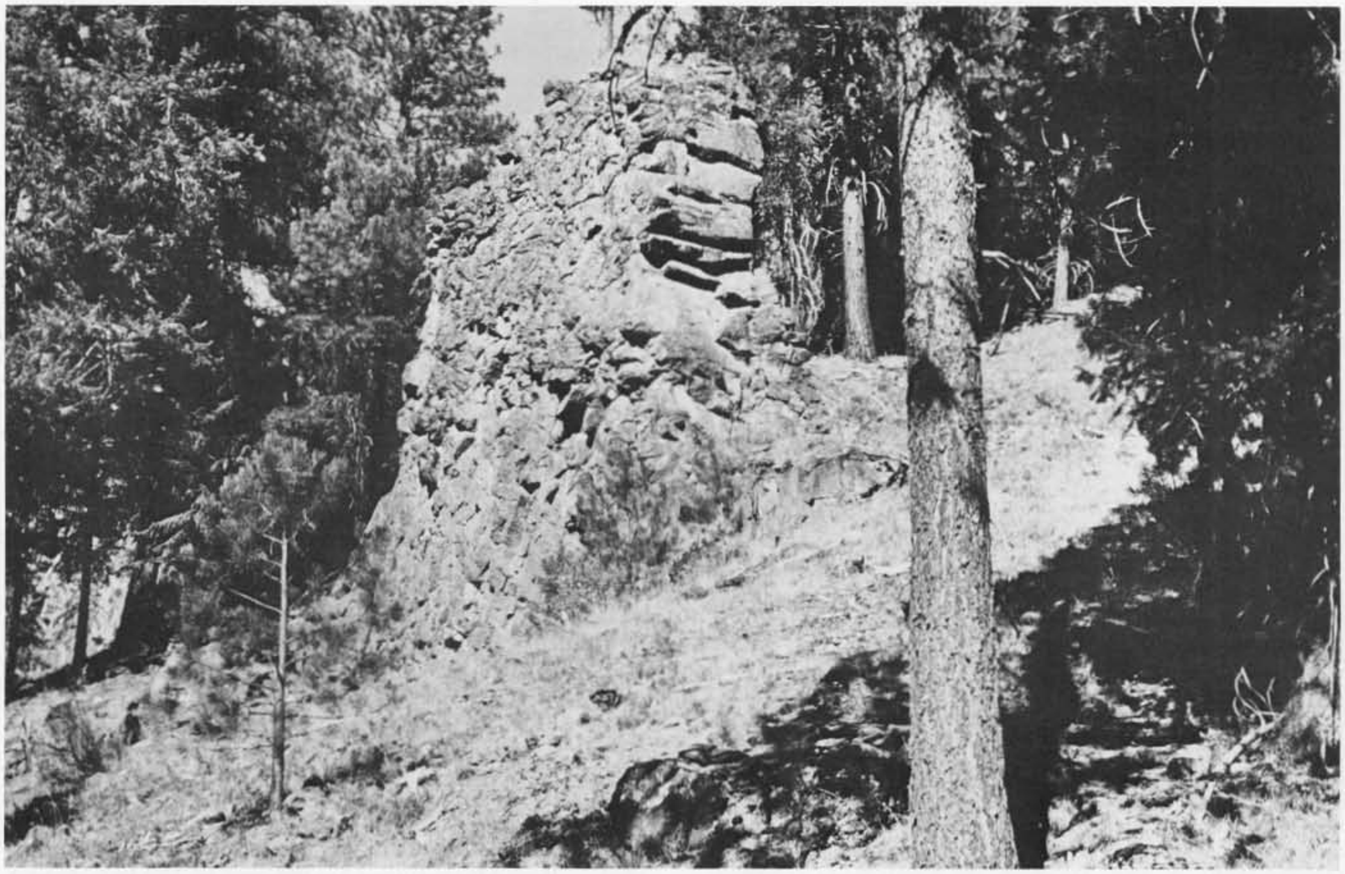

Figure 5. Hornblende andesite dike in the Clarno Formation northwest of Bates, Oregon, along the Middle Fork Road, sec. 5, T. 11 S., R. 34 E.

the above-mentioned two samples reported by McBirney must belong to rocks of an earlier, pre-Strawberry episode of igneous activity. These older rocks of roughly John Day age may be equivalent to small intrusions along U.S. Highway 26 near Dixie Summit and to many undated intrusions into the Clarno Formation of the Mitchell quadrangle to the west.

The large outcrop at Blue Mountain Summit on U.S. Highway 26 and the 0.1-ha (0.25-acre) outcrop at Cow Camp, east of Bates, are definitely intrusive. The steeply dipping contact with Eocene Clarno Formation conglomerate is brecciated, baked, and iron stained. The andesite at both locations has concentric, concave-outward joints such as those typically developed in a dome. The joints are closely spaced (10-20 cm [4-8 in]) and parallel to formational contacts. There are no flow structures and no columnar joints in these outcrops. Rocks collected by the author from the Cow Camp plug were dated by Sutter (1975, written communication) with potassium-argon methods. The resulting age of 40.06 ± 1.06 m.y. is well within the Clarno age group. There are many intrusives in the Clarno Formation (Figures 4, 5, and 6). This author believes that many intrusives of Clarno age have been mapped as Strawberry Volcanics, as was the Cow Camp plug.

CONCLUSIONS

Robyn's (1977) conclusion that the Strawberry Volcanics represent episodic eruptions beginning 20 m.y. ago and extending to the late Miocene is well supported. Although age determinants indicate contemporaneity of the Columbia River Basalt Group (Swanson and others, 1979) and the Strawberry Volcanics, no contacts between these units have been identified. Fossil evidence from the Bates quadrangle, potassium-argon ages from rocks at the Bates airstrip and the type locality, and field relationships indicate that the age of the Strawberry Volcanics is middle to late Miocene in much of the Canyon City $1° \times 2°$ quadrangle. This portion of the Strawberry Volcanics postdates Columbia River Basalt Group flows in that area. The petrographic variety in this post-Columbia River Basalt Group portion of the Strawberry Volcanics is not great. The majority of rocks are andesites and basaltic andesites.

Some intrusive units previously included in the Strawberry Volcanics are parts of earlier igneous sequences and should be recognized and excluded from this formation.

ACKNOWLEDGMENTS

Thanks are due to C.J. Smiley of the University of Idaho who identified fossil leaves and to J.F. Sutter who supplied

Figure 6. Sill in the Clarno Formation, near Sunshine Guard Station, sec. 26, T. 10 S., R. 33 E.

two critical radiometric dates through A.R. McBirney of the University of Oregon. Early stages of the research and writing were greatly aided through discussions with H.A. Coombs, E.S. Cheney, E.B. McKee, and H.E. Wheeler of the University of Washington and with T.P. Thayer of the U.S. Geological Survey. C.C. Plummer and N.C. Janke of California State University, Sacramento, critically reviewed an early manuscript. H.C. Brooks of the Oregon Department of Geology and Mineral Industries and A.R. McBirney of the University of Oregon reviewed a later draft. Financial support for this research project included a Geological Society of America Penrose Grant in both 1971 and 1972. I also wish to acknowledge support, both financial and in geologic interpretation, from the Oregon Department of Geology and Mineral Industries.

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Wheeler, G.R., 1976, Geology of the Vinegar Hill area, Grant County, Oregon: Seattle, Wash., University of Washington doctoral dissertation, 94 p. □

Short course on diatoms to be taught in Canada

L. H. Burkle of the Lamont-Doherty Geological Observatory will teach a two-day short course on diatoms on March 8th and 9th, 1982, at the University of British Columbia. The course will deal with the morphology, paleoecology, and fossil record of this important fossil group, with particular emphasis on the North Pacific. For details contact Paul L. Smith, Department of Geological Sciences, University of British Columbia, Vancouver, B.C., Canada, V6T 2B4. □

OIL AND GAS NEWS

Willamette Valley:

After drilling to a depth of 6,005 ft, Reichhold Energy Corp. has abandoned its Bagdanoff 23-28 near Woodburn. The well, the deepest ever drilled by Paul Graham Drilling Co., was plugged on November 17, 1981, after four weeks of drilling.

Clatsop County:

Oregon Natural Gas Development Co. drilled to a total depth of 10,006 ft on its Johnson 33-33 south of Svensen. The ROVOR rig that drilled the hole has been moved to Yakima, Washington, for Shell Oil Co., and the well is now being tested using a John Taylor Drilling rig.

Douglas County:

As we reported last month, Florida Exploration Co. has applied to drill a 10,000-ft well in sec. 4, T. 21 S., R. 6 W. Because the well will be closer than 500 ft from a spacing unit boundary, a hearing was held December 7, 1981, to hear comments by the neighboring mineral rights owners. The following day, the Governing Board of the Oregon Department of Geology and Mineral Industries agreed to hold the hearing open for an additional 30 days so that further written comments could be accepted. A decision on whether to grant the permit is expected from the Board on January 25, 1982.

Mist Gas Field:

American Quasar Petroleum has once again drilled in the Mist Field after an absence of several months. Benson Timber 8-14 was spudded November 21, 1981, in sec. 8, T. 6 N., R. 4 W., and in only a few days a total depth of 2,196 ft was reached. The hole was dry, however, and was abandoned on November 27, 1981.

Proposed changes to Administrative Rules:

Due to legislation passed by the 1981 session of the Oregon Legislature, the Department of Geology and Mineral Industries is proposing changes to its Administrative Rules governing oil and gas drilling. Comments have been gathered from industry and from other state agencies on the first draft of the rules. The proposed rules in draft form will soon be publicized, and a date set for a hearing on the rules.

Proposed changes to the rules include:

1. New definitions.
2. Change in information on application to drill.
3. Change in time from 20 to 60 days for filing data.
4. Possible extension of 2-year confidentiality of data.
5. Change in requirements for directional surveys.
6. Removal of mandatory hearings for spacing rule exceptions.
7. Change in abandonment plugging requirements.

Division of State Lands schedules lease sale:

The Oregon Division of State Lands has scheduled its next lease auction for February 24 and 25, 1982, to be held at the Marriott Hotel in Portland. Nominations for over 125,000 acres in 14 counties have been received. The counties with the most acreage nominated include Malheur, Gilliam, Harney, Lake, Marion, Clatsop, and Clackamas. Other counties receiving nominations are Columbia, Morrow, Umatilla, Union, Washington, Yamhill, and Sherman.

The auction will begin at 9 a.m. each day. Questions about the lease sale may be directed to the Division of State Lands, phone (503) 378-3805. □

Thermal springs near Madras, Oregon

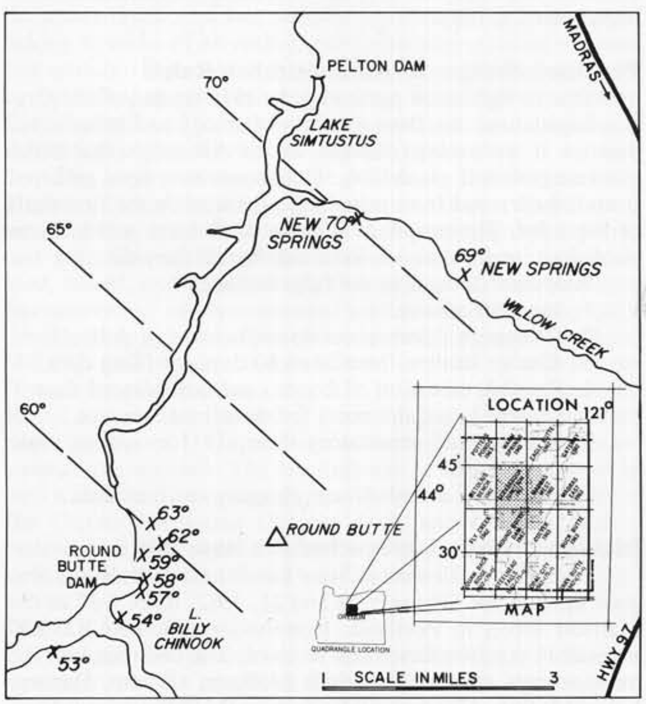
by Mel S. Ashwill, 940 SW Dover Lane, Madras, OR 97741

Before Portland General Electric Company (PGE) constructed Pelton Dam (late 1950's) and Round Butte Dam (completed 1964) on the Deschutes River near Madras, Oregon, it was known that water from Round Butte Spring, located about 0.8 km (0.5 mi) downstream from Round Butte Dam, was of a higher temperature than other springs in the area. Preparatory studies for the construction of Round Butte Dam identified at least seven more low-temperature thermal springs in the vicinity.

In the first few years following the filling of Lake Simtustus (Pelton Dam), among the many new springs that appeared about its perimeter was a group of seven new thermal springs which became activated approximately 3.5 km (2.2 mi) east of the impoundment. These springs are just above creek level in Willow Creek Canyon and approximately 91 m (300 ft) above the normal pool level of the lake. The subsequent filling of Lake Billy Chinook (Round Butte Dam) resulted in more new springs, including another group of seven new thermal springs at the mouth of Willow Creek Canyon, about 61 m (201 ft) above Lake Simtustus level. This sequence of events was reported by several local residents and was confirmed by Vic Bacon (1980, personal communication), who was project manager during the construction of Round Butte Dam.

In the spring and summer of 1980, this author was guided to the sites of these new thermal springs by Bill Robinson and Ray Grant of Madras. At that time, temperature measurements and photographs were taken.

The area discussed in this paper lies in Jefferson County, Oregon, approximately 11 km (7 mi) west of the city of Madras. Thermal springs emerge along both banks of the Deschutes River, with the majority on the east bank, and also in lower Willow Creek Canyon. The southwesternmost spring of the group is in the SE¼ sec. 22, T. 11 S., R. 12 E. The northeasternmost site is in the NW¼ sec. 32, T. 10 S., R. 13 E. An intensive search for further extensions of the thermal area by means of spring- and well-temperature measurements was not made by the author; the bounds of the area as well as the direction of thermal gradients remain undetermined.



Location and temperatures (in degrees Fahrenheit) of selected springs in the area. Direction of gradient lines is an estimate only, based on direction of recent linear features locally and correlation with Pipp Spring, a 61°F spring just west of the area shown.

Group of seven thermal springs (left center) emerging from base of thick basalt flow at mouth of Willow Creek. Streams from springs descend steeply to road level.

Previous studies of the thermal springs in existence prior to construction of the dams include those of E.T. Hodge (1958) and of other geologists who did work for Portland General Electric Company (Bechtel Corporation, 1958).

The geologic units in the area are middle Miocene to early Pliocene Deschutes Formation, volcanic rocks, and Quaternary sediment, all of Farooqui, Beaulieu, and others (1981) and Farooqui, Bunker, and others (1981). Exposures consist of sedimentary beds of fluviatile and lacustrine origin, with interbedded basalt flows, mudflows, ash flows, and pyroclastic material. Basaltic lava flows form a plateau that has been deeply eroded by the Deschutes, Crooked, and Metolius Rivers. Above the basaltic plain rises Round Butte, a shield volcano capped by a cinder cone dated at 5.9 ± 0.6 m.y. (Farooqui, Bunker, and others, 1981).

The first of the two groups of new springs visited by the writer includes seven springs and is in the SW¼ sec. 30, T. 10 S., R. 13 E., about 61 m (201 ft) higher than and immediately above the place where Willow Creek enters Lake Simtustus.

The waters issue from the lower contact of a thick basaltic lava flow on the south face of the canyon. All of the springs are at a uniform elevation along a total distance of approximately 160 m (525 ft). Temperatures of the springs vary between a minimum of 19° C (66° F) and a maximum of 21° C (70° F). Measurements were made on April 24, 1980. The collective waters of the springs flow over a 1-m (3-ft)-wide weir at a depth of 7.6 cm (3 in). Temperatures of other springs in the area are 12° C (54° F).

The microclimate provided by the combined effects of the warm water and the sheltered, north-facing slope has resulted in a surprising change in flora, even though the new springs have only existed for approximately 15 years. The typical low desert plant community of bunch grass, rabbit brush, sage-

Grass, sage brush, and juniper typical of the area grow to within 30 m (100 ft) of thermal springs at mouth of Willow Creek.

Sword fern in immediate area of thermal springs at mouth of Willow Creek.

brush, and juniper occupies the slope to within 30 m (100 ft) of the springs. The flora in the immediate vicinity of the springs, however, is reminiscent of Cascade province types. Plants growing here include sword fern, willow, wild raspberry, elm, and a luxuriant growth of miner's lettuce.

The second group of seven springs is about 3 km (2 mi) farther upstream on Willow Creek, in the NW¼ of sec. 32, T. 10 S., R. 13 E. The area is on private land, and permission is required to enter. All of these springs come from the lower contact of a lava flow along the north bank of Willow Creek and extend over approximately 275 m (907 ft). There are two exceptions: One spring is at the same level, but on the south bank of the stream; another spring emerges on the north bank, but approximately 30 m (100 ft) above the other springs. Several of the larger springs are in grottoes formed by erosion of material from beneath the lava flow. Some of the grottoes may be parts of lava tubes. The temperatures of this group range from 17° C (62° F) to 21° C (69° F). These measurements were made July 20, 1980.

In the center of this line of springs there is one additional spring with a lower temperature of 13° C (55° F). This colder water spring is reported to have been in existence for an unknown number of years prior to the construction of either of the local dams.

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Northwest Mining Association elects new leaders at 87th annual convention

The Northwest Mining Association (NWMA) elected new leaders Wednesday, December 2, 1981, to guide its more than 2,500 members from five western states and western Canada.

On the eve of the NWMA 87th annual convention, NWMA trustees unanimously selected Keith J. Droste to replace 1981 president John C. Balla. Droste, former general manager of Day Mines, Inc., before its recent takeover by Hecla Mining Co., currently holds the position of manager, new mine development, for Hecla.

The trustees also elected Joseph McAleer, Molycorp, and George Tikkanen, Cominco American, Inc., as first and second vice presidents. Spokane attorney John L. Neff and David M. Menard, Seattle-First National Bank, were re-elected secretary and treasurer.

Newly elected trustees include John Beaulieu, Oregon Department of Geology and Mineral Industries; Earl H. Beistline, University of Alaska; Lovon Fausett, Sr., Wallace Diamond Drill Co., Inc.; Bernard J. Guarnera, Boise Cascade Corp.; Mike W. Keevan, R.A. Hanson Co., Inc.; Ernest H. Gilmour, Eastern Washington University; Earl D. Lovick, W.R. Grace and Co., Inc.; Lynn A. Pirozzoli, Hecla Mining Co.; Robert A. Lothrop, J.R. Simplot Co.; and John C. Balla, ASARCO, Inc. □

USGS maps increase in price

Due to a directive from the U.S. Geological Survey (USGS), USGS maps sold by the Oregon Department of Geology and Mineral Industries have gone up in price as of December 1, 1981. New prices: 7½- and 15-minute quadrangle topographic maps, $2; AMS topographic maps, $3.25; Map I-325 (geologic map of Oregon west of 121st meridian), $3.50; Map I-902 (geologic map of Oregon east of 121st meridian), $5; State topographic map, $3.25; and State base map, $3.25. □

Nation's mineral resources assessed in USGS report

A 722-page report that assesses more than 60 mineral and energy commodities in the United States and describes the importance, availability and possible future sources of each commodity, has been reprinted and is again available from the U.S. Geological Survey (USGS), Department of the Interior.

The report was written by USGS scientists with nearly 2,300 person-years of experience in the geology of mineral resources. The report, compiled in 1972 and published in 1973 as part of Interior's response to the Mining and Mineral Policy Act of 1970, is now being reprinted for the third time.

According to Don Brobst, one of the two co-editors of the report, and a recently retired geologist at the USGS National Center, Reston, Va., "The major patterns in resources seen in 1973 have not changed greatly overall in the last decade. With few exceptions, the geologic sources of most commodities are still as they were a decade ago, and as a result, this report is still as vital and germane today as it was 10 years ago."

The types of commodities described in the report range from major metals and industrial minerals, such as copper, silver, chromium, manganese and fluorspar, to commodities of greatly varied geologic nature, such as pigments or gemstones, and commodities that are currently of minor importance, such as scandium or thallium.

In his chapter on mineral resource estimates and public policy, Dr. Vincent E. McKelvey, former director of the USGS, now retired, describes the magnitude of the United States' mineral supply and consumption problem. "...in attaining our high level of living in the United States, we have used more minerals and mineral fuels during the last 30 years than all the people of the world used previously," McKelvey said. "This enormous consumption will now have to be doubled just to meet the needs of people now living in the United States through the remainder of their lifetime, to say nothing about the needs of succeeding generations, or the increased consumption that will have to take place in the lesser developed countries if they are to attain a similar level of living."

Some commodity highlights from the report:

- *ALUMINUM:* Industrial use in the U.S. is about 18 million tons of bauxite and alumina annually, but the nation produces only 13 percent of its needs. There are enormous (250-300 million tons) low-grade resources, but they cannot be recovered without major technological breakthroughs or higher costs.
- *CHROMIUM:* Domestic resources of this indispensable industrial metal—used for plating, to harden and toughen steel, and in stainless steel, cutting tools, and wear-resistant alloys—are low grade, totaling 7 million tons of ore, and represent only about a four to five-year supply. At least 90 percent of the world's known chromium resources are in southern Africa. There is little or no likelihood of discovering significant new domestic resources, and at present, all chromium used (about 430,000 tons of metal annually) in the United States is imported.
- *COPPER:* Of the 2 million tons of copper used annually in the United States, about one-half is used in electrical applications, about one-sixth in construction, and one-eighth in industrial machinery. In 1971, the nation imported only 6 percent of its copper, but known domestic economic resources (76 million tons of copper metal) are adequate for about 45 years at current rates of consumption. Adequate supplies for a longer time or increased rates of consumption must depend on discovery of new deposits and development of extractive methods for very low-grade deposits.
- *GOLD:* The United States produces only about 1.8 million ounces of gold a year, representing only about one-third to one-quarter of its needs. About 40 percent of the production is a byproduct from the refining of other metals, chiefly copper. It is unlikely that the nation will become self-sufficient in meeting its gold needs in the foreseeable future. Production from vast (about 300 million ounces) low-grade resources would require solving formidable technological and legal problems.
- *MANGANESE:* So essential is manganese to the manufacture of steel, that a simple phrase sums up their relationship: "When we can do without steel, we can do without manganese." The United States has virtually no domestic reserves of manganese. Known resources (960 million tons) are both very low grade and difficult to process. Geologic research might lead to discovery of new high-grade ore deposits in several regions. A promising means of relieving our dependence on foreign sources would require vigorous research to perfect techniques of recovering sea floor nodules, which would also provide a potential "bonus" in copper, cobalt, and nickel.

According to the USGS report, a serious aspect of the mineral supply problem is the extent to which commodity byproducts are literally being wasted because there is no apparent economic incentive for recovering them during ore processing. Some elements go into slurry ponds, some into slags, and some up the flues. These commodities include vanadium in iron deposits, selenium, tellurium, and gold lost through in-place leaching of copper deposits; fluorine, vanadium, uranium, and rare earths in marine phosphate deposits; cadmium, bismuth, and cobalt in lead ores; and several metals in coal ash.

Maps showing the distribution of known deposits of many commodities in the United States are available in the mineral resource map series of the USGS. A free listing showing the minerals covered in this series can be obtained by writing: Branch of Geologic Inquiries, U.S. Geological Survey, 907 National Center, Reston, Va. 22092.

The report, titled "United States Mineral Resources," and published as USGS Professional Paper 820, may be purchased for $17.00 from the U.S. Geological Survey, Branch of Distribution, 604 South Pickett St., Alexandria, Va., 22304 and over the counter at USGS Public Inquiries Offices in Los Angeles (7638 Federal Bldg., 300 N. Los Angeles St.); San Francisco (504 Custom House, 555 Battery St.); Denver (1012 Federal Bldg., 1961 Stout St.); Dallas (1C45 Federal Bldg., 1100 Commerce St.); Salt Lake City (8105 Federal Bldg., 125 South State St.); Spokane (678 U.S. Courthouse, West 920 Riverside Ave.); Anchorage (108 Skyline Bldg., 508 Second Ave.); Menlo Park, Calif. (room 12, Bldg. 3, 345 Middlefield Rd.); Washington, D.C. (1028 General Services Bldg., 19th and F Sts., N.W.); and Reston, Va. (room 1C402, USGS National Center, 12201 Sunrise Valley Dr.). □

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:

January 15, 1982—*Plant and Animal Fossils*: by Leo F. Simon, photographer, retired, and president 1949.

February 5—*China's Ancient Capitals*: by Hazel Newhouse, geographer and recent voyager to China.

February 19—*Canadian Maritime Provinces: Bus Tour*: by Margaret Steere, geologist/editor, retired. □

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