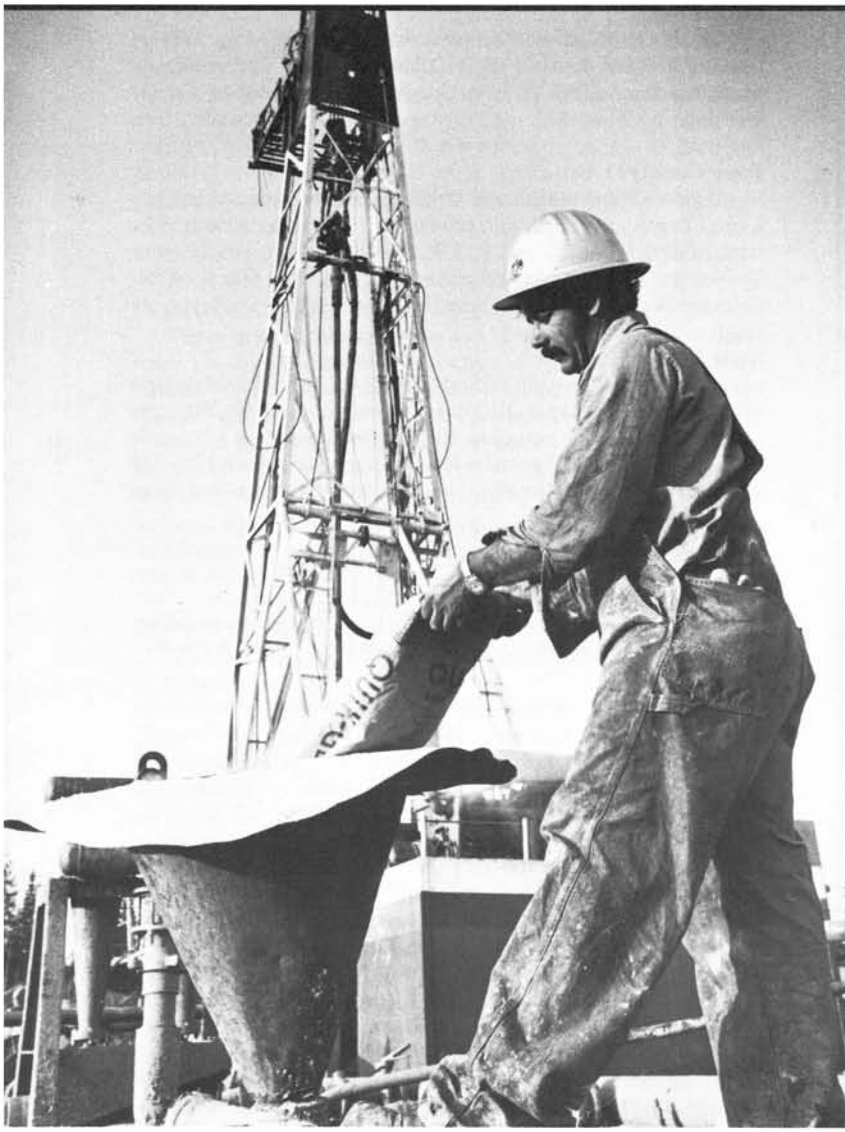
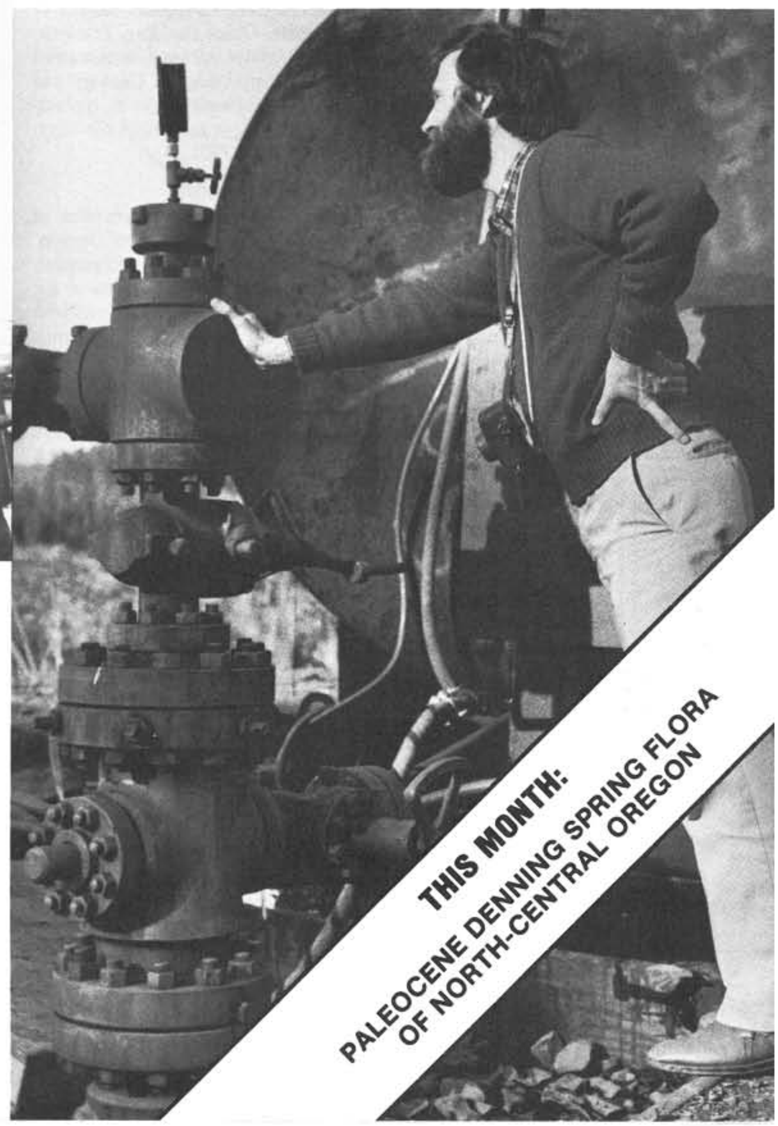
OREGON GEOLOGY

published by the

Oregon Department of Geology and Mineral Industries

VOLUME 47, NUMBER 10 OCTOBER 1985





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(ISSN 0164-3304)

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

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Information for contributors

Oregon Geology is designed to reach a wide spectrum of readers interested in the geology and mineral industry of Oregon. Manuscript contributions are invited on both technical and general-interest subjects relating to Oregon geology. Two copies of the manuscript should be submitted, typed double-spaced throughout (including references) and on one side of the paper only. Graphic illustrations should be camera-ready; photographs should be black-and-white glossies. All figures should be clearly marked, and all figure captions should be typed together on a separate sheet of paper.

The style to be followed is generally that of U.S. Geological Survey publications (see the USGS manual *Suggestions to Authors*, 6th ed., 1978). The bibliography should be limited to "References Cited." Authors are responsible for the accuracy of their bibliographic references. Names of reviewers should be included in the "Acknowledgments."

Authors will receive 20 complimentary copies of the issue containing their contribution. Manuscripts, news, notices, and meeting announcements should be sent to Beverly F. Vogt, Publications Manager, at the Portland office of DOGAMI.

COVER PHOTO

Mist Gas Field: Left photo — Roughneck adds gel to drilling fluid (Photo by permission of Kight Photography, Gresham, Oregon). Right photo — DOGAMI Petroleum Engineer Dennis Olmstead checks pressure gauge on saltwater disposal well. The history of the Mist Gas Field is detailed in a recently released DOGAMI publication announced on page 122.

OIL AND GAS NEWS

Columbia County

Exxon Corporation spudded its GPE Federal Com. 1 on September 1. The well name is a change from GPE Federal 2, permitted for section 3, T. 4 N., R. 3 W. Proposed total depth is 12,000 ft. The contractor is Peter Bawden.

Coos County

Amoco Production Company is drilling ahead on Weyerhaeuser "F" 1 in section 10, T. 25 S., R. 10 W. The well has a projected total depth of 5,900 ft and is being drilled by Taylor Drilling.

Lane County

Leavitt's Exploration and Drilling Co. has drilled Merle 1 to a total depth of 2,870 ft and plugged the well as a dry hole. The well, in section 25, T. 16 S., R. 5 W., was drilled 2 mi southeast of Ty Settles' Cindy 1, drilled earlier this year to 1,600 ft. A.M. Jannsen Well Drilling Co. was the contractor.

State lease sale

The Oregon Division of State Lands on July 24 held its first oil and gas lease sale in 3½ years. Approximately 60,000 acres were offered in nine counties. Bidding took place on 31 parcels with a high bid of $42 per acre bonus on two parcels totaling 220 acres in Columbia County. The next lease sale has not been scheduled.

Recent permits

Permit no.	Operator, well, API number	Location	Status, proposed total depth (ft)
328	Exxon Columbia County "B" 1 009-00169	SW¼ sec. 2 T. 4 N., R. 3 W. Columbia County	Location; 12,000.
329	Exxon Columbia County "C" 1 009-00170	NW¼ sec. 14 T. 4 N., R. 3 W. Columbia County	Location; 6,800.
330	Reichhold Energy Columbia County 33-35 009-00171	SE¼ sec. 35 T. 7 N., R. 5 W. Columbia County	Application; 3,100±.
331	Reichhold Energy Columbia County 43-32 009-00172	SE¼ sec. 32 T. 6 N., R. 5 W. Columbia County	Application; 2,500.
332	Reichhold Energy Columbia County 11-34 009-00173	NW¼ sec. 34 T. 6 N., R. 5 W. Columbia County	Application; 2,500.
333	Reichhold Energy Columbia County 41-2 009-00174	NE¼ sec. 2 T. 5 N., R. 5 W. Columbia County	Application; 2,500.
334	Reichhold Energy Columbia County 13-3 009-00175	SW¼ sec. 3 T. 5 N., R. 5 W. Columbia County	Application; 2,500.

□

CONTENTS

The Paleocene Denning Spring flora of north-central Oregon

by Ian Gordon, geology student, Department of Geology, Oregon State University, Corvallis, OR 97331-5506

ABSTRACT

The previously undescribed Denning Spring flora is recognized as north-central Oregon's oldest known Tertiary flora. Taxonomic similarities between the Denning Spring flora and other fossil assemblages in the western United States indicate a Paleocene age. Physiognomic analysis of dicotyledonous leaves suggests that the flora grew under cooler climatic conditions than did the middle to late Eocene-age Clarno floras of the same region.

INTRODUCTION

There are few places in the world where the Tertiary floral record is as extensive as it is in Oregon. Several workers, most notably R.W. Chaney, dedicated a large part of their lives to the interpretation of this rich history. However, many fossil floras remain to be studied. Among these poorly known assemblages are those near the town of Pilot Rock in Umatilla County (Figure 1). A recent collection made by the author at Denning Spring, one of the Pilot Rock localities, provides new information about the flora and the sedimentary rocks in which it is found.

LOCATION AND GEOLOGY

The Denning Spring locality is situated along the west bank of Pearson Creek, 20 km southeast of Pilot Rock and 5 km north of the Denning Spring (NE¼ sec. 31, T. 2 S., R. 33 E.) (Figure 1). Exposures of fossil-bearing rock are approximately 800 m² in areal extent and consist of coarse sandstone with a few interbedded layers of silt and clay. The absence of conglomerates and the presence of rooted *Equisetum* (horsetail rush) suggest that the sediments were deposited in a low-energy freshwater environment.

Structurally, the unit dips 20° to the northeast in concert with uplift from the nearby Blue Mountain anticline (Figure 2). The sediments have a projected thickness of nearly 170 m. The base of the unit is not exposed, and the top is unconformably overlain by the Columbia River Basalt Group (Hogenson, 1964).

FLORAL COMPOSITION

Thirty-three species representing 32 genera are recognized in the Denning Spring flora (Figure 3, Table 1). Most of these are dicotyledonous taxa, represented by leaves of 22 species from 20 genera. One flower of *Hydrangea* sp. has also been collected. The most abundant leaves in the flora are those of *Euodia*? sp. (Figure 3g), a member of the Rutaceae (citrus family), and a betulaceous (birch family) leaf, probably *Corylus* (hazelnut). *Planera* sp. (water elm) and two species of *Litseaphyllum* (members of the laurel family) also occur frequently.

Although dicotyledonous taxa dominate the floral diversity, gymnosperms and pteridophytes constitute the vast majority of specimens (approximately 70 percent). Pteridophyte taxa include *Equisetum* sp. and six genera of ferns, the most common being a wood fern, *Dryopteris* sp. (Figure 3a). Gymnosperms are represented by three genera, including *Taxodium* (bald cypress) and *Glyptostrobus* (Figures 3e, 3f, 3i).

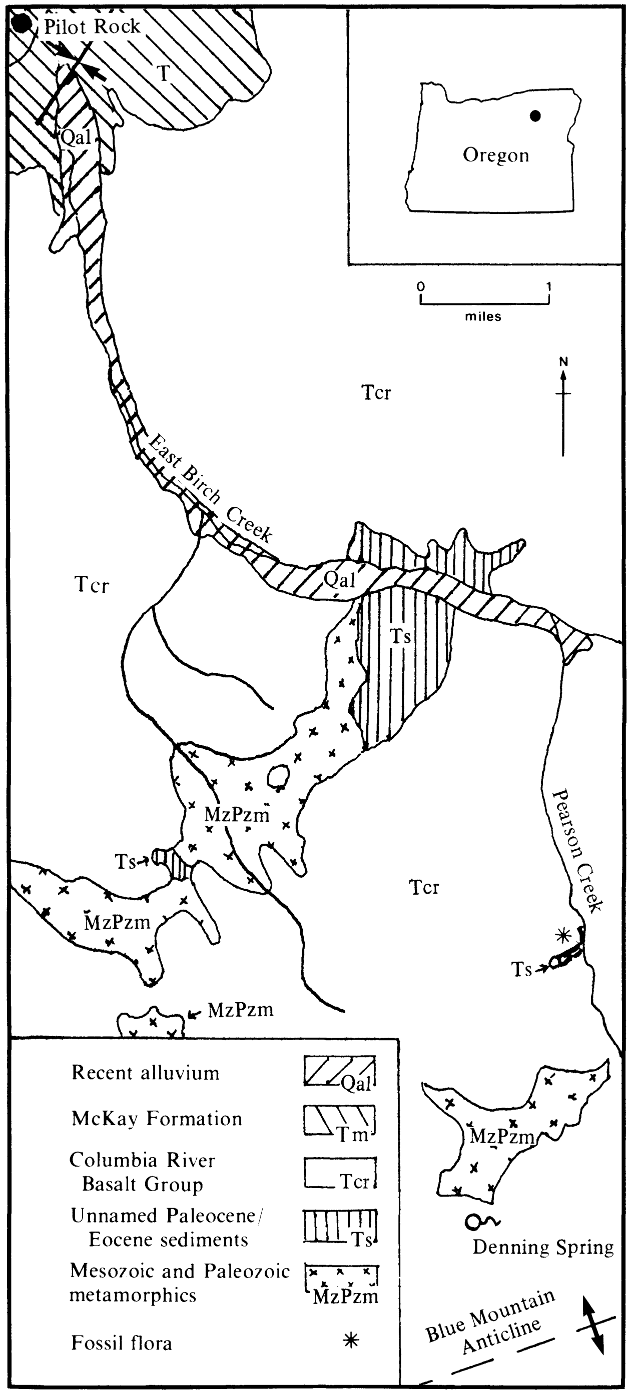

Figure 1. Geologic map of the area southeast of Pilot Rock. The Denning Spring flora lies along Pearson Creek in a small outcrop of early Tertiary sedimentary rocks. Modified from Hogenson (1964).

Figure 2. The Denning Spring fossil locality. The solid line follows one of the bedding planes where fossil leaves have been recovered. The dip of the beds suggests that they were tilted by uplift of the Blue Mountain anticline.

CLIMATE

Floristically, the Denning Spring flora reflects a mildly subtropical climate. *Alnus* (alder), *Glyptostrobus*, and members of the Menispermaceae (moonseed family) were typical constituents of early Tertiary forests in North America (Brown, 1962; Wolfe, 1971). Other types common in subtropical forests include members of the families Rutaceae, Palmae (palm family), and Flacourteaceae (flacourtia family).

By contrast, a study of the structural characters in the Denning Spring flora indicate a warm temperate climate (e.g. inland southern China). The percentage of entire-margined dicotyledonous leaf species, regarded as a reliable climatic indicator (Wolfe, 1971), is similar in both the Denning Spring flora and modern warm temperate forests. Of the 22 dicotyledonous species, five (26 percent) are entire margined and seventeen (74 percent) are serrate margined.

The paleoenvironmental conditions responsible for the conflict between the floristic and physiognomic (leaf structure) analyses are not clear. Presumably, the Denning Spring flora represents a zone where subtropical and warm temperate forests mixed. In any case, given the taxa identified, it seems reasonable to designate the climate as mild subtropical.

AGE

The Denning Spring locality was mapped by Hogenson (1964) as part of the Clarno Formation. However, the taxonomic record indicates that only five species from the Denning Spring flora are known also from the Clarno Formation. Two dicotyledonous species of undetermined affinity (S.R. Manchester, written communication, 1984) and a fern, *Dryopteris* sp. (author's observation), are known from the middle Eocene Clarno Nut Beds. Of the remaining two species, *Hydrangea* sp. is found in the Clarno floras near Horse Heaven

Table 1. *Taxa of the Denning Spring flora*

Family	Genus	Organs represented	Number of species recognized
Equisitaceae	*Equisetum*	Rhizone, stem	1
Aspidaceae	*Allantiodiopsis*	Leaf	1
Dryopteridaceae	*Dryopteris*	Leaf (see Figure 3a)	1
	Onoclea	Leaf	1
Blechnaceae	*Woodwardia*	Leaf	1
Hydromystriaceae	*Hydromystria*	Leaf (see Figure 3d)	1
Schizaceae	*Anemia*	Leaf	1
Taxodiaceae	*Taxodium*	Foliage	1
	Glyptostrobus	Foliage, seed, cone scale (see Figures 3e, 3f, and 3i)	1
Palmae	Undetermined	Frond	1
Betulaceae	*Alnus*	Leaf	1
	Betula	Leaf	1
	Corylus?	Leaf	1
	Undetermined	Leaf	1
Flacourteaceae	Undetermined	Leaf	1
Lauraceae	*Litseaphyllum*	Leaf	2
	Undetermined	Leaf	2
Menispermaceae	Undetermined	Leaf (see Figure 3h)	1
Rutaceae	*Euodia*	Leaf, fruit (see Figure 3g)	1
Saxifragaceae	*Hydrangea*	Infertile flower	1
Undetermined	——	Dicotyledonous leaves	9
Undetermined	——	Fern leaf (see Figure 3b)	1
Undetermined	——	Fruit (see Figure 3c)	2
Undetermined	——	Coniferous foliage	1

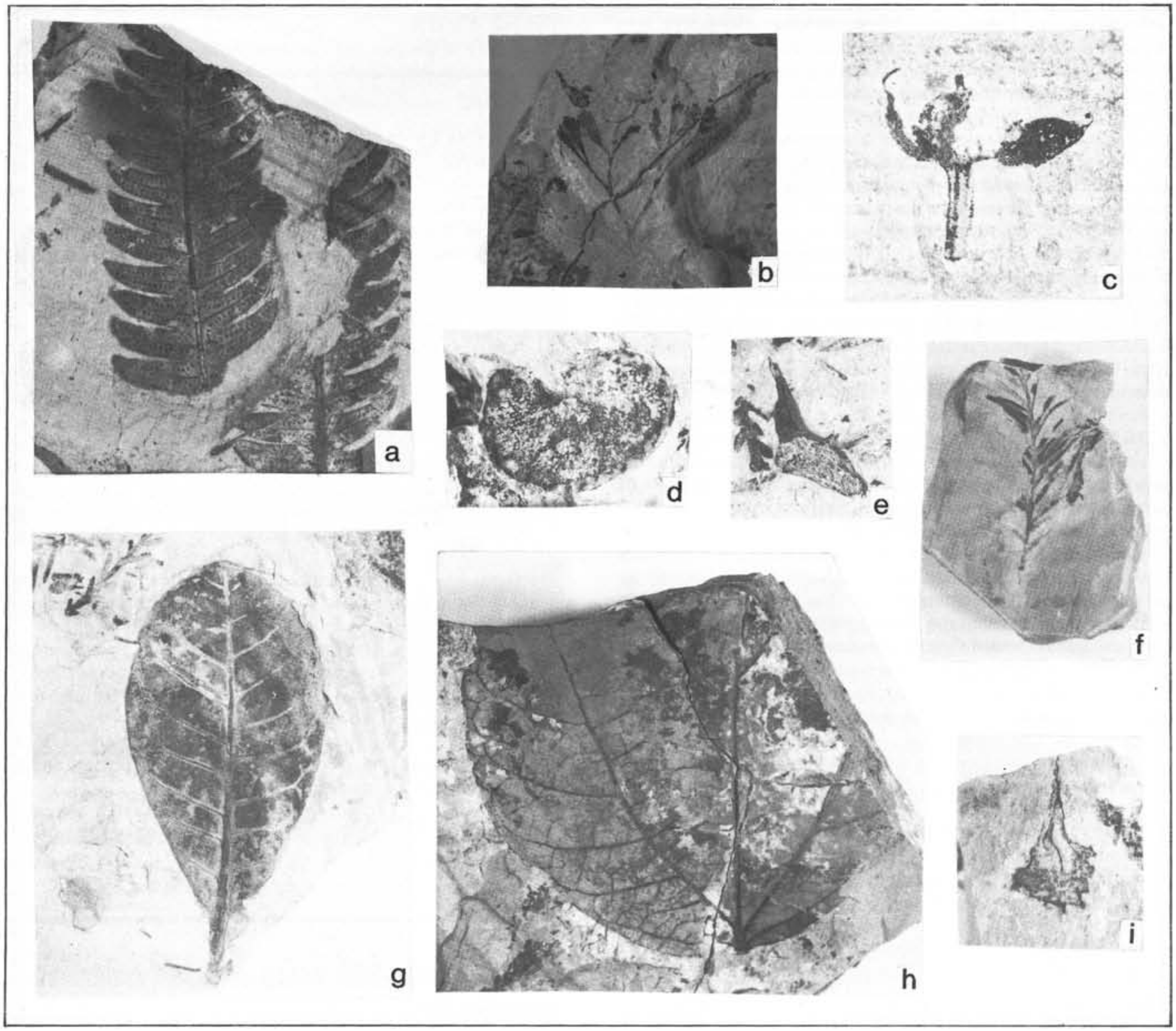

Figure 3. Fossil specimens from the Denning Spring locality: a) Dryopteris, *a sword fern (1x); b) unidentified fern (2x); c) unidentified fruit (4x); d)* Hydromystria, *a water fern (2x); e) seed of* Glyptostrobus, *a deciduous conifer common to swampy areas (2x); f) taxodioid foliage of* Glyptostrobus *(1x); g) leaf of* Euodia?, *a member of the citrus family (1x); h) leaf belonging to a member of the moonseed family,* Menispermaceae *(1x); i) cone scale of* Glyptostrobus *(2x). U.C.M.P. locality number PA527.*

in Wasco and Jefferson Counties (S.R. Manchester, personal communication, 1984), and *Onoclea* sp. is found near Mitchell, Oregon (author's observation). However, the dicotyledonous taxa that are common in the middle to late Eocene Clarno flora (such as *Platanophyllum, Cercidiphyllum,* and *Engelhardia*) are absent in the Denning Spring assemblage. In general, there are dramatic floristical differences between the Clarno and Denning Spring floras.

The Clarno and Denning Spring floras also reflect quite different climates. The Denning Spring flora indicates a notably cooler environment than the subtropical to paratropical Clarno assemblages (Wolfe, 1971; Manchester, 1981). It is assumed that this difference in the climates of the two floras was not a consequence of a significant contrast in elevation. Although the fossil-bearing shales at the Denning Spring locality presently lie 900 m above sea level, uplift along the Blue Mountain anticline since the time of deposition probably accounts for much of the present elevation. The other geographic circumstance that can account for a difference in climate is relative proximity to the ocean. The floras of coastal areas are generally more temperate than those of inland floras; hence, the Denning Spring flora could, theoretically, have lived at the same time as the warmer Clarno flora, provided the Clarno area was farther inland from the ancestral Pacific Ocean. Because the Denning Spring locality lies 150 km east of Clarno, such a scenario is highly unlikely. In essence, the difference in climate between the Clarno and Denning Spring floras is unrelated to geographic circumstances, which implies that a climatic change took place over a significant period of time.

A similar lack of taxonomic homogeneity is recognized when comparison is made with post-Clarno floras. Genera such as *Acer, Carya, Platanus,* and *Metasequoia* are abundant in the later assemblages (Chaney, 1948) but absent at Denning Spring.

There is, however, evidence supporting a pre-Clarno age determination. First, several specimens of the water fern *Hydromystria* (Figure 3d) have been recovered from the locality. *Hydromystria* is found in Paleocene floras throughout the Rocky Mountain region but disappeared from North America during the early Eocene (Brown, 1962). Secondly, a taxonomic comparison between the Denning Spring flora and the Paleocene/early Eocene Chuckanut flora of western Washington (Pabst, 1968) shows striking similarities. With the exception of *Hydromystria* sp., all of the conifers and ferns in the Denning Spring flora are identical or very similar to species found in the Chuckanut flora. At this time a comparison of the angiosperm taxa in the two floras can not be offered; the author has not yet examined the Chuckanut angiosperms in detail, and the latter flora's angiosperm record remains unpublished. Nevertheless, the close relationship between the nonangiosperm taxa in the Chuckanut and Denning Spring floras suggests a concurrent age.

CORRELATION AND STRATIGRAPHY

The first attempt to correlate the Denning Spring sediments was made by Hogenson (1964). He mapped the locality as part of the Clarno Formation, basing his decision upon an informal paleobotanical survey by R.W. Brown (Hogenson, 1964). Brown dated the flora as Eocene after identifying only three genera. This meager collection is inadequate for assigning an age or making floral comparisons. Furthermore, Hogenson overlooked the fact that the Denning Spring deposits bear little physical resemblance to the type area of the Clarno Formation (Merriam, 1901), which is characterized by igneous rocks and mudflow debris. The Denning Spring sediments are highly micaceous and also bear little resemblance to Clarno deposits near Mitchell and Clarno.

Apparently, the Denning Spring sediments are part of the unnamed unit described by Pigg (1961). Pigg considered the shale and sandstone in the East Birch Creek (Figure 1) and Arbuckle Mountain areas to be a separate formation of pre-Clarno age. Preliminary collections made by the author indicate that the fossil floras in these latter two areas (Chaney, 1948; Hergert, 1961) contain taxa atypical of the Clarno (S.R. Manchester, personal communication, 1984) and later floras of Oregon. More detailed paleobotanical correlations within the formation, as well as mapping and formal description of the unit, are current projects of the author.

In order to eliminate any possible confusion, it should be noted that the Denning Spring flora, though found on Pearson Creek, has no relationship to the Miocene Pearson Creek flora (Elmendorf and Fisk, 1978). This latter assemblage is found on the east bank of Pearson Creek 2 km north of the Denning Spring locality.

IMPLICATIONS FOR THE GEOLOGIC HISTORY OF NORTHEAST OREGON

The very presence of the Denning Spring flora establishes that the widespread Cretaceous seas had withdrawn locally by the end of the Paleocene. The ancestral Blue Mountains had become a positive topographic feature by the late Paleocene, as suggested by Pigg (1961). Also, the climate in north-central Oregon was cooler near the Paleocene/Eocene boundary than it was later in the Eocene. The Denning Spring outcrop includes the first rocks of known Paleocene age found in Oregon.

ACKNOWLEDGMENTS

I wish to thank Mel Ashwill of Madras and Tita Owre of Monmouth for their help in obtaining reference materials and support in general. Identifications and the collection of specimens were greatly enhanced by Dr. Steven Manchester of Indiana University. Dr. Manchester and Dr. William Orr, University of Oregon, are thanked for final manuscript review. This research was funded in part by the Northwest Scientific Association.

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GeoRef covers 200 years of North American geology

Earth scientists and information specialists searching the GeoRef (Geological References) database on DIALOG or CAN/OLE can now access North American geological references from 1785 to the present, GeoRef Director John Mulvihill announced recently. The addition of 40,322 references from the *Bibliography and Index of North American Geology* (1785-1918) increases the size of the database to more than a million citations and greatly simplifies the task of researchers seeking early geological literature, he added. (Photocopies of documents cited may be ordered through the GeoRef Document Delivery Service. For details, see the announcement in this year's February issue of *Oregon Geology*, p. 14.)

The early references include the works of Hayden, Wheeler, Gilbert, Powell, and many other earth scientists who contributed to the original descriptions and interpretations of North American geology. Many of the newly added citations will also delight history-of-geology buffs. For example, Thomas Jefferson's memoir on certain Virginia fossils from 1799 is cited as are the original journals of the 1802 Lewis and Clark expedition.

— *AGI news release*

ABSTRACTS

The Department maintains a collection of theses and dissertations on Oregon geology. From time to time, we print abstracts of new acquisitions that we feel are of general interest to our readers.

SEDIMENTARY RESPONSE TO EOCENE TECTONIC ROTATION IN WESTERN OREGON, by Paul L. Heller (Ph.D., University of Arizona, 1983)

Published paleomagnetic studies have shown that the Oregon Coast Range has rotated 60° clockwise since middle Eocene time, probably by pivoting either during collision of a seamount terrane or during an episode of asymmetric extension within western North America. Eocene sedimentary deposits within the Oregon Coast Range basin, in particular the Tyee Formation, document changes in basin evolution that provide geologic constraints for proposed rotation models.

The Tyee Formation comprises an arkosic petrofacies which is different from underlying lithic sandstones that were derived from the adjacent Klamath Mountains. Isotopic study of sandstones of the arkosic petrofacies, including Sm-Nd, Rb-Sr, K-Ar, and ^{18}O analyses, indicate that much of the sandstone was not derived from the Klamath Mountains or nearby Sierra Nevada. The source area most likely included S-type granites of the Idaho Batholith.

Lithofacies within the Tyee Formation include a sandy deltaic system to the south, a thin muddy shelf/slope sequence farther north, and a thick basinal sequence of sandy high-density turbidites that grade northward into low-density turbidites. Absence of facies segregation within the turbidite sequence precludes application of classical deep-sea fan depositional models and forms the basis for the delta-fed submarine ramp model introduced here. Delta-fed submarine ramps are short-lived sandy systems that result from rapid rates of progradation as well as aggradation.

Synchronous changes in depositional style, structural deformation, sandstone composition, and rates of tectonic subsidence of the Oregon Coast Range basin are interpreted to record the transition from collisional trench-fill deposition to a subsiding forearc basin. The Tyee Formation was deposited after collision was complete and yet is rotated as much as the seamounts on which it lies; therefore, rotation must have occurred subsequent to collision. Since these sediments were partially derived from the Idaho Batholith region, the Oregon Coast Range probably lay much farther east during deposition and subsequently rotated westward to its present position.

Tectonic rotation of the Oregon Coast Range may have resulted from continental extension that began in the Pacific Northwest about 50 m.y. ago. Paleogeographic reconstructions show that basin development was synchronous with regional extension, arc migration, and tectonic rotation throughout the Pacific Northwest.

GEOLOGY AND PETROLOGY OF SOUTH SISTER VOLCANO, HIGH CASCADE REGION, OREGON, by James G. Clark (Ph.D., University of Oregon, 1983)

South Sister is a Quaternary volcanic complex located along the axis of the High Cascade Range in central Oregon. The composite cone overlies an extensive platform of Plio-Pleistocene basaltic shield lavas. The eruptive sequence following the shield-forming basalts was rhyodacite-andesite, dacite, and minor basalt-basaltic andesite. The bulk of the main cone formed during the andesitic and dacitic activity. Post-glacial, divergent basaltic and rhyodacitic eruptions completed the sequence. The post-glacial basalts preceded the rhyodacites by as much as 10,000 years.

Major-element analyses demonstrate the calc-alkaline character of lavas from South Sister. The suite of lavas has a compositional gap between 65 percent SiO_2 and 72 percent SiO_2. The post-glacial, divergent suite has an even larger compositional gap, between 55.5 percent SiO_2 and 72 percent SiO_2. Petrologic modeling of major and trace element variations in the main- and summit-cone lavas suggests that these lavas are related primarily by discrete partial melting events with minor subsequent modification by crystal fractionation. The andesitic and dacitic magmas did not undergo the extensive fractionation required to produce the rhyodacites. Geochemical data suggest that early and post-glacial rhyodacites are genetically related despite their age difference, and neither was consanguinous with main- and summit-cone magmas. Field, petrographic, and geochemical data indicate that the post-glacial basalt-rhyodacite suite developed as a consequence of extensive interaction between ascending basaltic magma and silicic crustal rocks at shallow depths (< 10km). The most likely parental crustal rock for the post-glacial rhyodacites was the intrusive equivalent of the early rhyodacitic lavas. A model is proposed in which basalt-crustal interaction produced a magma chamber stratified by both density and composition, with dense basaltic liquid overlain by lighter rhyodacitic liquid. Rhyodacitic liquid accumulated at the top of the chamber by diffusion-controlled boundary-layer flow at the chamber wall. The olivine-plagioclase basalt from Le Conte Crater represents a hybrid liquid generated by limited mixing of basalt and rhyodacite at the interface between the upper and lower zones. This study suggests that multiple genetic processes may be required to generate the chemical variation in a single volcanic complex.

A PETROLOGIC AND TECTONIC COMPARISON OF THE HELL'S CANYON AREA, OREGON-IDAHO, AND VANCOUVER ISLAND, BRITISH COLUMBIA, by Joanna M. Scheffler (M.S., Washington State University, 1983)

It has been suggested that Hell's Canyon, Oregon-Idaho, and Vancouver Island, British Columbia, were once continuous members of the allochthonous terrane called Wrangellia. To test this hypothesis, the Permian and Triassic volcanic strata of each area were examined lithologically, petrographically, and geochemically. The formations studied include the Upper Paleozoic Sicker Group and the Upper Triassic Karmutsen Subgroup on Vancouver Island. In Hell's Canyon, they include the Permian Windy Ridge and Hunsaker Creek Formations and the Upper Triassic Wild Sheep Creek and Doyle Creek Formations.

Significant differences occur between the proposed correlative sections, especially between the Triassic volcanics. Lithologically and petrographically the major differences are in the pervasive high proportion of volcaniclastic rocks and diverse lithologies from basalt to rhyolite in the Wild Sheep Creek Formation, in contrast to the restricted occurrence of volcaniclastic rocks and relatively uniform basaltic lithologies of the Karmutsen Subgroup. On geochemical diagrams, the Karmutsen samples plot in tight fields or distinct trends, whereas the Wild Sheep Creek samples show different trends or greater scatter than the Karmutsen samples. The Karmutsen samples are similar to oceanic or plateau-type basalts, while findings of this study concur with earlier reports that the Wild Sheep Creek Formation represents a calc-alkaline volcanic-arc system.

Results indicate that the two volcanic suites formed in different tectonic environments. They may have been juxtaposed in an island arc-backarc rift system, or in another setting incorporating two tectonic systems. However, the simplest and most logical interpretation of information collected in this study, including available paleomagnetic and paleontological data, is that the Permian and Triassic volcanic section of Vancouver Island and Hell's Canyon evolved in separate locations and in different tectonic systems.

FORMATION AND ZONATION OF FERRUGINOUS BAUXITE DEPOSITS OF THE CHAPMAN QUADRANGLE, OREGON, by Richard C. Marty (M.S., Portland State University, 1983)

Two major theories have been advanced to account for the scattered distribution of ferruginous bauxite deposits. Original workers proposed that ferruginous bauxite originally developed over all exposed Columbia River basalt in western Oregon and was subsequently removed by erosion. Studies which followed have suggested that it may be locally favorable conditions, especially of drainage, which are responsible for deposit distribution. Field mapping in the Chapman quadrangle shows a possible correlation between a series of sheared zones, which may have improved drainage, and the distribution of ferruginous bauxite deposits. Examination of the pisolitic-zone ferruginous bauxite of the Chapman quadrangle failed to show any evidence supporting the theory that this zone was produced by fluvial action. It appears, instead, that the pisolitic zone of the deposits studied developed in place and that the structures seen in this zone are the result of authigenic processes. Mineralogical study of samples from the Chapman quadrangle suggests that the ferruginous bauxite of the area probably developed under slightly acidic pH conditions and that the assemblage quartz, kaolinite, gibbsite may exist in ferruginous bauxite deposits because of the presence of iron oxide and hydroxide coatings on the quartz which may cut off contact between quartz and gibbsite. Chemical study shows that the lateral variation in elemental concentrations is much less than the vertical variation in concentrations seen by some previous workers and that lateral variation appears to be randomly distributed for most elements. The behavior of elements during weathering can best be modeled by taking into account the various sorbtive reactions between ions formed during weathering and clays and hydroxides.

HOLOCENE GEOLOGIC HISTORY OF THE CLATSOP PLAINS FOREDUNE RIDGE COMPLEX, by David K. Rankin (M.S., Portland State University, 1983)

This research formulated a recent geologic history of the Clatsop Plains dating from 3,500 yr B.P. to the present. Research consisted of geomorphic mapping, near-surface stratigraphic evaluation, carbon dating and subsurface interpretation of available data.

The Plains were formed from a series of arcuate-shaped foredune ridges and interdunal flats oriented subparallel to the coastline. Groups of dune ridges and associated interdunes are differentiated by similar morphology separated by wave cut discontinuities which truncate dune forms. Ages of these prehistoric shorelines range between 3,500 yr B.P., at the mountain front, to 110 yr B.P., some 1 to over 5 km west. Dune ridges within a group diverge from one another in two distinct patterns: Type A – where the ridge crests are sinuous and hummocky and the westernmost or youngest ridge acts as a main stem from which older truncated ridges branch and Type B – where the ridge crests are subparallel, continuous, and curvilinear and most ridges extend along much of the Plains length.

Sea-level oscillations during progradation appear to show a sharp rise at 3,500 yr B.P. (initial growth) from −7 m elevation, peak at 2,200 yr B.P. (−1 m), drop to −3 m and reversal at 1,400 yr B.P. and a rise to the present.

Progradation rates apparently are at a maximum during level peaks and falling sea level. Major accretion occurred from 3,500 to 1,400 yr B.P. Between 1,400 yr (reversal) to 400 yr B.P., maximum growth occurred in the central Plains. Before and after this period, maximum growth was in the north. Highest rates have occurred since jetty construction. The discontinuous and longitudinally nonuniform growth is likely due to fluctuating sea level and littoral sediment supply. The shifting zone of maximum accretion apparently is the result of a proportional shift in sediment supplied from the Columbia River or sediment-dispersal patterns.

The dune mass rapidly accumulated under likely wet and low-velocity conditions with variable influence of binding vegetation. Renewed sand activity appears to have been restricted to localized areas.

PLIOCENE STRATIGRAPHY OF THE KLAMATH RIVER GORGE, OREGON, by Jeffrey R. Walker (M.A., Dartmouth College, 1983)

The Pliocene stratigraphy of the Klamath River Gorge in southern Oregon has been divided into two units: an older unit of mildly alkaline basalts, informally referred to as the lower Outerson formation; and an overlying younger unit of calc-alkaline basalts, basaltic-andesites, and andesites referred to as the upper Outerson formation. The basal contact between these Pliocene lavas and the underlying Western Cascade series is a prominent disconformity marked by a thick soil horizon; the upper contact with the overlying Pleistocene lavas is an angular unconformity. The lower Outerson rocks are thought to represent the base of the High Cascade series in southern Oregon.

The mildly alkaline lower Outerson lavas can be distinguished from the overlying calc-alkaline rocks by distinctly higher percentages of P_2O_5, TiO_2, iron, and alkalis. They cluster around the projection of the critical plane of silica undersaturation in the system Fo-Di-Ne-SiO_2, and they lack signs of extensive differentiation with time. QMODE analysis of the suite resulted in a four-factor model (plagioclase, olivine, clinopyroxene, and magma) which required the addition of 0.5 to 19.5 percent olivine and −3 to 39 percent plagioclase and the removal of 10 to 56 percent clinopyroxene from an initial basaltic magma, with percentages of total fractionation ranging from 0 to 18 percent. The preferred petrogenetic model for these rocks is that they represent small degrees of partial melting of a mantle undepleted in phosphorus at a pressure of greater than 30 kbars. The individual lava flows appear to represent distinct pulses of magma from this source.

The upper Outerson rocks exhibit increases in differentiation indicators with time and a well-defined trend from silica undersaturated to silica oversaturated. QMODE analysis produced a four-factor model (plagioclase, clinopyroxene, amphibole, and magma) which required the removal of 6 to 32 percent plagioclase, 11 to 27 percent amphibole, and 3 to 16 percent clinopyroxene from an initial basaltic magma, and in which a relatively constant ratio of plagioclase to pyroxene indicates that they may have had a cotectic relationship. The calc-alkaline magmas are thought to have been derived from moderate degrees of partial melting under water-rich conditions, and to have experienced an intermediate stage of differentiation before eruption.

In a comparison of a compilation of all of the mildly alkaline rocks reported from the Cascades with a similar suite of rocks in the Basin and Range province, it was found that the same four factors used in modeling the lower Outerson suite could also be used to model the genesis of the Cascade and Basin and Range mildly alkaline groups. It is unclear whether this implies that the two groups are actually part of one larger population, or whether they are similar because they formed by processes common to areas of extensional tectonism. The mildly alkaline lavas of the Cascades are located in a major graben which underlies the present volcanic axis and are believed to have been erupted at the same time of, or soon after, the formation of this graben. The alkalinity of these rocks, and the formation of the Cascade graben, may be related to an extensional tectonic event which affected the Oregon Cascades during the Pliocene. □

Allen's laws of field geology

During my 20 years as a field geologist, I gradually came to understand and appreciate some of the immutable laws of nature which affect field geologists. As these laws occurred to me over the years, I wrote them down, and I now share this collection with you. Your appreciation of their deep philosophical significance will be in direct proportion to the amount of time you have spent in constructing geologic maps in the field.

1. The basic law of science (Murphy's Law): If anything can go wrong, it will.
2. Laws of recognition:
   a. The more you know, the more you see.
   b. You see only what you are looking for.
   c. You can't see something you are not looking for.
   d. When investigating the unknown, you do not know what you will find.
   e. Because of their different backgrounds, two geologists looking at the same outcrop will seldom agree upon the same interpretation.
3. Laws of complexity:
   a. The geology of any area is always more complex than you think it is going to be.
   b. The complexity of the geology is proportional to the area of outcrop in the area.
   c. In mapping complicated structures, the interpretation may be considered valid if not more than 50 percent of the mapped dips and strikes need to be discarded to obtain a correspondence with hypothesis.
4. Law of accuracy:
   a. The care and accuracy taken in mapping should be inversely proportional to the distance from the main roads and the edge of the map. Your superior will check your work along the main roads, and your map must agree with work done by other geologists in adjacent quadrangles.
5. Law of efficiency:
   a. The curve of field efficiency is bimodal, peaking at 9:00 a.m., with a smaller peak after lunch. It drops to near zero after 4:00 p.m.
6. Laws of frustration:
   a. The key outcrops and fossil localities are usually found at dusk in the most inaccessible part of the area on the last day of the field season.
   b. Whenever specimens must be collected and photographs taken, they usually are those in the most inaccessible part of the area, and the photographs don't turn out when they are developed.
7. Laws of specimens:
   a. The weight of a hand specimen is inversely proportional to the square of the distance from the car.
   b. The number of specimens collected is inversely proportional to the abundance of the rock types represented in the area. The result of this is that the season may end without the collection of a specimen of the dominant rock type. The psychology behind this ancient law has for many years been represented in the mining industry by the "Mexican sample."
8. Laws of note-taking:
   a. When writing your report at the end of the field season, the information you need the most is not to be found in your notebook.
   b. The most important notes and sketches are the most illegible or unintelligible.
9. Other miscellaneous laws of value:
   a. Allen's Axiom: When all else fails, read the instructions.
   b. Woodward's Law: A theory is better than its explanation.
   c. Finangle's Law: Once a job is fouled up, anything done to improve it makes it worse.
   d. Gumperson's Law: The outcome of any desired probability will be inverse to the degree of its probability.

— John Eliot Allen, Professor Emeritus,
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Box 751, Portland, Oregon 97207

Northwest Mining Association announces short course and program for 91st Annual Convention

The Northwest Mining Association will hold its 91st Annual Convention on December 5-9, 1985, at the Sheraton Hotel in Spokane, Washington. Sessions over the three-day period will include the geology of precious metals, state reports from the United States, provincial reports from Canada, geophysics/geochemistry, new opportunities for mining, regulatory developments, markets/economics, industrial minerals, health and safety, mine management, energy, geostatistics, and Alaskan development.

Prior to the convention, a short course entitled "Mini-Computer Applications for the Mineral Industry" will be taught December 2-4, also at the Sheraton Hotel, Spokane. The course is designed to familiarize participants with computers and will present a series of computer applications presently in use in the minerals industry. Participants will have the opportunity for hands-on experience. The course director is James B. Lincoln, Manager of Exploration Administration for Cominco American, Inc. The course faculty is composed of industry and academic experts who are using computers in their work and who will share commercial and captive software applications involving the business and technical aspects of mineral industry problems. Academic credit for the course is available through the University of Washington.

For additional information about either the short course or the convention, contact NWMA, 633 Peyton Building, Spokane, WA 99201, phone (509) 624-1158. □

GSOC meetings announced

The Geological Society of the Oregon Country (GSOC) holds noon luncheon meetings in the Standard Plaza Building, 1100 SW Sixth Ave., Portland, Oregon, in Room A adjacent to the third floor cafeteria. Upcoming meetings, topics, and speakers are:

Oct. 18 — Mt. McKinley (Denali), Alaska, by John Bullinger, member Forest Grove Camera Club.

Nov. 1 — The Floating Continents, by Donald Botteron, chemistry professor, Syracuse University, retired.

Nov. 15 — How Do We Know It Is Us Without Our Past? by Leo D. Williams, Architect Chief Planner, Urban Design Section, Bureau of Planning, City of Portland, Oregon. Members and guests will have lunch at the Standard Plaza Cafeteria before noon and then adjourn to the second floor auditorium in the Portland Building. The three-projector and three-screen audio-visual presentation on Portland's landmarks is in four parts and will begin promptly at 12:10. Friends are invited.

For additional information about the lectures or luncheons, contact Viola L. Oberson, GSOC 50th President, phone (503) 282-3685. □

DOGAMI releases two new publications

GMS-40: AEROMAGNETIC-ANOMALY MAPS

Geophysical maps of the entire Oregon portion of the Cascade Range are now available in publications by the Oregon Department of Geology and Mineral Industries (DOGAMI). DOGAMI has just released the sixth and final map set, *Total Field Aeromagnetic Anomaly Maps, Cascade Mountain Range, Northern Oregon*, as Map GMS-40 in its Geological Map Series.

This completes aeromagnetic coverage of the mountain range, together with maps for the central (GMS-9) and southern (GMS-17) Cascades. Similarly, gravity maps are available as GMS-15 (north), GMS-8 (central), and GMS-16 (south).

GMS-40 covers the Western and High Cascades from the Columbia River to Redmond. Like the previous geophysical maps, it was produced by members of the Geophysics Group at Oregon State University. The authors of the new map set are R.W. Couch, M. Gemperle, and R. Peterson.

On a topographic base (scale 1:250,000), each of the three one-color maps of the set shows contours of aeromagnetic anomalies that were derived from data gathered on numerous flights across the area. Because of the differences in elevation of the terrain, overflights were made at four different altitudes and mapped separately: 9,000 ft (Plate 1), 7,000 ft (Plate 2), and 5,000 ft (Plate 3), the latter with inserts for Mount Hood and Mount Jefferson flown at 11,000 ft.

Studies of the magnetism of the earth's crust yield basic information about density, structure, faults, and temperatures that is used in assessing geothermal and mineral resource potential. Such studies can also be used to locate buried bodies of rock and can help in identifying the paleomagnetic orientation of the rocks. Thus they are of interest to mineral exploration and geologic mapping.

The latest map has been used, for example, to locate a buried volcano beneath much of Green Ridge, located southeast of Mount Jefferson. Also, observed anomalies between Mount Hood and Mount Jefferson suggest that flows of the Columbia River Basalt Group extend across the Cascade Range beneath the younger rocks of the High Cascades.

OGI-10: MIST GAS FIELD HISTORY

The gas field at Mist in Columbia County began to produce natural gas in 1979, and its discovery added Oregon to the ranks of 32 other states that have oil and gas production. The history of the field through the first five years of production has been summarized in a report released by DOGAMI.

The new report, *Mist Gas Field: Exploration and Development, 1979-1984*, has been published as DOGAMI's Oil and Gas Investigation 10. It was written by DOGAMI staff member Dennis L. Olmstead and includes a chapter by Michael P. Alger of Reichhold Energy Corporation on the geology of the field. Funding was provided by the U.S. Department of Energy.

The 36-page report describes the geography, history, and geology of the gas field and discusses details of the drilling practices, the production methods, and the most recent plans for use of the field for gas storage. It is richly illustrated with maps, tables, diagrams, and photographs. Appendices provide detailed statistical information on the gas field, particularly its producing wells.

The oil and gas potential of northwestern Oregon was suspected as early as 1896, and exploratory drilling began in 1945. A DOGAMI report of 1976 recommended the area near Mist for exploration. This recommendation finally led to the first gas well completion in Oregon on May 1, 1979.

Both reports are available now at the Oregon Department of Geology and Mineral Industries, 910 State Office Building, 1400 SW Fifth Avenue, Portland, OR 97201. The purchase price for each of the two publications is $4. Orders under $50 require prepayment. □

Geoscience Information Society issues guidelines for field trip guidebook authors

Those who prepare guidebooks for field trips make a significant contribution to the geoscience community. The guidebooks for the field trips are recommended to colleagues and students by field trip participants. Librarians have found that guidebooks are difficult to acquire and once obtained may be difficult to catalog and identify. The searcher to whom someone has recommended a guidebook usually wants to find a guidebook associated with a particular meeting or area. Difficulties in locating guidebooks led the Geoscience Information Society to begin publication of the *Union List of Geologic Field Trip Guidebooks of North America*. Those who prepare guidebooks could contribute to the identification and control of the guidebook literature by applying the following guidelines (prepared by the Ad Hoc Committee to Write Guidelines for Geologic Field Trip Guidebooks):

Title page should include:
- Specific geographic area as part of a descriptive title, e.g., county, state, or province.
- Clearly indicated subtitle.
- Name and place of meeting when the field trip is held in conjunction with a meeting. If it is an annual meeting, specify the number of the annual meeting and the number of the field trip.
- Day(s), month, and year that the field trip is conducted or the date of publication if guidebook is not compiled for a specific field trip.
- Name of the organization(s) sponsoring the field trip.
- Name and number of the consistently phrased publication series, when applicable.
- Name of field trip leader.
- Title on cover and title page should be identical.
- If reprinted, list the original publication series, guidebook number, and year of publication.

Reverse side of the title page:
- Name and address of the publisher.
- Name and address of the distributor.
- Price of the publication.

General recommendations:
- Use good quality paper, printing, and binding (preferably not spiral binding).
- Print more copies of the guidebook than are needed for the field trip participants.
- Send publication announcements containing all information that appears on the title page and its verso to *Geotimes* and *Episodes*. If possible, send announcements to all libraries listed in the *Union List of Geologic Field Trip Guidebooks of North America* and to Geoscience Information Society members.
- Deposit a copy of the guidebook in the USGS Library in Reston, VA, and a copy in the nearest library listed in the *Union List*.
- Number the pages consecutively.
- Identify all illustrations.
- List all unbound illustrative material in a table at the front of the guidebook and include a pocket to hold all these pieces in the back of the publication. □

— *Geoscience Information Society release*

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