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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 the bibligraphic 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

Model of *Tyrannosaurus*, one of a group of animated dinosaur models created by Dinamation International Corp. that are on display through February in the exhibit "Dinosaurs II" at the Oregon Museum of Science and Industry (OMSI). Photo courtesy Burt Peterson and OMSI.

Tyrannosaurus lived during the Late Cretaceous, the period that concluded the Mesozoic era. The cause of mass extinctions that mark the boundaries between geologic eras is the topic of an upcoming lecture program at OMSI. Abstracts of the papers to be presented are printed in article beginning on next page.

OIL AND GAS NEWS

Mist Gas Field

ARCO has finished its 1987 drilling program at Mist with two more successful wells. The Columbia County 21-35-65 and the Foster 42-30-65 were drilled to depths of 1,924 and 2,658 ft, respectively, and both are currently suspended, awaiting connection to gas pipeline. This means ARCO's 1987 drilling program at Mist Gas Field resulted in seven new-pool gas discoveries, one dry hole, and one dry redrill. This is the highest number of new pool discoveries made in a single year since the discovery well at Mist was drilled in 1979.

Production rates for these wells have not yet been released, but may be released in the near future.

Gas production summaries for 1987

During 1987, cumulative gas production at Mist Gas Field was approximately 3.8 billion ft^3 of gas for a value of about $5.9 million. This is down somewhat from the approximately 4.6 billion ft^3 of gas for a value of about $9.2 million produced during 1986. Cumulative gas production at Mist since the 1979 discovery is approximately 31.6 billion ft^3 of gas.

There are currently 12 producing gas wells at Mist, all operated by ARCO, with seven new pool discoveries awaiting gas pipeline connection during 1988. The Tenneco Columbia County 41-28 well was suspended in September pending abandonment.

Mist Gas Field map updated

The Mist Gas Field map has been updated through December 1987 and is now available as DOGAMI Open-File Report O-88-02. It supersedes Open-File Report O-84-04. The purchase price is $5.00. □

Board of Geologist Examiners issues policy for professionals in hydrogeology and geothermal geology

At its regular meeting in Salem on November 10, 1987, the Board of Geologist Examiners adopted the following policy statement, which affects the public practice of geology in Oregon:

In response to questions presented to it, the Board of Geologist Examiners has reviewed the issue of registration requirements for individuals practicing in the fields of hydrogeology and geothermal geology. The review process included the establishment of a subcommittee, solicitation of comments from the community of registered geologists and certified engineering geologists, and discussion of the issue by Board members.

In considering this issue, the goals of the Board have been to ensure minimum risk to the general public, to adhere to the provisions of the statutes and administrative rules governing Board activities, to promote the availability of efficient and economical geologic services, and to ensure the freedom of professionals to pursue gainful practice.

The Board feels that the public practice of hydrogeology and geothermal geology in Oregon clearly is under the category of activities requiring registration and that any person practicing in these fields must be registered as a geologist by the Board. The Board also feels that, as is the case in most fields of geology, the practice of hydrogeology and geothermal geology can and does encompass a broad range of geologic expertise and is clearly not limited to the domain of engineering geology. Because of this, persons practicing in these fields are not required to be certified by the Board as engineering geologists.

However, any registered geologist practicing in the field of hydrogeology or geothermal geology must adhere to the Code of Professional Conduct (Chapter 809 of Oregon Administrative Rules) and must be competent by both training and experience to engage in that practice. *—Board of Geologist Examiners news release*

Mass extinctions: Meteorites or evolution?

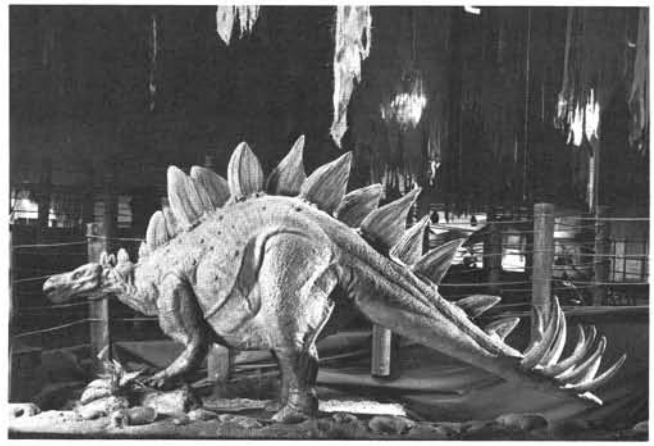
by R.E. Corcoran, private consultant and former State Geologist, Portland, Oregon; D.J. McLaren, Professor of Geology, Department of Geology, University of Ottawa, Ottawa, Canada; William N. Orr, Professor of Geology and Paleontology, Department of Geology, University of Oregon, Eugene, Oregon; and Peter D. Ward, Professor of Geology, Department of Geological Sciences, University of Washington, Seattle, Washington

INTRODUCTION

by R.E. ("Andy") Corcoran

Catastrophic events in the earth's past history are usually of great interest to the general public as well as to scientists. The controversy surrounding the demise of the dinosaurs is certainly no exception. No one is completely certain of the real reason at this time, but it should be largely determined within a few years when ongoing field studies have been completed. In the meantime, the public is being given a rare opportunity to follow the development of an important scientific theory.

The Geological Society of the Oregon Country (GSCO), the Oregon Museum of Science and Industry (OMSI), and the Department of Geology at Portland State University are sponsoring a series of lectures concerning the earth and its development. On February 12, 1988, the second of this series will deal with theories of mass extinction through geologic time. The emphasis will be on the nature of the Cretaceous-Tertiary (K-T) boundary. Three distinguished scientists will be addressing this topic: Dr. William N. Orr, Professor of Geology and Paleontology at the University of Oregon; Dr. Digby J. McLaren, Professor of Geology at the University of Ottawa, Canada; and Dr. Peter D. Ward, Professor of Geology at the University of Washington. Abstracts of the papers they will be presenting at the February lecture and a list of selected reading are printed below.



Model of Late Jurassic Stegosaurus *from "Dinosaur II" exhibit at OMSI mentioned in cover photo caption on previous page. Photo courtesy Burt Peterson and OMSI.*

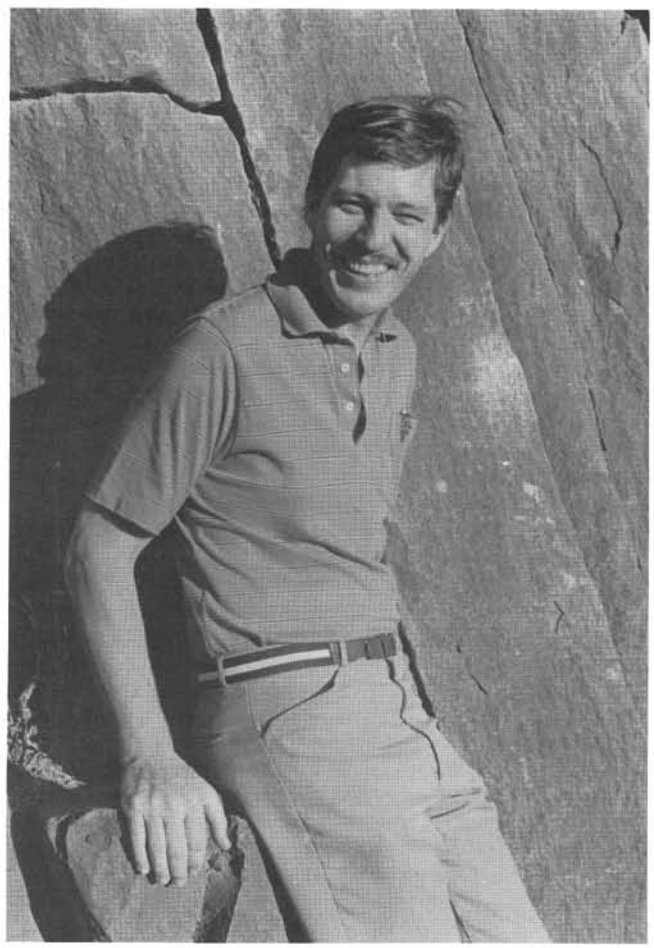
THE TERMINAL CRETACEOUS EVENT: CATASTROPHE OR HYPE?

by William N. Orr

Geologic events that capture the public's imagination are ordinarily real-time happenings such as earthquakes and their stepchildren—tidal waves, volcanoes, landslides, and avalanches. The geologic event that rivets our attention here is none of the above in that it caused no loss of human life or property, and it occurred some 65 million years ago (Ma). Very early on in their study of the earth, geologists came to divide the time scale on the basis of easily recognized changes they noticed in the fossil record at 570 Ma, 240 Ma, and 66 Ma (the Precambrian-Cambrian boundary, the Permo-Triassic boundary, and the Mesozoic-Cenozoic boundary). The most profound of these was without question the Permo-Triassic boundary, when as many as 95 percent of the then-living species experienced extinction. This boundary represents the earth's closest call ever with total annihilation. While the Mesozoic-Cenozoic (or Cretaceous-Tertiary [K-T] boundary) cannot boast nearly the extinction ratio of the Permo-Triassic, it is the current darling of science writers everywhere because (1) its cast of characters included dinosaurs and enormous meteorites as well as a possible "deathstar"; and (2) its possible byproducts include a nuclear-winter-style "darkness at noon," acid rain, global wildfires, and tidal waves.

In 1980, Berkeley physicists discovered abnormally high amounts of the element iridium in the K-T boundary interval in Italy. They hypothesized that the concentration of iridium might represent extraterrestrial fallout from a huge meteorite crashing into the earth at 66 Ma to wreak havoc with the earth's biota of that period. Later published reports of abnormal amounts of carbon (soot) at the same level combined with a sprinkling of "shocked" quartz grains and spherules of what looked like microtektites greatly heightened the excitement surrounding the theory.

Meanwhile, back at the fossil beds, paleontologists have in the



William N. Orr (Photo courtesy John Bauguess) cold light of day slowly begun to reexamine the biological events surrounding the K-T boundary and have been able to demonstrate that (1) the "catastrophe" involved several but not all groups of plants and animals; (2) the "event" as recorded by the fossil record is more often than not gradual and not sudden, in some cases beginning several hundred thousand years *prior* to the K-T boundary; and (3) dinosaurs lived well beyond the K-T boundary, and the youngest occur hundreds of thousands of years above the boundary. Worse yet, volcanologists have only recently written papers to suggest that both iridium and shocked quartz might easily be volcanologically derived. Meanwhile, "microtektite" spherules at the K-T boundary have been shown to be unequivocally authigenic and not extraterrestrial in origin. Standing in the wreckage of their rapidly crumbling theory, physicists have retrenched and now suggest "multiple impacts" of meteorites in the general K-T boundary interval. Stay tuned...

Aside from the actual heat of the battle now being fought, this is a major idea of earth and astronomical science that the interested public is monitoring step by step as it matures. Certainly not all bets are in, but most scientists would expect to see the major features of this idea resolved in the next two or three years. Resolution entails careful petrographic, geochemical, and paleontological examination of available K-T boundary sections worldwide. The focus will be a search for a series of events (or lack thereof) common to all the sections. In the meanwhile, the public is being given a rare opportunity to track the progress of an important scientific idea or theory as it evolves.

DETECTION AND SIGNIFICANCE OF MASS KILLINGS

by Digby J. McLaren

Mass killings that involve a large number of animals or plants are found as abrupt disappearances of organisms in the rock succession in many parts of the world. Some are known that appear to have occurred synchronously over wide areas in several continents and, where the record is preserved, in several oceans. Such synchroneity may be difficult to prove but suggests a common cause. Alternative hypotheses are necessarily complex. Such mass killings identify a horizon that may be examined for evidence of cause. Certain misconceptions have developed concerning detection of sudden events. Plotting changes in diversity and the names of genera or families that disappeared against time are of dubious value in detecting periodicity of extinctions and cannot identify an event horizon with any precision. Less common taxa (i.e., named groups) often show a gradual decline before any arbitrary horizon, and survivors after a major disturbance are (fortunately) not uncommon. Geochemical markers may be ephemeral, and their absence may not be significant. Ultimate causes are discussed—impacts of meteoroids or comets and episodes of a paroxysmal volcanicity—although it may be that no single cause was responsible for all events. It appears unlikely that ongoing phenomena such as climate and sea-level changes are primary causes of anomalous episodic extinctions.

Digby J. McLaren

THE CRETACEOUS-TERTIARY BOUNDARY EXTINCTION AND ITS EFFECT ON MARINE INVERTEBRATES

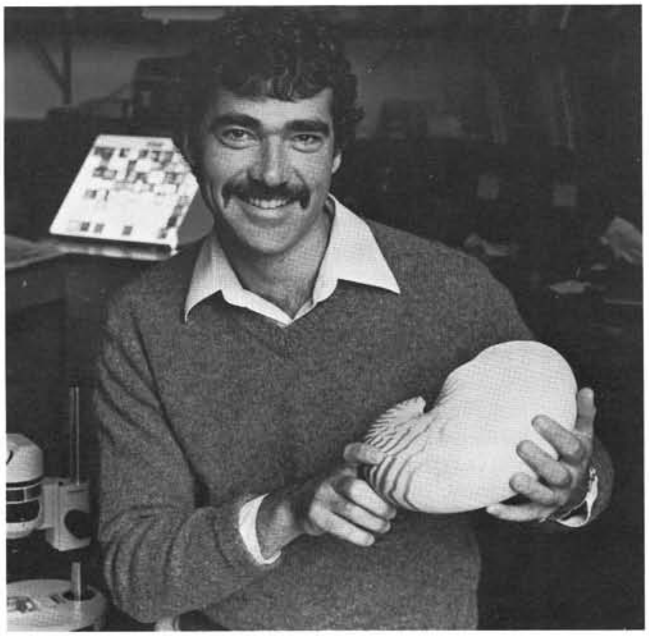
by Peter D. Ward

It has long been known that geologic time is punctuated by a number of major changes in the earth's fossil content, times when a large percentage of animals that previously had left skeletal remains as fossils suddenly disappear from the earth's fossil record. These periods of rather rapid change in the fossil faunas were used by 19th-century geologists to divide the fossil record into major groupings. Today, the three largest divisions of geological time (since the advent of common skeletonized life beginning about 560 Ma) are called (1) the Paleozoic Era, or time of ancient life; (2) the Mesozoic Era, or time of middle life; and (3) the Cenozoic Era, or time of modern life. These three great divisions are separated by mass extinctions, when as many as 95 percent of the species leaving fossils underwent extinction in time periods as short as several million years or less.

One of these mass extinctions ends the Mesozoic Era, which was characterized by dinosaurs on land and curious shelled cephalopods and large reclining bivalves in the sea. These latter two groups, respectively called ammonites and inoceramid bivalves, disappeared at the end of the Mesozoic Era in one of the most interesting of all the mass extinctions. Much research has centered on this particular mass extinction, in large part because of the hypothesis suggesting that this extinction was caused by the impact of one or more extraterrestrial bodies, such as meteors or comets, striking the earth with catastrophic consequences for life on land and in the sea.

In order to resolve whether or not this particular extinction was indeed caused by a catastrophic event of extraterrestrial source rather than longer term changes normal and inherent in earth processes, we need to closely examine the record of fossils in actual piles of sedimentary rock from many localities of the same age. This type of painstaking work is actively being pursued to answer the following fundamental questions: Did the extinctions on land and the sea occur at the same time? How long did the extinctions take? Were the extinctions selective, or did all groups and environmental types of organisms suffer equally? Do the stratigraphic sections giving information about the extinctions record the time when the extinctions took place, or are they only time averages, masking much information?

My research has centered on a depositional basin of Cretaceous age now found in the Bay of Biscay in Europe. In this talk, I will present data about these European stratigraphic sections that will give information pertaining to questions about mass extinctions.



Peter D. Ward

LECTURE PROGRAM INFORMATION

These papers will be presented to the public at a lecture at 7:30 p.m. on February 12, 1988, at OMSI. Tickets will go on sale on February 1. The price of the lecture for OMSI and GSOC members is $3.50, for student or senior-citizen members $2; the cost for nonmembers is $4 and for student or senior-citizen nonmembers $2.50.

SUGGESTED READING

Alvarez, L.W., 1987, Mass extinctions caused by large bolide impacts: Physics Today, July 1987, p. 24-33.

Gerstel, J., Thunell, R., and Ehrlich, R., 1987, Danian faunal succession: Planktonic foraminiferal response to a changing marine environment: Geology, v. 15, no. 7, p. 665-668.

Izett, G.A., 1987, Authigenic "spherules" in K-T boundary sediments at Caravaca, Spain, and Raton Basin, Colorado and New Mexico, may not be impact derived: Geological Society of America Bulletin, v. 99, no. 1, p. 78-86.

McLaren, D.J., 1970, President's address: Time, life, and boundaries: Journal of Paleontology, v. 44, no. 5, p. 801-814.

Olsen, P.E., Shubin, N.H., and Anders, M.H., 1987, New Early Jurassic tetrapod assemblages constrain Triassic-Jurassic tetrapod extinction event: Science, v. 237, p. 1025-1029.

Petrusky, B., 1986, Mass extinctions: The biological side: Mosaic, v. 17, no. 4, p. 3-13. □

NWMA elects new president, honors students

At its 93rd annual convention held in December 1987 in Spokane, Washington, the Northwest Mining Association (NWMA) announced the election of William B. Booth as its president for 1988. The NWMA has 1,400 individual and 130 corporate members and attracted over 2,000 attendants to the convention.

Booth is assistant to the vice president of investor and public affairs for Hecla Mining Company in Coeur d'Alene, Idaho. He grew up in Post Falls, Idaho, did his undergraduate work at the University of Idaho, and earned his master's degree in business administration at the University of North Dakota while serving in the Air Force as a captain in missile maintenance.

Booth, who succeeds Bernard Guarnera as president, has been a director of the NWMA since 1981 and has worked in the mining industry for 15 years, the past two years with Hecla.

Five prizes were awarded in the convention's student poster contest. The awards were judged on the basis of how well the papers and posters explained the students' technical papers on mining. Chairman of the poster contest was Professor Ernest H. Gilmour of Eastern Washington University. Prizes were donated by the Wray D. Farmin family and the William C. Jordan Fund. The prizes, winners, and their topics were as follows:

Most outstanding poster (a calculator and $100): Jacob Margolis, University of Washington, on "Epithermal gold mineralization, Wenatchee, Washington: Hydrothermal aquifers and structure."

First place ($250): Terri Plake, Western Washington University, on "Structural analysis of the Colebrooke Schist, southwestern Oregon."

Second place ($100): Robert Hammond, University of Idaho, on "Radar mapping of sulfide zones beneath glaciers."

Third place ($75): David Szumigala, UCLA, on "The Tin Creek zinc-lead silver skarn prospects, Farewell Mineral Belt, Alaska."

Fourth place ($50): Jeff Cary and Joe Dragovich, Western Washington University, on "The geology and economic potential of late Triassic metavolcanic area rocks and Cretaceous plutons in the Marble Creek area, Skagit County, Washington."

—Compiled from NWMA news releases

Field mappers working on Oregon-Idaho projects

Field mapping crews from the U.S. Geological Survey (USGS) are working in five counties in Oregon and Idaho, gathering and checking field data that will be used in producing 48 new topographic maps covering about 2,520 mi² of land and water.

Twelve crews of cartographers and field assistants from the USGS Mid-Continent Mapping Center in Rolla, Mo., have been working their way along trails and roads, across pastures and up steep slopes in Baker, Wallowa, and Union Counties in eastern Oregon and Adams and Idaho Counties in western Idaho to locate benchmarks, determine elevations, measure distances, verify occupied and abandoned structures, and locate public boundaries.

The USGS mapping crews have established field offices in Enterprise, Oregon, for the work in both states. Enterprise residents J.R. Bissett, J.W. Ryan, P.O. Schallert, and D.R. Yaccarino have been hired as local field assistants. Transportation for the crews to field areas that are often remote and difficult to reach is by pack horses, in four-wheel-drive vehicles, or on foot.

Much of the Oregon and Idaho mapping is being conducted on federal, state, and state-leased land, but private property is also being mapped and must be traversed when necessary, according to District Cartographer David Bennett of Rolla. Bennett emphasized that the mappers need the cooperation of landowners in allowing USGS crews to go on their properties. "We respect property rights, try to cause as little disruption as possible, and never go on anyone's land without permission," Bennett said. "All we need is access for the short time it takes us to do our work."

The surveyors are using sophisticated electronic distance-measuring instruments and theodolites, as well as the traditional surveyor's alidade and stadia (rods) to measure horizontal and vertical distances and determine elevations. They measure each distance twice to reduce the possibility of errors.

Each of the 48 new maps to be produced from the projects will be at a scale of 1:24,000 (one inch on the map representing about 2,000 ft on the ground) and will cover an area of 7.5 minutes of latitude by 7.5 minutes of longitude or approximately 55 mi². It is the first time these areas in Oregon and Idaho are being mapped at this scale, although various parts were mapped in the 1950's at a less detailed scale.

The new maps, which will be available in about three years, will show individual buildings in rural areas, as well as outbuildings, water and fire towers, civic buildings, campgrounds, and camp shelters. The various types of roads and trails will be designated by solid or dashed lines. Political boundaries, such as city limits, county lines, wilderness boundaries, and the boundaries of state-owned and state-controlled land, will also be outlined.

During their stay in Oregon and Idaho, the USGS mappers are available to talk to civic groups and interested individuals about their work and the USGS mapping program. Inquiries may be directed to David Bennett at the USGS Mid-Continent Mapping Center, Mail Stop 311, 1400 Independence Road, Rolla, MO 65401, phone (314) 341-0885; or to James T. Felkerson, Projects Chief, P.O. Box 218, Enterprise, OR 97828, phone (503) 426-4621.

Information about the mapping projects is also available, in Oregon, from Glenn W. Ireland, State Resident Cartographer, USGS, 847 NE 19th Ave., Portland, OR 97232, phone (503) 231-2019; and in Idaho from Michael Sety, State Resident Cartographer, Idaho Department of Lands, 801 S. Capitol Blvd., Boise, ID 83702, phone (208) 334-2419.

As the nation's largest civilian mapping agency, the USGS expects to sell and distribute, in 1987, more than 7 million copies of its more than 74,000 published topographic and thematic maps. Indexes listing the availability, prices, and outlets for Oregon and Idaho are available free from Map Distribution, USGS, Box 25286, Federal Center, Denver, CO 80225, phone (303) 236-7477. The Oregon Department of Geology and Mineral Industries sells these maps at its Portland office (see first inside page for information).

—USGS news release

USGS develops guidelines for naming aquifers

Guidelines for naming aquifers more systematically have been developed for authors of U.S. Geological Survey (USGS) reports and are described in a recent USGS report.

In the past, aquifer names have been based on a variety of physical, geologic, geographic, and age designations, which has caused confusion among readers of reports that involve descriptions of aquifers. When names are proposed for aquifers, it is recommended now that they be named only after lithologic terms, rock-stratigraphic units, or geographic names, according to the report's authors Robert L. Laney and Claire B. Davidson at the USGS National Center in Reston, Va.

The USGS Water Resources Division is the Nation's largest water-resource information and research agency and publishes more than 1,000 reports each year. The new guidelines are expected to help reduce confusion caused by conflicting or imprecise aquifer terminology in the rapidly expanding field of water-resource studies, which has produced a proliferation of aquifer names.

The report contains examples of comparison charts and tables that are used to define the hydrogeologic framework. Aquifers are defined in 11 hypothetical examples that characterize hydrogeologic settings throughout the country.

Copies of Open-File Report 86-534, *Aquifer-nomenclature Guidelines,* by Robert L. Laney and Claire B. Davidson, may be purchased from the U.S. Geological Survey, Books and Open-File Reports Section, P.O. Box 25425, Federal Center, Bldg. 1, Denver, Colo. 80225, for $8 for each paper copy and $4 for microfiche. Orders must include the report number (OFR 86-534) and checks or money orders payable to the U.S. Department of the Interior—USGS. □

Central Cascades and Gorda Ridge are subjects of new publications

GEOLOGIC MAP OF CRESCENT MOUNTAIN AREA RELEASED

A new geologic map published by the Oregon Department of Geology and Mineral Industries (DOGAMI) and partially funded by the U.S. Department of Energy provides a detailed geologic description of the Crescent Mountain area west of Santiam Pass in the central Oregon Cascade Range. The area includes the transition between rocks of the older Western Cascade Range and the younger High Cascade Range.

Geologic Map of the Crescent Mountain Area, Linn County, Oregon ($6.00), by DOGAMI staff members G.L. Black, N.M. Woller, and M.L. Ferns, has been released in DOGAMI's Geological Map Series as map GMS-47. At a scale of 1:62,500, it covers over 200 square miles of the region both east and west of State Highway 22 between Marion Forks and Santiam Junction. This map complements DOGAMI's recently published map GMS-46 that covered the Breitenbush River area immediately to the north.

The report consists of two parts, a map sheet and a data table sheet. The map sheet (approximately 27 by 40 inches) contains a multicolored geologic map and two geologic cross sections. It describes six surficial and 35 volcanic rock units of Tertiary and younger age and identifies six volcanic vent complexes and eight intrusive rock units in the area. The data-table sheet presents chemical analyses of 77 rock samples and potassium-argon dates for nine samples.

GORDA RIDGE RESEARCH YIELDS TWO MORE REPORTS

DOGAMI has also released two new reports presenting the results of research on the Gorda Ridge. Both reports deal with ecological aspects of this sea-floor spreading region off the coast of southern Oregon and northern California.

Distribution and Abundance of Seabirds in the Vicinity of the Gorda Ridge, off Eureka, California, during July 1986 ($5.00), by D.R. Matthews, has been published as DOGAMI Open-File Report O-87-04. The 49-page report presents research conducted in connection with geologic sea-floor studies at a dive site about 150 nautical miles due west of Eureka, as well as en route to the site. It includes graphs and tables showing seabird distribution and abundance in relation to distance off shore and time of day at the dive site.

Analysis of Benthic Epifaunal Community Structure of the Gorda Ridge ($5.00), by A.G. Carey, Jr., D.L. Stein, and G.L. Taghon of the Oregon State University College of Oceanography, has been published as DOGAMI Open-File Report O-87-05. The 48-page report presents analyses of photographic and video recordings taken by submersibles and camera sleds and of animal collections, all conducted between 1984 and 1986. It is a continuation of earlier research published by DOGAMI in 1986 as Open-File Report O-86-11.

Both reports represent an integral part of the mineral studies in the Gorda Ridge area and will serve as baseline ecological information for assessing the impact of possible submarine mineral exploration on this habitat. DOGAMI published five related ecological reports in 1986 (O-86-06 through O-86-09 and O-86-11).

The Gorda Ridge research program began in 1985 and is directed by the joint federal-state Gorda Ridge Technical Task Force. It is funded by the U.S. Minerals Management Service and managed by DOGAMI.

The new reports are now available at the Oregon Department of Geology and Mineral Industries, 910 State Office Building, 1400 SW Fifth Avenue, Portland, OR 97201. Orders under $50 require prepayment. □

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.

PETROLOGY OF THE BEND PUMICE AND TUMALO TUFF, A PLEISTOCENE CASCADE ERUPTION INVOLVING MAGMA MIXING, by Brittain Eames Hill (M.S., Oregon State University, 1985 (compl. 1984)

The Bend pumice and Tumalo tuff are products of a Plinian eruption that occurred sometime between 0.89 and 2.6 Ma. The Bend pumice is a poorly consolidated, air-fall vitric lapilli tuff that overlies a zone of reworked tephra. Perlitic obsidian in the reworked zone probably represents the remains of a dome that filled the eruptive vent and is chemically related to the Bend pumice magma. Detailed grain-size analysis of the air-fall part of the Bend pumice shows that the eruptive vent was located approximately 10-20 km west of Bend, Oregon. Grain-size variations in the vertical section are probably related to fluctuations in the diameter of the vent rather than interruptions in deposition of the Bend pumice.

The Tumalo tuff is a nonwelded to moderately welded ash-flow tuff that directly overlies the Bend pumice. Lack of discernible normal grading in the upper 50 cm of the Bend pumice indicates that the Tumalo tuff was emplaced before the Bend pumice was completely deposited and leads to the conclusion that the Tumalo tuff is the product of collapse of the Bend pumice eruption column. The Tumalo tuff was formed by one episode of flow and has a well-developed basal 2a layer. Variations in the distal character of layer 2a are thought to represent complex flow conditions in the head of the Tumalo tuff ash flow. Mixed pumices also are found in proximal Tumalo tuff deposits.

The Bend pumice and Tumalo tuff are peraluminous and rhyodacitic. Within analytical uncertainties, they have identical major, minor, and trace element abundances. Both contain fresh hornblende in the mineral assemblage Plg + Opx + Mgt + Zr + Ap. The hornblende appears to have been a liquidus phase and indicates that the rhyodacite evolved under high-pressure, hydrous conditions. A higher La to Ce ratio and a strong negative Eu anomaly in the Bend-Tumalo rhyodacite further indicate that the Bend pumice and Tumalo tuff evolved under physical conditions quite distinct from other rhyodacites in the central Oregon High Cascades analysed by Hughes (1982).

Mixed pumices in the Tumalo tuff represent the incomplete mixing between Bend-Tumalo rhyodacite and a dacitic magma. Trace element modeling fails to provide an unequivocally common path of crystal fractionation between these two magmas. The magmas cannot be directly related through thermogravitational diffusion or assimilation. While mixed pumice formation is usually attributed to mixing of genetically related magmas, Tumalo tuff mixed pumices were produced through the mixing of genetically unrelated magmas.

GEOLOGY OF THE FISHHAWK FALLS - JEWELL AREA, CLATSOP COUNTY, NORTHWEST OREGON, by David Ezra Nelson (M.S., Oregon State University, 1985)

The study area is located on the northwest flank of the northern Oregon Coast Range. Seven Tertiary formations compose the bedrock units: the Tillamook Volcanics; the Cowlitz, Keasey, and Pittsburg Bluff Formations; Oswald West mudstone (informal); Astoria Formation (Silver Point member); and Grande Ronde (Depoe Bay) Basalt of the Columbia River Basalt Group.

Major-element geochemistry, petrology, and radiometric ages of volcanic rocks near Green Mountain suggest that this is an upthrown tectonic block of middle to upper Eocene Tillamook Volcanics. This outlier is composed of subaerial basaltic andesite flows and epiclastic debris flows which are intruded by complexes of basaltic andesite dikes. The volcanics typically contain 58-62 percent SiO_2 and reflect a rugged stratovolcano or mid-ocean island that rose above sea level. Radiometric dates from the uppermost part of the upper Tillamook Volcanics in and near this study area are from 37.1 $\pm$ 0.4 m.y. (late middle Eocene) to 42.4 $\pm$ 0.5 m.y. (early late Eocene). Preliminary paleomagnetic investigation of three sites in the Tillamook Volcanics and overlying Cougar Mountain intrusions indicates that $48.4° \pm 26°$ of clockwise rotation has occurred since the late middle Eocene.

The middle to upper Eocene (Narizian) Cowlitz Formation overlies the Tillamook Volcanics with angular unconformity in the study area. The Cowlitz is an onlapping marine sequence of basaltic and arkosic sandstone and deep-marine turbidite sandstone overlain by a regressive sequence of arkosic sandstone. Four lithofacies are considered informal members of the 465-m-thick Cowlitz Formation. These are: a basal fluvial-littoral basaltic andesite conglomerate (Tc_1), a lower shallow-marine sandstone composed of intrabasinal basaltic sandstone and extrabasinal micaceous arkosic sandstone and mudstone (Tc_2), a thin turbidite sandstone and siltstone unit (Tc_3), and an upper shallow-marine arkosic sandstone (Tc_4). The lower sandstones are volcanic arenites derived locally from the Tillamook Volcanics. They are interbedded with micaceous plagioclase-bearing arkosic sandstone redistributed from the Cowlitz delta of southwestern Washington via longshore drift. The friable arkosic upper sandstone member may be correlative to the "Clark and Wilson" reservoir sandstone in the Mist Gas Field.

The Cowlitz Formation is overlain by the 1,640-2,050-m-thick upper Narizian to Refugian Keasey Formation. Three mappable lithofacies of the Keasey are defined as informal members based on lithology and biostratigraphy. The tuffaceous Jewell mudstone forms the lower member of the Keasey Formation. It contains foram and coccolith assemblages that correlate to the *Valvulineria tumeyensis* Zone of California of Donnelly (1976). The middle member is the Vesper Church member, which is late Refugian in age. This well-bedded to laminated graded sandstone and mudstone unit was deposited in nested slope channels by turbidites as micaceous arkosic Cowlitz sands and muds were redistributed offshore. The thick-bedded, structureless tuffaceous upper mudstone member is upper Refugian and contains Foraminifera equivalent to the *Uvigerina vicksburgensis* Zone of California. Foraminifera paleoecology suggests that the three members were deposited in upper bathyal depths.

The upper Eocene to Oligocene (upper Refugian to Zemorrian) 200-500-m-thick Pittsburg Bluff Formation disconformably overlies the Keasey Formation. The thick-bedded tuffaceous to arkosic Pittsburg Bluff sandstones were deposited in a shallow-marine inner to middle shelf environment. Local uplift and/or eustatic sea level fall (corresponding to the end of cycle TE3 of Vail and Hardenbol, 1979) combined to cause a late Eocene marine regression and disconformity at the base of the Pittsburg Bluff Formation.

The mollusc-rich bioturbated Pittsburg Bluff sandstone and the overlying tuffaceous Oswald West deep-marine mudstone are, in part, coeval facies that represent inner to middle shelf sands and an adjacent deep-water outer shelf-upper slope depositional environment, respectively. An Oligocene marine transgression corresponding to Vail and Hardenbol's cycle TO1 eventually caused onlap of Oswald West slope muds over inner shelf Pittsburg Bluff sands. The Oswald West is Oligocene (Zemorrian) in age in the thesis area but is as young as lower Miocene (Saucesian) in western Clatsop County. The deep-marine lower Miocene to middle Miocene Silver Point mudstone and the turbidite sandstones of the Astoria Formation overlie the Oswald West mudstones with minor unconformity.

The sedimentary strata of the thesis area were intruded by several dikes and sills of middle Miocene tholeiitic basalt. Principal among the intrusions are three extensive dikes (Beneke, Fishhawk Falls, and Northrup Creek) composed of low-MgO-high-TiO_2 and low-

MgO-low-TiO_2 basalt. These subparallel northeast-trending dikes are 10 to 20 km long and are geochemically and magnetically correlative to low-MgO-high-TiO_2 and low-MgO-low-TiO_2 subaerial flows of the Grande Ronde Basalt that are exposed 6.5 km northeast of the thesis area near Nicolai Mountain and Porter Ridge. This correlation supports the hypothesis of Beeson and others (1979) that these intrusions were formed by "invasive" flows of Columbia River basalt. The dikes and flows represent the R_2 and N_2 magnetozones. Paleomagnetic results and detailed mapping along the three major dikes indicate that the dikes are cut into many small blocks by northeast-trending dextral and northwest-trending sinistral faults. Oblique slip along these faults may have rotated these small blocks clockwise from the expected middle Miocene declination. One such fault-bounded block in Beneke quarry has been rotated 11° clockwise relative to other blocks in the quarry.

The area has apparently undergone four periods of structural deformation. Late Eocene deformation produced normal faults and a highly faulted anticline in the Cowlitz, Keasey, and Pittsburg Bluff Formations. Uplift of the Oregon Coast Range commenced during the Oligocene. Northwest-southeast extension in the middle Miocene permitted intrusion of the northeast-trending dikes, perhaps along pre-existing faults or joints. Post-middle Miocene north-south compression produced a conjugate shear couplet of dextral northwest-trending and sinistral northeast-trending oblique-slip faults and associated east-west thrust faults. These may compose a 20-km-wide zone of distributed shear between the Oregon Coast Range tectonic block and the smaller tectonic blocks of southwestern Washington (Wells, 1981). These post-middle Miocene faults may be related to wrench tectonics and northwest-trending dextral slip faults observed on the Columbia Plateau. They may have formed sympathetically to regional right-lateral wrenching of the North American plate by oblique subduction of the Juan de Fuca plate and/or extensional opening of the Basin and Range province (Magill and others, 1982).

The north-central and eastern parts of the study area hold the greatest potential for natural gas accumulation in the permeable upper Cowlitz sandstones (Tc_4) that may be correlative to the Clark and Wilson sand. Mapping of the limited outcrops of this potential reservoir suggests that the unit may pinch out to the west. It is overlain by Keasey mudstones that could form cap rock. A highly faulted northwest-trending antiform in the subsurface, postulated from surface mapping, represents the best structural trap in the area if the reservoir sands are not breached by faulting.

GEOLOGY, PETROLOGY, AND VOLCANIC HISTORY OF A PORTION OF THE CASCADE RANGE BETWEEN LATITUDES 43° - 44° N, CENTRAL OREGON, U.S.A., by David R. Sherrod (Ph.D., University of California, Santa Barbara, 1986)

This report describes the stratigraphy, structure, and petrology of the Cenozoic volcanic and volcaniclastic rocks mapped along a 30-minute by 60-minute strip of the Cascade Range between latitudes 43° -44°N (map scale 1:125,000). That part of the Cascade Range is customarily divided into physiographic subprovinces: the deeply eroded Western Cascades and the relatively uneroded High Cascades. In the map area, the Western Cascades are built chiefly of rocks about 24 to 3.5 m.y. old that were tilted slightly eastward ($<5°$) between 8? and 3.5 m.y. ago; whereas rocks in the High Cascades were erupted during the last 3.5 m.y. and are essentially undeformed.

The High Cascades-Western Cascades boundary began developing about 4 to 5 m.y. ago. Late Miocene or early Pliocene normal faults with up to 300 m of dip separation mark 45 percent of the boundary length. The remaining 55 percent of boundary is a somewhat diffuse zone of volcanic onlap. There is no subprovince-wide graben coincident with High Cascades volcanism between latitudes 43° -44° N.

Though volcanism in the map area has been more or less continuous during the last 24 m.y., two temporally distinct, well-defined arcs allow comparison of composition and rate. Middle Miocene rocks (about 17 to 12? m.y. old) are in volumetric proportions of 30:35:35 for basalt:basaltic andesite:andesite-to-rhyolite, respectively. They were erupted at a minimum rate of 3 to 4 km³ per kilometer per m.y. (km³/km/m.y.). The modern arc—the volcanic rocks of the High Cascades (3.5 to 0 m.y. old)—has volumetric proportions of 40:50:10, erupted at a rate of 3 to 6 km³/km/m.y. Although temporally distinct, the rocks from these two suites are chemically and mineralogically similar: for example, low K_2O (1.0-1.5 percent at 57.7 percent SiO_2); and moderate TiO_2 (1 percent at 57.5 percent SiO_2). The chemical similarity of rocks younger than 17 m.y. old suggests relative source homogeneity and the repeated operation of similar petrogenetic mechanisms through time.

A STRATIGRAPHIC AND STRUCTURAL STUDY OF COAL MINE BASIN, IDAHO-OREGON, by Kyle Douglas Walden (M.S., Michigan State University, 1986)

Coal Mine Basin, Idaho-Oregon, lies within a broad, block-faulted, gently plunging anticline or dome northwest of the Owyhee Mountains of southwestern Idaho. The major emphasis of this study was the preparation of a measured stratigraphic section and a structural map of the basin. The composite stratigraphic section measured is comprised of 265 m of predominately volcaniclastic fluvial, lacustrine, and deltaic sediments of the Miocene Sucker Creek Formation. Reconnaissance field observation led to the suggestion of three tentative stratigraphic marker zones. Maar volcanism was widespread during Sucker Creek time, leaving local stratigraphic marker tuffs. Twenty-one plant and two animal fossil zones were precisely placed stratigraphically. The rocks of Coal Mine Basin have been subdivided into five episodes during Sucker Creek time based on sediment source and depositional environment.

MID-TERTIARY ECHINOIDS AND OLIGOCENE SHALLOW MARINE ENVIRONMENTS IN THE OREGON CENTRAL WESTERN CASCADES, by Robert Andrew Linder (M.S., University of Oregon, 1986)

Fossil echinoids from the late Oligocene Scotts Mills Formation were studied to determine their stratigraphic occurrences, systematic paleontology, paleoautoecology, and paleobiogeographic distribution. The echinoid remains collected are referable to the genera *Salenia, Glyptocidaris, Arbacia, Lytechinus, Gagaria, and Kewia.* These echinoids supplement the sparse fossil record of Echinodermata in Oregon, which includes fossil material from 27 formations ranging from the Permian to middle upper Miocene. Of particular interest are the preservation of *Kewia* tests infilled with abundant heavy minerals, and several whole *Arbacia* tests that are spineless with intricate epistromal ornamentation. The echinoid fossils occur in sediments associated with basaltic sea stacks that were deposited in a rocky-coast, storm-dominated environment. The sediments were dated by obtaining K-40/Ar-40 ages of the nonconformabley underlying "Little Butte Voclanics" and intrusive dikes, along with compatible age assignments suggested by echinoids as well as the associated fossils *Chlamys* sp. and *Balanus* sp.

CURIE-POINT ISOTHERM MAPPING AND INTERPRETATION FROM AEROMAGNETIC MEASUREMENTS IN THE NORTHERN OREGON CASCADES, by Robert W. Foote (M.S., Oregon State University, 1986 [thesis compl. 1985])

During the summer and fall of 1982, personnel from the Geophysics Group in the School of Oceanography at Oregon State University conducted an aeromagnetic survey in the northern Oregon Cascades to assess geothermal potential and study the thermal evolution of the Cascade volcanic arc.

Total field and low-pass filtered magnetic anomaly maps obtained from the survey data show high amplitude positive and negative anomalies associated with volcanic cones and shallow source bodies along the axis of the High Cascades. Spectral analysis of the aeromagnetic data yielded source depths and depths-to-the-bottom of the magnetic sources. The magnetic source bottom, in the northern Oregon Cascades, is interpreted as the depth to the Curie-point isotherm.

The northern Oregon study area shows shallow Curie-point isotherm depths of 5 to 9 km below sea level (BSL) beneath the axis of the High Cascades from the southern boundary (44° N. latitude) to near Mount Wilson (45° N. latitude). A smaller region of shallow Curie-point depths of 6 to 9 km BSL lies west of Mount Wilson (45° N. latitude, 122° W. longitude). The shallow Curie-point isotherm suggests the emplacement of relatively recent intrusive bodies in the upper crust beneath the axis of the High Cascades and west of Mount Wilson.

A major northeast-trending structure observed in magnetic and residual gravity anomalies near Mount Wilson is the northernmost extent of shallow Curie-point depths and high geothermal gradients mapped in the northern Oregon Cascades. This northeast-trending structure appears to mark a division between high intrusive activity in localized areas south of Mount Wilson and intrusive activity confined beneath the major cones north of Mount Wilson.

TEMPORAL VARIATIONS IN VOLUME AND GEOCHEMISTRY OF VOLCANISM IN THE WESTERN CASCADES, OREGON, by Emily Pierce Verplanck (M.S., Oregon State University, 1985)

Fifty-one K-Ar age determinations of basalts, basaltic andesites, and ash-flow tuffs from the central Western Cascades in Oregon range in age from 32 to 3.0 m.y. The oldest material is exposed on the western margin, and ages decrease progressively with increasing elevation and distance eastward. The age data indicate decreasing eruption rates with time in the Western Cascades volcanic arc. There was approximately twice as much volcanic material deposited between 30 and 20 m.y. as between 20 and 10 m.y.

Major- and trace-element geochemical analyses on the dated samples reveal temporal variations during the Western Cascades eruptive history. There is an increase in calc-alkaline volcanism relative to tholeiitic volcanism and an increase in K_2O/SiO_2 and Zr/Nb ratios with time.

It is proposed that the volume and geochemical character of volcanism in the Western Cascades volcanic arc are influenced by changes in the direction and rate of convergence between the Farallon and North American Plates. A model of the convergence rate and direction, based on the mantle-fixed hotspot reference frame, during the Tertiary indicates a factor of five decrease in rate (16.0 to 3.2 cm/yr). When the clockwise rotation of the Coast Range and Western Cascades is compared with the convergence vectors, the convergence angle is found to decrease with time from about 35 m.y. to the present. Apparently, slower, more oblique subduction results in a decrease in eruption rate, an increase in calc-alkaline composition relative to tholeiitic compositions, and an increase in K_2O/SiO_2 and Zr/Nb ratios.

GEOLOGY OF THE IDOL CITY AREA: A VOLCANIC-HOSTED, PRECIOUS-METAL OCCURRENCE IN EAST-CENTRAL OREGON, by Daniel J. McGrane (M.S., University of Montana, 1985)

The Idol City area is 32 km northeast of Burns, Harney County, Oregon. The property is underlain by a thick sequence of lower Miocene lavas of intermediate composition. These lavas were intruded by several porphyritic rhyolite dikes and plugs and coarser grained quartz-porphyry granitic bodies. Intrusive and extrusive rocks are exposed along the crest of a regional south-plunging anticline and are flanked by younger ash-flow tuffs. Base- and precious-metal mineralization is confined to andesitic rocks, which are sheared, brecciated, and hydrothermally altered.

Previous studies viewed mineralization at Idol City as typical of the upper part of a vein-type hydrothermal system. This study shows that base and precious metals occur primarily as disseminations and filling stockworks within two broad tourmalinized breccia zones that formed during explosive hydrothermal activity. Mineralization within these zones is remarkably consistent over broad vertical and lateral distances.

Deposition of metals occurred in response to boiling triggered by episodic explosive brecciation events. Boiling temperatures of approximately 300° C, which were determined from fluid inclusion studies on mineralized stockworks, indicate that metal deposition could have occurred at depths as shallow as 315 m. Felsic intrusive bodies are spatially, temporally, and probably genetically related to the mineralizing event.

VOLCANIC STRATIGRAPHY AND GEOCHEMISTRY OF THE HOLE IN THE GROUND AREA, OWYHEE PLATEAU, SOUTHEASTERN OREGON, by Patrick S. Plumley (M.S., University of Idaho, 1986)

Volcanic and volcaniclastic units of middle to late Pliocene age are exposed along a 28-km-long section of the Owyhee River Canyon, located immediately south of Lake Owyhee in Malheur County, southeastern Oregon. Geologic mapping has defined the stratigraphy and structure of this previously unmapped portion of the Owyhee Plateau. The oldest volcanic rocks exposed are rhyolitic ash-flow tuffs. The tuffs are overlain by silicic volcaniclastic sediments intercalated with basalt, andesite, and occasional rhyolite lava flow units. Two fault sets have been recurrently active since the Miocene: (1) a north-trending fault set that is the manifestation of Basin and Range faulting in the Owyhee Plateau, and (2) a subordinate west-northwest-trending fault set.

The oldest volcanic unit is the Leslie Gulch tuff: a nonwelded, phenocryst-poor, ash-flow and air-fall tuff sequence that was erupted from the Mahogany Mountains caldera. Overlying the Leslie Gulch tuff is the Birch Creek tuff, a small volume (<1 km), densely welded, rhyolitic ash-flow tuff that was erupted from a water-rich, homogeneous magma. The tuffs are overlain by a thick sequence of sediments that have been divided into several units. The sediments are predominantly fine-grained, evenly bedded tuffaceous sediments that accumulated in lacustrine and fluvial-lacustrine settings. The composition and texture of the sediments indicates that they were derived primarily from silicic and pyroclastic-rich source areas. The volcaniclastic sequence is 1,200 m thick and includes a total of 300 m of intercalated mafic to intermediate (49-61 percent SiO_2) lava flows. These lavas do not display systematic compositional changes with time, although there is a tendency toward eruption of less evolved magma with time. The youngest volcanic rocks are depleted olivine tholeiites that veneer the Owyhee Plateau and are the most primitive lavas in the sequence. In addition, basaltic and rhyolitic lava flows interfinger together in the sequence and record a period of pene-contemporaneous bimodal volcanism.

Chemically, the entire suite of volcanic rocks is calc-alkaline. The area evolved petrologically from rhyolite volcanism in middle Miocene to bimodal basalt-rhyolite volcanism in late Miocene to late Pliocene time. Furthermore, chemical data suggest that the mafic and silicic suites were not derived from a single parent magma composition.

STRATIGRAPHY, SEDIMENTOLOGY, AND PETROLOGY OF NEOGENE ROCKS IN THE DESCHUTES BASIN, CENTRAL OREGON: A RECORD OF CONTINENTAL-MARGIN VOLCANISM AND ITS INFLUENCE ON FLUVIAL SEDIMENTATION IN AN ARC-ADJACENT BASIN, by Gary Allen Smith (Ph.D., Oregon State University, 1986 [compl. 1985])

Neogene rocks of the Deschutes basin include the middle Miocene Columbia River Basalt Group and Simtustus Formation and the upper Miocene to lower Pliocene Deschutes Formation. Assignment of Prineville chemical-type flows to the Grande Ronde Basalt of the Columbia River Basalt Group is based upon correlation of these lavas from their type area, through the Deschutes basin, and onto the Columbia Plateau, where they have been previously mapped as Grande Ronde Basalt. The Simtustus Formation is a newly defined unit intercalated with and conformable upon these basalts and is unconformably overlain by Deschutes Formation.

Burial of mature topography by middle Miocene basalts raised local base levels and initiated aggradation by low-gradient streams within the basin represented by the tuffaceous sandstones and mudstones of the Simtustus Formation. These sediments are enriched in pyroclastic constituents relative to contemporary Western Cascades volcanics reflecting preferential incorporation of easily eroded and more widespread pyroclastic debris in distal sedimentary sequences compared to epiclastic contributions from lavas.

Following a 5- to 7-m.y. hiatus, aggradation was renewed at about 7.5 Ma, when coarse-grained volcanogenic sediments, lava flows, and ignimbrites from the early High Cascades entered the basin for 2 m.y. The proximal Deschutes Formation is primarily basalt and basaltic andesite lava flows, but andesite to rhyolite ignimbrites are the primary volcanic constitutents in the sedimentary-dominated section farther east. Deposition on a broad, eastward-tapering alluvial plain was by debris flows, sheetfloods, and hyperconcentrated flood flows. Episodic aggradation correlates to periods of sediment influx following eruptions of widespread pyroclastic debris and was separated by periods of incision.

The abundance of basalts, combined with the paucity of hydrous minerals and FeO and TiO_2 enrichment in intermediate lavas, characterizes early High Cascade volcanics as atypical for convergent-margin arcs. These petrologic characteristics are consistent with high-level fractionation in an extensional regime. Extension culminated in the development of an intra-arc graben that ended Deschutes Formation deposition by structurally isolating the basin from the High Cascade source area. Intra-arc extension may represent invasion of Basin and Range tectonism into the Cascades or may relate to plate-margin processes, particularly decreasing convergence rate and highly oblique convergence vector. □

BOOK REVIEW

Earth Treasures (volume 3): Northwest Quadrant, 1987, by Allen W. Eckert. Published by Harper and Rowe, 10 East 53rd Street, New York, New York.

Earth Treasures is a four-volume publication designed to show where to collect minerals, rocks, and fossils in the United States. The publishers have divided the U.S. into four quadrants, and the *Northwest Quadrant* (volume 3) claims to be "a precise guide to more than 1,000 specific localities in Idaho, Iowa, Kansas, Minnesota, Missouri, Montana, Nebraska, North Dakota, Oregon, South Dakota, Washington, and Wyoming." Although the concept is admirable and the need for such a book quite apparent, Oregon Department of Geology and Mineral Industries (DOGAMI) reviewers soon discovered that the book did not live up to its promise—-as least as far as Oregon is concerned.

Northwest Quadrant contains numerous inaccuracies, ranging from errors in a diagram showing compass directions to misinformation, such as stating that, in Multnomah County, superb-quality agate, bloodstones, jasper, and petrified wood are found "countywide in gravel bars of the Willamette River"—a tough job, as anyone who has walked beside or boated on the Willamette knows.

The information is often old or incomplete. For Jefferson County, Eckert mentions the Kennedy Ranch, which is now instead part of the Richardson Ranch; the highway locations of the Richardson and former Kennedy Ranches are inaccurately given; and the Priday Ranch that he mentions is now controlled by the Richardsons. The location for the hyalite and opal deposit on Opal (Peters) Butte is shown at the town of Heppner but is actually 30 road miles to the south—and Eckert provides no information on how to find the site.

The instructions on how to find the "Dolly Drummond Agate Beds" in Linn County are wrong, which is just as well because they and other nearby locations that are mentioned are all closed down and are not available for digging. Furthermore, none of the Quartzville mining district sites where pyrite, quartz, tourmaline, galena, and sphalerite occur are even mentioned in the Linn County section.

In his introduction, Eckert warns the reader to learn and obey local regulations while collecting—a prudent reminder because in his Deschutes County section, he tells his reader to "collect [obsidian] on both sides of the road between Paulina Lake and East Lake [in Newberry volcano]." Anyone who has been to the Big Obsidian Flow will remember the signs warning against just such collecting. In fact, collecting from many of the sites mentioned in the Oregon section is impossible because of local, State, or federal regulations or because of restrictions placed on private property by owners.

Sources of data used in the book are not cited, the author's credentials for doing such a volume are not given, and local sources of information and names of local collecting clubs are not provided. In general, Oregon's rocks, minerals, and fossils are not given the treatment they deserve—and a purchaser of the book will spend many long hours trying to follow woefully inadequate or inaccurate instructions. So while *Northwest Quadrant* is attractive, handy to pack (4½ by 8½ inches), and impressive at first glance, it is not the "precise guide" it claims to be—at least for Oregon. What it does do, however, is point out the need for a comprehensive, accurate, and easy-to-follow collecting guide to the rocks, minerals, and fossils of Oregon. □

"Maturation profiles" explained

Several readers told us that they did not understand the term "maturation profiles" in the article published in the November 1987 issue of Oregon Geology. This may provide some explanation.

Organic-rich sediments, which provide the material from which hydrocarbons (oil and gas) form, are called source rocks. When the organic-rich sediments accumulate, they are subjected to increased pressure and temperature as they are buried. The organic material changes as it becomes stratified and is converted into oil and gas during what is called the maturation process. The maturation state of the sediments may be gauged by the degree to which they have been thermally altered during burial and stratification. Generally, source rocks may be indexed as immature (not yet generating significant hydrocarbons), mature (rich in hydrocarbons), or metamorphosed (lean in hydrocarbons due to the destruction of the hydrocarbon-generating capacity of the source rock.

In the November article by Summer and Verosub, maturation profiles show the degree of maturity of sediments as a relationship between measured vitrinite reflectance and depth. Normal profiles show a gradual increase of maturity with depth (see comparison of "normal" and measured profiles in the article's Figure 2 on page 137). In contrast to normal profiles, however, studies in the Pacific Northwest showed near-vertical profiles, which was attributed to heating of sediments at shallow depths by volcanic rocks. □

AVAILABLE DEPARTMENT PUBLICATIONS

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GMS-26.	Residual gravity maps, northern, central, and southern Oregon Cascades. 1982	5.00		
GMS-27.	Geologic and neotectonic evaluation of north-central Oregon. The Dalles 1°x2° quadrangle. 1982	6.00		
GMS-28.	Geology and gold deposits map, Greenhorn 7½-minute quadrangle, Baker/Grant Counties. 1983	5.00		
GMS-29.	Geology and gold deposits map, NE¼ Bates 15-minute quadrangle, Baker/Grant Counties. 1983	5.00		
GMS-30.	Geologic map, SE¼ Pearsoll Peak 15-minute quadrangle, Curry/Josephine Counties. 1984	6.00		
GMS-31.	Geology and gold deposits map, NW¼ Bates 15-minute quadrangle, Grant County. 1984	5.00		
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GMS-36.	Mineral resources map of Oregon. 1984	8.00		
GMS-37.	Mineral resources map, offshore Oregon. 1985	6.00		
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