

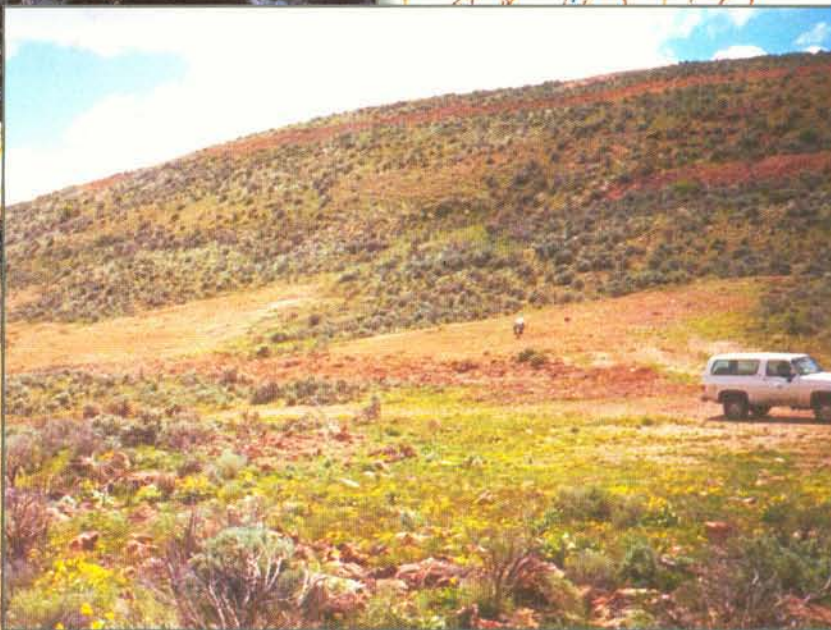
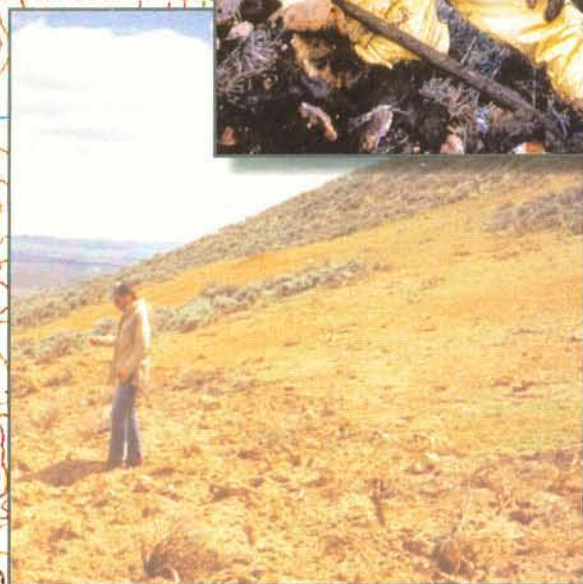
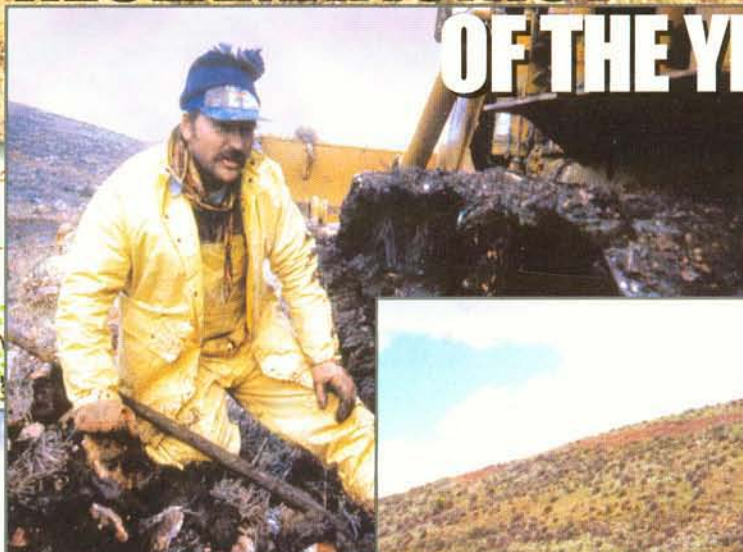
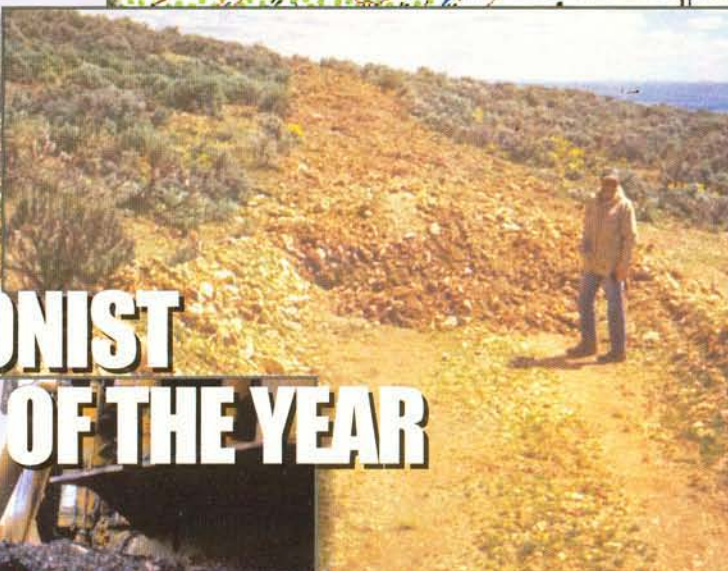
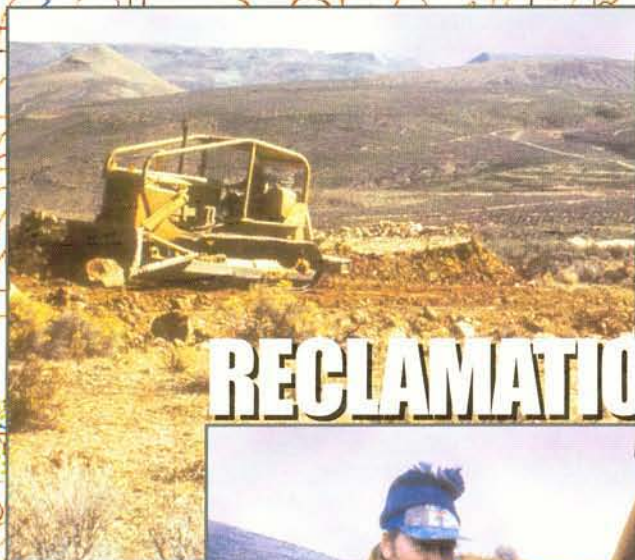


OREGON GEOLOGY

Oregon Department of Geology and Mineral Industries

Volume 61, Number 4, July/August 1999

RECLAMATIONIST OF THE YEAR



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VABM 3640
▲
Hope Butte

THROUGH THE EYES OF THE STATE GEOLOGIST



John D. Beaulieu
Oregon State Geologist

Over the years I have been privileged to learn many things about the geology and natural systems of Oregon. As the new State Geologist and Director of the Oregon Department of Geology and Mineral Industries, I will continue to learn. In this column, with each issue I will communicate some of my insights to our readers.

One (just one) of the core values of a geology department is the production and delivery of useful geologic maps. Good geologic maps are simply diagrams of the earth beneath our feet. They depict how and when various earth events happened (or are happening). As such, geologic maps become four-dimensional translating devices that can be used to discern what Mother Nature is telling us with patterns of rocks and soil.

This information and other insights imbedded in geologic maps are central to management of our resources, to managing geologic hazards, and to approaching sustainable relationships with our ecosystems. Our job is to bring these insights to the busy public in the quest to solve earth-related problems.

To solve today's complex problems, especially those involving ecosystems and endangered species, however, we also need parallel insights from other fields besides geology, such as engineering, range science, biology, hydraulics, and soil science. This broad view is particularly acute at DOGAMI in our responsibilities to guide the reclamation of mined lands.

Integration of sciences within the programs of the agency and partnering by the agency with other agencies and the private sector are central to our services now and will be the foundation of our successes in the future.

Creative delivery systems for our information to the public are also required. These include traditional publications, digital files, web sites, personal presentations, policy discussions, and enlightened earth-resource workshops and regulations.

The task assigned to the Oregon Department of Geology and Mineral Industries is to provide the geology- and earth-science-related information needs of society and to see ways to best provide the right information to the right people at the right time.

It is a privilege for me to serve this agency as it serves the people of Oregon.

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Cover photos

Successful and exemplary reclamation is demonstrated in these pictures of ongoing and completed work at Hope Butte in eastern Oregon, which earned John Jordan of Vale the award of Reclamationist of the Year 1998.

The honor is one of several given annually by the Oregon Department of Geology and Mineral Industries through its Mined Land Reclamation Program and the winners are chosen by a panel of representatives from private industry and environmental and regulatory agencies.

See story beginning on next page (83) for complete report on this year's awards.

DOGAMI honors outstanding mined land reclamation

Salmon habitat enhancement, agricultural land reclamation, water-quality protection, and an educational partnership entitled, "Let's Rock" were highlights of this year's Reclamation Awards presented by the Mined Land Reclamation Program of the Oregon Department of Geology and Mineral Industries (DOGAMI).

Winners were chosen by a panel of regulatory, industry and environmental experts, and the awards were presented at the annual conference of the Oregon Concrete and Aggregate Producers Association. The annual awards recognize mining companies and individuals who lead by example, surpassing the basic requirements of planning, operation, and reclamation at Oregon mine sites.

"These companies are being recognized because they go above and beyond the standards required by the law in their reclamation efforts," said Gary Lynch, Supervisor of DOGAMI's Mined Land Reclamation (MLR) office. "They show a deep commitment to the environment and the communities where they are based."

This year, Reclamation awards, judged on performance in the past year, were given in eight categories: Outstanding Operator, Outstanding Reclamation, Outstanding Small Operator, Outstanding Voluntary Reclamation, Good Neighbor Award, Salmon Enhancement Award, Outstanding Reclamation by Government Agency, and Reclamationist of the Year.

OUTSTANDING OPERATOR

Bayview Transit Mix, Inc.
Square Creek Quarry
Joe Perrigo
Seaside, Oregon

The Square Creek Quarry is located 2 mi south of Seaside in Clatsop County. A small perennial stream, Square Creek, flows be-



Square Creek quarry operated by Bayview Transit, winner of the Outstanding Operator Award.

tween the quarry floor and the stockpile site. The creek drains into Circle Creek and then into the Necanicum River and is a spawning and rearing habitat for sea-run cutthroat and steelhead trout.

Bayview Transit has been operating it for over ten years, expanding the affected area from about 2–3 acres to currently 17 acres.

This site has been operated in an exemplary manner from the beginning. All barren areas are seeded every fall. Areas where heavy equipment is used have been covered in a rock veneer. All storm water is conveyed through French drains and culverts to a settling pond. Interior haul roads have been paved, which significantly reduces the amount of sediment generated by the mine operation. Reshaping and scalping of waste rock prevent runoff over the highwall. Diversion ditches have been placed between the conically stacked waste piles to increase infiltration and redirecting runoff into stable areas above the highwall.

The operation is an excellent example of careful planning and implementation of a mine plan that protects fragile adjacent natural resources while providing a high qual-

ity aggregate resource for asphalt and concrete production.

OUTSTANDING RECLAMATION

O'Neil Sand and Gravel Division
Lexus Johnson
Redmond, Oregon

This site is located 7 mi northeast of Redmond in Crook County. Two separate extraction areas within the approved 180-acre permit boundary had been mined prior to 1972. The operator has voluntarily reclaimed one of the areas, and will have reclaimed the other, once mining is complete at this site.

The site is surrounded by agricultural fields in the Crooked River valley. Since 1990, the operator has made a concerted effort to improve the aesthetics at this mine site. This operation is unique for a sand and gravel pit in that the mined area is returned to original grade, making it suitable for farming, while most sand and gravel excavations develop below-grade ponds for wildlife habitat as a beneficial use.

Since 1990, over sixty acres of ground have been mined, graded, topsoiled, and replanted to commercial crops of alfalfa and mint. The areas where the gravel layers have been removed and the soil



Hooker Creek operation of the O'Neil Sand and Gravel Division and winner of the Outstanding Reclamation Award, showing agricultural fields that were taken out of production for less than 12 months.

layer has been replaced are actually sloped smoother than unmined areas, so that wheel line irrigation systems will be more easily managed over the recontoured fields. In 1995, 20 acres of mint root were planted. After the harvest, the operator went back in and regraded some rough spots in the field. The entire reclamation process on this 20-acre parcel, from grading to harvest, was 12 months.

Over the past four years, O'Neil Sand and Gravel has also worked closely with neighbors to remove high areas of ground in agricultural fields to allow irrigated farming where it was not previously possible. One farmer stated the crop yield on a reclaimed piece of ground, the first season after reclamation, was at least 90 percent of the same crop yield on adjacent unmined lands.

OUTSTANDING SMALL OPERATOR

Powelson Pit
Keith Powelson
Timber Rock Enterprises
Elgin, Oregon

This basalt quarry is located 2 mi west of Elgin in Union County. It was first opened in 1974 required an Operating Permit in 1977. After several slow years, this site was re-

claimed, the bond was released, and the file was closed.

The quarry was reopened in 1995 and mined for aggregate by several different operators, while Keith Powelson obtained and held the Operating Permit for the site.

Throughout the most recent development, Powelson has diligently employed all best management practices (BMPs) necessary to insure that the site remained in compliance with all applicable regulations and was operated in an environmentally sound manner.

Mature trees were left to provide visual and noise screening. Storm water controls were put into place to prevent any turbid water discharges into adjacent Phillips Creek. Storm water is discharged from several points, rather than in one concentrated flow, to a low-angle, well-vegetated slope within the permit boundary. The excavation and processing areas are sloped toward the working face so as to retain storm water. In order to further reduce storm water impact, mining has been voluntarily restricted to the summer months. Overburden stockpiles were immediately stabilized to prevent wind or rain erosion.

OUTSTANDING VOLUNTARY RECLAMATION

Nickel Mountain
Glenbrook Nickel Company
Greg Schoen
Riddle, Oregon

This site is located 3 mi west of Riddle in southern Douglas County. Mining began on this property prior to World War II, and hundreds of acres are exempt from reclamation rules and regulations at this mine complex. However, Glenbrook Nickel has done extensive reclamation work to protect the site's as well as adjacent natural resources.

Reclamation has begun on approximately 10 acres that had been mined by the previous mine operator. In the 1970s, a storm water control program was begun. A two-acre pond was constructed as a sediment control structure, with the pond and accompanying dam disturbing around four acres. This impoundment was approximately 20 ft deep and had a discharge system that required constant maintenance.

The pond has now been drained. Much of the fill from the dam was pushed into the impoundment, and a permanent surface outfall was constructed. The pond that remains has side slopes of 4:1 or flatter and is no deeper than 8 ft. Wetland-type vegetation and hundreds of willow and ash cuttings have been planted around the margins of the pond. The regraded embankment has been hydroseeded and planted with Douglas fir. The permanent outfall will require no maintenance, and the limited pond capacity poses no threat, should the remaining dam fail. Use of this site as a water source for big game animals will continue.

A severely eroded water diversion ditch was filled in and the water flow returned to approximately the pre-mine drainage. The reclaimed ditch line was left in a very rough condition, which reduces erosion, and then planted with Douglas firs.

In additional reclamation work, a pit area was ripped to decompact

the surface and then planted with 1,000 Ponderosa pines. A new water course that caused slumping of an old fill slope was diverted. Old culverts that no longer serve the storm water control system, the access road to the pond and the old mine area, and a 2-mi-long tram system that transported ore from the mine to the smelter were removed. A total of 5,000 firs were planted in various places of the mine area, as well as additional willows and ash trees to stabilize new intermittent water courses.

GOOD NEIGHBOR AWARD

"Let's Rock" School Partnership Program
Morse Brothers, Inc.
Eileen Shufelt
Tangent, Oregon

Morse Brothers, in partnership with mid-valley school districts, has developed an educational curriculum that provides an understanding of the value of the aggregate industry, the process of mining for aggregate, and the steps taken to preserve the land for future generations.

The "Let's Rock" curriculum can be used in grades two through four and meets the Oregon Department of Education's earth science requirements for the Certificate of Initial Mastery (CIM). Curriculum packs contain lesson plans, material samples, and video and audio cassettes and were made available free to over 300 schools in the market area served by Morse Brothers.

An additional element of the curriculum is a tour of Morse Brothers facilities with several hands-on activities. During the tour season (November through March), 12 to 14 groups of up to 25 students tour the corporate offices in Tangent and the mine site at Corvallis.

Students of the 3rd grade class from Jefferson Elementary School in Corvallis and their teacher Mary Anne Pullam assisted in preparing a demonstration slide program of the curriculum.



Reclaimed storm water settling pond at Nickel Mountain, one of the many projects performed voluntarily by Glenbrook Nickel Company that were awarded with the Outstanding Voluntary Reclamation Award.

SALMON ENHANCEMENT AWARD

Copeland Sand and Gravel, Inc.
Dave Staley
P.O. Box 608
Grants Pass, Oregon

Copeland Sand and Gravel has mined aggregate in the lower reaches of the Applegate River for decades. Most of the sand and gravel was mined from large, deep pits adjacent to the river channel. This was an efficient way of operating for the producer, and was a process preferred by regulatory agencies because it kept the operation out of the active river channel. Unfortu-

nately large pits do not always remain separate from the stream during high water flows and can actually capture the stream and change the channel location.

In 1997, Copeland Sand and Gravel representatives posed a question to state and federal regulators: "Is there a way that gravel extraction could be done in the Applegate River that would not be detrimental to fish and wildlife, would not impact water quality, and could perhaps improve fish habitat?" This question began a long planning and permitting process to develop a design to mine gravel within the active stream channel with the potential to enhance conditions for fish.

The plan developed by private consultants proposed removing a thin veneer (up to 8 ft) of gravel from two gravel bars within the



Educational pack of the "Let's Rock" curriculum, which is part of the partnership efforts that earned Morse Brothers, Inc., the MLR Good Neighbor Award.



Applegate River near Murphy, Josephine County, showing gravel bar that was mined and off-channel salmon habitat behind the gravel bar. For this project, Copeland Sand and Gravel received the MLR Salmon Enhancement Award.

main stem of the Applegate River upstream of Murphy. Copeland Sand and Gravel completed the work in the summer of 1998. Even though in the active channel, the mining operation was out of the water at all times. Water quality was protected in this way. After the gravel was removed, Copeland excavated alcoves on the bars to provide off-channel habitat for fish. The alcoves were planted with native vegetation such as willows and alders to provide stability, wildlife habitat, and shade. About 88,000 cubic yards of material were removed from the project site.

This experiment will be monitored over the next several years to determine the effectiveness of the project. The success of this project shows that industry and regulatory agencies can seek solutions together to allow natural resource extraction in the face of endangered species listings and provides a framework for other operators to follow.

OUTSTANDING RECLAMATION— GOVERNMENT AGENCY

Mount Meares Quarry
Tillamook County Road Dept.
John Oshel
Tillamook, Oregon

The Mount Meares Quarry is located 6 mi southwest of Tillamook on property now owned by Shiloh Forest Enterprises.

The Tillamook County Road Department obtained a permit for the site in 1978. From the first inspection in April 1977, protection of an adjacent stream, Short Creek, was the principal environmental concern, primarily because this small drainage is part of the watershed for the City of Oceanside.

Sloping of the floor and the benches of the quarry directs storm water away from the creek to a retention pond. An undisturbed buffer strip between all operations and the creek provides additional protection, keeping sediment from reaching Short Creek. Soils and overburden were salvaged, stockpiled and vegetated to prevent erosion in this high-rainfall area.

Over the years, several inspections by DOGAMI personnel noted problems with barren overburden and storm water management. The county responded quickly to address all concerns and to insure that protection of the creek was maintained. Several inspection reports from the 1980s and early 1990s commend

the work accomplished by the county road department at this quarry.

In early 1998, Tillamook County decided to relinquish the Operating Permit for this quarry, and the landowner assumed the DOGAMI permit. Because the quarry had been developed in an orderly manner, Tillamook County was able to complete reclamation in those areas that had been mined out. Complex final slopes, 2:1 and flatter, were formed and revegetated. Terraces were built across the face of the remaining overburden dump to trap sediments and to break up the flow of surface water down the face. Because of the amount of rock in the overburden pile the slope configuration is stable and will create a suitable timber ground after revegetation.

The Tillamook County Road Department was nominated for this award due to their long-term diligence to operate and reclaim this quarry without impacting adjacent natural resources, which includes the water supply for Oceanside.

RECLAMATIONIST OF THE YEAR

John Jordan
Exploration Services, Inc.
Carson City, Nevada

John Jordan, originally of Vale, has performed reclamation at numerous precious-metal exploration sites in eastern Oregon. He has been involved in such projects at Hope Butte (see cover photos), Quartz Mountain, Bully Creek, and Grassy Mountain.

Jordan has embraced the latest technology and techniques in the field of reclamation to the benefit of the exploration companies and the environment. When he is involved in the earliest planning stages of a project, he is able to evaluate the disturbance he will be making and calculate how to minimize the impact before the project starts.

Although recent times have seen an overall decline in the mineral exploration business in Oregon, Jordan continues to refine and develop innovative reclamation methods.

Intrinsic permeability, porosity, and microstructure of Holocene vesicular basaltic andesites in the Oregon Cascades

by Martin O. Saar and Michael Manga, Department of Geological Sciences, University of Oregon, Eugene, OR 97403

Note: This is a modified abstract of the master's thesis by M.O. Saar (Saar, 1998). Coauthor M. Manga also collaborated on a related paper published recently in *Geophysical Research Letters* (Saar and Manga, 1999). The subject matter addresses issues in water-resource and water-quality research. —ed.

Vesicular basalts can serve as aquifers, as has been shown for Hawaii by Ingebritsen and others (1993) or for the Pacific Northwest by Manga (1996). These aquifers typically show dual porosities and permeabilities (Sanford, 1997). The overall aquifer permeability is probably governed by the fracture network, whereas contaminant storage and release (by diffusion) may depend on the interfracture permeability and porosity. Here, we discuss laboratory measurements of interfracture permeability, porosity, and microstructure (shape, size, and orientation of small features such as crystals and bubbles).

Samples were taken from blocks of Holocene and Pleistocene vesicular basaltic andesite flows and cinder cones in the Oregon Cascade Range (Figure 1). From these blocks, cores were drilled with a diameter of 7.2 cm and lengths between 2 and 23 cm, such that length always greatly exceeds bubble radius. Permeability measurements were made with a steady-state gas permeameter. Connected porosity was measured with a gas-expansion technique, and total porosity was obtained from a determination of rock matrix density and mass of the cylindrical cores. A comparison of total and connected porosity showed that virtually all pores were connected. The microstructure was investigated through thin section observations and image analysis on images scanned at high resolution (1,200 dpi) from discs representing cross sections of the cores.

Based on bubble shape and microstructure, samples can be grouped into five categories (four are shown in Figure 2): (1) Scoria samples, from cinder cones, contain a very fine-grained, partly glassy matrix, no micropores, and a wide range in the size of its subspherical

bubbles. (2) Flow-1 samples, which probably cooled relatively close to the vent, have a fine-grained matrix with some glass and few plagioclase crystals; micropores are usually not abundant, and bubbles are elongated to an ellipsoidal shape. (3) Flow-2 samples, which are believed to have

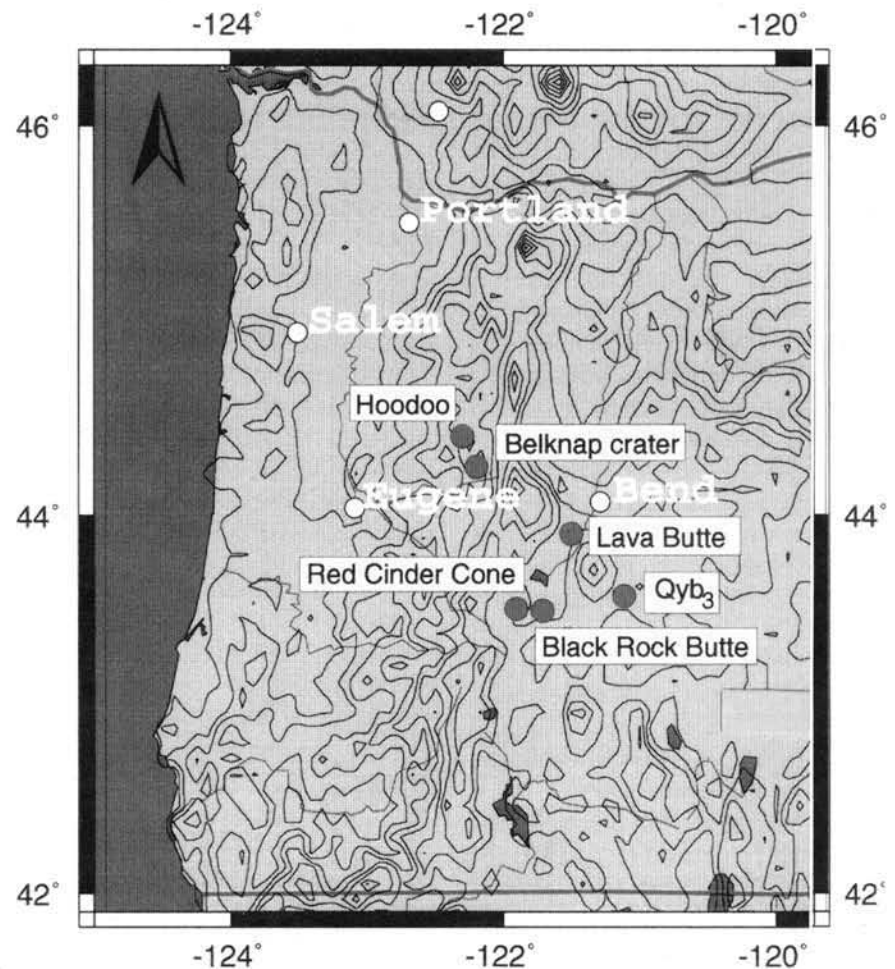


Figure 1. Map of western Oregon showing locations (filled circles) of basaltic andesite flows from which samples were taken. Qyb₃ = Mokst Butte flows at Newberry volcano, from MacLeod and others (1995).

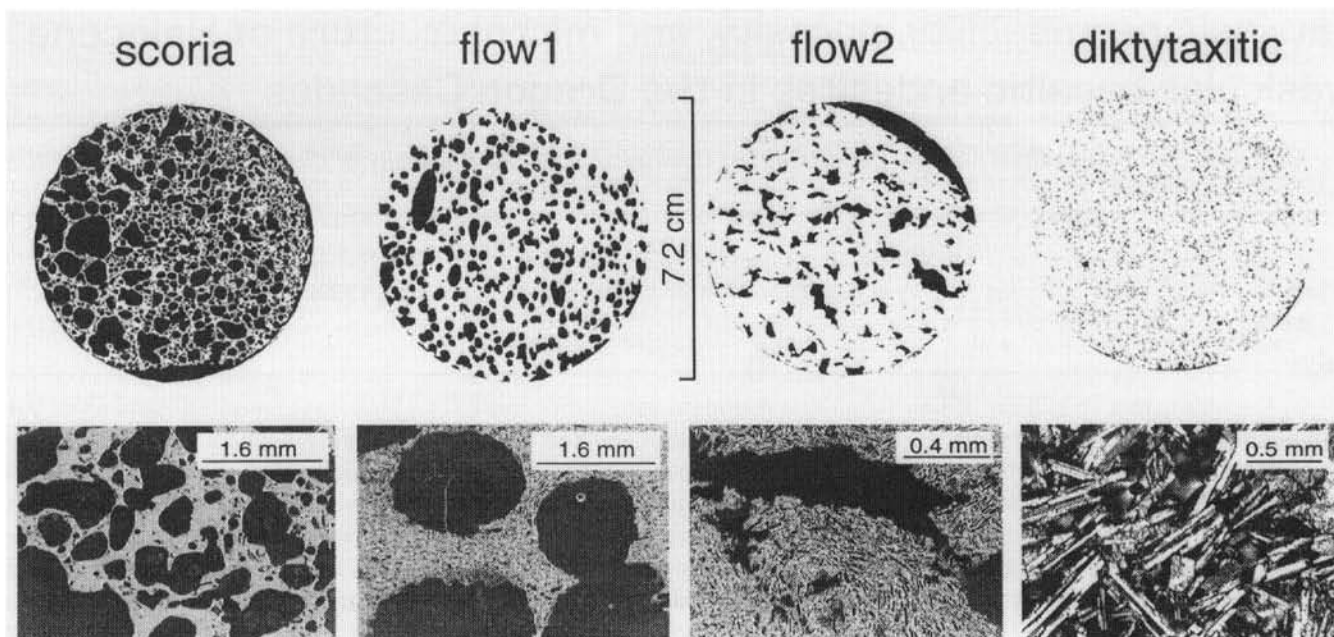


Figure 2. Images of scanned cores (upper row) and respective thin-sections (lower row). Bubbles are black, solids are white.

formed farther away from the vent than the Flow-1 samples, contain densely packed plagioclase crystals (size ~ 0.2 mm) with subparallel orientation, few micropores, and highly deformed, partially "collapsed" bubbles. (4) Diktytaxitic samples show randomly oriented, larger plagioclase crystals (size ~ 0.7 mm) and inter-crystalline micropores (Chitwood, 1994). (5) Finally, some samples contain micropores only but do not have a diktytaxitic texture.

Typical permeability (k) of samples containing bubbles is in the range between 10^{-14} and 10^{-11} m^2 and agrees well with values of 10^{-14} – 10^{-9} m^2 for unfractured vesicular basalts reported by Freeze and Cherry (1979, p. 29). Diktytaxitic samples show a similar permeability range. Samples containing micropores only, representing the dense middle part of lava flows, have very low permeabilities of approximately 10^{-17} m^2 .

Our results show that similar permeabilities for a wide range of porosities can be expected if different microstructures are present (Figure 3). However, the five sample types plot in distinct clusters, depending on their microstructural characteristics. During a possible evolution of samples from scoria to

Flow-1 samples and finally to Flow-2 samples, the porosity may decrease, whereas the permeability could stay approximately constant or even increase. An explanation involving degassing processes is presented in Saar (1998) and Saar and Manga (1999).

Only the scoria samples show a characteristic permeability-porosity relationship, possibly as a result of a lack of degassing. Diktytaxitic samples show textures that are more similar to those of granular materials with respect to fluid pathways; these structures result in relatively high permeabilities (10^{-14} – 10^{-12} m^2) for low porosities (~ 2 –5 percent).

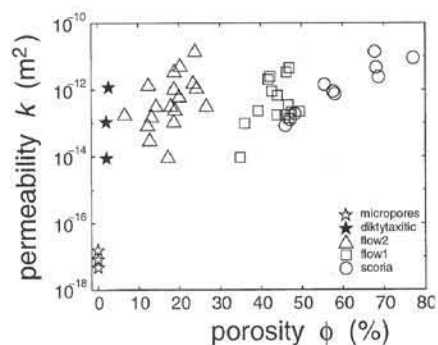


Figure 3. Measured permeabilities (k) versus porosity (ϕ) for the five sample types.

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Donald A. Hull retires from DOGAMI

After 21 years as State Geologist, Donald A. Hull retired in June. Hull's background was in mining, but he broadened the focus of the Department of Geology and Mineral Industries (DOGAMI) to include research and mitigation of geologic hazards, along with the more traditional mineral regulation and mapping activities.

Hull was a tireless advocate to increase resources available for earthquake and tsunami preparation. One of his legacies is the construction of signs up and down the Oregon coast, teaching residents and tourists about the dangers of coastal earthquakes and tsunamis.

It is difficult to summarize such a long and impressive career, but here are some of the most important activities of the department under Hull's direction.

DOGAMI MILESTONES 1977-1999

- 1977 Intensive investigation of geothermal resources of Oregon initiated.
- 1978 First multi-year (1978-1985) Mission and Goals Plan adopted to guide Department activities.
- 1979 Charged with coordinating federal and state mapping through chairmanship of State Map Advisory Committee.
- 1979 Oregon's first commercial gas well near Mist.
- 1981 Surface mining regulatory authority expanded for metal mining.
- 1983 Dormant mineral interest legislation passed.
- 1984 Partnership formed with Minerals Management Service to jointly study mineral deposits and environment of Gorda Ridge.
- 1985 Plugged mined land reclamation loophole for "valid contract" grandfather rights.
- 1985 Added underground mining to Mined Land Reclamation Program authority.
- 1987 Co-hosted with Oregon State University Geology Depart-

ment a landmark professional gathering of earth scientists to discuss the potential of a Cascadia subduction zone earthquake.

- 1987 Hosted a "cluster" meeting of regional state surveys with U.S. Geological Survey scientists to discuss the earthquake potential of the Pacific Northwest.

- 1987 Chemical heap leach regulatory authority added to Department responsibilities.

- 1987 Bonding authority increased for mined land reclamation to full cost of reclamation.

- 1987 Oregon sunstone became the official state gemstone.

- 1989 Regulation of mineral exploration authority added to Department responsibilities.

- 1989 Enabling legislation expanded to include various hazard and earthquake assessment, public education, and risk reduction.

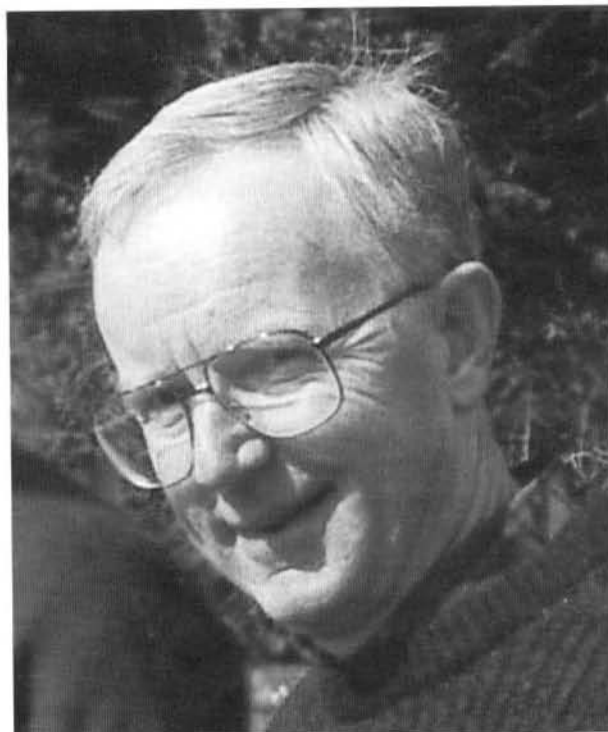
- 1989 Sponsored national meeting of the Industrial Minerals Forum.

- 1993 Opened the Nature of Oregon Information Center (now the Nature of the Northwest).

- 1995 Tsunami legislation passed to regulate construction of certain buildings in tsunami inundation zone and to map the tsunami inundation zone. Other legislation mandated tsunami training in coastal schools.

- 1995 Earmarked Federal mining royalties to the Department.

- 1996 Seismic Rehabilitation Task Force appointed and legislation developed.



- 1997 Oregon Seismic Safety Policy Advisory Commission membership revised to include private sector representation.

HIGHLIGHTED ACTIVITIES

Treasurer and member of Executive Committee of American Geological Institute; member of Federal Emergency Management Agency Technical Floodplain Mapping Advisory Council; member, Western States Seismic Policy Advisory Commission Executive Board; Treasurer, Vice-President, President-Elect, and President of Association of American State Geologists; member, National Research Council Committee on offshore geologic information; State Co-chair, Federal-State Placer Minerals Task Force; State Co-Chair, Federal-State Gorda Ridge Technical Task Force; chaired the legislative State Flood Control Plan Task Force; served as ex-officio member of the State Board of Geologist Examiners and as member of the Oregon Geographic Names Board. In addition, served on numerous other State and Federal committees and task forces.

What you know about tsunamis could save your life

Results of a recently repeated poll by the Oregon Department of Geology and Mineral Industries (DOGAMI) suggest that Oregon coastal residents still need to be better informed to protect themselves from these giant waves. Tsunamis can be generated by earthquakes off the Oregon coast or elsewhere in the Pacific Ocean. Along the coast, their waves are generally expected to be up to 25 ft high, but might be up to 50 ft high.

When asked, "If you feel an earthquake at the Oregon coast, how much time do you have to evacuate to a safe place before the first tsunami wave hits?" only 39% of coastal residents correctly answered 30 minutes or less, but this is an improvement over the 31% who correctly answered the question a year ago. About a third (38%) said they didn't know.

A third of those questioned (32%) knew that after a distant earthquake, they would have 1–8 hours before the first tsunami wave hit the Oregon coast. That is an increase over the 27% who correctly answered the question earlier.

More than a third of respondents (36%) knew when it's safe to return to low-lying areas after a tsunami has struck (only after given approval by appropriate authorities, because tsunamis are a series of waves), but another third (32%) said they didn't know.

About half the respondents had seen tsunami information signs along the beach (45%) or seen a video or brochure about tsunamis (55%). Three-quarters read about tsunamis in a newspaper (77%) or saw a story on TV (75%).

Most people (85%) say they know what to do in an earthquake or tsunami, and more than half (51%) know their local evacuation route. Only 24% of coastal residents said they had earthquake insurance.

Residents in 18 coastal cities (As-

toria, Bandon, Brookings, Cannon Beach, Coos Bay, Florence, Gold Beach, Lincoln City, Newport, North Bend, Pacific City, Port Orford, Reedsport, Rockaway, Seaside, Tillamook, Waldport, and Yachats) were polled. The survey has a margin of error of plus or minus 5%.

To get information about how to protect yourself in an earthquake or tsunami or to purchase tsunami inundation maps, contact the Nature of the Northwest Information Center, 800 NE Oregon St. #5, Portland, phone (503) 872-2750, <http://www.naturenw.org>.

Survey results broken down by coastal region

| North | Central | South |
|--------------------|--------------------|---------------------|
| Respondents: 128 | Respondents: 165 | Respondents: 107 |
| Margin of error 9% | Margin of error 8% | Margin of error 10% |
| Astoria | Pacific City | Reedsport |
| Seaside | Lincoln City | Coos Bay |
| Cannon Beach | Newport | North Bend |
| Rockaway Beach | Waldport | Brookings |
| Tillamook | Yachats | Bandon |
| | Florence | Gold Beach |
| | | Port Orford |

1. How much time before the first tsunami wave after an Oregon coastal earthquake?

| | Correct (30 minutes or less) | Don't know |
|---------|------------------------------|------------|
| North | 45 | 29 |
| Central | 44 | 36 |
| South | 22 | 52 |

2. How much time before the first tsunami wave after a distant earthquake?

| | Correct (1-8 hours) | Don't know |
|---------|---------------------|------------|
| North | 34 | 30 |
| Central | 30 | 30 |
| South | 33 | 43 |

3. When is it safe to return to low-lying areas?

| | Correct (after authorities OK) | Don't know |
|---------|--------------------------------|------------|
| North | 45 | 29 |
| Central | 33 | 32 |
| South | 31 | 36 |

4. Seen tsunami information signs on beach?

| | Yes | No |
|---------|-----|----|
| North | 53 | 47 |
| Central | 42 | 58 |
| South | 39 | 61 |

5. Seen tsunami video or brochure?

| | Yes | No |
|---------|-----|----|
| North | 63 | 37 |
| Central | 54 | 46 |
| South | 45 | 55 |

6. Do you know what to do in an earthquake or tsunami?

| | Yes | No |
|---------|-----|----|
| North | 88 | 12 |
| Central | 84 | 16 |
| South | 83 | 17 |

7. Do you have earthquake insurance?

| | Yes | No |
|---------|-----|----|
| North | 23 | 71 |
| Central | 21 | 76 |
| South | 27 | 66 |

PLEASE SEND US YOUR PHOTOS

Since we have started printing color pictures on the front cover of *Oregon Geology*, we are finding ourselves woefully short of good color photographs showing geologic motifs in Oregon.

We also want to make recommendations for scenery well worth looking at in a new series of black-and-white photos on the back cover of *Oregon Geology*. For that, too, your contributions are invited.

Good glossy prints or transparencies will be the best "hard copy," while digital versions are best in TIFF or EPS format, on the PC or Mac platform.

If you have any photos that you would like to share with other readers of this magazine, please send them to us (you know, "Editor, etc."). If they are used, the printing and credit to you and a one-year free subscription to *Oregon Geology* is all the compensation we can offer. If you wish to have us return your materials, please include a self-addressed envelope.

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Oregon Geology is designed to reach a wide spectrum of readers interested in the geology and mineral industry of Oregon. Color photos for publication on the front cover are highly welcome, as are letters or notes in response to materials published in the magazine and notices of meetings that may be of interest to our readers.

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Conclusions and opinions presented in articles are those of the authors and are not necessarily endorsed by the Oregon Department of Geology and Mineral Industries.

Authors will receive 20 complimentary copies of the issue containing their contribution.

Manuscripts, letters, notices, and photographs should be sent to Klaus Neuendorf, Editor, at the Portland office (address in masthead on first inside page).

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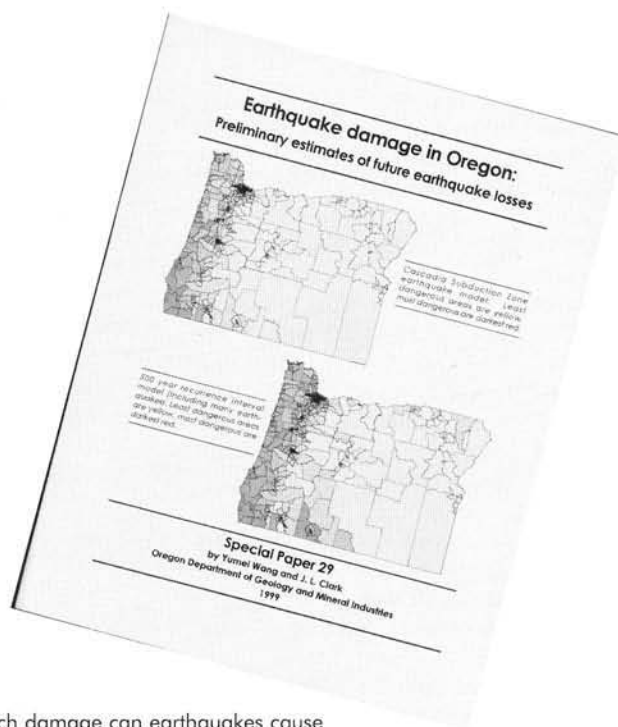
Highlighting Recent Publications

now available from The Nature of the Northwest Information Center

Most injuries and damages in earthquakes are caused by buildings. If we can improve our buildings, we can reduce future danger. Between 1989 and 1994, the five largest disasters in the U.S. caused almost \$40 billion in damage to homes. Mary Comerio



of U.C Berkeley looks at housing losses and post-disaster rebuilding after four earthquakes and two hurricanes, and she suggests concrete measures for reducing future losses. *Disaster Hits Home*, University of California Press, 300 pages, \$39.95; add \$3.00 for ship-



How much damage can earthquakes cause in Oregon? This eye-opening report estimates the damage from a single Cascadia subduction zone quake at more than \$13 billion, with 7,000 casualties. It also breaks down damage forecasts by county so you can see how your area would fare: *Earthquake damage in Oregon: Preliminary estimates of future earthquake losses*, DOGAMI Special Paper 29, 59 pages, \$10.

Although you may think of 1996 as the year of floods, there were also hundreds of landslides. Portland State University Professor Scott Burns has documented more than 700 of them in the Portland area, as shown on this map. Find out why they occurred and learn about the geologic formations that are most at risk. As we head into landslide season, it's time to prepare for another round. The map, the data behind it, and the illustrated report prepared for the Portland Region Metro are assembled on a CD-ROM disk: *Landslides in the Portland, Oregon, metropolitan area resulting from the storm of February 1996: Inventory map, database, and evaluation*. (\$25)



Washington earthquake hypocenter deepest since 1965

A powerful earthquake (magnitude 5.9) shook the Pacific Northwest on July 2, 1999, at 6:44 p.m., snapping utility lines, crumbling chimneys, and severely damaging the historic Grays Harbor County Courthouse in Montesano, Wash.

The quake originated at a depth of 25 mi beneath Satsop, Wash., about 68 mi southwest of Seattle. It is the deepest quake to hit the region in almost 35 years. The earthquake was similar to those that struck Washington near Olympia in 1949 (magnitude 7.1) and Renton (magnitude 6.5) in 1965. "The only historical earthquakes that have done significant damage were ones that occurred like this one, deep down in the subducted plate. These quakes can kill people," Steve Malone, a University of Washington seismologist, said.

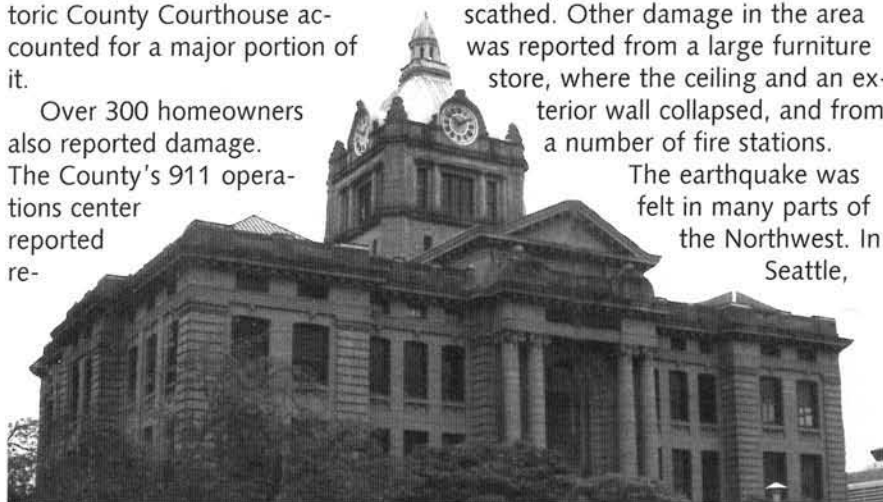
Gas leaks, toppled chimneys, and power outages were reported all over Grays Harbor County after the earthquake, according to Rob Harper of Washington State Emergency Management, particularly in Hoquiam, Aberdeen, Brady, Satsop, and Montesano. Karin Frinell-Hanrahan of Grays Harbor County Emergency Management reported initial damage estimates at ten million dollars

for county buildings alone. The historic County Courthouse accounted for a major portion of it.

Over 300 homeowners also reported damage. The County's 911 operations center reported re-

larger quakes in 1949 and 1965 unscathed. Other damage in the area was reported from a large furniture store, where the ceiling and an exterior wall collapsed, and from a number of fire stations.

The earthquake was felt in many parts of the Northwest. In Seattle,



Grays Harbor County Courthouse in Montesano, Washington. This historic building suffered several million dollars' worth of damage during the July 2 earthquake whose epicenter was about 7 mi away.

ceiving over 2,700 phone calls the night of the quake. Many callers asked about the danger of a tsunami following the tremor. No tsunami warning system exists in the area.

In Montesano, Dennis Selberg, Facilities Director for Grays Harbor County, said that the County Courthouse, built in 1910, sustained "very scary, substantial damage," and will remain closed until a team of structural engineers can assess the damage. The courthouse survived the

diners in the Space Needle restaurant felt the floor jump; and in the Portland offices of the Oregon Department of Geology and Mineral Industries, employees felt the building shake for about 30 seconds.

Early reports pegged the earthquake at magnitudes of 3.5, 5.1, and 5.5, but the U.S. Geological Survey most recently determined that the earthquake had a "moment" magnitude of 5.9, based on a more elaborate measurement system.

Reprinted with permission from John Hughes' "Letter from the Editor" column in *The Daily World*, Aberdeen, Washington, July 4, 1999, page A4.

Do we really need another wake-up call?

Dear Reader: That got my attention. By eerie coincidence, reporter Ryan Teague Beckwith and I were discussing the major natural disasters of the 20th century on Grays Harbor—the Columbus Day Storm of 1963, the blizzard of 1950, the rainfall record of 113.49 inches in 1933—when two tectonic plates did a bump and grind that stopped short of cataclysmic. A Richter here and a Richter there, and we could have had a front row seat for the No. 1 headline of the fast-ebbing old mil-

lennium and never lived to write about it.

Although we're joking about the emotional fallout—the brain's way of coping—most of us now have a better understanding of post-traumatic stress. When I think of the what-ifs, I really get scared. And I was scared at 6:43 p.m. Friday, July 2, 1999. So scared that I stood for several seconds in front of a seven-foot-tall bookcase instead of diving under my desk, an antique so substantial that it likely could withstand

a direct hit by an ICBM.

(Would I have shared my space with Ryan? He has his whole life ahead of him. I'm 55. I've lived in Bermuda, owned two Porsches and have a personal letter from Annette Funicello. Although he sometimes looks at me with the secret glint of youthful contempt, as if I'm just another worn-out Boomer worried about prostate trouble and glued to a 401(k) hotline, it would have been the right thing to say, "Quick, Ryan! Under here!" But naaaaa! Crawl

under your own desk, cheeky twirp!)

Beckwith, given often to ironic understatement, stood frozen in the doorway and declared, "I think this is an earthquake." And I said, "Holy #@*!" Or words to that effect.

The newsroom emptied into the parking lot fronting historic State Street, which sits atop several jillion cubic yards of sawdust spaltz. In fact, this whole end of town was a salmonberry marsh a century ago.

We rode the wave for 40 seconds. It seemed like an eternity. Streetlight poles shook, my Volkswagen Beetle did the Macarena while Dee Anne Shaw's Chrysler coupe was undulating. There were a half-dozen of us looking at one another like deer caught in the headlights of an oncoming car. Then the shaking stopped. Seconds later, the first siren.

I've been in bigger quakes—a lot bigger quakes—but this one lasted longer and felt stronger.

A RUDE AWAKENING

In June of 1992, I was finishing up a month-long stint as acting editor of our company's newspaper at Hemet, Calif., east of L.A., when I endured the longest 30 seconds of my life. Then it happened all over again three hours later.

It was the definitive rude awakening at 4:58 a.m., when the bright-red Mickey Mouse alarm clock my daughter Sarah had loaned me for the trip rocketed off the nightstand. The four heavy drawers in the bureau slid open with a whoosh and everything in the bathroom medicine cabinet crashed onto the tile floor. The room was rolling. I was riding the bed and saying Hail Marys.

It was California's strongest earthquake in 40 years—7.4 on the Richter, infinitely stronger than the 5.5 we experienced Friday night.

The aftershocks were relentless. I couldn't get back to sleep, so I actually read the Gideons' Bible.

I was brushing my teeth at 8:07,

when the second one hit. It was only a 6.5, but the jolt was even stronger—a violent side-to-side motion.

As a rule, I only need one wake-up call, literally and figuratively. I had to go to the bathroom, but the thought crossed my mind that I didn't want to be found dead on the toilet a thousand miles from home, so I threw everything in the suitcase and headed for the stairs.

I waited for an hour in the hotel parking lot, bags at my side. The sky was alive with arcing bolts of light, as transformers exploded for miles around.

Dave Caffoe, who was general manager at The Daily World in the early '70s, was the publisher at Hemet. I was there as a favor to him.

He was laughing, as he pulled into the portico of the Doubletree and popped the trunk lid on his white Oldsmobile.

"I gather you'd like to go home," he said.

I declined his offer of a Bloody Mary with celery stalk, opting for black coffee and a boarding pass.

NOT IN MY BACKYARD

That was then; this is a more sobering now. This is home. Despite the absolute consensus by scientists that The Big One is coming to the Northwest—not if, but WHEN—I've always kidded my friends in California about their precarious existence.

Sure, it could happen here, I thought, but it probably won't. It's gonna be -Seattle or, better yet, Bellevue. Not in my backyard.

I've been in denial. You too?

I lost a lovely Tiffany-style lamp Friday night. A thousand-dollar lamp that I got for a song 30 years ago. It tumbled off the rolltop desk in the hallway. There's plaster damage in the kitchen and dining room, and a beam in the garage is askew.

But I'm counting my blessings. The lamp, with its heavy leaded-glass shade, could have hit Sarah,

who was scrambling for cover. If those tectonic plates had shifted just a little bit more, the ground could have turned to goo and swallowed my family—maybe yours too. Forget the lamp.

The tsunami that followed could have killed thousands.

As I made a quick reconnaissance of the area around the newspaper, I imagined the center span of the Chehalis River Bridge upright in the water, like the arm from the Statue of Liberty in the climactic scene of "Planet of the Apes."

I imagined the Becker Building a pile of smoking rubble and the parking lot of Wal-Mart as one giant field hospital.

I saw the remains of Community Hospital half-way down the hill. Dee Anne's house, with husband John and 9-month-old Gordon, the cutest baby in the world, is just below the hospital.

Driving home to Hoquiam through the pitch-black along Sumner Avenue at 2:30 a.m. Saturday after the presses rolled, I imagined no lights anywhere, no water, fires out of control in a hundred homes and businesses, gas lines ruptured. Chaos.

Survival could require a blend of luck, pluck, and smarts.

I, for one, as the letter writers always say, am going to start paying attention to those emergency checklists of do's and don'ts.

And if you think the best thing to do in an earthquake is call 911, you might as well hang up and kiss your silly derriere goodbye.

Be prepared.

There will be another earthquake. Earthquakes. One is bound to be bigger. Maybe a whole lot bigger.

I don't need another wake-up call, but if you can repair leaded glass I'd like to hear from you.

John Hughes can be reached at [360] 532-4000, ext.112, or editor@thedailyworld.com

Intensities for the February 1999 Molalla earthquake

by Gerald L. Black, Oregon Department of Geology and Mineral Industries

INTRODUCTION

On February 24, 1999, a small (M_L 2.7) earthquake occurred approximately 14.6 km (9.1 mi) south of Canby, Oregon (Figure 1). The earthquake occurred at 08:45 a.m. PST and was located at lat 45.11°N., long 122.66°W. The location quality was rated as B by the Pacific Northwest Seismograph Network (with "A" rated as "good" and "D" rated as "bad" location qualities).

The earthquake was unusual for two reasons. First, its hypocenter was quite deep, nearly 35.7 km (22.2 mi). Second, given its small size, it was felt over an extremely large area. Because of the large felt area, the Oregon Department of Geology and Mineral Industries (DOGAMI) placed a questionnaire on the DOGAMI web page (<http://sarvis.dogami.state.or.us/>) and in local newspapers in the northern Willamette Valley, asking people to describe what they felt during the earthquake.

DOGAMI received a total of 250 responses. These responses indicated

that the earthquake was felt in Vancouver, Wash., 53.3 km (33.8 mi) north of the epicenter; in Sweet-home, Oreg., 84.7 km (52.7 mi) south of the epicenter; and in Sheridan, Oreg., 57.1 km (35.5 mi) west of the epicenter. The earthquake was felt only 24.6 km (15.3 mi) east of the epicenter, a lesser distance which probably reflects the lower population density in the foothills of the Cascade Range.

A M_L 2.7 earthquake is typically felt only by people located very close to the epicenter and does little or no damage. While this particular earthquake was felt over an unusually large area, the only damage reported was that minor cracks were opened in walls and ceilings in the Oregon City High School, and an 83-year-old home was shifted off its foundation in West Linn (Oregon Geology, 1999). Despite its small size and relatively minor effects, DOGAMI decided to do an intensity study of this earthquake because we wanted to document the size of the felt area and determine why it was so widely felt.

METHODS

The intensity is a number that describes the effects of an earthquake on people, manmade structures, and the Earth's surface. The intensity scale most commonly used in the United States is the Modified Mercalli (MMI) scale of 1931 (Wood and Neumann, 1931). For a small earthquake such as the one in question, only the lower intensity values are encountered. The effects of intensities I–V are listed in Table 1.

It should be noted that the assignment of intensities is subjective, particularly so at the lower intensity values. Ideally, a random telephone survey is completed after a significant earthquake. The number of people who "felt" the earthquake is tabulated and used to assign intensi-

Table 1. Modified Mercalli intensity scale of 1931 (abridged)

- | | |
|-----|---|
| I | Not felt except by a very few under especially favorable circumstances. |
| II | Felt by only a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing. |
| III | Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing of truck. Duration estimated. |
| IV | During the day, felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls heard to make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably. |
| V | Felt by nearly everyone; many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbance of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop. |

ties of II to IV. For example, Dengler and Dewey (1998) conducted a telephone survey after the 1994 Northridge, California, earthquake. They assigned an intensity II to a community if fewer than 10 percent of respondents felt the earthquake, intensity III if it was felt by 20–40 percent of respondents, and intensity IV if felt by more than 50 percent of respondents. The M_L 2.7 earthquake under discussion did not warrant that degree of effort. Therefore, we read each of the 250 responses and assigned an intensity on the basis of Table 1. Once intensities were assigned, they were grouped by zip code and plotted (Figure 1). For those zip codes with fewer than three responses an intensity I was assigned. For zip codes with more responses, likewise an intensity I was assigned, if 50 percent or more of the responses received indicated "not felt."



Figure 1. Earthquake intensities for the February 24, 1999, M_L 2.7 earthquake. Star is epicenter. Isoseismal contours outline the (larger) felt area and the area with Intensity III or greater effects. Responses were grouped by zip code and plotted at the zip-code centroids.

The grouping by zip code enabled us to outline the felt area and draw general isoseismal contours, but it does not provide information that can be related to local soil conditions. Therefore all intensities of III or greater (122 of 250 or 49 percent of the responses) were plotted at their exact location.

RESULTS

The earthquake was felt over a very large area. Responses received by DOGAMI indicate that it was felt 54.3 km north, 84.7 km south, 24.6 km east, and 57.1 km west of the epicenter. Assuming these responses represent the true maximum extent of the felt area, the area over which the earthquake was felt is 9,412 km². (Areas were determined with MapInfo, a commercial desktop GIS software). It is quite likely, however, that the true maximum extent of the felt area is larger than that indicated by survey responses. Felt reports to the east are probably lacking because of low population densities in the foothills of the Cascade Range, and felt reports to the north are missing because questionnaires were not placed in papers published farther north than the Portland *Oregonian*.

If it is assumed that the felt area is roughly symmetric around the epicenter, the felt area is 15,240 km². Are these felt areas exceptionally large? Yes, Topozada (1979) did a study of shallow California and western Nevada earthquakes that related felt area to earthquake magnitude. The expected felt area for a M_L 2.7 earthquake is 977 km². Thus, the reported felt area is more than nine times larger than expected. When it is assumed that the felt area is symmetric around the epicenter, it is over fifteen times larger than expected. On the basis of the empirical relationships developed by Topozada (1979), the earthquake magnitude as represented by the reported felt area would be M_L 4.2. In the case of a symmetric felt area, it would be M_L 4.5.

Magnitudes calculated from the

area enclosed by isoseismal contours are generally within 0.5 units of the true magnitude (Topozada, 1979). For example, for the March 1993 Scotts Mills ("Spring Break") earthquake, the magnitude calculated using the area enclosed by the Intensity V isoseismal is M_L 5.3 (Black, 1996). The true magnitude was 5.6. Thus, for this particular M_L 2.7 earthquake of February, magnitudes calculated using the area enclosed by isoseismal lines are much too large. This does not mean that the relationships developed by Topozada (1979) are wrong, merely that they were developed for shallow crustal earthquakes and do not apply to deeper earthquakes like the one under discussion.

Since the felt area is larger than expected, why is it so large and why is the large area significant? The felt area is large because the focus is unusually deep, nearly 36 km (The focal depth of the Scotts Mills earthquake was 15.1 km; Thomas and others, 1996). From a deep-focus earthquake, the seismic waves travel to the surface through materials that are more homogenous and of higher velocity than near-surface materials. Thus there is less attenuation, and the waves arrive at the surface with more of their initial energy preserved. This is significant because, should a stronger earthquake occur with a similarly deep focus, damaging effects will not only be greater but also occur over a much larger area than expected.

The deep focus is important for another reason. Throughout the western United States, the thickness of the seismogenic crust varies from 15 to 20 km. In western Oregon (west of the Cascade Range), based on observed seismicity (Ludwin and others, 1991), the seismogenic crust is 25–30 km thick. Earthquakes occasionally occur on faults that have no surface expression. The 1994 Northridge earthquake (M_L 6.8), which occurred on a previously unknown, "blind" thrust fault, is an example. Previous studies have shown

that for typical crustal thicknesses of 15–20 km, earthquakes larger than M_L 6.5 will be accompanied by surface rupture and that continued earthquakes on the fault will develop recognizable surface features (Wong, 1997). Because the magnitude of an earthquake is a function of the rupture area, the thicker crust in western Oregon gives us more "room" to hide a fault that has no surface expression. In western Oregon, faults capable of a magnitude 7 earthquake may not rupture the surface (Wong, 1997). Thus a deep-focus earthquake in western Oregon could be quite large and could result in damage over a much larger area than expected.

SUMMARY

The (M_L 2.7) earthquake on February 24, 1999, was felt over at least 9,412 km², even though the expected felt area for an earthquake that size is 977 km². A M_L 2.7 earthquake is typically felt only by people located very close to the epicenter and does little or no damage. This event was felt so widely because its hypocenter was quite deep, nearly 35.7 km (22.2 mi). A deep-focus earthquake in western Oregon could be quite large and could result in damage over a much larger area than expected.

ACKNOWLEDGMENTS

Thanks to the many people who sent in responses, including the classes of Dr. Scott Burns at Portland State University! The task of processing the data was made much easier by the help of Robert Schumacher; and the intensity map could not have been completed without Kate Halstead of DOGAMI.

REFERENCES CITED

- Black, G.L., 1996, Earthquake intensity maps for the March 25, 1993, Scotts Mills, Oregon, earthquake: Oregon Geology, v. 58, no. 2, p. 35–41.
- Dengler, L.S., and Dewey, J.W., 1998, An intensity survey of households affected by the Northridge, California, earthquake of 17 January, 1994: Bulletin of the Seismo-

(Continued on page 102)

BOOK REVIEW

Reprinted with permission from *California Geology*, v. 52, no. 4, p. 26.

The Earth in Turmoil, by Kerry Sieh and Simon LeVay. New York, NY, W.H. Freeman and Company, 1998. ISBN 0716731517, 324 p., hard cover, \$24.95.

Sieh and LeVay's first popular science title should be required reading for anyone interested in how earthquakes and volcanoes work and how these natural phenomena have affected our world and society. In *The Earth in Turmoil*, Sieh and LeVay have written a very readable book about the science behind earthquakes and volcanic eruptions, and the destruction these events have had and the hazards they still pose. Except they go beyond that. The book gives many first-hand accounts (including the authors') from people who experienced some of the more catastrophic earthquakes in U.S. history. The volcanic histories of North America and Hawaii are also introduced with a human viewpoint. Some of these accounts are compelling, and all illustrate the potential destruction these events can have on our lives. The authors describe the science in well-written and very understandable terms. Some of the more technical terms used in the book are included in a glossary. An appendix is also added for those who want a better understanding about how earthquake magnitudes are obtained, the Global Positioning System, and the method of radiocarbon dating.

Although the information mostly covers the U.S., the book is sprinkled with comparisons to events or examples from other parts of the world. It is organized into chapters that start with the Pacific Northwest to California, then across to the Mississippi Valley and the east coast, and finally, in chapter 12, "Peles Wrath: The Volcanoes of Hawaii," an absorbing description of the Hawaiian volcanic chain. The book ends with a chapter

primarily on earthquake hazard mitigation issues that have arisen in California. In this last chapter, as with some of the others, the authors are not shy about presenting their opinions.

Three chapters are devoted to the San Andreas Fault. The reason for this emphasis has more to do with, as they state, "The San Andreas Fault [being] a star among faults, a seismological celebrity," than the fact that Kerry Sieh, a Caltech geologist, has spent years working on the San Andreas Fault. His paleoseismic background does, however, explain why such relatively detailed descriptions of trench studies are included—more perhaps than many would be willing to read through. However, there are few publications that contain such detail for the lay reader, and the book is invaluable in that regard. Throughout the book, historical perspective is included, and the authors cite the work of many geologists who have made important contributions. There are over 60 clearly constructed figures, photos, and satellite images; 23 are included as color plates in the center portion. The book is well indexed, and references are listed by chapter. Some chapter titles—1. *When Push Comes to Shove: Giant Earthquakes in the Pacific Northwest*; 2. *Blasts from the Past: Mount St. Helens and her Sleeping Sisters*; 3. *The Great Divide: Discovering the San Andreas Fault*; 6. *The Enemy within the Gates: Earthquakes on Urban Faults*; and 7. *The Little Volcano that Couldn't: Fear and Trembling at Mammoth Lakes*—hint at the authors' sense of irony and humor that is cleverly intertwined throughout the text. Along with this, they offer their own philosophical views about dealing with a future that will undeniably contain a catastrophic volcanic eruption and earthquake.

—Review by Graben Horst

New poster highlights Earth Science Week '99

In anticipation of Earth Science Week'99 (Oct. 10–16), the American Geological Institute (AGI) has produced another vibrant poster.

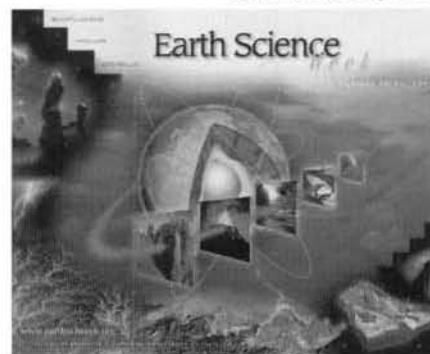
Eighteen AGI member societies and a number of other organizations are distributing the new Earth Science Week poster to more than 200,000 geoscientists and educators along with their societies' journals or newsletters.

The front of the poster features a model of Earth's interior structure. The investigation on the back, "Modeling from Evidence," is a "mystery bag" activity that will help students develop scientific inquiry skills as they gather evidence, propose models based on evidence, and debate and discuss their observations and inferences. In the process, they also learn to revise and improve their models by gathering new evidence and by reevaluating and modifying their interpretations.

The Earth Science Week poster is the newest addition to AGI's Earth Science Week'99 information kit. The kit includes four posters, a 32-page booklet filled with ideas and activities for Earth Science Week and other useful materials and is available from AGI at no charge.

To learn more about Earth Science Week or to request an Earth Science Week information kit, visit the Earth Science Week web site, <http://www.earthsciweek.org> or send your request to Earth Science Week, AGI, 4220 King St., Alexandria, VA 22302.

—Julie Jackson, AGI



Site-specific seismic reports in DOGAMI library nearing 200

On May 1, 1994, the Oregon Structural Specialty Code, a part of the Oregon Administrative Rules, was changed to order that a copy of each legally required "seismic site hazard report" should be deposited with the DOGAMI library and accessible to the public for inspection. This growing collection now holds nearly 200 reports. The following list is derived from the records in the library's bibliographic database. It is organized by county and USGS 7½-minute topographic quadrangle.

This list covers a first portion of the quadrangles in counties outside the Portland metropolitan area. The remaining counties as well as the Portland metropolitan area will be included in subsequent issues of *Oregon Geology*. A few reports are associated with more than one quadrangle.

BAKER COUNTY QUADRANGLES

Baker City

15296. Kleinfelder, Inc. (1996): Phase I geotechnical study, Oregon Department of Corrections, Bootsma site, Baker City, Oregon, ODC #BK-BC-1. (Report for KPFF Consulting Engineers/ODC, Project No. 60-8080-14), 4 pages, 1 fig., 3 tables.

BENTON COUNTY QUADRANGLES

Corvallis

15919. AGRA Earth & Environmental (1998): Geotechnical engineering investigation, Weatherford Hall renovation, Oregon State University, Corvallis, Oregon. (Report prepared for Oregon State University Facilities Services, Job No. 8-61M-09710-0), 25 pages, 7 figs., 19 p. app.
15616. CH2M Hill, Joe Lukas (1996): Geotechnical recommendations [with Addendum], Oregon State University Alumni Center. (Report for Industrial Design Corporation (Ken Lundgren), Project No. 132132.A0.ZZ, submitted by City of Corvallis, Development Services Division), 15 pages, 10 p. app., 4 p. add.; 2d copy submitted by CH2M Hill.
15617. Fujitani Hilts and Associates, Inc. (1995): Site-specific seismic hazard evaluation and geotechnical design addendum, Central Library expansion, Oregon State University. (Report prepared for OSU Dept. of Facilities Services, Project No. 2749-01), 18 pages, 4 figs., 8 p. app.
15658. GeoEngineers, Inc. (1996): Report of geotechnical engineering services, proposed replacement fire station, Corvallis, Oregon. (Report prepared for City of Corvallis, File No. 4635-001-00-2130), 13 pages, 2 figs., 13 p. app.

Riverside

14882. CH2M Hill (1996): Hewlett-Packard Building 9 seismic site hazard report. (Report for Hewlett Packard, Project No. 117161.A0.02, submitted by City of Corvallis, Development Services Division), 12 pages, 4 figs., 19 p. attachments.

CLACKAMAS COUNTY QUADRANGLES

Bull Run

15630. Kleinfelder, Inc. (1997): Smejkal site #CK-SD-1, Clackamas County, Sandy. Final report, prison site location analysis, State of Oregon, Department of Corrections. (Report for KPFF Consulting Engineers/ODC), var. pages.

Estacada

15659. Braun Intertec Corporation (1997): Site-specific seismic evaluation, proposed Eagle Creek fire station, Hwy 211 and Judd Road, Clackamas County, Oregon. (Report for Boring Fire Protection District No. 59, Project No. EAAX-97-0143), 13 pages, 4 figs., 26 p. app.

Molalla

13384. HongWest & Associates (1995): Seismic evaluation, Molalla United Methodist Church, Molalla, Oregon. (Report for Molalla United Methodist Church, Project No. 95040-01, incl. geotechnical exploration, Project No. 95040), 9 pages; geotech. exploration 15 p., 1 fig.
15634. Kleinfelder, Inc. (1997): Sharp site #CK-SAFETY-12A, Clackamas County, Molalla. Final report, prison site location analysis, State of Oregon, Department of Corrections. (Report for KPFF Consulting Engineers/ODC), var. pages.

Willhoit

12603. Carlson Testing, Tigard (1995): Seismic hazards report, Butte Creek Scout Ranch, 13462 South Butte Creek Road, Clackamas County, Oregon. (Report prepared for Cascade Pacific Council, 2145 SW Front Ave., Portland, Oregon, CTI Job No. 95-4282), 12 pages, 2 figs., 2 p. App.

CLATSOP COUNTY QUADRANGLES

Astoria

15886. Braun Intertec Corporation (1997): Site-specific seismic evaluation, proposed 73-unit motel, Hwy 30 and East of 34th Avenue, Astoria, Oregon. (Report for Super One, Inc., Beaverton, Oregon, Project No. EAAX-97-0624, Report No. 09-127-3457), 14 pages, 3 figs., 13 p. app.

Tillamook Head

4942. David J. Newton Associates (1996): Seismic hazards report and preliminary geotechnical investigation for the impact site for proposed new elementary school, N.E.C. of Monroe and Spruce Street, Cannon Beach, Oregon. (Report for City of Cannon Beach, Project No. 628 101), 19 pages, 1 table, 3 figs., 14 p. app.
14869. David J. Newton Associates (1996): Seismic hazards report and preliminary geotechnical investigation for the RV site for proposed new elementary school, 345 Elk Creek Road, Cannon Beach, Oregon. (Report for City of Cannon Beach, Project No. 628 101), 20 pages, 1 table, 3 figs., 20 p. app.

12583. Kelly, Patrick B (1995): Seismic site hazard study, proposed new fire station, NE corner of Sunset and Spruce Streets, Cannon Beach, Oregon. (Report for Cannon Beach Rural Fire District, Project No. K128.01), 11 pages, 1 fig., 2 tables, 8 p. app.

15642. Wright/Deacon and Associates (1994): Geologic, tectonic, and seismic studies and geologic hazards report for Clatsop County Department of Planning and Development [Peterson Point Dam and Reservoir project]. (Report submitted to Foundation Engineering, Inc., Project No. J94-298), 9 pages, 2 figs.

COLUMBIA COUNTY QUADRANGLES

Birkenfeld-Marshland-Pittsburg-Vernonia

15625. Northwest Natural Gas Company (1997): Application to amend site certificate for Mist underground natural gas storage facility. (Submitted to the Oregon Energy Facility Siting Council, March 20, 1997), var. pages.
16005. Northwest Natural Gas Company, NW Natural (1998): Application to amend the site certificates for Mist underground natural gas storage and the South Mist feeder pipeline. (Report for Oregon Energy Facility Siting Council) (Gray Literature Collection, Siting studies, energy.), 140 pages (at least as many pages app.; second volume contains exhibits).

COOS COUNTY QUADRANGLES

Bandon

16546. Terra Firma Geologic Services (1999): Seismic hazard investigation, Bandon's Little Theater in the Park, Bandon City Park, Bandon, Oregon. (Report prepared for Richard PTuri Architecture and Planning, North Bend, Oregon), 18 p., incl. 4 figs. and 3 p. app.

DESCHUTES COUNTY QUADRANGLES

Bend

15611. Mark V. Herbert and Associates, Inc. (1996): Geotechnical investigation, Deschutes County Public Safety Center, North Highway 97 adjacent to existing Criminal Justice Center, Bend, Oregon. (Report for Deschutes County Sheriff, Project No. 96-051. Submitted by Lombard-Conrad Architects, Bend, Oregon), 26 pages, 1 table (7 p.), 21 figs., 7 p. app.

La Pine

12590. Siemens & Associates (1995): Results of geotechnical and seismic site hazard investigation, La Pine Fire Station, La Pine, Oregon. (Report for La Pine Fire Department, Project No. 951008), var. pag.

DOUGLAS COUNTY QUADRANGLES

Sutherlin

16538. Professional Service Industries, Inc. (1999): Site-specific seismic evaluation for the proposed remodels and additions, East Primary School, 301 East Third Avenue, Sutherlin, Oregon. (Report for Sutherlin School District, PSI Project no. 704-95113, Braun Intertec Report no. 3974-069-001), 10 pages, 4 figs., 12 p. app.

HOOD RIVER COUNTY QUADRANGLES

White Salmon

12591. Dames & Moore (1995): Seismic hazard investigation, Pine Grove Fire Station addition, Hood River, Oregon. (Report prepared for Pine Grove Fire Department, Job No. 31566-001-016), 6 pages, 1 site plan.

JACKSON COUNTY QUADRANGLES

Ashland

12597. Marquess and Associates, Inc. (1995): Seismic hazard investigation report, Ashland Community Hospital additions, Ashland, Oregon. (Report for Ashland Community Hospital, Job No. 1-5743, deposited by McNamara Engineering & Construction, Ashland, Ore.), 5 pages, 5 figs.

Eagle Point

15288. Kleinfelder, Inc. (1996): Phase I geotechnical study, Oregon Department of Corrections, Orchard site, Medford, Oregon, ODC #JK-MD-2. (Report for KPFF Consulting Engineers/ODC, Project No. 60-8080-15), 5 pages, 1 fig., 3 tables.

Sams Valley

15287. Kleinfelder, Inc. (1996): Phase I geotechnical study, Oregon Department of Corrections, Roseburg Resources site, Medford, Oregon, ODC #JK-MD-1. (Report for KPFF Consulting Engineers/ODC, Project No. 60-8080-07), 5 pages, 1 fig., 3 tables.

Medford East/Medford West

14897. Marquess and Associates, Inc. (1995): Soil investigation report, additions to Hedrick and McLoughlin Middle Schools, Medford 549C School District. (Report for Medford 549C School District, Job No. 1-5655), 14 pages, 21 figs.

JEFFERSON COUNTY QUADRANGLES

Buck Butte

15284. Kleinfelder, Inc. (1996): Phase I geotechnical study, Oregon Department of Corrections, Zemke site, Madras, Oregon, ODC #JF-MA-6. (Report for KPFF Consulting Engineers/ODC, Project No. 60-8080-20), 4 pages, 1 fig., 3 tables.

Culver

15285. Kleinfelder, Inc. (1996): Phase I geotechnical study, Oregon Department of Corrections, Dover Lane site, Madras, Oregon, ODC #JF-MA-3. (Report for KPFF Consulting Engineers/ODC, Project No. 60-8080-02), 4 pages, 1 fig., 7 tables.

Madras West

16070. Raytheon Infrastructure, Inc. (1997): Seismicity evaluation, Pelton hydroelectric project. Federal Energy Regulatory Commission licensed project no. 2030. (Report for Portland General Electric Company), 28 pages, 11 figs., 2 p. letter of September 17, 1998 (volcanic hazard).
16071. Raytheon Infrastructure, Inc. (1998): Seiche analysis, Pelton and Round Butte developments. (Report for Portland General Electric Company), 9 pages, 12 figs., 12 p. app., 2 p. letter of February 16, 1999.

JOSEPHINE COUNTY QUADRANGLES

Cave Junction

15289. Kleinfelder, Inc. (1996): Phase I geotechnical study, Oregon Department of Corrections, Martin Dairy site, Cave Junction, Oregon, ODC #JO-CJ-1. (Report for

KPFF Consulting Engineers/ODC, Project No. 60-8080-03), 5 pages, 1 fig., 3 tables.

KLAMATH COUNTY QUADRANGLES

Klamath Falls

14877. Golder Associates, Inc. (1996): Preliminary geologic and seismic hazards evaluation, Klamath Cogeneration Project, Klamath Falls, Oregon. (Report for Resource Management International, Inc., 3100 Zinfandel Drive, Suite 600, Sacramento, Calif. 95670, Project No. 953-7065), 23 pages, 5 tables, 6 figs.

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14872. David J. Newton Associates (1996): Geotechnical investigation and seismic hazard report for the Springfield High School additions, 7th Street at "G" Street, Springfield, Oregon. (Report for Springfield School District, c/o Heery International, Springfield; Project no. 619 111), 18 pages, 4 figs., 1 table, 13 p. app.

15637. Foundation Engineering, Inc. (1996): A seismic study for Lane Community College. (Report for Biggs Cardosa Associates, Inc., Eugene, Oregon, Project No. 96100174), 10 pages, 3 figs. 1 table.

16535. Professional Service Industries, Inc. (1999): Geotechnical engineering services report, proposed Natatorium Building addition, Willamalane Park Swim Center, 1276 G Street, Springfield, Oregon. (Report for Willamalane Park and Recreation District, PSI File No. 704-95096), 12 pages, 11 p. app., incl. 2 figs.

Junction City

15299. Kleinfelder, Inc. (1996): Phase I geotechnical study, Oregon Department of Corrections, Meadow View site, Eugene, Oregon, ODC #LA-EU-1. (Report for KPFF Consulting Engineers/ODC, Project No. 60-8080-06), 5 pages, 1 fig., 3 tables.

Mount Hagan

15927. Professional Service Industries, Inc. (1998): Geotechnical engineering services

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Oakridge

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Springfield

13378. David J. Newton Associates (1995): Geotechnical investigation and seismic hazards report for the Springfield Middle School, South 32d Street and Jasper Road, Springfield, Oregon. (Report for Soderstrom Architects, Portland, Project No. 619 101), 21 pages, 6 figs., 1 table, 40 p. app.

14873. David J. Newton Associates (1996): Geotechnical investigation and seismic hazard report for the Thurston High School additions, 58th Street at "A" Street, Springfield, Oregon. (Report for Springfield School District, c/o Heery International, Springfield; Project no. 619 121), 17 pages, 4 figs., 8 p. app.

Veneta

16050. Braun Intertec Corporation (1999): Site-specific seismic evaluation, proposed Elmira High School addition, 24936 Fir Grove Lane, Elmira, Oregon. (Report for Fern Ridge School District No. 28J, Elmira, Oregon, Project No. EAAX-99-0112), 12 pages, 3 figs., 15 p. app.

Penrose Conference to focus on Great Cascadia Earthquake Tricentennial

The year 2000 marks the tricentennial of the last great earthquake at the Cascadia subduction zone. Coastal and offshore geological work has confirmed that many great subduction earthquakes have struck this region in the last several thousand years. In addition, geodetic studies have shown that the subduction zone is accumulating strain that will be released in one or more future earthquakes.

This will be background and focus of the Geological Society of America (GSA) Penrose Conference in the tricentennial year of the A.D. 1700 Cascadia earthquake.

The GSA Penrose Conference of the year 2000 will be held at Seaside, Oregon, June 4-8, 2000. It will bring together 75 earth scientists,

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New State Geologist to guide Oregon activities

Earthquakes—Ecosystems—Landslides—Floods—Tsunamis—Volcanic Eruptions—

Oregon's new chief geologist wants to provide information Oregonians need about these events and processes. "It's simple," says Dr. John Beaulieu, "the more we know about areas at risk and the mechanisms of these geologic processes, the safer we can be and the better managers we can be of natural systems."

Beaulieu also wants to provide more and better information aimed at other problems in Oregon's future, including groundwater supply, watershed health, and resource development.

Beaulieu is uniquely qualified to be the new State Geologist and director of the state's Department of Geology and Mineral Industries. Since becoming Deputy Director in 1977, he has helped fashion the department's current programs but knows where he'd like to make a few changes. "We're the people who gather the information. We need to make sure that local governments, other state agencies, businesses, volunteer assistance organizations like the Red Cross, and everybody else has the balanced information they need to solve geology-related problems in Oregon. That should result in keeping Oregonians reasonably safe."

Years of researching Oregon's geology, lobbying the Legislature, working with other state and federal agencies, and developing the current staff give him the tools he needs to be effective. "Twenty years ago we didn't really appreciate how geologically active Oregon was; we didn't know, for example, that part of Oregon was at risk of a magnitude 9 earthquake. Now that we know that it's a huge potential problem, we're able to work with a variety of public and private organizations to get ready for it."

"The purposes of the department are clear," says Beaulieu. "We're the centralized source of geology information for Oregon that people need to make wise decisions. In addition, we're expected to provide informed and creative regulation and voluntary problem-solving for earth resources like aggregate and natural gas."

With a world-class reputation and dozens of maps and research papers bearing his name, Beaulieu has been invited to speak at conferences in Paris, Kobe, and Cyprus as well as various places in the United States. He is one of the authors of a recent United Nations publication describing the use of geologic data to prepare for earthquakes.

Much of his earlier research has involved landslides, an especially important topic to Oregonians these

days. "We're building in riskier places in much higher densities than we ever have before. Put that together with wetter winters than we're used to, and a lot of places are seeing landslides," he explains. "Unfortunately, the loss of an entire neighborhood to a landslide, as recently in places like Kelso, Washington, has happened in the past in Oregon and could happen again."

Along with developing applied geologic information and partnering to reduce the risk from natural hazards, Beaulieu will guide regulatory functions in mining and energy resources. "We have an exceptional staff here; that's one of the great benefits of this job. For example, one of our staff members was named the Best Reclamationist in the nation a couple of years ago. With that level of commitment and creativity of the staff, we will continue to improve our research and application of geologic information in serving Oregonians."

Family life is also important to Beaulieu. He and Kathy, his wife for 32 years, have raised three sons: Mike, Pat, and Matt. "You're a better worker and a better person when you have a challenging job and a rewarding life outside the office. I'm fortunate to have both," he said.

Beaulieu became State Geologist on August 1.

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Call for papers

The Geological Society of Nevada (GSN) will hold a symposium, *Geology and Ore Deposits 2000: The Great Basin and Beyond*, May 15-18, 2000, in Reno-Sparks, Nevada. Information can be found on the GSN web site (<http://www.seismo.unr.edu/GSN>) or from the GSN office, P.O. Box 12021, Reno, NV 89510-2021, phone (775) 323-4569.

New geologist joins DOGAMI staff in Baker City

Vicki S. McConnell has joined the Oregon Department of Geology and Mineral Industries (DOGAMI) as a Natural Resource Geologist in the Baker City Field Office. She will be primarily involved in field work, mapping the volcanic terrain of northeastern Oregon.

McConnell comes to DOGAMI from positions as research associate in stable isotope geochemistry at the University of Wisconsin-Madison and, before that, as research fellow with the Alaska Volcano Observatory, where she conducted mapping work in the Aleutians.

Before her graduate studies which she concluded with earning a Ph.D. degree from the University of Alaska Fairbanks, McConnell worked for Sandia National Laboratories in Albuquerque, N.Mex. There she had the opportunity to work on a myriad of research projects in the geosciences, including magma energy



Vicki S. McConnell, Ph.D.

research, basic research for the nuclear waste isolation projects in Yucca Flats, Nev., and Carlsbad, N.Mex., and scientific drilling research in volcanic areas. She brings with her 13 years of experience in the study of volcanoes and hydrothermal systems in Alaska, California, and New Mexico.

"In addition to my duties as a field geologist I have a strong commitment to improving the understanding of science within the local community through relevant outreach activities," McConnell said. "Science in general and geology in particular should not be perceived as mysterious or threatening, and the best way to dispel these perceptions is through grassroots activities and involvement with the community by scientists and professionals."

McConnell has worked in the past as a geology instructor with Elderhostel groups and as a volunteer science instructor with local primary schools.

Although McConnell grew up in West Virginia, she has spent so many years in "really western" states that Baker City and northeastern Oregon feel like home to her. "Yet," she confessed, "I can't wait to explore the whole state."

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engineers, public officials, and hazard-mitigation professionals, who will critically review current knowledge about great Cascadia earthquakes and hazards posed by future earthquakes, discuss appropriate strategies for reducing losses from these earthquakes, and identify new research directions.

The conference will consist of three days of discussions, prompted by talks and posters, and a one-day field trip. Sessions will deal with hazards posed by great Cascadia earthquakes and the mitigation of these hazards; past earthquakes and tsunamis; tectonics; and present-day seismicity and strain accumulation. Evidence of past Cascadia earthquakes and tsunamis will be examined and discussed during a canoe trip along nearby Lewis River, Washington. The field trip will also include a visit to historic Fort Clatsop and examination of cores from Bradley Lake, Oregon, which contain a

7,000-year record of tsunamis produced by great Cascadia earthquakes. A public forum will be held just before or during the conference to give participants an opportunity to hear concerns of coastal residents.

The format of the conference is designed to ensure critical thought and interaction among participants. Formal lectures will be limited in favor of group discussions and poster sessions.

The conference is limited to 75 participants. Interested scientists, engineers, public officials, hazard-mitigation professionals, and graduate students are invited to apply. Application deadline is December 1, 1999. Invitations will be mailed to participants at the end of January 2000. Letters of application should be sent to John Clague, Department of Earth Sciences, Simon Fraser University, Burnaby, BC V5A 1S6, Canada. They should include a brief abstract of the poster or talk the applicant would like to present at the

conference.

Graduate students working on Cascadia great earthquake topics are particularly encouraged to apply. Limited subsidies will be provided to selected students. The registration fee, which will cover lodging, meals, the field trip, and all other conference expenses except personal incidentals, is not expected to exceed U.S. \$700. Participants will be responsible for transportation to and from Seaside.

Co-conveners are John J. Clague, Simon Fraser University and Geological Survey of Canada, jclague@sfu.ca; Brian F. Atwater, U.S. Geological Survey at University of Washington, atwater@u.washington.edu; Kelin Wang, Pacific Geoscience Centre, Geological Survey of Canada, wang@pcg.nrcan.gc.ca; Yumei Wang, Oregon Department of Geology and Mineral Industries, meimei.wang@state.or.us; and Ivan G. Wong, URS Greiner Woodward-Clyde Federal Services, Ivan_Wong@urscorp.com.

Places to see—Recommended by the Oregon Department of Geology and Mineral Industries:

Kiger Gorge in the Steens Mountain Recreation Lands, Harney County

Kiger Gorge is one of several glacial valleys on Steens Mountain in southeastern Oregon. It is here seen from the rim rock at the head of its broad, U-shaped valley. The U shape is typical of a valley carved by a glacier, while river valleys have a V shape. Glaciers advanced during the Pleistocene (less than 2 million years ago), when the climate was colder and wetter than today. At that time, the present-day Alvord Desert (15 mi to the southeast of Kiger Gorge) was part of lake that was 70 mi long and 12 mi wide. Access: Loop Road from State Highway 205 to the east between Frenchglen and Roaring Springs Ranch. Geologic guide: Lund and Bentley, "Steens Mountain, Oregon," Oregon Department of Geology and Mineral Industries, Ore Bin, v. 38, no. 4 (April 1976), p. 51–66. (Photo by Oregon Department of Transportation)

