Officials and Scientists Discuss Earthquake Hazards

Geologists have long believed that the seismically active Northwest U.S. could produce a magnitude 7.5 earthquake with the potential for killing thousands and injuring thousands more. Now there is growing evidence to suggest that parts of Oregon, Washington, and British Columbia could be rocked by a so-called great earthquake of magnitude 9 that might cause destruction far beyond today's planning goals for government and industry emergency managers.

While there is no means consensus supporting the theory that a magnitude 9 could occur in the region, recent scientific research points to the possible occurrence of eight great earthquakes in the Pacific Northwest in the past 5,000 years. Capable of widespread destruction, sudden submergence of coastal areas, and massive water waves (tsunamis), these great earthquakes would be similar to the devastating 1964 Alaska earthquake or the 1985 Mexico earthquake. Some scientists believe that future research will provide other explanations for this geologic evidence that is being used to infer that catastrophic earthquakes have occurred in the Northwest. Until other origins for the features are proven, a great earthquake along the coast of Oregon, Washington, and British Columbia must be considered a possibility.

In mid-April nearly 200 scientists, emergency managers, engineers, and business and community leaders attended a workshop held in Olympia and sponsored by federal and state agencies. The purpose of the meeting was to review earthquake hazards in the Puget Sound and Portland, Oregon, areas. This workshop was part of a 5-year cooperative program funded by the U.S. Geological Survey and the Federal Emergency Management Agency (FEMA) to study the dangers earthquakes pose to people living in the Pacific Northwest. In addition to discussing the likelihood of catastrophic earthquakes, those meeting also reviewed the well-established earthquake history of the area. Historic earthquakes indicate that earthquakes as large as magnitude 7.5 will continue to occur deep beneath Puget Sound and at shallow depths in the North Cascade mountains. Recent earthquake activity in southwest Washington suggests the possibility of earthquakes of magnitudes to 7 in the Southern Cascade mountains, posing hazards to both Washington and the Portland area.

While earthquakes cannot be prevented, the damage they do can be significantly reduced. Information about how to reduce damage is available from FEMA in Bothell and from local emergency management offices. (The previous issue of this newsletter contains lists of information sources.) Information about the geology of Washington and Oregon can be obtained from the Washington Division of Geology and Earth Resources in Olympia and from the Oregon Department of Geology and Mineral Industries in Portland, respectively.
Seabed Mining Jurisdiction
Question

by

Raymond Lasanian, State Geologist

Before any serious attempts to explore for and develop seabed resources in the federal Exclusive Economic Zone (EEZ) are undertaken, a long-standing jurisdictional controversy between the federal Minerals Management Service (MMS, Department of the Interior) and Department of Commerce has to be resolved.

The Commerce Department claims jurisdiction for leasing outside the continental shelf under the Deep Seabed Hard Mineral Resources Act of 1980. MMS has received jurisdiction for seabed mining in the EEZ from the Outer Continental Shelf Lands Act of 1953.

To resolve the question, Rep. Mike Lowry has introduced H.R. 1260, the National Seabed Hard Minerals Act. A similar bill was to be introduced in the Senate by Sen. Daniel Inouye of Hawaii. A substitute form of H.R. 1260, under consideration, would give the National Oceanic and Atmospheric Administration (NOAA) sole authority over seabed mining regulation. The bill would authorize $28 million to the U.S. Geological Survey and NOAA for geological and biological research.

Consultation with coastal states is a major feature of the House bill. Revenue sharing would provide 50 percent of the royalties to go to the affected states.

(Read related article, page 5.)


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Development of up-to-date global plate reconstruction atlas—D. C. Engbretson

Sediment transport in Deer Creek and slope stability along the main channel of Deer Creek, Skagit County, Washington—H. M. Kelsey

Petrology, provenance, and depositional environment of sedimentary rocks of the Crescent terrane—C. A. Suczek

Petrology of modern sands from western Washington—C. A. Suczek

Sain in the crystalline core of the North Cascades; its relation to block rotation and right-lateral movement—L. Talbot

Student Projects

Structural analysis of eugeosynclinal rocks in Big Sheep Creek area, Northport, Washington—Frank Shore

Geochemistry and petrology of plutonic rocks between the Kettle Gnesis Dome and Republic graben, Currew and Togo Mountain quadrangles, Washington—Charles Kreb

Petrochemistry of Eocene hornblende-bearing plutonic rocks of the Colville batholith in the central Okanogan highlands and correlation with graben-filling volcanics—Grace Holder

Ground-water infiltration estimation for the Washington State University hazardous waste facility—Hernando Muniz

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May and June, 1988

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Coal Mine Subsidence in Washington

by

Timothy J. Walsh, Geologist

In 1977, Congress enacted Public Law 95-87, the Surface Mining Control and Reclamation Act (SMCRA), which provided, among other things, for the closure of abandoned, underground mine openings, reclamation of coal mine-induced subsidences, and the amelioration of mine-related hazards. Funds for this work are provided by a tax on active coal mines at a rate ranging from 10 to 35 cents/ton, depending on coal rank. The act established an agency, the Office of Surface Mining Reclamation and Enforcement (OSMRE), to administer the provisions of SMCRA.

In Washington, mine reclamation is approached by OSMRE in two ways:

1. Emergency actions, which are defined as recent, sudden events, are reclaimed on a first priority basis. These are most commonly subsidences but have included gas flows caused by a drop in hydrostatic pressure in a mine void during dry weather.

Table 1. Mine-subsidence reclamation projects, 1977-1987, performed by OSMRE since enactment of SMCRA. Location: the abbreviated location SW/4 28 22.7, for example, indicates southwest quartes of section 28 in T. 22 N., R. 7 E. Failure type: 1, failure of fill in a shaft, slope, or rock tunnel; 2, cave-in due to roof fall; 3, sag due to roof fall; 4, hydrocompaction of spoil.

<table>
<thead>
<tr>
<th>Project name</th>
<th>Mine name</th>
<th>Location</th>
<th>Date</th>
<th>Failure type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engel</td>
<td>Wonder</td>
<td>SW/4 28 22.7</td>
<td>2-79</td>
<td></td>
</tr>
<tr>
<td>Bevan</td>
<td>Burnett</td>
<td>S/2 16 (19-6)</td>
<td>6-79</td>
<td></td>
</tr>
<tr>
<td>Campbell</td>
<td>Burnett</td>
<td>S/2 16 (19-6)</td>
<td>5-81</td>
<td></td>
</tr>
<tr>
<td>Burdic</td>
<td>Wonder</td>
<td>SW/4 28 22.7</td>
<td>9-81</td>
<td></td>
</tr>
<tr>
<td>Lake Whatcom</td>
<td>Rocky Ridge</td>
<td>SW/4 31 (38-4)</td>
<td>11-82</td>
<td></td>
</tr>
<tr>
<td>Neoskial</td>
<td>Denny-Renton</td>
<td>SW/4 17 (23-5)</td>
<td>11-82</td>
<td></td>
</tr>
<tr>
<td>Gatto</td>
<td>Burnett</td>
<td>S/2 16 (19-6)</td>
<td>2-82</td>
<td></td>
</tr>
<tr>
<td>May Creek</td>
<td>May Valley</td>
<td>SB/4 2 (23-6)</td>
<td>6-82</td>
<td></td>
</tr>
<tr>
<td>Beacon Hill</td>
<td>Beacon Hill</td>
<td>NB/4 14 (23-4)</td>
<td>1-84</td>
<td></td>
</tr>
<tr>
<td>#12</td>
<td>#12</td>
<td>S/2 12 (21-6)</td>
<td>1-84</td>
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<tr>
<td>Diamond</td>
<td>Diamond</td>
<td>SW/4 13 (23-4)</td>
<td>7-84</td>
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<tr>
<td>Davis</td>
<td>Davis</td>
<td>NW/4 14 (21-7)</td>
<td>6-85</td>
<td></td>
</tr>
<tr>
<td>Denny-Renton</td>
<td>Renton</td>
<td>NW/4 20 (23-3)</td>
<td>3-86</td>
<td></td>
</tr>
<tr>
<td>Scott</td>
<td>unknown</td>
<td>NW/4 28 (19-6)</td>
<td>5-87</td>
<td></td>
</tr>
<tr>
<td>Ogrilich</td>
<td>#2</td>
<td>NB/4 14 (21-6)</td>
<td>5-87</td>
<td></td>
</tr>
<tr>
<td>Koch</td>
<td>Rocky Ridge</td>
<td>SW/4 31 (38-4)</td>
<td>9-87</td>
<td></td>
</tr>
<tr>
<td>Waterhouse</td>
<td>Waterhouse</td>
<td>SW/4 28 (24-5)</td>
<td>2-88</td>
<td></td>
</tr>
</tbody>
</table>
Emergency reclamation typically is accomplished within a few weeks, but funding is available only for reclaiming actual subsidence, not for repairing structural damage caused by subsidence. For this reason, prompt attention must be given to suspected coal mine subsidence before it causes damage, and contractors should consider the likelihood of future subsidence when building in areas of historic coal mining.

Local planning can help ease the potential impact of subsidence, planners are aware of mine-related hazards and can recommend construction techniques for areas affected by coal mines. King County, which has large areas underlain by abandoned coal mines, requires developers of lands designated as Coal Mine Hazard Areas to perform geotechnical studies in order to obtain building permits. King County Code 21.54.190 specifies that these studies must identify and quantify:

1. existing underground voids resulting from previous mining activity;
2. location and definition of all surface openings resulting from previous mining activity;
3. location of all concentrations of lethal or noxious gases and groundwater within abandoned mine workings; and
4. location, depth, and characteristics of all mine tailings on the surface of the site.

Any building permit issued requires, among other things, that all openings be sealed and all voids beneath building sites that present significant risk to human health, safety, and welfare be filled or otherwise remedied.

While this ordinance and a similar ordinance in Pierce County currently provide a measure of protection for homeowners, construction prior to its enactment is not covered. Many homes have already been built over or immediately adjacent to abandoned coal mines in Bellingham, Renton, Newcastle, Issaquah, and rural King County. Most of these structures will not experience any problems because subsidence has already gone to completion or because mine workings are too deep for subsidence to propagate to the surface. However, once the land surface is modified, it becomes more difficult to assess the subsidence potential.

A housing development that was built a few miles south of Bellevue in the mid-1970s contained an abandoned prospect (Table 1, Waterhouse prospect). Meager historic records indicated the presence of the prospect, but fill and grading concealed the exact location of the hole. Because the prospect was only poorly documented, its original extent, the amount and integrity of its fill, and the degree of hazard (if any) that it posed were unknown. In February 1988, the plug of fill in the mine entry failed, leaving a portion of a house foundation unsupported (Fig. 1). The hole grew for several days, eventually reaching a diameter of approximately 30 feet and damaging the house's foundation and plumbing. While the prospect itself was reclaimed by OSM, the homeowner will have to bear the burden of the damage to the house, and, at least temporarily, local property values are likely to suffer, even for properties not at risk.

The Division of Geology and Earth Resources (DGER) maintains a large collection of mine maps, and other historical information that can be used to locate areas affected or potentially affected by coal mining. Inventories of known and suspected mine hazards are available for inspection at DGER's library and the index to DGER's mine map collection is available for a $1.00 postage and handling charge. (DGER Open File Report 83-8 by Schase and others)

Sources of mine information:


Figure 1. Collapse of an abandoned Waterhouse slope near Bellevue, February 1988. Note dangling support of stairway.

University of Washington, Geophysics Program

(Abbreviated project titles; see also National Science Foundation list)

**Faculty Projects**

Agassiz ice cap survey—Eduin D. Waddington
Avalanche prediction—Charles F. Raymond
Core structure—Kenneth C. Creager (Dai McClurg)
DAC geophysics—Yosik S. Sorensen
Deep conductivity—John R. Booker (Nong Wu)
Domain structure—Ronald T. Mereill
Earthquake hazards— Robert S. Crosson (John VanDerarlo)
Earthquakes in the Pacific Northwest—Robert S. Crosson (Jonathan Lees)
Floods and currents—J. Dungan Smith (David Mohr)
Geothermal seismicity—Stephen D. Malone, Anthony Qamar (Sally Barker, Robert Leet)
Glacier comparison—Charles F. Raymond
Glacier time scales—Charles F. Raymond
Hydrogen in metals—J. Michael Brown
Marine sediment transport—J. Dungan Smith
Mendocino Induction— John R. Booker (Maryann Helfert)

**Student Projects**

Structure, petrology, and associated mineralization of the Similkameen batholith, Okanogan County, Washington—A. M. Budding

Structural and metamorphic history of the Cascade River Schist in the Silsley Creek area, North Cascades—J. D. Dragasich
Hydrologic and geologic mechanisms for the generation of channelized debris flows, Boulder Creek drainage basin, North Fork Nooksack River, Washington—M. E. Gouan
Hydrothermal alteration associated with the Devils Mountain fault zone, Skagit County, Washington—D. Graham

A fluid inclusion study of hydrothermal processes at the Cannon mine, Chelan County, Washington—M. Kitch

An investigation of tourmaline as a pathfinder mineral for base metal-bearing breccia pipes and associated porphyry copper-type deposits in the Cascade Range of Washington—C. Smith

Washington State University

**Faculty Projects**

Development of short- and long-term plans for development of conceptual models of ground-water flow within Hanford Reservation post-basalt sedimentary deposits—David R. Gaylord, with Ken Lindsey

Sedimentology, stratigraphy and geological evolution of Eocene volcaniclastic and siliciclastic deposits in the Republic and Tororoko Creek grabens, north-central Washington—David R. Gaylord (Scott Price)

Stratigraphic and sedimentary controls on hydraulic conductivity in the Ringold Formation and glacial-fluvial strata on the Hanford Reservation, Washington—David R. Gaylord (Ken Lane)

Tectonic models of the Kootenay Arc—A. John Watson

Columbia River basin research—Peter R. Hooper
Geophysical studies of the eastern Columbia Plateau—Richard L. Thiesen and Kent R. Johnson

Study of ground-water quality and ground-water contamination in Palouse loess—C. Kent Keller (Vicki Martinez)

Occurrence of carbon dioxide and oxygen in unsaturated Palouse loess—C. Kent Keller

Western Washington University

**Faculty Projects**

Geochemistry of plutonic and metamorphic rock units in the North Cascades—R. S. Babcock

Geochemistry and tectonic evolution of the Crescent Basin—R. S. Babcock

Geochemistry and petrology of the Files Peak Formation—R. S. Babcock

Geochmistry and petrology of alkaline intrusives in north-central Washington—R. S. Babcock

Thermoluminescence dating of volcanic ash—G. W. Berger

Thermoluminescence dating of eolian and waterlaid sediments from North America and New Zealand—G. W. Berger

Analysis of metamorphic deformation in the North Cascades—E. H. Brown

Paleomagnetism of volcanic rocks from the Olympic Peninsula—D. C. Engerbretson

Global investigation of asymmetric seafloor spreading—D. C. Engerbretson

Computer animation of plate tectonic processes—D. C. Engerbretson

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Geological Projects in Washington Supported by the National Science Foundation, 1988

(The following list is taken from material submitted by the geology departments of the state's colleges and universities. Named in parentheses with the faculty projects are student collaborators. Some projects involve areas outside Washington.)

Central Washington University

Faculty Projects

- Deep crustal transect, 117th meridian, Oregon and Washington (in cooperation with Cornell University—Steven E. Farkas, Don Ringe (Clifton E. Mitchell)
- Study of 1 methods to transfer geologic map information to a Geographic Information System with public-domain software, and 2 computer-assisted petrography for the same color image analysis—James H. Mithen
- Structural geology at the western margin of the Columbia River basalt—Robert D. Bentley, John E. Powell (Steven D. Jenson)

Student Project

- Detailed surficial geology of the Ryegrow grass waste disposal site, east of Ellensburg—Susan A. Lovas

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1988 Geological Projects, Washington Colleges and Universities

Clark College

Faculty Projects

- Geologic evolution and morphology of Mount St. Helens dome—A map series at 1:20,000—Wayne E. Colony (with Robin Holcomb, USGS)
- Geology of the Blanco Fracture Zone using side-looking sonar—Wayne E. Colony (with John R. Delaney, University of Washington)

Pacific Lutheran University

Faculty Projects

- Geology of the Olympic Peninsula coastal strip, Olympic National Park—Steve Bencham
- Zoistites from Eocene basalts, Olympic and Kitsap Peninsulas—Steve Bencham

Tacoma Community College

Faculty Project

Roadside geology of Mount Rainier National Park—Jack H. Hyde


Washington Offshore Mineral Resources

by

Raymond Lasmanis, State Geologist

(Reports presented to the Washington State Legislature, Joint Select Committee on Marine and Ocean Resources, March 29, 1988)

INTRODUCTION

The oceans of the world contain vast quantities of minerals. These commodities occur in sea water, in deep ocean-bottom rift systems, as unconsolidated placer deposits on the sea bed, and as deposits in bedrock under the ocean.

On a world scale, sea water is a large source of chemical commodities, such as bromine. There is also significant production of gold, diamonds, tin, rare earth minerals, zinc, chromium, and titanium-bearing iron minerals from marine placer deposits. Sand and gravel are being mined from deep water off the shores of Great Britain and Japan. In several nations bedrock deposits of coal, base metals, and tin are extracted by underground mining below the sea from shafts located on islands and the mainland. Salt and sulfur are exploited from subsea bedrock domes by wells. However, there has not yet been any mining of phosphorite, manganes, or polymetallic sulfides from the ocean floor.

In the United States, mineral production has taken place and is presently occurring along the intertidal zone and in shallow state waters. Table 1 below provides an overview.

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Source</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salt</td>
<td>Sea water</td>
<td>California, Gulf coast</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Sea water</td>
<td>Gulf coast</td>
</tr>
<tr>
<td>Bromine</td>
<td>Sea water</td>
<td>Gulf coast</td>
</tr>
<tr>
<td>Sand and gravel</td>
<td>Unconsolidated New York, New Jersey</td>
<td></td>
</tr>
<tr>
<td>Oyster shells</td>
<td>Unconsolidated Gulf coast</td>
<td></td>
</tr>
<tr>
<td>Gold</td>
<td>placer</td>
<td>Oregon, Alaska</td>
</tr>
<tr>
<td>Chromite</td>
<td>placer</td>
<td>Florida</td>
</tr>
<tr>
<td>Titanium</td>
<td>placer</td>
<td>Florida</td>
</tr>
<tr>
<td>Zircon</td>
<td>placer</td>
<td>Florida</td>
</tr>
<tr>
<td>Barite</td>
<td>Bedrock</td>
<td>Alaska</td>
</tr>
<tr>
<td>Salt</td>
<td>Bedrock</td>
<td>Gulf coast</td>
</tr>
<tr>
<td>Sulfur</td>
<td>Bedrock</td>
<td>Gulf coast</td>
</tr>
</tbody>
</table>

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In the United States the value of sand and gravel recovered from offshore deposits exceeds that of all other mined marine minerals.

**OFFSHORE MINERALS OF WASHINGTON**

There has been no mineral production offshore of Washington in either state or federal waters. However, titaniferous sands and gravel resources have been identified offshore. The polyhalite and sulphates have been found on Juan de Fuca Ridge more than 200 nautical miles seaward from the Washington coastline and therefore are beyond the federally declared Exclusive Economic Zone.

Titaniferous iron-bearing sands have been outlined by drilling, surface sampling, and geophysics along the intertidal zone and as much as 2 miles offshore in the following areas: Baker Bay at the mouth of the Columbia River, on accreted lands (Benson Beach) and offshore of Fort Canby on Cape Disappointment, and at Leadbetter Point, all in Pacific County. Such black sands have also been explored offshore of North Bay of Grays Harbor.

Titaniferous sands at Moclips and Copalis have been characterized (Table 2) and contain minor amounts of gold.

In Washington, as elsewhere, by far the most valuable offshore resource is gravel. Large deposits are found from Cape Flattery to Grays Harbor. The deposits have been confirmed by bottom sampling (Fig. 1); studies show that they are associated with ancient shorelines of meters 20 to 280 meters (1 meter = 3.28 feet). These gravel deposits exist in the waters beyond the 3-mile limit and are clustered around the entrance to Juan de Fuca Strait and the outfalls of the Hoh, Quinault, and Chehalis Rivers. These sea-floor gravels have remained unburied on the seabed since they were deposited 15,000 years ago. At that time the sea level was 200 meters lower than at present (Fig. 2).

The U.S. Geological Survey has conservatively estimated that if gravel off Washington is present as a layer 1 meter thick, offshore resources contain 1,500 million cubic meters of material (1 cubic meter = 1.31 cubic yards). Gravel at depths of less than 50

---

**Table 2.** Percentages of magnetite plus ilmenite and zircon concentrates in the heavy minerals (from Venkataraman and McManus, 1973)

<table>
<thead>
<tr>
<th>Station Number</th>
<th>Latitude</th>
<th>Longitude</th>
<th>% magnetite plus ilmenite</th>
<th>% zircon concentrates</th>
<th>% of total</th>
<th>House</th>
</tr>
</thead>
<tbody>
<tr>
<td>OC14-1A</td>
<td>46°50.7&quot;N</td>
<td>124°07.6&quot;W</td>
<td>2.7</td>
<td>0.4</td>
<td>3.1</td>
<td>2</td>
</tr>
<tr>
<td>-3A</td>
<td>46°52.5&quot;N</td>
<td>124°06.5&quot;W</td>
<td>4.3</td>
<td>0.0</td>
<td>4.3</td>
<td>4</td>
</tr>
<tr>
<td>-3B</td>
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<td>124°05.9&quot;W</td>
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<td>124°14.0&quot;W</td>
<td>18.4</td>
<td>1.1</td>
<td>19.5</td>
<td>18</td>
</tr>
<tr>
<td>-15B</td>
<td>47°00.7&quot;N</td>
<td>124°11.0&quot;W</td>
<td>2.9</td>
<td>0.3</td>
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<td>3</td>
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<td>124°11.4&quot;W</td>
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<td>0.1</td>
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<tr>
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<td>124°31.3&quot;W</td>
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**Seismograph in Division Office**

Kinematics Systems of Pasadena, CA, has donated a short-period seismograph to the Division. The company has been supportive of seismology and seismic research for two decades. According to A. M. Serri, President of Kinematics, the donation, "while primarily intended to provide useful technical instrumental data to better understand local earthquakes and geological conditions, may also promote increased legislative and public awareness of the pressing need for improved earthquake hazard research and mitigation in the Pacific Northwest area."

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**Meetings**

**Pacific Northwest American Geophysical Union**

35th Annual Meeting
September 29-30
Royal Roads Military College
Victoria, British Columbia

**Abstract deadline: August 28**

**Information:**
John Mothertill
Royal Roads Military College
FMO Victoria, British Columbia

**VOS 180 Canada**

(604) 380-4516

**Friends of Mineralogy**

14th Annual meeting
September 30-October 2

**Topic: Carbonate Show**

The Executive Inn
5700 Pacific Highway East
Tacoma, Washington

**Information:**
Ed Godsey
450 110th Ave., S.E.
Bellevue, Washington 98007
(206) 746-3306

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**Northwest Mining Association**

94th Annual Convention and Trade Show

November 30-December 3, 1988
Sheraton Spokane Hotel, Spokane Riverpark Convention Center
Spokane, Washington

**Information:**
Northwest Mining Association
414 Peyton Building
Spokane, WA 99201
(509)624-1158

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The Division plans to make a permanent display for public education, complete with sample seismograms of various types of ground motion. At the present time, placement of the seismometer in the office setting is being tested.

The seismograph will supplement the work of the University of Washington's Geophysics Program, which is the current center for earthquake information. Questions about earthquakes are best referred to members of the program at Mall Stop AK-50, University of Washington, Seattle, WA 98195, or by phone to (206) 543-8020.
Interior Proposes Rulemaking to Increase Mining Law Fees

The Department of the Interior’s Bureau of Land Management (BLM) has proposed rules in the Federal Register that would increase three mining claim fees and establish four new fees.

BLM Director Robert F. Burford characterized the proposed fee changes as a much needed action to help BLM recover an allowable share of the costs of carrying out the agency’s mining law administration program under the Mining Law of 1987, as amended. The proposed fees would not recover all costs associated with the mining program, but would put the program on an equitable base, establishing reasonable fees for services provided by the federal government.

Burford said that the increased fees would generate about $5.7 million in additional revenues, which when combined with current revenues from existing fees would make available approximately $6.4 million to be appropriated to BLM for the mining law program.

“The fee changes would be relatively small overall,” Burford added, “and informal consultations with industry members, small and large, lead us to believe that this action should not cause economic hardship. These modifications are also consistent with existing county government recording fees.”

Under the mining law, a U.S. citizen is entitled to locate a claim on federal land that is not otherwise withdrawn from mineral entry. The claimant may then explore for minerals and develop any valuable deposits that are discovered. In order to obtain these benefits, a claimant must properly maintain the claim by, among other things, complying with the Federal Land Policy and Management Act of 1976, which requires recordation of each claim initially, followed by an annual filing of an affidavit that the required amount of assessment work has been done, or a notice that the owner intends to hold the claim. Any active disturbing in excess of 5 acres requires submission and approval of a mining plan, which is subject to environmental analysis.

Comments on the proposed rulemaking should be submitted not later than August 22, 1988, to Director (140), Bureau of Land Management, Room 5555, Main Interior Building, 1800 C Street N.W., Washington, D.C. 20240.

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PAST OFFSHORE MINERAL ACTIVITY IN WASHINGTON

The only mineral-related activity conducted in state waters has been the search for and development of titanium- and iron-rich black sands. The minerals that are present in such black sands are magnetite, hematite, and ilmenite. Exploration has meters can be reached for mining by a suction dredge; at least 144 million cubic yards of gravel in deposits with 1 meter thickness exists at this depth or shallower (Table 3).

Staff Notes

Brent Barnett has rejoined the Olympia office staff. Brent served as Project Geologist for the State of Washington during the 1985 geothermal drilling program. Since earning his B.S. degree from Ohio State University in 1979, he has worked throughout the Northwest in minerals exploration and hydrogeology. Brent received his M.S. degree in geology from Eastern Washington University in 1985. He will again be overseeing geothermal drilling.

William Phillips is one of the junior authors of "Residual Bouguer gravity anomaly map of the Cascade Range, California, Oregon, Washington, and British Columbia (D. L. Williams, senior author, U.S. Geological Survey Geophysical Investigations Map GP-973, 1988)."

William Lingley, William Phillips, Weldon Rau, and Timothy Walsh assisted with the field trips in conjunction with the Northwest Petroleum Association Meeting in May.

Figure 1. Offshore sampling stations (from Venkataraman and McManus, 1973). All samples were analyzed for grain size. The samples designated by open circles were separated for heavy minerals.

Figure 2. Areal extent of Washington sand and gravel deposits (from Moore and Laken, 1979). Submarine contours in meters.
be concentrated around Cape Disappointment at the mouth of the Columbia River and in Grays Harbor.

A succession of companies has explored in these areas since 1949. The titanium division of National Lead Co. explored in Grays Harbor in 1949. Exploration activity was extended to the mouth of the Columbia River by 1959 with Nareco, Inc. leasing the Baker Bay tidelands from the Department of Natural Resources (DNR). The most serious attempt to produce titanium and associated products was by Washington Mineral Products, Inc. from leased seabed lands in the Cape Disappointment area. After pilot plant operations, the company constructed a concentrating plant at Kalama during January 1967. The operation failed to produce a saleable product and closed. Beach Mining, Inc. acquired most of these leases and filed for mining contracts with DNR on the washed 1 to 2 miles offshore of Benson Beach (Fig. 3). These leases covered a major elliptical magmatic anomaly. After several baseline studies and the release of an Environmental Impact Statement prepared under the direction of Fisheries and Game Departments, DNR issued mining permit No. 11202 on November 1, 1982. The operator was unable to make the lease payments, and the offshore leases were cancelled on July 18, 1985.

The most recent exploration effort was by Columbia Ocean Minerals, Inc. In 1986 they drilled four vibrocore holes from a barge to test the magnetic anomaly west of Benson Beach and Iwaco. Results apparently were unfavorable.

It should be noted that the mouth of the Columbia River is repeatedly dredged to keep shipping channels open. Any potential mining operations would use similar techniques and equipment to recover minerals from the ocean floor.

CONCLUSIONS

For offshore Washington there is no potential for bedrock mineral deposits, and it is not likely that commercial placer deposits of tin, chrome, gold, or diamonds will be found there.

Domestic onshore titanium resources seem to be sufficient to keep foreign imports below 10 percent of national consumption. Washington black sands have characteristics that make them difficult and expensive to treat metallurgically. Therefore, it is unlikely the sands will be commercially developed in state waters within the next 20 years.

Gravel deposits have the best potential for development by the year 2000. In 1978, the national per-capita consumption was 9.140 pounds of stone and 8.580 pounds (6.7 cubic yards) of sand and gravel. Figures are higher for large metropolitan areas such as Seattle, Portland, and San Francisco. The U.S. Bureau of Mines has estimated that for 1987 every person in Washington was “consumed” 9.34 cubic yards of sand and gravel.

Washington is blessed with abundant gravel deposits because much of the area was glaciated. However, high quality gravel resources in the Seattle/Tacoma area are rapidly being depleted. The largest sand and gravel operation in the state, on tidelands near Stilwell, is nearing 100 years of production. Urban development in that area and elsewhere in King and Pierce counties is severely restricting access to or removing potential resources from production. Crushed rock, which is more expensive, can replace gravel to some extent in paving by using asphalt instead of concrete.

As noted, land sources of gravel within reasonable distances of metropolitan markets will continue to be depleted. In my opinion, offshore mining will begin by the year 2000. At that time Washington's offshore gravel deposits will be attractive for exploration.

Jim Goedert (with saw) and Howell Thomas working to free the whale's scapula, which is embedded in a concretion lying in the Malahc sediments.

According to Rau, this assemblage is best referred to an upper part of the Refugian Stage, which is presently regarded as a lower part of the Oligocene (Walsh and others, 1987, accompanying explanatory sheet). It should be pointed out that the matrix comes from the Jansen Creek member of the Malahc Formation (Snowley and others, 1980) and that this member is a lithostratigraphic unit from which Rau and his colleagues have found numerous misplaced assemblages of foraminifers usually of the Refugian Stage. The Jansen Creek member actually lies within rocks of a lower part of the Refugian Stage, slightly higher stratigraphically than the uppermost part of the Refugian Stage, which this assemblage represents. Rau (written commun., 1988) also notes, "In regard to the environment of deposition, three of the five (and the most abundant) species listed [above] represent bithyal conditions, and two of these are likely confined to lower bithyal depths. Thus the assemblage most likely lived at depths no less than 1,000 meters and possibly as great as 2,000 meters."

Though it has not yet been described, this cetacean is potentially an important find. Cetacean evolution began in the middle Eocene, roughly 50 million years ago. These first whales, of the suborder Archaeoceti, became extinct at the end of the Eocene. At some time in the early to middle Oligocene, the modern cetacean suborders evolved: the Odontocetes (toothed whale) and the Mysticeti (baleen whales). Whether these arose from the archaeocetes remains controversial (Barnes, 1984). The key to the early evolution of these suborders and the resolution of this controversy may lie in fossils of late Eocene or earlier Oligocene age. Fossils of early Oligocene Cetacea are rare; most Oligocene representatives are of middle or later age. Thus, with a proved early Oligocene age for the matrix fauna, any cetacean found in these Malahc sediments has a good chance of being new and important. This Washington specimen, one of the earliest found in the entire Pacific basin, may well help clarify the origins and evolution of living whales.

Cited References


Whale Hunting on the Olympic Peninsula

by
Keith L. Kaler

In early June a party from the Natural History Museum of Los Angeles County, Los Angeles, California, began the tedious process of excavating a skeleton of a primitive toothed cetacean (whale) from a site on the Olympic coast. The party consisted of museum associate Jim Goedert, Bill Buchanan, and museum preparators Fritz Clark and Howell Thomas. The fossil had been found 2 years earlier by Jim and his wife Gall, both of whom have extensively explored the Cenozoic marine sediments of Washington over the last 10 years.

The crew had a week in which to excavate the specimen. The site is exposed only at minus tides. Access is difficult because of rugged topography and slippery rocks. Work could be done only during the 5 to 6 hours between recession of the water from the site and the time when waves again began lapping at the fringes of the work site. During this short period excavation went on uninterrupted. Rain, high wind, and breakdown of equipment were the week's fate.

The fossil consists of a fairly complete skeleton of a cetacean of uncertain identity. The skeleton, when assembled, will be about 10 feet long. It consists of most of the skull, mandibles, cervical and thoracic vertebrae, ribs, and parts of the front appendages (scapula). All the bones are encased in an extremely refractory sandstone concretion. The team used a portable rock saw, electric chisel (with accompanying generator), and hand tools to remove the concretion from the surrounding matrix. As it would have been impractical if not impossible to have removed the entire skeleton in one block, smaller sections were dislodged. These smaller pieces ranged from fist size to blocks weighing several hundred pounds.

The skeletal material will be removed from the matrix and reassembled at the lab in Los Angeles. Because of the durability of the matrix, none of the blocks had to be encased in plaster for strengthening before being transported.

Weldon W. Rau examined samples of the matrix and found the following foraminifers:
- Melonis pompilioides (Fitchel and Moll) - common
- Gyroidina soldani d'Orbigny - few
- Guttula G. frankel Cushman and Otsawa - rare
- Quinqueloculina sp. - rare

Also found were well-preserved fish teeth.

Fritz Clark using a portable electric chisel to undermine a concretionary block that contains vertebrae and ribs.

Figure 3. Beach Mining Inc. black-sand leases (expired) in Pacific County (from Dearborn Assoc., Inc., 1980).

SELECTED REFERENCES

Geothermal Gradient Test Planned for 1988

by

Brent Barnett, Geologist

Since the mid-1970s the Washington Division of Geology and Earth Resources has engaged in geothermal resource research and assessment throughout the state. Funding for the program has come largely from U.S. Department of Energy and National Science Foundation contracts and grants, coupled with subordinate State contributions.

A major portion of these investigations has been the drilling of shallower (500 to 1,200 ft) geothermal gradient test holes in Washington’s Cascade Mountains. Early drilling projects (1975-1983) were aimed at assessing potential resource targets distributed more or less throughout the range, such as known hot springs, sites surrounding Quaternary stratovolcanoes, and fields of Pleistocene-to-Holocene fissure-type volcanism. More recently, efforts have focused on the southern Washington Cascades, with emphasis on the drilling of favorable structural trends, many of which host Pleistocene-to-Holocene intrusive and volcanic rocks, and on evaluating other broad areas of recent volcanism that remain unstudied.

The geothermal gradient drilling planned for 1988 is the sixth project of the kind since 1975. As many as six holes will be drilled this summer in the Gifford Pinchot National Forest, in a corridor extending roughly south from Mount Rainier to the Columbia River. Brent Barnett will be supervising the drilling project. In addition to down-hole gradient measuring, the program will include sampling for isotopic and geochemical analyses of Quaternary volcanic rocks, as well as detailed geologic mapping in the vicinity of the drill sites. Mike Korosec, the geothermal program manager, will be conducting the Quaternary volcanic rocks study and assisting Barnett with the mapping. The work will allow further refinement of the heat-flow characteristics of the Cascade volcanic arc and improve interpretations of Quaternary volcanism in southern Washington.

Washington Geologic Newsletter, Vol. 16, no. 3

AIMCOR Honored by U.S. Forest Service

by

Nancy L. Joseph, Geologist

Applied Industrial Minerals Corp. (AIMCOR) has been honored as the Mineral Operator of the Year (1987) by the Pacific Northwest Region of the U.S. Forest Service. The company was cited for "exceptional environmental stewardship" exhibited at their AIMCOR Olimve property in the Mt. Baker-Snoqualmie National Forest, near Hamilton.

The deposit consists of olivine-rich sands that are mined, crushed, and screened to produce olivine for foundry and blast sands. Between 1959 and 1986, the Twin Sisters quarry had been operated by IMC Olimve, a division of Industrial Minerals and Chemical Corp. In late 1986 the Industry Group of IMC was sold to the newly formed AIMCOR.

Prior to 1984, a washing process was used to screen the olivine, and rejected fines were contained in tailings ponds. This fine sand is highly erodible. Because of the steep surrounding topography, runoff is naturally funneled to the tailings pond area and can carry the fines into the South Fork of the Nooksack River approximately 1/4 mile away. The river is a major anadromous fishery for spring Chinook salmon, a valued but depleted species. A dry screening is now being used, and newly produced fines are no longer placed in a tailings pond. The environmental impact of the operation has been dramatically reduced.

Dennis Wheeland, the new plant manager, and AIMCOR were committed to reclamation of the former tailings pond site when they took over the operation. The goals of the reclamation project were to stabilize and reclaim the 13-acre site and to prevent the dispersal of fines. Soil samples were taken to determine the appropriate fertilizer, grass seed mixture, and tree species; this site is dry and the soil is slightly basic, unusual conditions for west of the Cascades. The area was then limed, hydro-seeded, and planted with lodgepole pine, a local native species.

After the first winter and spring of the project, runoff is reportedly remaining in the boulder-lined channels, and erosion of the former tailings ponds is minimal. More lodgepole seedlings will be planted this year. The hydro-seeded grass is flourishing, and AIMCOR, with the aid of the Forest Service, is looking into planting more grasses, including fescue, that might appeal to elk in the area.

Washington Geologic Newsletter, Vol. 16, no. 3

Dennis Wheeland, plant manager for AIMCOR (center), accepting U.S. Forest Service award from Jerry Allen, Special Assistant to the Regional Forester, Region 6 (left) and Larry Hudson, District Ranger, Mt. Baker-Snoqualmie National Forest. (Photo courtesy of Bureau of Land Management)
Mineral Industry News Notes

by Nancy L. Joseph, Geologist

METALS

Chelan County

Asamera Minerals Inc. and Breakwater Resources Ltd., owners of the Cannon mine, announced in March the discovery of gold mineralization on lands held by the joint venture near Wenatchee. The discovery, in an area 2 miles southeast of the Cannon Mine, is the result of several years of exploration. Breakwater Resources reports that 42 of 60 holes drilled along a strike length of 9,000 feet intersected gold and silver mineralization in silicified feldspathic sediments. The Asamera-Breakwater joint venture plans a 6,000-foot exploration adit on the property to facilitate underground drilling and bulk metallurgical sampling. The estimated cost of the project, scheduled for completion in mid-1989, is $3 million.

During the first quarter of 1988 the Cannon mine milled 125,120 tons of ore having an average grade of 0.325 ounces of gold per ton to produce 37,285 ounces of gold and 56,972 ounces of silver. The Cannon mine is presently the largest gold mine in the state and the second largest underground gold mine in the country.

Althouse Placers, Inc. has signed an option agreement with Asamera Minerals Inc. for three other properties of the Wenatchee area, one of which is near the Asamera-Breakwater discovery.

Ferry County

The Republic Unit of Hecla Mining Company in Republic produced 16,000 ounces of gold during the first quarter of 1988. Recent exploratory work by Hecla resulted in expansion of known reserves by 1.2 million tons of mineralized rock averaging 0.5 ounce of gold per ton.

Tangeray Resources Ltd. has acquired an option to earn a 60 percent working interest in the Valley mine, north of Republic, through a work commitment of more than $500,000 over the next 14 months and other considerations. The company's first-quarter report states that of ten drill holes completed during 1988, eight intersected the principal vein, but commercial grades were not reported. Additional surface drilling has been completed, and results are being evaluated. The mine has been idle since late 1987.

Coal Exploration in Whatcom County

by Henry Schasse, Geologist

Crawford Coal Company of Cadiz, Ohio, has filed a notice of intent with the U.S. Department of Energy, Office of Surface Mining, to pursue coal exploration activities this summer in the Glacier coal field in Whatcom County. The property, owned by the Crawford Land Company, is located approximately 4 miles south of the town of Glacier and northwest of Mount Baker in sections 19, 20, 29, and 30, T.39N., R.7E. (Fig. 1). The company plans to explore the property using air-rotary and air-core drilling techniques.

At various times interest in the Glacier seams has been rekindled, but most plans have been aborted. Work has been mostly centered around the discovery tunnel (Fig. 2) near the south edge of the field. The property was last explored in 1976 by Gates and Fox, an affiliate of Canadian-American Exploration Company (Can Am). Can Am did not initiate mining as a result of their exploration. To date, exploration has not unravelled the complex geology of the Glacier area to provide a meaningful estimate of reserves or mining conditions.

The Glacier property is unique in Washington in that it contains anthracite. The coal occurs as lenses mainly in three beds ranging in average thickness from 6 to 10 feet. At least four other coal beds lie above the highest of these three beds but these are much thinner and contain coal of lower rank. The Glacier coal seams occur near the base of the Chuckanut Formation in sandstone and shale that rest on the Yellow Aster Complex and the Darrington Phyllite (Brown and others, 1987).

Figure 1. Glacier coal field (from Moen, 1969).

Figure 2. Original adit, Discovery seam, Glacier coal field. (Photo by Ellis VonHeedere, DNR)
A high-altitude 1:63,360-scale photographic stereogram of the John Day Dam in Klickitat County. When a stereoscope is used with this photo pair, the scene will appear to be three dimensional, as if the viewer were flying overhead.

Resources for Earth Scientists

John Brown, a geologist, finds Department of Natural Resources (DNR) aerial photos very useful in identifying land forms such as landfills, stream drainage patterns, and geologic structures. "Air photos are more current than any map I know of," John says, "and I can get them easily. I certainly get my money's worth out of them."

DNR produces maps and air photos to assist in the management of 5 million acres of state land scattered throughout Washington. Revenue generated from activities on this land, such as timber harvesting, agricultural leasing, and gravel extraction, is used to support trust beneficiaries: public schools, universities, institutions, and local governments.

DNR is a revenue-generating agency. It makes all these photos and maps available to the public. Through its sales efforts, the Photo and Map Sales Office in Olympia supports the Department's extensive aerial photography program.

Aerial photography is available for most of the state, although, generally, national forests and parks are not covered. Projects have been flown almost every year since 1957.

Aerial photo prints come in various scales and in color or in black and white, depending on the county. The different scales available include 1:12,000 (1" = 1,000'), 1:24,000 (1"=2000'), and 1:63,360 (1" = 1 mile). Standard print size is 9" x 9".

All DNR aerial photography is flown in "flight lines," which results in continuous strips of photographs covering north-south slices of the state's terrain. Consecutive photos in a flight line overlap by about 60 percent. This permits an individual to use a stereoscope to see a three-dimensional image of topographic features in a pair of overlapping photographs. (See example, this page).

Orthophotography is also available. The photograph of the hydroelectric station at the John Day Dam is an example of this type of photography. Orthophotos are prepared from high-resolution black-and-white photographs that have been corrected to eliminate distortion caused by terrain relief. They are true to scale and have been modified to include section lines and some geographic names.

Orthophoto maps are available for eastern Washington at a scale of 1:24,000 (1" = 2,000'). Each map covers an entire township. For western Washington, two scales are available: a 1:24,000-scale township format (photo in upper right column) and a 1:12,000 (1" = 1,000') scale that covers a quarter township per map.

The Photo and Map Sales Office also sells DNR 1:100,000-scale Public Lands maps, DNR township topographic maps at scales of 1"=1,000' and 1"=2,000', and other miscellaneous types of maps. This office is also a dealer for U.S. Geological Survey topographic maps.

Ortho photo that includes the area of John Day hydroelectric facility. The Photo is shown in the stereo pair. This ortho photo is at a scale of 1:24,000. The 20 is the section number. North is at the top.

John Day Dam as it appears in a 1:12,000 black-and-white aerial photo. North is at the top of the photo.

Black-and-white aerial photos cost $7.00 each plus tax. The price is $17 plus tax for the color photo; additional photos on the same roll are $7 each. (Please contact the sales office for more information on color photo pricing.) Orthophotos cost $5.00 each plus tax. Maps can be ordered by mail; specify section, range, and township numbers. A free index is available to assist in locating the area of interest. The Photo and Map Sales office is open between 8:00 and 4:30 on weekdays. The address and phone number are:

Department of Natural Resources
Photo and Map Sales
1065 South Capitol Way
Olympia, WA 98504
Phone: (206) 753-5338

(From text provided by Resource Mapping staff, Photo and Map Sales office)
A high-altitude 1:63,360-scale photographic stereogram of the John Day Dam in Klickitat County. When a stereoscope is used with this photo pair, the scene will appear to be three dimensional, as if the viewer were flying overhead.

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Orthophoto maps are available for eastern Washington at a scale of 1:24,000 (1" = 2,000'). Each map covers an entire township. For western Washington, two scales are available: a 1:24,000-scale township format (photo in upper right column) and a 1:12,000 (1" = 1,000') scale that covers a quarter township per map.

The Photo and Map Sales Office also sells DNR 1:100,000-scale Public Lands maps, DNR township topographic maps at scales of 1"=1,000' and 1"=2,000', and other miscellaneous types of maps. This office is also a dealer for U.S. Geological Survey topographic maps.

Aerial photo prints come in various scales and in color or in black and white, depending on the county. The different scales available include 1:12,000 (1" = 1,000'), 1:24,000 (1"=2000'), and 1:63,360 (1" = 1 mile). Standard print size is 9" x 9".

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John Day Dam as it appears in a 1:12,000 black-and-white aerial photo. North is at the top of the photo.

Black-and-white aerial photos cost $7.00 each plus tax. The price is $17 plus tax for the first color photo; additional photos on the same roll are $7 each. (Please contact the sales office for more information on color photo pricing.) Orthophotos cost $5.00 each plus tax. Maps can be ordered by mail; specify section, range, and township numbers. A free index is available to assist in locating the area of interest. The Photo and Map Sales office is open between 8:00 and 4:30 on weekdays. The address and phone number are:

Department of Natural Resources
Photo and Map Sales
1065 South Capitol Way
Olympia, WA 98504
Phone: (206) 753-5338

(From text provided by Resource Mapping staff, Photo and Map Sales office)
Mineral Industry News Notes

by Nancy L. Joseph, Geologist

METALS

Chelan County

Asamaera Minerals Inc. and Breakwater Resources Ltd., owners of the Cannon mine, announced in March the discovery of gold mineralization on lands held by the joint venture near Wenatchee. The discovery, in an area 2 miles southeast of the Cannon Mine, is the result of several years of exploration. Breakwater Resources reports that 42 of 60 holes drilled along a strike length of 9,000 feet intersected gold and silver mineralization in silicified feldspathic sediments. The Asamaera-Breakwater joint venture plans a 6,000-foot exploration adit on the property to facilitate underground drilling and bulk metallurgical sampling. The estimated cost of the project, scheduled for completion in mid-1989, is $3 million.

During the first quarter of 1988 the Cannon mine milled 125,120 tons of ore having an average grade of 0.325 ounces of gold per ton to produce 37,285 ounces of gold and 56,972 ounces of silver. The Cannon mine is presently the largest gold mine in the state and the second largest underground gold mine in the country.

Altholse Placers, Inc. has signed an option agreement with Asamaera Minerals Inc. for three other properties of the Wenatchee area, one of which is near the Asamaera-Breakwater discovery.

Ferry County

The Republic Unit of Hecla Mining Company in Republic produced 16,000 ounces of gold during the first quarter of 1988. Recent exploratory work by Hecla resulted in expansion of known reserves by 1.2 million tons of mineralized rock averaging 0.5 ounce of gold per ton.

Tanquaray Resources Ltd. has acquired an option to earn a 60 percent working interest in the Valley mine, north of Republic, through a work commitment of more than $500,000 over the next 14 months and other considerations. The company's first-quarter report states that of ten drill holes completed during 1988, eight intersected the principal vein, but commercial grades were not reported. Additional surface drilling has been completed, and results are being evaluated. The mine has been idle since late 1987.

Coal Exploration in Whatcom County

by Henry Schasse, Geologist

Crawat Coal Company of Cadiz, Ohio, has filed a notice of intent with the U.S. Department of Energy, Office of Surface Mining, to pursue coal exploration activities this summer in the Glacier coal field in Whatcom County. The property, owned by the Glacier Land Company, is located approximately 4 miles south of the town of Glacier and northwest of Mount Baker in sections 19, 20, 29, and 30, T.39N., R.7E. (Fig. 1). The company plans to explore the property using air-rotary and air-core drilling techniques.

At various times interest in the Glacier seams has been rekindled, but most plans have been abortive. Work has been mostly centered around the discovery tunnel (Fig. 2) near the south edge of the field. The property was last explored in 1976 by Gates and Fox, an affiliate of Canadian-American Exploration Company (Can Am). Can Am did not initiate mining as a result of their exploration. To date, exploration has not unravelled the complex geology of the Glacier area to provide a meaningful estimate of reserves or mining conditions.

The Glacier property is unique in Washington in that it contains anthracite. The coal occurs as lenses mainly in three beds ranging in average thickness from 6 to 10 feet. At least four other coal beds lie above the highest of these three beds but these are much thinner and contain coal of lower rank. The Glacier coal seams occur near the base of the Chuckanut Formation in sandstone and shale that rest on the Yellow Aster Complex and the Darrington Phyllite (Brown and others, 1987).

Figure 1. Glacier coal field (from Moen, 1969).

Figure 2. Original adit, Discovery seam, Glacier coal field. (Photo by Ellis Vorheeder, DNR)

References


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AIMCOR Honored by U.S. Forest Service

by

Nancy L. Joseph, Geologist

Applied Industrial Minerals Corp. (AIMCOR) has been honored as the Mineral Operator of the Year (1987) by the Pacific Northwest Region of the U.S. Forest Service. The company was cited for "exceptional environmental stewardship" exhibited at their AIMCOR Olivine property in the Mt. Baker-Snoqualmie National Forest near Hamilton.

The deposit consists of olivine-rich sands that are mined, crushed, and screened to produce olivine for foundry and blast sands. Between 1959 and 1986, the Twin Sisters quarry had been operated by IMC, a division of Industrial Minerals and Chemical Corp. In late 1986 the Industry Group of IMC was sold to the newly formed AIMCOR.

Prior to 1984, a washing process was used to screen the olivine, and rejected fines were contained in tailings ponds. This fine sand is highly erodible. Because of the steep surrounding topography, runoff is naturally funneled to the tailings pond area and can carry the fines into the South Fork of the Nooksack River approximately 1/4 mile away. The river is a major anadromous fishery for spring Chinook salmon, a valued but depleted species. A dry screening is now being used, and newly produced fines are no longer placed in a tailings pond. The environmental impact of the operation has been dramatically reduced.

Dennis Wheeland, the new plant manager, and AIMCOR were committed to reclamation of the former tailings pond site when they took over the operation. The goals of the reclamation project were to stabilize and reclaim the 13-acre site and to prevent the dispersal of fines. The site was contoured, and water breaks were built to reduce runoff. Old culverts were replaced with boulder-lined channels to channelize runoff and eliminate erosion of the fine sands. Rock was also placed at the toe of the slopes of the tailing ponds to maximize stability. Soil samples were taken to determine the appropriate fertilizer, grass seed mixture, and tree species; this site is dry and the soil is slightly basic, unusual conditions for west of the Cascades. The area was then limed, hydro-seeded, and planted with lodgepole pine, a local native species.

After the first winter and spring of the project, runoff is reportedly remaining in the boulder-lined channels, and erosion of the former tailings ponds is minimal. More lodgepole seedlings will be planted this year. The hydro-seeded grass is flourishing, and AIMCOR, with the aid of the Forest Service, is looking into planting more grasses, including fescue, that might appeal to elk in the area.

Dennis Wheeland, plant manager for AIMCOR (center), accepts U.S. Forest Service award from Jerry Allen, Special Assistant to the Regional Forester, Region 6 (left), and Larry Hudson, District Ranger, Mt. Baker-Snoqualmie National Forest. (Photo courtesy of Bureau of Land Management)
Whale Hunting on the Olympic Peninsula

by

Keith L. Kaler

In early June a party from the Natural History Museum of Los Angeles County, Los Angeles, California, began the tedious process of excavating a skeleton of a primitive toothed cetacean (whale) from a site on the Olympic coast. The party consisted of museum associate Jim Goedert, Bill Buchanan, and museum preparators Fritz Clark and Howell Thomas. The fossil had been found 2 years earlier by Jim and his wife Gall, both of whom have extensively explored the Cenozoic marine sediments of Washington over the last 10 years.

The crew had a week in which to excavate the specimen. The site is exposed only at minus tides. Access is difficult because of rugged topography and slippery rocks. Work could be done only during the 5 to 6 hours between recession of the water from the site and the time when waves again began lapping at the fringes of the work site. During this short period excavation went on uninterrupted. Rain, high winds, and breakdown of equipment were the week's fare.

The fossil consists of a fairly complete skeleton of a cetacean of uncertain identity. The skeleton, when assembled, will be about 10 feet long. It consists of most of the skull, mandibles, cervical and thoracic vertebrae, ribs, and parts of the front appendages (scapula). All the bones are encased in fish vertebrae, ribs, and parts of the front appendages (scapula). All the bones are encased in an extremely refractory sandstone concretion. The team used a portable rock saw, electric chisel (with accompanying generator), and hand tools to remove the concretion from the surrounding matrix. As it would have been impractical if not impossible to have removed the entire skeleton in one block, smaller sections were dislodged. These smaller pieces ranged from fist size to blocks weighing several hundred pounds. The skeletal material will be removed from the matrix and reassembled at the lab in Los Angeles. Because of the durability of the matrix, none of the blocks had to be encased in plaster for strengthening before being transported.

Weldon W. Rau examined samples of the matrix and found the following foraminifers:

- Melonis pomptantidus (Fichtel and Moll) - common
- Gyroidina soldanii d'Orbigny - few
- Guatina G. frankel Cushman and Ozawa - rare
- Quinqueloculina sp. - rare
- Valvulineria williamsensis Rau - common
Also found were well-preserved fish teeth.

SELECTED REFERENCES


Table 3. Offshore gravel resources of Washington (from Moore and Lukens, 1979)

<table>
<thead>
<tr>
<th>Center of deposit</th>
<th>Area (square miles)</th>
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<th>Depth (feet)</th>
<th>Average water thickness (feet)</th>
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<td>4</td>
<td>20</td>
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</tbody>
</table>

Jim Goedert (with saw) and Howell Thomas working to free the whale’s scapula, which is embedded in a concretion lying in the Malahai sediments.

According to Rau, this assemblage is best referred to an upper part of the Refugian Stage, which is presently regarded as a lower part of the Olignocene (Walsh and others, 1987, accompanying explanatory sheet). It should be pointed out that the matrix comes from the Jensen Creek member of the Malahai Formation (Swaney and others, 1980) and that this member is a lithostatic unit from which Rau and his colleagues have found numerous mislabeled assemblages of foraminifers usually of the Refugian Stage. The Jensen Creek member actually lies within rocks of a lower part of the Refugian Stage, slightly higher stratigraphically than the uppermost part of the Refugian Stage, which this assemblage represents. Rau (written commun., 1988) also notes, "In regard to the environment of deposition, three of the five (and the most abundant) species listed [above] represent benthal conditions, and two of these are likely confined to lower benthal depths. Thus the assemblage most likely lived at depths no less than 1,000 meters and possibly as great as 2,000 meters."

Though it has not yet been described, this cetacean is potentially an important find. Cetacean evolution began in the middle Eocene, roughly 50 million years ago. These first whales, of the suborder Archaeoceti, became extinct at the end of the Eocene. At some time in the early to middle Oligocene, the modern cetacean suborders evolved: the Odontoceti (toothed whale) and the Mysticeti (baleen whales). Whether these arose from the archaecetos remains controversial (Barnes, 1984). The key to the early evolution of these suborders and the resolution of this controversy may lie in fossils of late Eocene or earliest Oligocene age. Fossils of early Oligocene Cetacea are rare; most Olignocene representatives are of middle or later age. Thus, with a proved early Oligocene age for the matrix fauna, any cetacean found in these Malahai sediments has a good chance of being new and important. This Washington specimen, one of the earliest found in the entire Pacific basin, may well help clarify the origins and evolution of living whales.

References cited
Interior Proposes Rulemaking to Increase Mining Law Fees

The Department of the Interior's Bureau of Land Management (BLM) has proposed rules in the Federal Register that would increase three mining claim fees and establish four new fees. BLM Director Robert F. Burford characterized the proposed fee changes as a much-needed action to help BLM recover an allowable share of the costs of carrying out the agency's mining law administration program under the Mining Law of 1987, as amended. The proposed fees would not recover all costs associated with the mining program, but would put the program on an equitable basis, establishing reasonable fees for services provided by the federal government.

Burford said that the increased fees would generate about $5.7 million in additional revenues, which, when combined with current revenues from existing fees would make available approximately $6.4 million to be appropriated to BLM for the mining law program.

"The fee changes would be relatively small overall," Burford added, "and informal consultations with industry members, small and large, lead us to believe that this action should not cause economic hardship. These modifications are also consistent with existing county government recording fees."

Under the mining law, a U.S. citizen is entitled to locate a claim on federal land that is not otherwise withdrawn from mineral entry. The claimant may then explore for minerals and develop any valuable deposits that are discovered. In order to obtain these benefits, a claimant must properly maintain the claim by, among other things, complying with the Federal Land Policy and Management Act of 1976, which requires recording of each claim initially, followed by an annual filing of an affidavit that the required amount of assessment work has been done, or a notice that the owner intends to hold the claim. Any active disturbing in excess of 5 acres requires submission and approval of a mining plan, which is subjected to environmental analysis.

Comments on the proposed rulemaking should be submitted not later than August 28, 1988, to Director (140), Bureau of Land Management, Room 5555, Main Interior Building, 1800 C Street N.W., Washington, D.C. 20240.

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<th>Existing fees</th>
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<td>New claims</td>
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<tr>
<td>Annual fillings of affidavits for assessment work</td>
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<td>Transfers of interest</td>
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<td>Mineral patents</td>
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<td>New application</td>
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<td>Each additional claim in application</td>
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<tr>
<td>Deferments of assessment work</td>
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</table>

PAST OFFSHORE MINERAL ACTIVITY IN WASHINGTON

The only mineral-related activity conducted in state waters has been the search for and development of titanium- and iron-rich black sands. The minerals that are present in such black sands are magnetite, hematite, and ilmenite. Exploration has meters can be reached for mining by a suction dredge; at least 144 million cubic yards of gravel in deposits with a 1-meter thickness exists at this depth or shallower (Table 3).

Staff Notes

William Phillips is one of the junior authors of "Residual Bouguer gravity anomaly map of the Cascade Range, California, Oregon, Washington, and British Columbia (D. L. Williams, senior author, U.S. Geological Survey Geophysical Investigations Map GP-973, 1988)."

William Lingley, William Phillips, Weldon Rau, and Timothy Walsh assisted with the field trips in conjunction with the Northwest Petroleum Association Meeting in May.

Figure 1. Offshore sampling stations (from Venkataraman and McManus, 1973). All samples were analyzed for grain size. The samples designated by open circles were separated for heavy minerals.

Figure 2. Areal extent of Washington sand and gravel deposits (from Moore and Laken, 1979). Submarine contours in meters.
In the United States the value of sand and gravel recovered from offshore deposits exceeds that of all other mined marine minerals.

**OFFSHORE MINERALS OF WASHINGTON**

There has been no mineral production offshore of Washington in either state or federal waters. However, titaniferous sands and gravel resources have been identified offshore. The polymetallic sulfides found on Juan de Fuca Ridge occur more than 200 nautical miles seaward from the Washington coastline and therefore are beyond the federally declared Exclusive Economic Zone. Titaniferous iron-bearing black sands have been outlined by drilling, surface sampling, and geophysics along the intertidal zone and as much as 2 miles offshore in the following areas: Baker Bay at the mouth of the Columbia River, on accreted lands (Benson Beach) of Fort Canby on Cape Disappointment, and at Leadbetter Point, all in Pacific County. Such black sands have also been explored offshore, Point in North Bay of Gray Harbor.

Titaniferous sands at Moclips and Copalis have been characterized (Table 2) and contain minor amounts of gold.

In Washington, as elsewhere, by far the most valuable offshore resource is gravel. Large deposits are found from Cape Flattery to Grays Harbor. The deposits have been confirmed by bottom sampling (Fig. 1); studies show that they are associated with ancient shorelines at depths of 20 to 280 meters (1 meter = 3.28 feet). These gravel deposits exist in federal waters beyond the 3-mile limit and are clustered around the entrance to Juan de Fuca Strait and the outfalls of the Hoquiam, Quinault, and Chehalis Rivers. These sea-floor gravel deposits have remained unburned on the seabed since they were deposited 15,000 years ago. At that time the sea level was 200 meters lower than at present (Fig. 2).

The U.S. Geological Survey has conservatively estimated that if gravel offshore Washington is present as a layer 1 meter thick, offshore resources contain 1,505 million cubic meters of material (1 cubic meter = 1.31 cubic yards). Gravel at depths of less than 50

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**Table 2. Percentages of magnetite plus ilmenite and zircon concentrates in the heavy minerals (from Venkatarathnam and McManus, 1973)**

<table>
<thead>
<tr>
<th>Station Number</th>
<th>Latitude/Longitude</th>
<th>% Magnetite Plus Ilmenite</th>
<th>% Zircon Concentrate</th>
<th>% Total Heavy</th>
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<tr>
<td>-3A</td>
<td>46°53.0’N 122°19.5’W</td>
<td>1.1</td>
<td>0.0</td>
<td>1.1</td>
</tr>
<tr>
<td>-3A</td>
<td>46°51.9’N 122°18.6’W</td>
<td>10.2</td>
<td>0.1</td>
<td>10.3</td>
</tr>
<tr>
<td>-4A</td>
<td>46°52.7’N 122°21.7’W</td>
<td>1.1</td>
<td>0.0</td>
<td>1.1</td>
</tr>
<tr>
<td>-4A</td>
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<td>9.2</td>
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<td>9.4</td>
</tr>
<tr>
<td>-4A</td>
<td>46°53.0’N 122°37.2’W</td>
<td>10.9</td>
<td>0.3</td>
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</tr>
<tr>
<td>-6A</td>
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<td>11.3</td>
<td>0.4</td>
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</tr>
<tr>
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<td>4.8</td>
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<tr>
<td>-7A</td>
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<td>10.8</td>
<td>0.3</td>
<td>11.1</td>
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<tr>
<td>-7A</td>
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<td>13.0</td>
<td>0.3</td>
<td>13.3</td>
</tr>
<tr>
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<td>0.6</td>
<td>11.3</td>
</tr>
<tr>
<td>-9B</td>
<td>46°54.1’N 122°45.3’W</td>
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<td>-9B</td>
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<td>13.4</td>
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<td>13.9</td>
</tr>
<tr>
<td>-11A</td>
<td>46°50.0’N 122°43.9’W</td>
<td>6.0</td>
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<td>6.0</td>
</tr>
<tr>
<td>-11A</td>
<td>46°50.3’N 122°42.8’W</td>
<td>11.2</td>
<td>0.3</td>
<td>11.5</td>
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<tr>
<td>-11A</td>
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<td>8.2</td>
<td>0.0</td>
<td>8.2</td>
</tr>
<tr>
<td>-12A</td>
<td>46°51.6’N 122°40.8’W</td>
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<td>0.0</td>
<td>7.3</td>
</tr>
<tr>
<td>-12A</td>
<td>46°51.2’N 122°49.2’W</td>
<td>17.5</td>
<td>0.0</td>
<td>17.5</td>
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</tbody>
</table>

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**Seismograph in Division Office**

Kinematics Systems of Pasadena, CA, has donated a short-period seismograph to the Division. The company has been supportive of seismology and seismics research for two decades. According to A. M. Serici, President of Kinematics, the donation, "while primarily intended to provide useful technical instrumental data to better understand local earthquakes and geological conditions, may also promote increasing legislative and public awareness of the pressing need for improved earthquake hazard research and mitigation in the Pacific Northwest area."

The Division plans to make a permanent display for public education, complete with sample seismograms of various types of ground motion. At the present time, placement of the seismometer in the office setting is being tested.

The seismograph will supplement the work of the University of Washington's Geophysics Program, which is the current center for earthquake information. Questions about earthquakes are best referred to members of the program at Mill Stop AK-50, University of Washington, Seattle, WA 98195, or by phone to (206) 543-8020.

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**Meetings**

**Pacific Northwest American Geophysical Union**

35th Annual Meeting September 29-30
Royal Roads Military College Victoria, British Columbia

Abstract deadline: August 28

Information: John Mothersill
Royal Roads Military College
FM0 Victoria, British Columbia
V0S 1B0 Canada
(604) 380-4516

**Friends of Mineralogy**

14th Annual meeting
September 30-October 2
Topic: Carbonate Show
The Executive Inn
5700 Pacific Highway East
Tacoma, Washington

Information:
Ed Godsey
450 110th Ave., S.E.
Bellevue, Washington 98007
(206) 746-3306

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**National Academy of Sciences**

U.S. Geological Survey, and
Association of American State Geologists (Convenors)
September 26-30, 1988
Sheraton Denver Tech Center
Denver, Colorado
Theme: Integrating technology and geoscience applications
Registration:
Buhl and Abraham, Inc.
8700 First Avenue
Silver Spring, MD 20910

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**Northwest Mining Association**

94th Annual Convention and Trade Show
November 30-December 3, 1988
Sheraton Spokane Hotel, Spokane Riverpark Convention Center
Spokane, Washington

Information:
Northwest Mining Association
414 Peyton Building
Spokane, WA 99201
(509)624-1158
Geological Projects in Washington Supported by the National Science Foundation, 1988

(The projects cover areas in Washington. Some of these projects are also listed under the pertinent university name in the academic projects list below.)

Evolution of the Ross Lake fault—Robert B. Miller (San Jose State University, California)

Whole mantle electrical conductivity and the velocity field of the upper core—Constrains from applied mantle filter theory—Adam Schults (University of Washington)

Magnetic phase transition and thermodynamic behavior of iron-bearing silicate minerals—Subrata Ghose (University of Washington)

Investigation of aspherical structure of the core and the core-mantle boundary—Kenneth Creager (University of Washington)

Mantle geophysics with high-pressure and high-temperature diamond cell technique—Yasuko Sorenson (University of Washington)

Hydrogen in iron at high pressures—J. Michael Brown (University of Washington)

Accurate dating of Quaternary sediments and tephra by thermoluminescence methods—Glenn W. Berger (Western Washington University)

Genes of late Quaternary loess and paleosols on the Columbia Plateau, eastern Washington—Alan J. Busso (Washington State University)

Time scales for advance and retreat of glaciers in response to climate changes—Charles F. Raymond (University of Washington)

Large-scale glacial erosion and debris production—James B. Harsh (Washington State University)

An electromagnetic study of the lithosphere and asthenosphere beneath the Juan de Fuca plate and the adjacent continent, main phase—John R. Brooker (University of Washington)

Experimental field and theoretical investigations of assimilation of peridotite in zoned calc-alkaline plutonic complexes—Mark S. Ghiorso (University of Washington)


Skelly and Loy, 1985, Abandoned coal mine survey. Coal Creek, King County. U.S. Office of Surface Mining under contract to Skelly and Loy (Birmingham, AL), 3 v., 2 plates.


Washington Offshore Mineral Resources

by Raymond Lasmanis, State Geologist

(Research funded by the Washington State Legislature, Joint Select Committee on Marine and Ocean Resources, March 29, 1988)

INTRODUCTION

The oceans of the world contain vast quantities of minerals. These commodities occur in sea water, in deep ocean-bottom rift systems, as unconsolidated placer deposits on the sea bed, and as deposits in bedrock under the ocean.

On a world scale, sea water is a large source of chemical commodities, such as bromine. There is also significant production of gold, diamonds, tin, rare earth minerals, zircon, chromite, and titanium-bearing iron minerals from marine placer deposits. Sand and gravel are being mined from deep water off the shores of Great Britain and Japan. In several nations bedrock deposits of coal, base metals, and tin are extracted by underground mining below the sea from shafts located on islands and the mainland. Salt and sulfur are exploited from subsea bedrock domes by wells. However, there has not yet been any mining of phosphorite, manganese, or polynemetic sulfides from the ocean floor.

In the United States, mineral production has taken place and is presently occurring along the intertidal zone and in shallow state waters. Table 1 below provides an overview.

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Source</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salt</td>
<td>Sea water</td>
<td>California, Gulf coast</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Sea water</td>
<td>Gulf coast</td>
</tr>
<tr>
<td>Bromine</td>
<td>Sea water</td>
<td>Gulf coast</td>
</tr>
<tr>
<td>Sand and gravel</td>
<td>Unconsolidated</td>
<td>New York, New Jersey</td>
</tr>
<tr>
<td>Oyster shells</td>
<td>Unconsolidated</td>
<td>Gulf coast</td>
</tr>
<tr>
<td>Gold</td>
<td>placer</td>
<td>Oregon, Alaska</td>
</tr>
<tr>
<td>Chromite</td>
<td>placer</td>
<td>Florida</td>
</tr>
<tr>
<td>Titanium</td>
<td>placer</td>
<td>Florida</td>
</tr>
<tr>
<td>Zinc</td>
<td>placer</td>
<td>Florida</td>
</tr>
<tr>
<td>Barite</td>
<td>Bedrock</td>
<td>Alabama</td>
</tr>
<tr>
<td>Salt</td>
<td>Bedrock</td>
<td>Gulf coast</td>
</tr>
<tr>
<td>Sulfur</td>
<td>Bedrock</td>
<td>Gulf coast</td>
</tr>
</tbody>
</table>

Washington Geologic Newsletter, Vol. 16, no. 3
Emergency reclamation typically is accomplished within a few weeks, but funding is available only for reclaiming actual subsidence, not for repairing structural damage caused by subsidence. For this reason, prompt attention must be given to suspected coal mine subsidence before it causes damage, and contractors should consider the likelihood of future subsidence when building in areas of historic coal mining.

Local planning can help ease the potential impact of subsidence, planners are aware of mine-related hazards and can recommend construction techniques for areas affected by coal mines. King County, which has large areas underlain by abandoned coal mines, requires developers of lands designated as Coal Mine Hazard Areas to perform geotechnical studies in order to obtain building permits. King County Code 21.54.190 specifies that these studies must identify and quantify:

1. existing underground voids resulting from previous mining activity;
2. location and definition of all surface openings resulting from previous mining activity;
3. location of all concentrations of lethal or noxious gases and groundwater within abandoned mine workings; and
4. location, depth, and characteristics of all mine fillings on the surface of the site.

Any building permit issued requires, among other things, that all openings be sealed and all voids beneath building sites that present significant risk to human health, safety, and welfare be filled or otherwise remedied.

While this ordinance and a similar ordinance in Pierce County currently provide a measure of protection for homeowners, construction prior to its enactment is not covered. Many homes have already been built over or immediately adjacent to abandoned coal mines in Bellingham, Renton, Newcastle, Issaquah, and rural King County. Most of these structures will not experience any problems because subsidence has already gone to completion or because mine workings are too deep for subsidence to propagate to the surface. However, once the surface is modified, it becomes more difficult to assess the subsidence potential.

A housing development that was built a few miles south of Bellevue in the mid-1970s contained an abandoned prospect (Table 1, Waterhouse prospect). Meager historic records indicated the presence of the prospect, but fill and grading concealed the exact location of the hole. Because the prospect was only poorly documented, its original extent, the amount and integrity of its fill, and the degree of hazard (if any) that it posed were unknown. In February 1988, the plug of fill in the mine entry failed, leaving a portion of a house foundation unsupported (Fig. 1). The hole grew for several days, eventually reaching a diameter of approximately 30 feet and damaging the house's foundation and plumbing. While the prospect itself will be reclaimed by OSM, the homeowner will have to bear the burden of the damage to the house, and, at least temporarily, local property values are likely to suffer, even for properties not at risk.

The Division of Geology and Earth Resources (DGER) maintains a large collection of mine maps and other historical information that can be used to locate areas affected or potentially affected by coal mining. Inventories of known and suspected mine hazards are available for inspection at DGER's library and the index to DGER's mine map collection is available for $1.00 postage and handling charge (DGER Open File Report 83-8 by Schasse and others).

Sources of mine information:
Student Projects

- Structural analysis of eugeosynclinal rocks in Big Sheep Creek area, Northport, Washington—Frank Shore
- Geochemistry and petrology of plutonic rocks between the Kettle Gneiss Dome and Republic graben, Curlew and Togo Mountain quadrangles, Washington—Charles Kock
- Petrochemistry of Eocene hornblende-bearing plutonic rocks of the Coquille batholith in the central Ouachita highlands and correlation with granitiform volcanic—Grace Holder
- Ground-water infiltration estimation for the Washington State University hazardous waste facility—Hermione Munir

Selected Additions to the Division of Geology and Earth Resources Library

May and June, 1988

These reports are available for reference in the Division library. Contact the individual publishers for loan or purchasing information.

Theses


U.S. Geological Survey Open-File Reports

Available for sale from:
Open-File Services Section
Branch of Distribution
U.S. Geological Survey
Box 25425, Federal Center
Denver, CO 80225
(303) 236-7476


Coal Mine Subsidence in Washington

by

Timothy J. Walsh, Geologist

In 1977, Congress enacted Public Law 95-87, the Surface Mining Control and Reclamation Act (SMCRA), which provided, among other things, for the closure of abandoned, underground mine openings, reclamation of coal mine-induced subsidence, and the amelioration of mine related hazards. Funds for this work are provided by a tax on active coal mines at a rate ranging from 10 to 35 cents/ton, depending on coal rank. The act established an agency, the Office of Surface Mining Reclamation and Enforcement (OSMRE), to administer the provisions of SMCRA.

In Washington, mine reclamation is approached by OSMRE in two ways:

1. Emergencies, which are defined as recent, sudden events, are reclaimed on a first priority basis. These are most common subsidence areas but have included gas flows caused by a drop in hydrostatic pressure in a mine void during dry weather.

2. Existing mine hazards were inventoried, and priorities for reclamation were established on a nationwide basis. These include subsidence areas that have been fenced and are thus not in need of rapid reclamation.

Funds for reclamation are allocated to those states with a federally approved surface mine regulatory program. States without such programs, such as Washington, receive funding at the discretion of the Secretary of the Interior to be expended directly by OSMRE. At present, OSMRE's reclamation expenditures in Washington are on the order of $750,000 annually. Reclamation of existing priority sites has been accomplished principally in the Roslyn-Cle Elum area, in the Newcastle coal field, and in the Wilkeson-Carbonado area. Emergency reclamation has been necessary about twice a year, chiefly for subsidence. Subsidence reclamation is summarised in Table 1.

Table 1. Mine-subsidence reclamation projects, 1977-1987, performed by OSMRE since enactment of SMCRA. Location: the abbreviated location SW/4 28 22 (227), for example, indicates southwest quarter of section 28 in T. 22 N., R. 7 E. Failure types: 1, failure of fill in a shaft, slope, or rock tunnel; 2, cave-in due to roof fall; 3, sag due to roof fall, 4, hydrocompaction of spoil.

<table>
<thead>
<tr>
<th>Project name</th>
<th>Mine name</th>
<th>Location</th>
<th>Date</th>
<th>Failure type</th>
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<tbody>
<tr>
<td>Engel</td>
<td>Wonder</td>
<td>SW/4 28 (22-7)</td>
<td>2-79</td>
<td>2</td>
</tr>
<tr>
<td>Bevan</td>
<td>Burnett</td>
<td>S/2 16 (19-6)</td>
<td>6-79</td>
<td>2</td>
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<tr>
<td>Campbell</td>
<td>Burnett</td>
<td>S/2 16 (19-6)</td>
<td>5-81</td>
<td>1</td>
</tr>
<tr>
<td>Burdic</td>
<td>Wonder</td>
<td>SW/4 28 (22-7)</td>
<td>9-81</td>
<td>1 or 2</td>
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<tr>
<td>Lake Whatcom</td>
<td>Rocky Ridge</td>
<td>SW/4 31 (38-6)</td>
<td>11-82</td>
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<tr>
<td>Neznanl</td>
<td>Denny-Renton</td>
<td>SW/4 17 (23-5)</td>
<td>12-82</td>
<td>1</td>
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<tr>
<td>Gatto</td>
<td>Burnett</td>
<td>S/2 16 (19-6)</td>
<td>2-82</td>
<td>1</td>
</tr>
<tr>
<td>May Creek</td>
<td>May Valley</td>
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<td>6-82</td>
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<td>NB/4 14 (23-4)</td>
<td>1-84</td>
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<tr>
<td>New #12</td>
<td>New #12</td>
<td>S/2 12 (21-6)</td>
<td>1-84</td>
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<td>Diamond</td>
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<td>6-85</td>
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<td>5-87</td>
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<td>Gurgich</td>
<td>#2</td>
<td>NB/4 14 (21-6)</td>
<td>5-87</td>
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<td>Rocky Ridge</td>
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</table>
Seabed Mining Jurisdiction Question

by
Raymond Lasmas, State Geologist

Before any serious attempts to explore for and develop seabed resources in the federal Exclusive Economic Zone (EEZ) are undertaken, a long-standing jurisdictional controversy between the federal Minerals Management Service (MMS, Department of the Interior) and Department of Commerce has to be resolved.

The Commerce Department claims jurisdiction for leasing outside the continental shelf under the Deep Seabed Hard Mineral Resources Act of 1980. MMS has received jurisdiction for seabed mining in the EEZ from the Outer Continental Shelf Lands Act of 1953.

To resolve the question, Rep. Mike Lowry has introduced H.R. 1260, the National Seabed Hard Minerals Act. A similar bill was to be introduced in the Senate by Sen. Daniel Inouye of Hawaii. A substitute form of H.R. 1260, under consideration, would give the National Oceanic and Atmospheric Administration (NOAA) sole authority over seabed mining regulation. The bill would authorize $28 million to the U.S. Geological Survey and NOAA for geological and biological research.

Consultation with coastal states is a major feature of the House bill. Revenue sharing would provide for 50 percent of the royalties to go to the affected states.


U.S. Geological Survey Published Reports
Available for sale from:


Officials and Scientists Discuss Earthquake Hazards

Geologists have long believed that the seismically active Northwest U.S. could produce a magnitude 7.5 earthquake with the potential for killing thousands and injuring tens of thousands more. Now there is growing evidence to suggest that parts of Oregon, Washington, and British Columbia could be rocked by a so-called great earthquake of magnitude 9 that might cause destruction far beyond today's planning goals for government and industry emergency managers.

While there is no means consensus supporting the theory that a magnitude 9 could occur in the region, recent scientific research points to the possibility of an earthquake between 7.0 and 7.5 in the Pacific Northwest in the next 5,000 years. Capable of widespread destruction, sudden submergence of coastal areas, and massive water waves (tsunamis), these great earthquakes would be similar to the devastating 1964 Alaska earthquake or the 1985 Mexico earthquake. Some scientists believe that future research will provide other explanations for this geologic evidence that is being used to infer that catastrophic earthquakes have occurred in the Northwest. Until other origins for the features are proven, a great earthquake along the coast of Oregon, Washington, and British Columbia must be considered a possibility.

In mid-April nearly 200 scientists, emergency managers, engineers, and business and community leaders attended a workshop held in Olympia and sponsored by federal and state agencies. The purpose of the meeting was to review earthquake hazards in the Puget Sound and Portland, Oregon, areas. This workshop was part of a 5-year cooperative program funded by the U.S. Geological Survey and the Federal Emergency Management Agency (FEMA) to study the dangers earthquakes pose to people living in the Pacific Northwest. In addition to discussing the likelihood of such a major earthquake, those meeting also reviewed the well-established earthquake history of the area. Historic earthquakes indicate that such an earthquake as large as magnitude 7.5 will continue to occur deep beneath Puget Sound and at shallow depths in the North Cascade mountains. Recent earthquake activity in southwest Washington suggests the possibility of earthquakes of magnitudes 7 in the Southern Cascade mountains, posing hazards to both Washington and the Portland area.

While earthquakes cannot be prevented, the damage they do can be significantly reduced. Information about ways to reduce damage is available from FEMA in Bothell and from local emergency management offices. (The previous issue of this newsletter contains lists of information sources.) Information about the geology of Washington and Oregon can be obtained from the Washington Division of Geology and Earth Resources in Olympia and from the Oregon Department of Geology and Mineral Industries in Portland, respectively.

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