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Division of Geology and Earth Resources

Decline shaft (left) and mill (right) at the Valley mine, Ferry County. (See article, page 3.)

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WASHINGTON GEOLOGIC NEWSLETTER

The Washington Geologic Newsletter is published quarterly by the Division of Geology and Earth Resources, Department of Natural Resoruces. The newsletter is free upon request. The Division also publishes bulletins, information circulars, reports of investigations, and geologic maps. A list of these publications will be sent upon request.



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# Mineral Collecting Opportunities in Washington

by Raymond Lasmanis, State Geologist

This issue of the Division newsletter features an article by Nancy Joseph on the status of Washington's mineral industry during 1987. Minerals provide one of the foundations for an industrialized society, as well as an important source of revenue for Washington.

In addition to their economic role, minerals, as well as fossils and other geologic materials, also provide enjoyment to a significant portion of Washington's population. Whether the activities involve field collection, the faceting of a gemstone, or the study of crystals, all are a means of learning about our Earth.

As with virtually everything else these days, we are becoming more specialized at work and play. So it is with "rockhounding". Depending on one's interest, there is an organization to match and foster it. With the advent of spring and opportunities to visit collecting sites, we offer some information for those wishing to get involved in mineral collecting. Among the groups active in Washington are the following:

### *Northwest Federation of Mineralogical Societies*

The northwest region covers Alaska, Idaho, Montana, Oregon, Utah, and Washington. The federation's individual member clubs are involved in all aspects of rockhounding, with emphasis on lapidary arts, but many members are basically collectors. The Northwest Federation has an annual exhibition. The membership directory lists, for example, 40 clubs for Washington and their memberships. The directory costs $3 and is available from:

Hermena Kolski, Directory Chair
Northwest Federation of Mineralogical Societies
208 Fairview 2 East
Great Falls, Montana 59404

(continued on p. 25)


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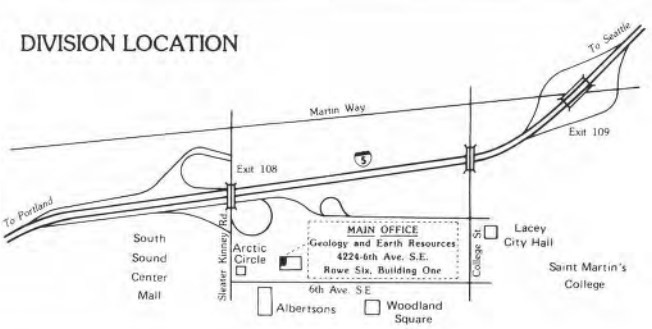


# The Mineral Industry in Washington, 1987

by
Nancy L. Joseph

According to information obtained by the Division of Geology and Earth Resources, 23 metal and industrial mineral operations (excluding sand and gravel) produced gold, silver, limestone, dolomite, silica, olivine, diatomite, and clay in 1987 (Table 1). Three portland cement plants and seven plants producing lime, calcium chloride, precipitated calcium carbonate, or ground limestone were also in operation (Table 2).

Nonfuel mineral production in Washington in 1987 was valued at $402 million, according to preliminary figures compiled by the U.S. Bureau of Mines. This represents a 7 percent increase over the 1986 value of $376 million. The 1986 figure, which is considerably greater than the preliminary $254-million figure previously reported (Joseph, 1987), includes adjustments to the preliminary figures and reporting by the Bureau of Mines, for the first time, of the value of magnesium metal production by Northwest Alloys, Inc.

In 1987 Washington ranked 20th in the nation in nonfuel mineral production, according to the Bureau of Mines. Precious metal production increased significantly because of increased output at both the Cannon mine and the Republic Unit. Increases in production and value of gold and silver, increased production of sand and gravel, and the steady, near-capacity output of magnesium metal were more than sufficient to offset a 25 percent decrease in the production of portland cement, which was caused, in part, by the shut-down of Columbia Northwest Cement Corp.

Total revenue from prospecting, mining, and quarrying, including sand and gravel production, on state lands was $506,069 for the fiscal year ending June 30, 1987 (Fig. 1). This represents a nearly 12 percent increase in revenues over the previous fiscal year. Revenues for the present fiscal year should exceed those of 1987 because of reform of the mineral leas-

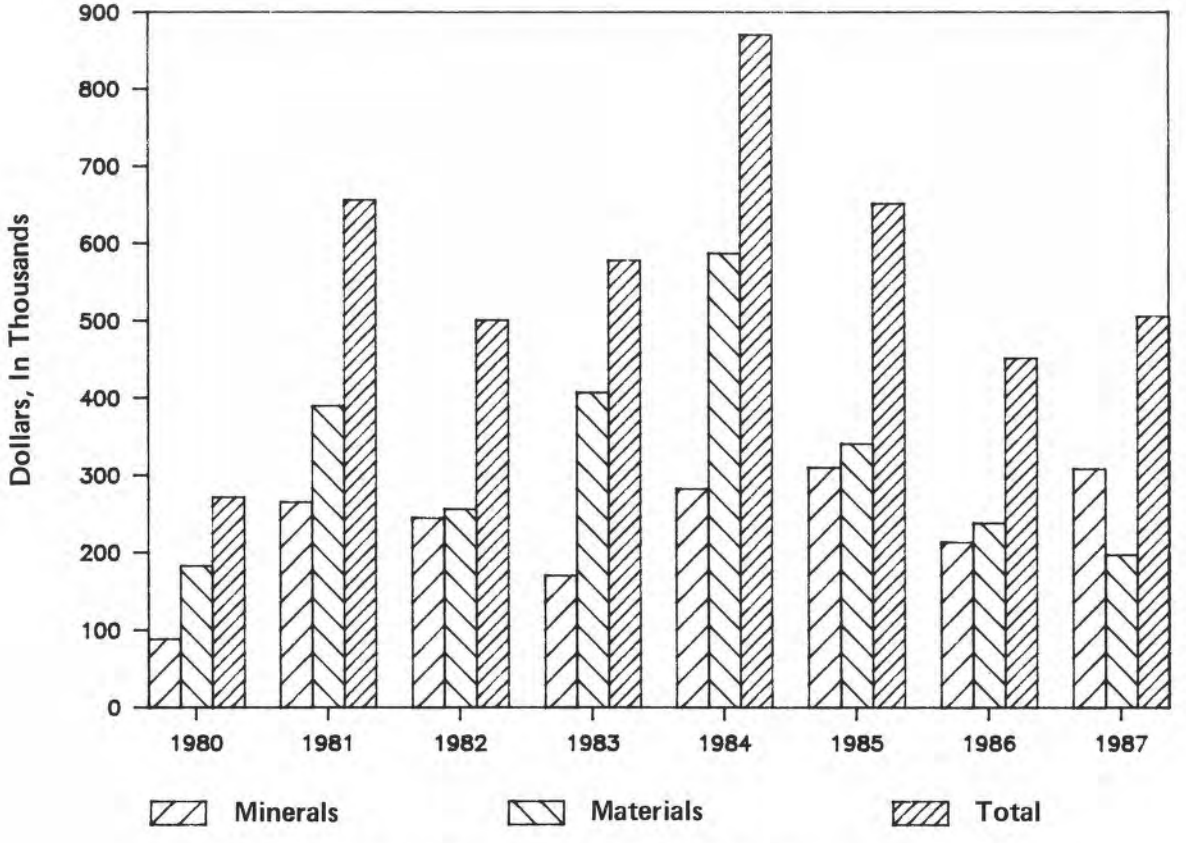



Figure 1.–Revenue from prospecting, mining, and quarrying on state lands.

Table 1.–Mineral exploration and development in Washington, 1987. Locations given where available. See Figures 2a and 2b for property locations.

| Loc. no. | County | Operator and/or Owner(s) | Property or area | Location | Commodity | Remarks |
|---|---|---|---|---|---|---|
| 1 | Chelan | Asamera Minerals Inc./Breakwater Resources Ltd. | Cannon mine | sec. 16 T.22N., R.20E. | Au, Ag | Mining and milling |
| 2 | Chelan | Asamera Minerals Inc./Grange Gold Inc., Teck Resources (U.S.) 1983, Inc. | Lovitt mine | sec. 22 T.22N., R.20E. | Au | Drilling and sampling |
| 3 | Chelan | Welcome Nugget Mines | Welcome Nugget #1 | sec. 30 T.26N., R.18E. | Au, Ag | Exploration |
| 4 | Clallam | Ideal Basic Industries, Inc. | Twin River | secs. 22-23 T.31N., R.10W. | Clay | Mining |
| 5 | Ferry | Chemgold, Inc./ Crown Resource Corp. | South Penn | secs. 27-28 T.37N., R.32E. | Au, Ag | Mining, heap-leach |
| 6 | Ferry | Cyprus Gold Exploration Corp. | Lone Ranch Creek | secs. 11-12, 18-19, 30 T.40N., R.35E. | | Drilling |
| 7 | Ferry | N.A. Degerstrom, Inc./Inland Gold and Silver Corp. | Leland property | secs. 10-15, 22-24, 27-28, 34-35, T.37N., R.33E. | Au, Ag | Reconnaissance |
| 8 | Ferry | Echo Bay Mines Ltd./Crown Resource Corp., Gold Texas Resource, Ltd. | Kettle | secs. 15-16, 22 T.39N., R.33E. | Au | Surface and underground drilling; exploration decline |
| 9 | Ferry | Echo Bay Mines Ltd./Crown Resource Corp., Gold Texas Resource, Ltd | Key, Overlook | secs. 7-8, 17-18, T.37N., R.34E. | Au | Pre-development surface drilling at Overlook deposit |
| 10 | Ferry | Hecla Mining Co. | Republic Unit, Golden Promise shaft | sec. 35 T.37N., R.32E. | Au, Ag | Mining and milling, exploration |
| 11 | Ferry | High Country Mining and Exploration | Valley mine | sec. 6 T.37N., R.33E. | | Mining and milling |
| 12 | Ferry | Herdrick Mining Co. | Morning Star | sec. 16 T.40N., R.34E. | Au, Ag, Cu | Mapping and sampling |
| 13 | Ferry | Kettle River Resources Ltd., Curlew Lake Resources Inc. | Empire Creek | sec. 6 T.38N., R.33E. | Au | Drilling and sampling |

Table 1.–Mineral exploration and development, 1987 (continued)

| Loc. no. | County | Operator and/or Owner(s) | Property or area | Location | Commodity | Remarks |
|---|---|---|---|---|---|---|
| 14 | Ferry | Sundance Mining-Development, Inc. | Gold Hill | Danville district | Au, Ag, Cu | Leased property to United States Borax and Chemical Corp. |
| 15 | Ferry | United States Borax and Chemical Corp. | Gold Dike/ Gold Hill | secs. 7-8 T.40N., R.34E. | Au | Signed option agreements, drilling, geological mapping |
| 16 | Ferry | Vulcan Mountain, Inc. | Gold Dike | secs. 7-8, 17-18, T.40N., R.34E. | Au, Ag, Cu | Mining |
| | Ferry | Asarco Inc. | Several areas | | Au, Ag | Geological mapping, sampling |
| | Ferry | Crown Resource Corp. | Several areas | | Au, Ag | Exploration |
| | Ferry | Newmont Gold | | West of Danville | Au | Exploration |
| | Ferry | Stuart Jackson | | Northwestern part of county | Au, Ag | Acquired state leases |
| 17 | Grant | Basic Resources Co. | Rock Top | sec. 20 T.22N., R.26E. | Clay | Access road completed |
| 18 | Grant | Witco Corp. | Grant County pits | secs. 7-8 T.17N., R.24E. | Diatomite | Mining and milling |
| 19 | Grant | Witco Corp. | Grant County pits | sec. 17 T.18N., R.23E. | Diatomite | Mining and milling |
| 20 | King | Ash Grove Cement West, Inc. | Superior quarry | sec. 1 T.19N., R.7E. | Silica | Mining |
| 21 | King | Kennecott Exploration | White River | sec. 6 T.19N., R.8E. | Au | Sampling |
| 22 | King | L-Bar Products, Inc. | Ravensdale | sec. 1 T.21N., R.6E. | Silica | Mining and screening |
| 23 | King | Mutual Materials Co. | Cougar Mountain pit | sec. 31 T.24N., R.6E. | Clay | Mined 170,000 cubic yards |
| 24 | Okanogan | Aviva Resources, Inc. | Black Bear | sec. 36 T.39N., R.25E. | Au | Geologic mapping and sampling |

Table 1.–Mineral exploration and development, 1987 (continued)

| Loc. no. | County | Operator and/or Owner(s) | Property or area | Location | Commodity | Remarks |
|---|---|---|---|---|---|---|
| 25 | Okanogan | Aviva Resources, Inc. | Ivanhoe | sec. 16 T.39N., R.25E. | Au | Geologic mapping and sampling |
| 26 | Okanogan | L.F. Baum Associates | Turtle Lake | secs. 9-10 T.36N., R.26E. | Au, Ag, Cu | Exploration |
| 27 | Okanogan | CM Silver Mines, Inc. | Reed Limestone | sec. 35 T.39N., R.26N. | Limestone | Drilling |
| 28 | Okanogan | Columbia River Carbonates | Wauconda quarry | sec. 24 T.38N., R.30E. | Limestone | Geologic study |
| 29 | Okanogan | Herdrick Mining Co. | Ida | secs. 21, 28 T.39N., R.31E. | Au | Sampling and mapping |
| 30 | Okanogan | Kerr-McGee Corp. | Near Chesaw | T.40N., R.29-30E. | Au | Exploration |
| 31 | Okanogan | Keystone Gold, Inc. | Crystal Butte/Gray Eagle | secs. 16, 25-26, 35 T.40N., R.30E. | Au, Ag | Geologic reconnaissance |
| 32 | Okanogan | Omak Minerals, Inc. | Haeberle Ranch | North of Riverside | Au, Mo | Drilling |
| 33 | Okanogan | Pacific Calcium, Inc. | Whitestone quarry | sec. 14 T.38N., R.26E. | Limestone, Dolomite | Quarrying and milling |
| 34 | Okanogan | Quintana Minerals Corp. | Mazama | | Au | Sampling |
| 35 | Okanogan | Newhawk Gold Mines Ltd.; Reliant Resources, Inc./ Nord Resources | Smith Canyon | T.32-33N., R.21E. | Au | Drilling |
| 36 | Okanogan | Silver Bell, Inc. | Silver Bell mine | sec. 25 T.38N., R.31E. | Au, Ag | Sampling |
| 37 | Okanogan | Sunshine Valley Minerals, Inc. | Billy Goat | secs. 14-15, 22-23 T.38N., R.20E. | Au, Ag, Cu, Mo | Exploration |
| 38 | Okanogan | Westmont Mining Inc./Crown Resource Corp. | Bodie | sec. 34 T.39N., R.31E. | | Geologic exploration and sampling |
| 39 | Pend Oreille | Bockman Construction Inc. | Easy Street claims | secs. 23, 26 T.39N., R.44E. | Silica | Mining |
| 40 | Pend Oreille | Lehigh Portland Cement Co. | Champane placer | sec. 27 T.39N., R.43E. | Limestone | Mining |
| 41 | Pend Oreille | Lewis and Clark Mines | Lewis and Clark 1-7 | sec. 17 T.38N., R.44E. | Ag, Mo, Pb, Zn | Drilling |

Table 1.–Mineral exploration and development, 1987 (continued)

| Loc. no. | County | Operator and/or Owner(s) | Property or area | Location | Commodity | Remarks |
|---|---|---|---|---|---|---|
| 42 | Pend Oreille | United Catalysts, Inc./FRM Minerals, Inc. | Totem Talc | secs. 23, 14 T.39N., R.44E. | Talc | Drilling |
| | Pend Oreille | Union Pacific Resources | | | U | Exploration |
| 43 | Pierce | Rampart Ventures, Inc. | Surprise Valley | T.17N., R.5E. | Au, Ag | Exploration |
| 44 | Skagit | Applied Industrial Materials Corp. (AIMCOR) | AIMCOR Olivine | secs. 3-4, 8-9, 16-17 T.36N., R.7E. | Olivine | Production from stockpile |
| 45 | Skamania | Plexus Resources Corp. | Silver Star | sec. 4 T.3N., R.5E. | Au, Cu, Mo | Drilled one hole |
| 46 | Spokane | Interpace Industries Inc. | Mica mine and plant | sec. 14 T.24N., R.44E. | | Mining and mine development |
| 47 | Stevens | Boise Cascade Minerals, Pathfinder Gold Corp./ Billiton Minerals | First Thought mine area | T.39N., R.37E. | Au, Ag | Exploration, drilling |
| 48 | Stevens | Art Bolt | near Flagstaff Mountain | secs. 1-5, 16 T.39N., R.39E. | Au, Ag | Sampling |
| 49 | Stevens | Champion Gold and Silver, Inc. | First Thought mine | secs. 7, 18 T.39N., R.37E. | | Leased property |
| 50 | Stevens | Chewelah Eagle Co. | Chewelah Eagle quarry | sec. 5, T.32N.; sec. 32, T.33N., R.41E. | Dolomite | Leased to Nanome Aggregates, Inc. |
| 51 | Stevens | Cortez International Ltd. (Oregon Leo Minerals and Timber) | Turk mine area | sec. 36 T.30N., R.37E. | Magnesite | Acquired state lease |
| 52 | Stevens | Hemphill Brothers, Inc. | Northport Limestone | sec. 8 T.39N., R.40E. | Limestone | Mining |
| 53 | Stevens | Lane Mountain Silica Co. (subsidary of Hemphill Brothers) | Lane Mountain Silica | sec. 27 T.31N., R.39E. | Silica | Mining |
| 54 | Stevens | Lead Point Consolidated Mines Co. | Lead Point Consolidated mines | secs. 2-13, 23, T.39N., R.41E. secs. 8, 17-18, 29 T.39N., R.42E. | Ag, Pb, Zn | Exploration |

Table 1.–Mineral exploration and development, 1987 (continued)

| Loc. no. | County | Operator and/or Owner(s) | Property or area | Location | Commodity | Remarks |
|---|---|---|---|---|---|---|
| 55 | Stevens | Nanome Aggregates, Inc. | Several quarries | | Dolomite | Mining and milling |
| 56 | Stevens | Northwest Alloys, Inc. | Addy dolomite quarry | secs. 13-14 T.33N., R.39E. | Dolomite | Mining |
| 57 | Stevens | Northwest Marble Products Co. | White quarry | sec. 10 T.38N., R.37E. | Dolomite | Mining |
| 58 | Stevens | Westmont Mining Inc./International Curator Resources Ltd. | Twilight Canyon | sec. 9 T.33N., R.38E. | Zn, Pb, Ag | Drilling |
| | Stevens | Crown Resource Corp. | | County | Au, Ag | Exploration |
| | Stevens | Union Pacific Resources | | County | U | Exploration |
| 59 | Whatcom | Clauson Lime Company | Near Maple Falls | secs. 7, 18 T.40N., R.6E. | Limestone | Mining |
| 60 | Whatcom | Columbia Northwest Cement Corp. | Kendall quarry | secs. 14-16, 22-23 T.40N., R.5E. | Limestone | Mining ceased operation in 3rd quarter |
| 61 | Whatcom | Olivine Corp. | Swen Larsen quarry | sec. 34 T.38N., R.6E. | Olivine | Mining |
| 62 | Whatcom | Seattle-St. Louise Mining Co. | Minnesota mine | sec. 2 T.37N., R.16E. | Au, Ag | Exploration |
| 63 | Whatcom | Steelhead Resources, Ltd. | Excelsior property | secs. 5-6 T.39N., R.8E. | Au, Ag | Geological exploration, drilling |
| 64 | Whatcom | Western Gold Mining, Inc. | New Light mine | sec. 27 T.38N., R.17E. | Au | Rehabilitation of portals |
| 65 | Yakima | Ardic Exploration and Development, Ltd. | Morse Creek | sec. 31 T.17N., R.11E. | Au, Ag | Drilling, geochemical sampling |

ing system, which includes higher lease payments, and because of renewed exploration interest in Washington.

No uranium was produced in Washington in 1987. The most recent uranium production in the state was in 1984, when two properties were being mined.

The information in this report is summarized from voluntary replies to a questionnaire sent to companies and individuals active in mineral exploration and development in the state, as well as from published information. The questionnaire is limited in scope, and therefore, details of activities on individual properties are not always available. Not all questionnaires were returned, and some information requested, particularly regarding expenditures and production, is considered confidential by many of those questioned and

Table 2.–Selected producers of processed carbonate products, 1987. Refer to Table 1 and Figures 2a and 2b for locations

| Commodity | Owner and/or operator | County |
|---|---|---|
| Portland cement | Columbia Northwest Cement Corp. | Whatcom |
| Portland cement | Ideal Basic Industries, Inc. | King |
| Portland cement | Lehigh Portland Cement Co. | Pend Oreille |
| Lime | Tacoma Lime, a division of Continental Lime, Inc. | Pierce |
| Lime | Northwest Alloys, Inc. | Stevens |
| Precipitated calcium carbonate | Tacoma Lime, a division of Continental Lime, Inc. | Pierce |
| Calcium chloride | Tahoma Chemical Co. | Pierce |
| Calcium chloride | Occidental Chemical Corp. | Pierce |
| Ground limestone | J.A. Jack and Sons, Inc. (Hemphill Brothers, Inc.) | King |
| Ground limestone | Columbia River Carbonates | Cowlitz |
| Ground, crushed dolomite | Nanome Aggregates, Inc. | Stevens |
| Ground dolomite and limestone | Pacific Calcium, Inc. | Okanogan |
| Crushed dolomite | Northwest Marble Products Co. | Stevens |

is not reported. Therefore, while this summary is a reliable indication of the mineral activity in the state, it is incomplete and general in nature.

The locations of the properties mentioned in this article are shown in Figures 2a and 2b (p. 10, 11), which cover western and eastern Washington, respectively.

## METALS

### Development

Gold and silver were the primary metallic minerals produced from the five active metal mines in Washington (Table 3). A record of more than 210,000 ounces of gold (Fig. 3) and 350,000 ounces of silver, having a combined value of more than $95 million, was produced from the mines located in Chelan County and Ferry County. The Bureau of Mines ranks Washington 6th in the nation for gold production and 10th for silver production.

#### *Chelan County*

The Cannon mine is the largest gold mine in the state and was the 11th largest gold producer in the

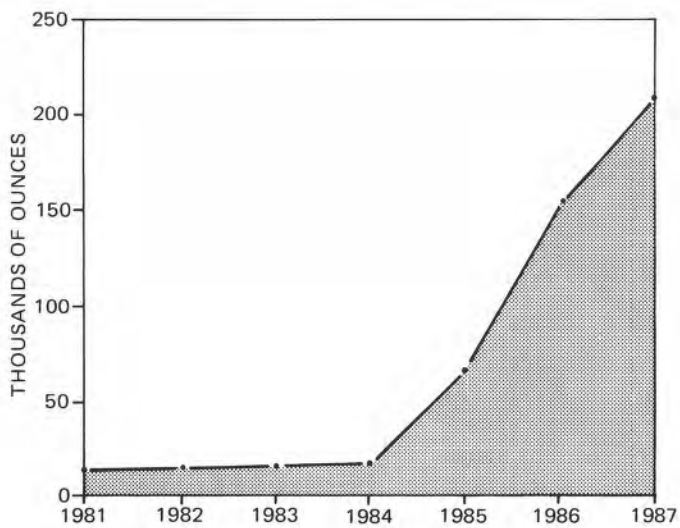



Figure 3.–Estimated gold production in Washington. Production increased dramatically beginning in 1985 as a result of the opening of the Cannon mine and increased production at the Republic Unit.

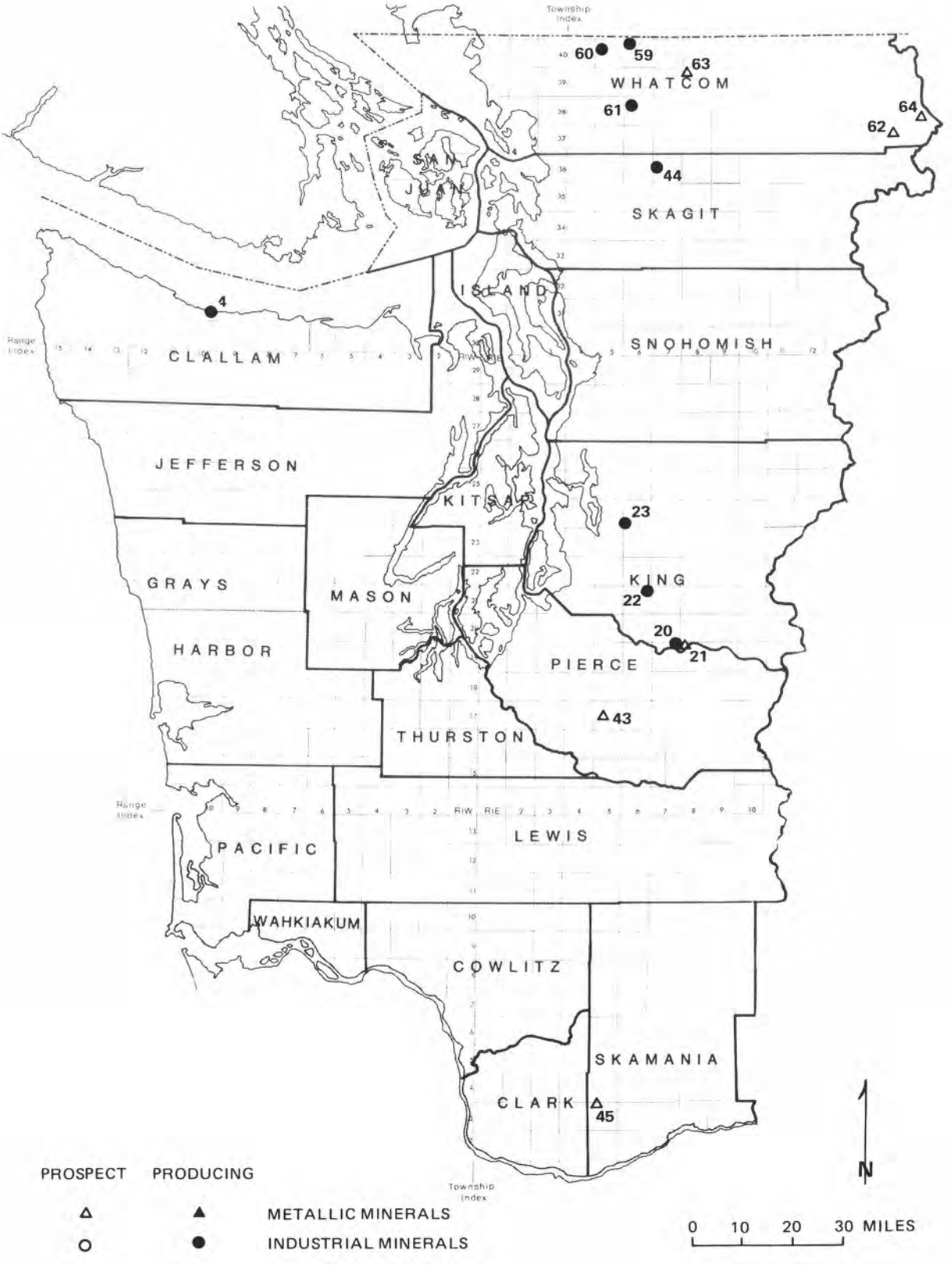



Figure 2a.–Location of selected mines (metallic and industrial minerals) and prospects in western Washington. Location numbers are keyed to Table 1.

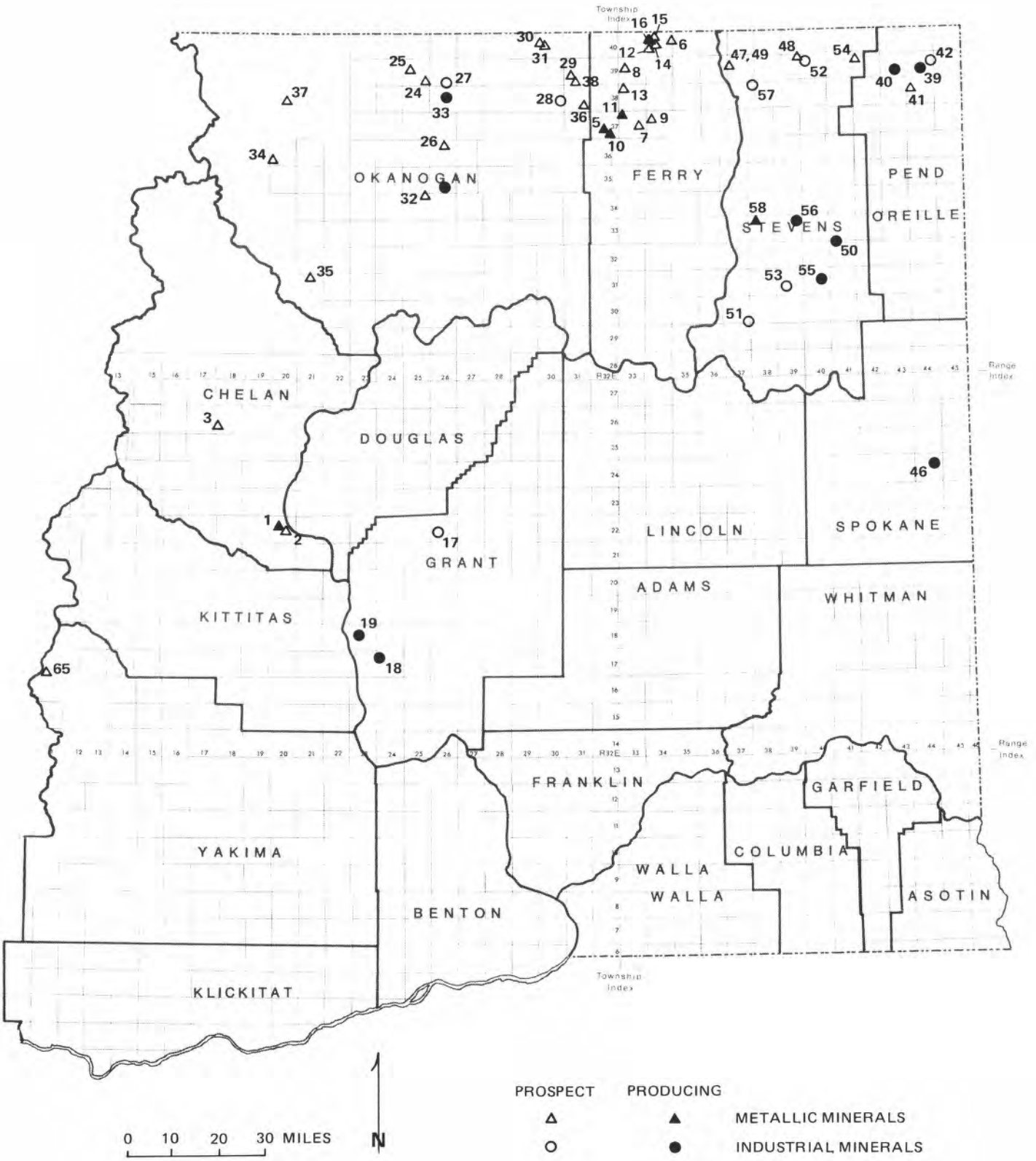



Figure 2b.–Location of selected mines (metallic and industrial minerals) and prospects in eastern Washington. Location numbers are keyed to Table 1.

Table 3.–Properties producing base and precious metals, 1987

| Property | Owner and/ or operator | County | Production and development |
|---|---|---|---|
| Cannon mine | Asamera Minerals (U.S.), Inc.; Breakwater Resources, Ltd. | Chelan | Produced 136,913 oz of gold and 184,660 oz of silver |
| South Penn | Chemgold, Inc.; Crown Resource Corp. | Ferry | Mined 33,000 tons of rock for heap-leach operation |
| Republic Unit | Hecla Mining Co. | Ferry | Produced 70,095 oz of gold |
| Valley mine | High Country Mining and Exploration | Ferry | Mining and milling |
| Gold Dike mine | Vulcan Mountain, Inc. | Ferry | Renewed mining, heap-leach operation |

United States during the year October 1986 through September 1987. The mine produced a record of 136,913 ounces of gold and 184,660 ounces of silver in 1987. The operation mined 487,065 tons with an average grade of 0.308 oz/ton gold; the average daily production was 1,600 tons.

The underground trackless mine is operated by Asamera Minerals Inc. (51%) in joint venture with Breakwater Resources Ltd. (49%). In July, stock was issued in a public offering for Asamera Minerals Inc., with Asamera Inc. as the majority stockholder holding 90 percent of the stock (Asamera Inc. third quarter report, 1987).

The Cannon mine employs approximately 189 workers and had a 1987 payroll of about $5.5 million (Wenatchee World, Oct. 23, 1987). In September the mine went to a 7-day work schedule, up from the previous 5-day work week.

In April, Asamera announced the discovery of the new B-4 ore zone which was first drilled in 1986. The zone extends north and west of the B-north body that is currently being mined. The new discovery, as of December 1986, adds to the mine's proven and probable reserves about 465,000 tons at a grade of 0.241 oz/ton gold, with a 0.1 oz/ton cut-off (Breakwater Resources Ltd., 1986 annual report). In addition, a new zone called the B-Tween has been identified (Asamera Inc. third quarter report, 1987). Underground and some surface drilling continued in these two areas during 1987 to increase the reserve base.

Modifications made to the mill in 1986 have resulted in an increase in gold recovery from 86 percent to 91 percent. The concentrate is sent to smelters in Japan and Montana for further refining (Wenatchee World, October 23, 1987).

The ore body at the Cannon mine "consists of widely spaced veins of quartz, chalcedony, adularia, calcite, sulfides, and gold in a pervasively silicified and mineralized section of Eocene feldspathic sandstone and sandy siltstone about 40 m thick." (Ott and others, 1986, p. 425).

### *Ferry County*

Three mines are presently active in the Republic Mining District, which has produced nearly 2.5 million ounces of gold in its 91-year history. Locations of mines and properties in the Ferry County area are shown in Figure 4.

It was a banner year at the Republic Unit, which is owned by Hecla Mining Company. The company dedicated the 1,300-foot Golden Promise (GP) Shaft in January and produced a record of 70,095 ounces of gold from the mine. Gold grades that were higher than anticipated and increased production from the GP veins resulted in a 76 percent increase in gold production over 1986. The new shaft accesses the Golden Promise veins whose discovery was announced in 1985. The banded chalcedony epithermal veins are in pyroclastic rocks in the upper part of the Eocene Sanpoil Volcanics.

Approximately 25,000 feet of diamond drilling, 3,500 feet of development drifting, and 300 feet of raises were developed during mining and exploration for the extensions of the recently discovered ore systems. The Republic Unit mine and mill employed 116 workers in 1987.

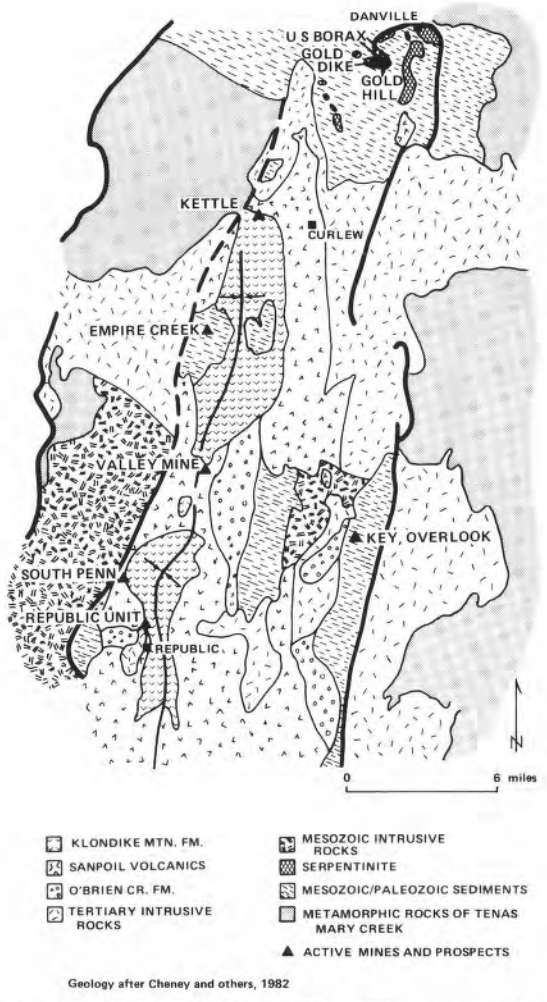



Figure 4.–Areas of active exploration in northwestern Ferry County.

At the Valley mine, operated by High Country Mining and Exploration, mining continued on the 200 and 300 levels. The privately held company took over the lease on the mine in 1983 and began rehabilitation of the underground workings and updating of the 72-ton/day mill before production began in September 1986. The vein mined at the Valley mine is in the Eocene Sanpoil Volcanics. The vein of banded chalcedonic quartz and calcite strikes northeast and dips approximately 35° to the east. Vein width varies from 5 to 35 feet and has an average width of 8 feet and an average grade of 0.2 oz/ton gold.

Chemgold Inc., a subsidiary of Glamis Gold Ltd., in joint venture with Crown Resource Corp., reported mining 33,000 tons of rock grading 0.03 oz/ton gold at the South Penn deposit. The heap leach operation was shut down in the fall because freezing weather decreased production; however, the operator will resume work in 1988. The company hopes to recover approximately 900 ounces of gold from the operation during the 2-year life of the project. The mineralized rock being mined is in the Sanpoil Volcanics near the contact with the Klondike Mountain Formation.

Vulcan Mountain Inc. resumed mining at the open-pit Gold Dike mine east of Danville, near the Canadian border. In July new equipment was acquired, including a 1,200-ton/day crusher. The top of the previously used leach pad was relined with plastic so that the site can be reused. Changes in the heap-leach process have increased recovery at the property (Wallace Miner, Dec. 3, 1987). Mineralization at the Gold Dike is associated with monzonite and shonkinite intrusive rocks.

## Exploration

A minimum of 55 companies and individuals explored for metals in Washington in 1987, according to replies to the questionnaire and other information. An overwhelming 92 percent of these companies explored for gold and silver. Copper, molybdenum, lead, zinc, platinum, and uranium were also sought by several companies.

### *Chelan County*

Asamera, in joint venture with Grange Gold Inc., explored the potential of the old Lovitt mine, which was last active in 1967, and the area between this mine and the Cannon mine. Nineteen surface holes were drilled for a total of more than 10,000 feet, and an extensive surface and underground sampling program was undertaken. The Wenatchee World (October 23, 1987) reported that a potential site for a small open pit operation was identified.

Tillicum Industries, which had drilled six holes in the Blewett District in 1986, dropped their claims in the area.

Welcome Nugget Mines explored their placer claims in the county.

### *Ferry County*

Ferry county was the most active area in the state for precious metals exploration. More than 14 companies conducted exploration in the county, including several extensive drilling programs.

Echo Bay Mines Ltd. announced in July that they would begin a $2.5-million feasibility study and expand exploration at the Kettle (formally the Granny), Key East, Key West, and Overlook deposits. Echo Bay, the operator of the properties, has been in a joint venture agreement with the owners, Crown Resource Corp. and Gold Texas Resource Ltd., since late 1985. The decision of whether to put the properties into production following the feasibility study will be made in mid-1988.

At the Kettle deposit, a 3,000-foot exploration decline was begun in October to allow more extensive exploration on the steeply dipping vein system. Drilling of low-angle, radial underground exploration holes

began in December and continued during early 1988. An office building and core storage facilities were also constructed at the site.

Surface core drilling done earlier in 1987 extended the known mineralization at the Kettle deposit and has identified two vein systems, the Brutus and the Lucy. Crown Resource reported that the two best intercepts on the Lucy were 7.7 feet (true width) grading 0.67 oz/ton gold and 26 feet grading 0.35 oz/ton gold. Gold mineralization on the Brutus veins has been extended over a horizontal distance of 900 feet and a vertical distance of 600 feet; it is open down dip. The two best assay intervals for the Brutus vein were 25.5 feet grading 0.39 oz/ton and 41 feet grading 0.25 oz/ton gold (The Mining Record, October 21, 1987). The banded epithermal quartz veins at this mine are in the upper part of the Sanpoil Volcanics near the contact with the Klondike Mountain Formation.

Two rotary reverse circulation drill rigs were utilized at the Overlook deposit, which was discovered in 1986. Nearly 100 rotary reverse circulation holes were completed at the property; the average hole depth was 650 feet.

The gold mineralization near Cooke Mountain occurs as manto replacements of limestone by magnetite, pyrite, and pyrrhotite and as quartz stockwork veins ± pyrite, pyrrhotite, arsenopyrite, magnetite, and chalcopyrite. The mineralization occurs in Permian metasedimentary rocks, which are in contact with dikes of the Eocene Scatter Creek Rhyodacite. Previous mining in the Belcher District occurred in the early 1900s.

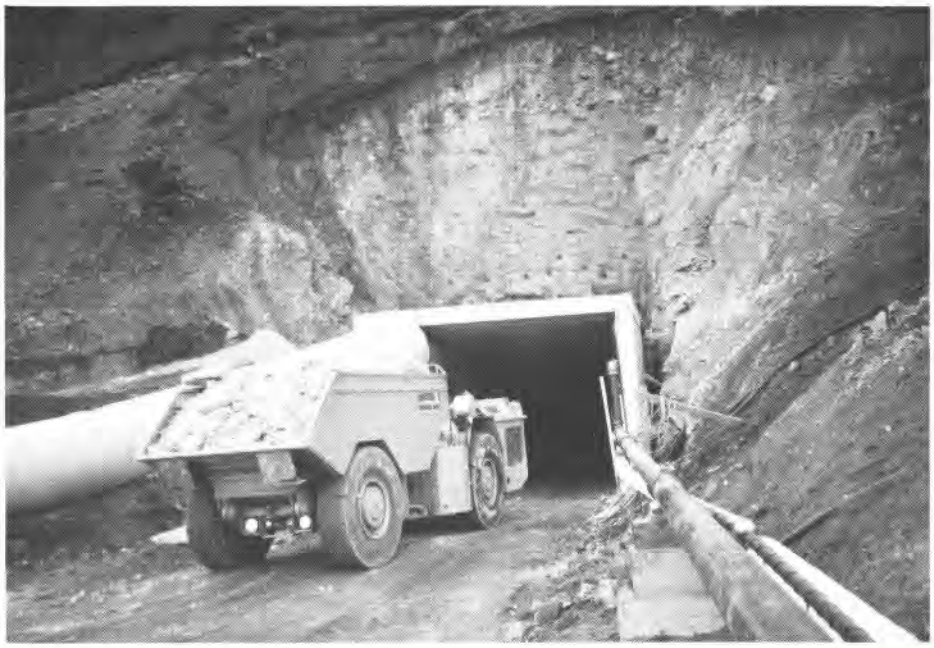
If put into production, the Kettle will be an underground mine, and the Key and Overlook properties could be accessed by underground and/or open-pit methods. One mill near the Key would serve both properties. The two operations would employ approximately 100 persons.

Hecla Mining Co. continued exploratory drilling on their properties, outside of the Golden Promise mine area, in the Republic Mining District.

Vulcan Mountain Inc. and Sundance Mining-Development Inc. signed exploration agreements with United States Borax and Chemical Corp. for the Gold Dike and Gold Hill properties, respectively. A drill program initiated by Borax in October included several angle and vertical core holes which averaged 200-300 feet deep; some deeper holes are planned. Geologic mapping and geochemical sampling were also undertaken.

Kettle River Resources Ltd., in joint venture with Curlew Lake Resources, explored claims near the headwaters of Empire Creek. Six core holes totaling more than 2,500 feet were drilled at the gold and base metal property. An extensive surface geochemical sampling program was also undertaken. The deposit is in Permian and Triassic greenstone and metasedimentary rocks (Parker and Calkins, 1964).

Reverse circulation drilling by Echo Bay Mines Ltd. at the Overlook deposit, Ferry County. Holes are drilled at 100-foot spacings. Drilling pads are visible on hillside in the background.



The portal of the decline ramp at the Kettle deposit in Ferry County, collared in October 1987.

N. A. Degerstrom, Inc., in joint venture with Inland Gold and Silver Corp., acquired the Leland property, west of the Key prospects. Geochemical sampling and geological mapping were conducted at the property.

Asarco Inc. conducted geological mapping and geochemical sampling throughout the county in their search for gold mineralization.

Cyprus Gold Exploration Corp. drilled on claims on Lone Ranch Creek east of Danville. The company also acquired property in the area.

Several other companies explored in the county. Crown Resource Corp. explored for precious metals. Herdrick Mining Co. did geologic mapping and geochemical sampling at the Morning Star property. Newmont Gold Co. conducted very limited exploration in the county. Numerous state mineral leases were acquired by Stuart Jackson.

### *King County*

Kennecott Exploration sampled at the White River property. The prospect is hosted by Tertiary volcanic rocks.

### *Okanogan County*

Westmont Mining Inc. signed a joint venture agreement with Crown Resource Corp. to explore the Bodie property, which was last mined in 1944 (Moen, 1980). Detailed geologic mapping and geochemical sampling were conducted on the property. Sites were also prepared for future drilling. The northeast-striking banded epithermal vein and breccia are located in the Toroda Creek graben and hosted by Eocene volcanic rocks (Moen, 1980).

Several other companies explored properties in the Eocene volcanic sequence. Silver Bell, Inc., continued geochemical sampling at the Silver Bell mine. Some mining was also done at the property. Herdrick Mining Co. conducted geologic mapping and sampling at the Ida mine, which was sold to Sundance Mining-Development.

In the Meyers Creek District, Kerr-McGee Corp. continued exploration at their gold property near Chesaw. Keystone Gold Inc. conducted geologic and geochemical reconnaissance at Crystal Butte and Gray Eagle.

Omak Minerals, Inc. drilled two core holes and undertook geological mapping at their prospect northwest of Omak. The newly incorporated company is seeking gold, molybdenum, and other minerals on the property.

Newhawk Gold Mines Ltd. in joint venture with Reliant Resources, Inc., drilled eight holes, for a total of 1,500 ft, on their prospects in Smith Canyon south of Twisp. The gold-copper property is under option from Nord Resources Corp. A large claim block staked in 1986 is part of the land package put together by the company in that area.

Several other companies explored in the Methow Valley area. Quintana Minerals Corp. continued sampling of gold properties at the margin of their copper porphyry deposit near Mazama. Sunshine Valley

Minerals, Inc. continued exploration of a gold-, copper-, and molybdenum-bearing fault zone at the Billy Goat property.

Other companies exploring in the county include Crown Resource, which sought precious metals. Aviva Resources Inc. did geological mapping and geochemical sampling of quartz veins in greenstone at their Black Bear and Ivanhoe properties. L.F. Baum Associates continued exploration of the brecciated and altered rocks at their Turtle Lake prospect.

### *Pend Oreille County*

Lewis and Clark Mines explored their silver and base metal property through core drilling. The company also worked to dewater the existing adit.

Union Pacific Resources conducted geochemical and geological exploration for uranium.

### *Pierce County*

Rampart Ventures, Inc., did geologic mapping and geochemical sampling at the Surprise Valley property in exploring epithermal gold and silver mineralization in Tertiary volcanic rocks.

### *Skamania County*

Plexus Resources Corp. drilled one hole at the Silver Star property.

### *Stevens County*

Boise Cascade Minerals in joint venture with Pathfinder Gold Corp. explored for gold and silver in the First Thought mine area. Several core holes were drilled to delineate epithermal gold vein mineralization in the upper part of the Sanpoil Volcanics. Geologic mapping, geochemical sampling, and geophysical work were conducted. Boise Cascade, which has land holdings in the area, has leased the land package put together by Billiton Minerals (formerly Shell Minerals). Patented claims owned by Champion Gold and Silver, Inc., are part of this group.

Several other companies and individuals explored for base and/or precious metals in the county. Westmont Mining, Inc., in joint venture with International Curator Resources Ltd., drilled in Twilight Canyon. Art Bolt undertook geochemical sampling at his gold and silver property near Flagstaff Mountain. Leadpoint Consolidated Mines Co. sought silver, lead, and zinc on their property. Crown Resource explored for precious metals in the county.

Union Pacific Resources conducted general reconnaissance for uranium.

### *Whatcom County*

Steelhead Resources, Ltd., through its wholly owned subsidiary, Nooksack Mines, Inc., completed 61 rotary reverse circulation holes for a total of 25,000 ft at the Excelsior property. Previous core drilling by U.S. Borax resulted in drill-indicated reserves of 4 million tons of 0.036 oz/ton gold and 3.16 oz/ton silver. According to the company, the mineralized zone has a minimum north-south strike length of 1,000 ft and an east-west width of 500 ft. Mineralization is hosted by the Wells Formation, a Jurassic volcanic and sedimentary sequence.

In the Slate Creek District, Seattle-St. Louis Mining Co. trenched on two veins parallel to the adits at the Minnesota mine. Western Gold Mining, Inc., rehabilitated mine portals at the New Light mine.

### *Yakima County*

Ardic Exploration and Development Ltd. continued exploration for bulk tonnage gold and silver in a Tertiary volcanic complex at the Morse Creek property in the Summit Creek District. Work at the property included drilling, geochemical sampling, and geology.

### *Statewide*

Several companies explored for precious metals throughout the state. Asarco Inc. and Boise Cascade Minerals conducted exploration programs in the northeast part of the state. Exploration Ventures Co. employed geologic mapping and sampling in their search for precious and base metals. Property examinations were conducted by Orvana Resources Corp., Placer U.S. Inc., and M.D. Regan and Associates. Battle Mountain Gold explored for precious metal epithermal deposits. Cominco American Resources, Inc. continued exploration in the state. J.C. Foxxxx Mining explored for precious metals, platinum, and opal.

## INDUSTRIAL MINERALS

### Development and Exploration

Seventeen companies mined industrial minerals, producing clay, dolomite, diatomite, limestone, olivine, and silica (Table 4).

Clay was produced by three companies and was primarily used for fire brick and cement. Limestone was mined by four companies and used mainly for portland cement. Silica was produced by four companies, largely for use in manufacturing container and float glass. All four dolomite operations were located in Stevens County. The production of magnesium by Northwest Alloys, Inc. was the largest use of the dolomite. One company produced diatomite. Olivine

Table 4.–Properties producing industrial minerals, 1987

| Commodity | Property | Owner and/ or operator | County | Production and development |
|---|---|---|---|---|
| Clay | Twin River quarry | Ideal Basic Industries, Inc. | Clallam | Mined 100,000 tons |
| | Mica mine and plant | Interpace Industries Inc. | Spokane | Mined 30,000 tons |
| | Cougar Mountain pit | Mutual Materials Co. | King | Mined 170,000 cubic yd |
| Dolomite | Chewelah Eagle Mining Co. | Chewelah Eagle Mining Co. | Stevens | Leased quarry to Nanome Aggregates, Inc. |
| | Several quarries | Nanome Aggregates, Inc. | Stevens | Mined from several quarries |
| | Addy dolomite quarry | Northwest Alloys, Inc. | Stevens | Mined more than 500,000 tons |
| | White quarry | Northwest Marble Products | Stevens | Mining white dolomite |
| Limestone | Quarry near Maple Falls | Clauson Lime Co. | Whatcom | Mining |
| | Kendall quarry | Columbia Cement Corp. | Whatcom | Produced 300,000 tons before shut down |
| | Northport Limestone Division | Hemphill Brothers, Inc. | Stevens | Mining and crushing |
| | Champane Placer | Lehigh Portland Cement Co. | Pend Oreille | Mined 240,049 tons |
| | Whitestone quarry | Pacific Calcium, Inc. | Okanogan | Mining and milling |
| Olivine | Aimcor Olivine | Applied Industrial Material Corp. | Skagit | Milling of material from stockpile |
| | Swen Larsen quarry | Olivine Corp. | Whatcom | Mined 100,000 tons |
| Diatomite | Grant County pits | Witco Corp. | Grant | Produced 48,000 tons |
| Silica | Superior quarry | Ash Grove Cement West,Inc. | King | Mined 40,000 tons |
| | Easy Street claims | Bockman Construction Inc. | Pend Oreille | Mined 15,000 tons |
| | Lane Mountain Silica | Hemphill Brothers, Inc. | Stevens | Mining and milling |
| | Ravensdale mine and plant | L-Bar Products, Inc. | King | Mined 120,000 tons |

was produced by two companies, making Washington one of only two states to produce this refractory mineral.

Locations of properties discussed in this section are shown in Figures 2a and 2b. Table 2 lists producers of processed carbonate products.

### *Clallam County*

Ideal Basic Industries, Inc. continues to mine clay from the Twin River quarry. The company produced 100,000 tons of clay, which is barged to their plant in Seattle where it is used in the manufacture of portland cement. The clay is mined from weathered mudstones of the Twin River Group of Oligocene age.

### *Grant County*

Witco Corp. is the sole producer of diatomite in the state. A net production of 60,000 tons was mined from two pits; this is a reduction of 30 percent from 1986. The diatomite was mined from former lake beds interbedded with flows of the Miocene Columbia River Basalt Group. The diatomite is utilized for filler in paints and as filters.

Basic Resources Co. completed the access road to their Rock Top clay property, where exploration drilling was undertaken. The deposit consists of non-swelling bentonite that is present in sedimentary layers interbedded with the Columbia River basalts. The clay is reported to be suitable for many uses, including absorbants, oil and gas drilling muds, and filters.

### *King County*

L-Bar Products Inc. continues to mine silica sand at the Ravensdale mine and plant. Approximately 120,000 tons of sand were mined, washed, screened, and dried to produce silica for colored bottles and cement. The sand is mined from the Eocene Puget Group.

Ash Grove Cement West, Inc., entered the silica market with the start-up of production at the Superior quarry. Approximately 40,000 tons of cement-grade silica were mined there in 1987.

Mutual Materials Co. mined 170,000 cubic yards of clay for use in the manufacture of structural brick from their Cougar Mountain pit. The company also has clay pits in Pierce, Thurston, Cowlitz, and Chelan counties.

### *Okanogan County*

Columbia River Carbonates completed detailed geological mapping and modeling of the Wauconda quarry, but no new rock was mined. Production of fine-ground high-brightness calcium carbonate continued from stockpiles at the plant near Woodland in Cowlitz County.

Pacific Calcium Inc. continued quarrying of limestone and dolomite from their Whitestone property near Spectacle Lake, 13 miles northwest of Tonasket.

CM Silver Mines, Inc. a wholly owned subsidiary of Lucky Three Mining Co., conducted geologic reconnaissance and core drilling at their limestone deposit near White Rock Mountain. The company is evaluating the potential of their high-calcium limestone deposit for use in cement and for agricultural lime.

### *Pend Oreille County*

Lehigh Portland Cement Co. produced slightly more than 240,000 tons of limestone from the Champane Placer. The limestone from the Cambrian Metaline Formation is used in the production of portland cement. Lehigh is presently the only company in the state to produce portland cement from limestone mined in Washington.

Bockman Construction Inc. produced 15,000 tons of silica from an alluvial deposit derived from Addy Quartzite. Rock from the Easy Street claims is trucked to Lehigh Portland Cement Co. for use in the manufacture of portland cement.

United Catalysts, Inc., in joint venture with FRM Minerals, Inc., continued to explore their Totem Talc property.

### *Skagit County*

Applied Industrial Materials Corp. produced olivine products after screening and milling olivine from the plant stockpile. Quarry development and exploration were also undertaken.

### *Spokane County*

Interpace Industries Inc. mined 30,000 tons of clay at their Mica mine and plant. The company has been approved by the Washington State Community Economic Revitalization Board to participate in bonds issued by the board. The funds will enable the company to expand their brick factory by 7 million bricks per year. The company employs 80 workers (Journal of Business, Nov. 25, 1987).

### *Stevens County*

Northwest Alloys, Inc., a wholly owned subsidiary of Aluminum Co. of America, mined more than 500,000 tons of dolomite from the Addy dolomite quarry. Northwest Alloys' mine and plant is the highest value mineral operation in the state because of the value added to the dolomite by the production of magnesium metal at the plant. The company is one of only three producers of magnesium metal in the United States and the only one to utilize the silicothermic process (whereby magnesia in calcined dolomite is reduced by silicon). The company employed more than

460 workers in 1986 and continues as the largest employer in Stevens County (TEAM WASHINGTON, 1986).

Crushed dolomite was produced by several companies. Nanome Aggregates, Inc., continues to produce dolomite from several quarries, including one leased from Chewelah Eagle Mining Company at which approximately 5,000 tons of dolomite was mined. The white and colored stone is used for architectural aggregate, filler, and agricultural lime. Northwest Marble Products Co. continued to mine white dolomite from their quarry northeast of Kelly Hill. The stone is used in the manufacture of ceramics.

Hemphill Brothers,Inc., continued to operate two quarries in Stevens County. Silica from a friable area of the Addy Quartzite is mined at their Lane Mountain Silica quarry. The rock is crushed, floated, dried, screened, and run through a magnetic separator to produce several grain sizes of high-purity silica. Limestone from the Cambrian Metaline Formation is mined by the Northport Limestone Division.

L-Bar Products Inc. continues to produce fertilizer and de-icer from magnesium sludge from the Northwest Alloys plant.

Cortez International Ltd. acquired a state lease in the Turk mine area. The company plans to investigate the renewed potential for magnesite from the former producer.

### *Whatcom County*

Columbia Northwest Cement Corp. mined approximately 300,000 tons of limestone from the Kendall quarry, before the company was purchased in September by Tilbury Cement Co. of Delta, B.C., Canada. The kilns have been shut down, and imported clinker is now being ground at the plant. A large staff reduction followed the takeover. The company had been the largest producer of portland cement in the state to mine limestone in Washington.

Olivine Corp. produced 100,000 tons of olivine from their Swen Larsen quarry.

Clauson Lime Company continues to mine limestone from their quarry near Maple Falls. The limestone is thought to be of Pennsylvanian age (Danner, 1966).

### *Statewide Exploration*

Meridian Mineral Company explored for and developed clay, diatomite, limestone, marble, and sources suitable for crushed stone at several places across the state.

## REFERENCES CITED


Cheney, E.S.; Rhodes, B.P.; Wilson, J.R.; McMillen, D.D., 1982, Geologic excursion of high-grade metamorphic rocks and low-angle faults of the Kettle and Okanogan Domes, Washington. *In* Roberts, Sheila; Fountain, David, editors, 1982, Tobacco Root Geological Society 1980 conference guidebook: Tobacco Root Geological Society [Spokane], p. 6-25.

Danner, W.R., 1966, Limestone resources of western Washington: Washington Division of Mines and Geology Bulletin 52, 474 p.

Joseph, N.L., 1987, Washington's mineral industry, 1986: Washington Geologic Newsletter, v. 15, no. 1, p. 3-21.

Moen, W.S., 1980, Myers Creek and Wauconda mining districts of northeastern Okanogan County, Washington: Washington Division of Geology and Earth Resources Bulletin 73, 96 p.

Ott, L.E.; Groody, Diane; Follis, E.L.; Siems, P.L., 1986, Stratigraphy, structural geology, ore mineralogy and hydrothermal alteration at the Cannon mine, Chelan County, Washington, U.S.A.: Proceedings of Gold '86 Symposium, Toronto, 1986, p. 425-435.

Parker, R.L.; Calkins, J.A., 1964, Geology of the Curlew quadrangle, Ferry County, Washington: U.S. Geological Survey Bulletin 1169, 91 p.

TEAM WASHINGTON and TRICO Economic Development District, 1986, Stevens County. *In* Washington State Standard County/City Profile: Washington State Department of Trade and Economic Development, 7 p.

# Chinasaurs: The Dinosaurs of Sichuan Come to the Burke Museum

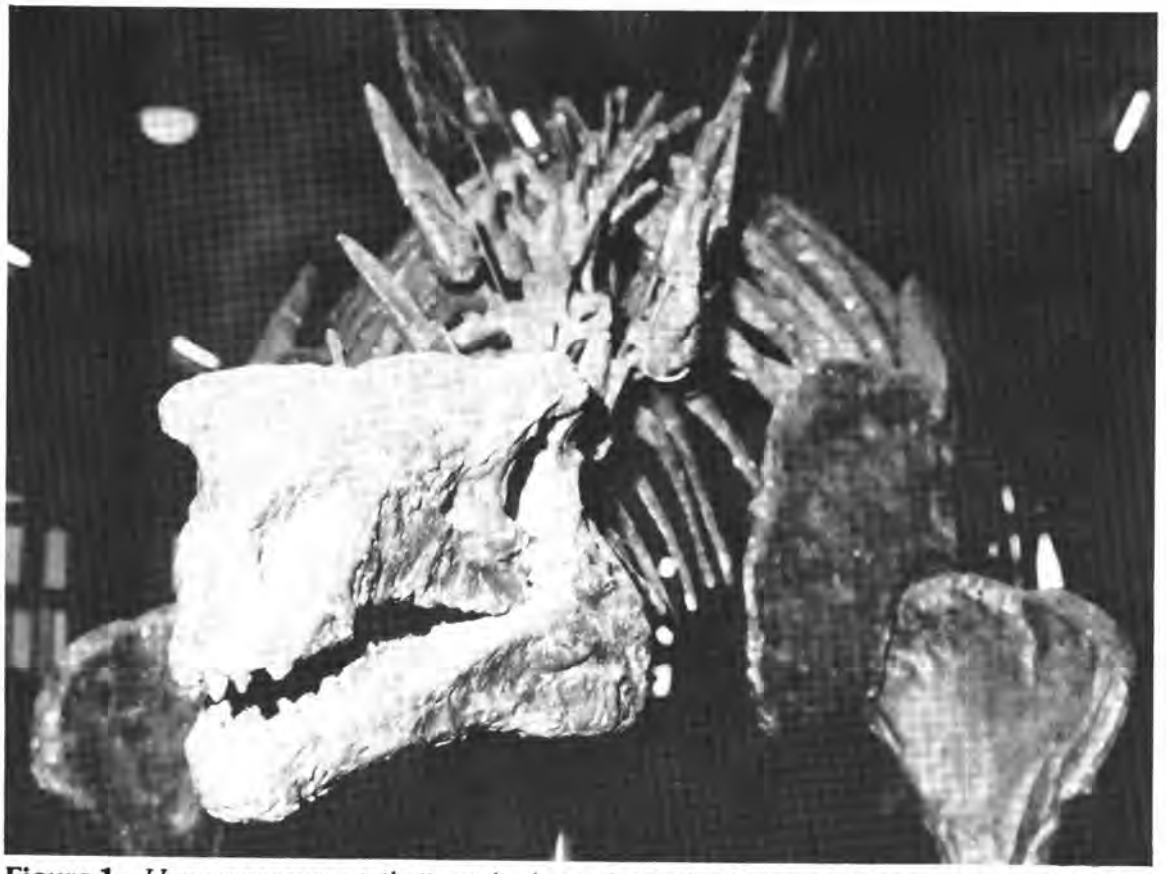


**Figure 1**—*Huayangosaurus taibaii*, on display at the Burke Museum. This species resembles the well-known American *Stegosaurus* in having a double row of plates along its back. Photo by Virgil Fassio.

The first North American viewing of dinosaur discoveries from Sichuan Province in the People's Republic of China are being presented by the Burke Museum. The exhibit, "Chinasaurs—The Dinosaurs of Sichuan", is a product of collaboration between the Chongquing Natural History Museum and the Burke Museum and is sponsored by The Seattle Post-Intelligencer and United Airlines. Eight Chinese scientists and curators have accompanied the fossils to the United States.

The core of the exhibit is three full dinosaur skeletons: *Omeisaurus fuxiensis*, a 45-foot-long plant eater with a long tail and neck; *Huayangosaurus taibaii*, a "stegosaur" type of dinosaur (Fig. 1); and *Yangchuanosaurus shangyuensis*, a massive erect meat-eater whose skull is one of the largest found in China. Ninety-eight other fossils are on view, including one of the largest nests of dinosaur eggs yet found in China, shells of extinct turtles, and dinosaur footprints.

The fossils on display are between 140 million and 160 million years old. They were recovered from an ancient lake bed, which has also yielded numerous other new forms. In fact, China's dinosaurs are unmatched in diversity and abundance. Hundreds of specimens representing 22 species have been found throughout the Sichuan Basin. While one species of stegosaur has been found in the United States, Chinese paleontologists have uncovered six species.

The dinosaurs will be on view through September 18, 1988. In conjunction with the exhibit, the museum is offering a series of lectures whose topics range from the Chinese material to the museum's efforts to expand its collection.

Admission to the exhibit costs $3.50 for adults, $2.50 for students and senior citizens, and $1 for children under 12. Group tours can be arranged by calling (206) 543-5591. More information about the exhibit and lectures is available from (206) 543-5590.

# Staff Notes

Jerry Thorsen

**Gerald (Jerry) W. Thorsen** retired from the Division at the end of February, after 30 years with the State and the Division's various predecessor agencies. Jerry came to the Division from Washington State University, The Bunker Hill Company, and Climax Molybdenum. In recent years he divided his time between on-site inspection of landslides and geologic hazards and representing the Department of Natural Resources as an expert witness in navigability, forest practices, geohydrology, seismic hazards, land-use conflicts, and other issues relating to environmental geology. Jerry looks forward to time on his boat and a relaxed pace, but we expect to see him on the "outcrop" in his capacity as consultant on geologic hazards for the Northwest Region of the Department of Natural Resources.

Bonnie Bunning

**Bonnie Bunning,** Geologist IV in the Olympia office, left the Division March 11 for a 2-year post as Chief Management Analyst for the Department of Natural Resources. In that capacity, Bonnie will examine and analyze a broad range of natural resource and management issues facing the Department and provide recommendations to the Department's executive management. The new position offers an opportunity to work with the diverse functions of the Department, from timber harvesting to natural heritage preservation and aquatic land management. Bonnie expects her background in economic geology to enable her to bring an added perspective to natural resource management in the agency.

# The State of Washington

## Proclamation

**WHEREAS,** earthquakes are among the most devastating of natural disasters; and

**WHEREAS,** earthquakes have caused death and damage in Washington state in the past, and may do so again; and

**WHEREAS,** a damaging earthquake could occur anywhere in the state without warning; and

**WHEREAS,** the citizens of Washington state must by made aware of the potential threat of earthquakes and of the measures that can be taken before, during and after a quake to save lives, protect property and mitigate damages and injuries;

**NOW, THEREFORE,** I, Booth Gardner, Governor of the State of Washington, do hereby proclaim April 10-16, 1988, as

**EARTHQUAKE AWARENESS WEEK**

in the State of Washington, and I urge all citizens to take advantage of opportunities to learn about this natural hazard.

Signed, this 22nd day of March, 1988

Booth Gardner

Governor Booth Gardner

# Earthquake Awareness Week:

## Planning and Preparation Can Reduce Losses

Because the threat of catastrophic earthquakes in Washington does not go away or diminish with time, Governor Booth Gardner has again set aside a full week for reminding citizens to prepare themselves. In this century, Washington has suffered the damaging effects of ten earthquakes, three in the month of April. The most recent occurred in Seattle on April 29, 1965; seven people were killed, and damages totalled more than $50 million (1984 dollars).

To reduce damages of this magnitude in the future, Governor Gardner has proclaimed April 10 through 16 *Earthquake Awareness Week*. Throughout the week, state and local emergency managers will be offering safety tips and information through educational programs, displays, and brochures.

"Citizens of Washington State must be made aware of the potential threat of earthquakes," Gardner stated. "They also need to know what can be done before, during, and after a quake to save lives and minimize injury and property damage." While it has been 23 years since the last damaging earthquake, another earthquake could happen at any time.

Earthquakes are caused by the shifting of the various plates that make up the Earth's crust. Vibrations of the ground accompanying the plate motions may sever phone, electric, sewer, and gas lines; destroy freeway overpasses; topple buildings; and dump tons of rubble on busy streets and sidewalks.

The Division of Emergency Management and several local emergency management agencies have prepared educational programs, brochures, and displays to help people to protect themselves from damage or injury. These will be available to the public during Earthquake Awareness Week. For more information, contact your local emergency management agency.

[From text supplied by the Department of Community Development]

**Note:** The March 1982 issue of Sunset Magazine offered an article titled "Getting ready for a big quake". In this article are many useful tips on preparing a residence for an earthquake and some basic advice about general earthquake preparedness.

The Division of Geology and Earth Resources has several technical publications about the locations and effects of earthquakes in Washington. Contact the Division for more information.

## Sources of Information about Earthquake Preparedness

From the Federal Emergency Management Agency (FEMA):

The following are representative titles; many other related publications are available from this agency. The FEMA publication number is given in parentheses. All these publications are free.

- "Earthquake Public Information Materials—An Annotated Bibliography" (67)
- "Earthquake Preparedness Information for People with Disabilities" (70)
- "Reducing the Risks of Nonstructural Earthquake Damage—A Practical Guide" (74)
- "An Action Plan for Reducing Earthquake Hazards of Existing Buildings" (90)
- "Improving Seismic Safety of New Buildings—A Non-technical Explanation of NEHRP Provisions" (99)
- "Marketing Earthquake Preparedness—Community Campaigns that Get Results" (112)

Federal Emergency Management Agency
(FEMA)
P. O. Box 70274
Washington, D.C. 20024

From the Washington State Division of Emergency Management:

- "Washington State Seismic Safety Report"

Washington State Division
of Emergency Management
Department of Community Development
4220 E. Martin Way
Olympia, WA 98504

From the U.S. Geological Survey:

- "The Interior of the Earth" (free)
- "Safety and Survival in an Earthquake" (free)
- "The Severity of an Earthquake" (free)
- "Earthquake" (free)
- "Seismicity Map of the World" ($3.10 each)

U.S. Geological Survey
Public Inquiries Office
Room 687, U.S. Courthouse
West 920 Riverside Ave.
Spokane, WA 99201

(continued on p. 24)

**Sources of Information about Earthquake Preparedness**

(continued from p. 23)

From the American Red Cross (local chapters):

- "Family Disaster Plan and Personal Survival Guide"
- "27 Things to Help Your Survive an Earthquake"
- "Safety and Survival in an Earthquake"

From county or local emergency management offices:

- "27 Things to Help You Survive an Earthquake"
- "Family Earthquake Drill"
- "Coping with Children's Reactions to Earthquakes and Other Disasters"
- "Earthquake Safety Checklist"
- "Safety Tips for Washington Earthquakes"
- "Home Hazard Hunt"
- "Learning to Live in Earthquake Country: Preparedness for People with Disabilities, and Preparedness for Apartments and Mobile Homes"

# DGER to Contribute to Timber, Fish and Wildlife Research and Monitoring Program

by
Robert (Josh) Logan

The Washington Department of Natural Resources (DNR) manages its own timberlands and regulates all non-federal timberlands within the state. With the help of funding from the Timber, Fish and Wildlife (TFW) Committee on Research and Monitoring, the Division of Geology and Earth Resources (DGER) can now initiate a preventive approach to landslide hazards.

An engineering geologist is currently being sought by DGER to complete a TWF pilot program for mapping landslide hazards on forested lands. Slope processes and landslide inventory maps will be completed for a test area to be selected by the project geologist. The map information will be compared in a series of manually prepared or computer-generated overlays to develop hazard zonation maps that may be used by field personnel to identify landslide hazards.

The pilot project will also be useful in determining the applicability of computerized geographic information systems to slope stability problems. Both DNR and the U.S. Geological Survey (USGS) have such systems available. The USGS has completed several landslide hazard maps for California. However, Washington has different terrain, geology, and forest cover than California; these differences may limit the utility of current computer programs in this type of project in Washington.

# Meetings

**American Mining Congress MINExpo International**

April 24-28, 1988
McCormick Place, Chicago, IL
For further information, write:

AMC MINExpo International '88
1920 N Street NW
Suite 300
Washington, DC 20036

**Pacific Northwest Metals and Minerals Conference**

AIME Columbia Section, "Gold Quest"
May 4-6, 1988
Sheraton Hotel
Spokane, WA
For further information, write:

PNMMC (AIME)
c/o NWMA
414 Peyton Bldg.
Spokane, WA 99201
(509) 624-1150

**Mineral Collecting Opportunities in Washington** (continued from p. 2)

***Washington State Mineral Council***

This is an umbrella organization for all rockhound clubs in the state of Washington. Their most noted activity is the establishment of recreational rockhound sites for the enjoyment of the public and club members. Walker Valley (Skagit County) and Hansen Creek (King County) are examples of such sites. For further information about the council, contact:

Earl Barnhart, President
Washington State Mineral Council
E. 2404 Desmet
Spokane, WA 99202

***Friends of Mineralogy, Pacific Northwest Chapter***

This chapter has members in British Columbia, Idaho, Oregon, and Washington. Members are primarily interested in mineral collection and the science of mineralogy. The group hosts an annual symposium in Tacoma during September. For information, contact:

Richard O'Donnell, President
Friends of Mineralogy
4601 E. 18th St., Apt. #57
Vancouver, WA 98661

***Society of Paleologgers***

This is an international organization drawing most of its members from the Pacific Northwest and having its headquarters in the state of Washington. Members' interests lie in collecting, display, and study of petrified wood. For membership information, contact:

L. Steve Edmondson, Secretary
Society of Paleologgers
6202 - 48th Ave. East
Tacoma, WA 98443

## Mining Awareness Week

The United States Senate has proclaimed April 24-30, 1988, as "Mining Awareness Week". A similar House resolution was being sponsored by Representative Jim Wright of Texas and others. Following is the text of Senate Resolution 298:

**Whereas**, the minerals extracted from the earth have opened doors to progress throughout history and are vital to the continuation of civilization;

**Whereas**, modern mining machinery, equipment and services permit the best available mining and reclamation technology on industry properties;

**Whereas**, the mining industry has made and will continue to make essential contributions to the industrial development of the United States, its standard of living, national security, and international competitiveness;

**Whereas**, the ability of the domestic mining industry to survive and prosper at home and in the international market is vital to the economic well-being and world leadership position of this nation; Now, therefore, be it

**Resolved**, That the Senate of the United States hereby proclaims April 24-30, 1988, Mining Awareness Week, in recognition of the domestic mining industry, which created, established and maintained our Nation's industrial cornerstone resulting in benefits to the entire world.

## Summer Course Offered: Geology of the Cascade Range

Portland State University is offering a summer session geology course, Aug. 1-19, 1988. This course covers the main features of the Cascade Range between Lassen Volcanic National Park, California, and Snoqualmie Pass, Washington. Participants travel by private vehicle and camp out. One prior geology course at an accredited institution is a prerequisite; no text book is required, but background reading is recommended.

A written report, due Aug. 26, completes requirements for a grade; 6 graduate credits can be earned. The course is tailored for geology teachers (high school, community college), geology students, and professional geologists. Cost: $310 undergraduate, $490 graduate; no additional charge for out-of-state participants. Syllabus: $20. Course charges payable at registration. Trip costs will include sharing transportation costs, camping fees, food, photocopying.

For futher information write or call the instructor:

Associate Professor Paul E. Hammond
Geology Department
Portland State University
Portland, OR 97207
telephone (503) 464-3022.

# Selected Additions to the Division of Geology and Earth Resources Library

**January-February, 1988**

## THESES

Christenson, L. G., 1986, Genesis of gold mineralization in the Lone Jack mine area, Mt. Baker mining district, Washington: Western Washington University Master of Science thesis, 87 p., 2 plates.

McCulla, Michael S., 1986, Geology and mineralization of the White River area, King and Pierce Counties, Washington: Oregon State University Doctor of Philosophy thesis, 213 p., 5 plates.

Rau, Robert L., 1987, Sedimentology of the Upper Cretaceous Winthrop Sandstone, northeastern Cascade Range, Washington: Eastern Washington University Master of Science thesis, 197 p.

## U.S. GEOLOGICAL SURVEY REPORTS

Dinehart, Randy, 1987, Vertical profiles of velocity and suspended sediment in streams near Mount St. Helens, Washington: U.S. Geological Survey Open-File Report 87-377, 140 p.

Jacobson, Muriel, compiler, 1987, Proceedings of workshop XXXVII, Physical and observational basis for intermediate-term earthquake prediction: U.S. Geological Survey Open-File Report 87-591, 2 v.

Kresch, D. L., 1987, Flood hazard assessment of the Hoh River at Olympic National Park ranger station, Washington: U.S. Geological Survey Water-Resources Investigations Report 86-4198, 22 p., 1 plate.

McClellan, P. H.; Snavely, P. D., Jr., 1987, Multichannel seismic-reflection profiles collected in 1976 off of the Washington-Oregon coast: U.S. Geological Survey Open-File Report 87-607, 2 p., 1 plate.

Radbruch-Hall, D. H.; Edwards, Kathleen; Batson, R. M., 1987, Experimental engineering-geologic and environmental-geologic maps of the conterminous United States: U.S. Geological Survey Bulletin 1610, 7 p., 5 plates.

Skrivan, J. A., 1987, Ground-water hydrology of the Toppenish Creek basin, Yakima Indian Reservation, Washington: U.S. Geological Survey Water-Resources Investigations Report 82-4010, 47 p.

## GEOLOGICAL SURVEY OF CANADA REPORTS

Canada Geological Survey, 1988, Current research, Part E, Cordillera and Pacific margin: Canada Geological Survey Paper 88-1E, 290 p.

Davis, E.; Currie, R.; Sawyer, B., compilers, 1987, Bathymetry—Explorer Ridge: Canada Geological Survey Marine Geophysical Maps of Western Canada, Map 4, 1 sheet, scale 1:250,000.

Davis, E.; Currie, R.; Sawyer, B., compilers, 1987, Bathymetry—Northern Vancouver Island margin: Canada Geological Survey Marine Geophysical Maps of Western Canada, Map 5, 1 sheet, scale 1:250,000.

Davis, E.; Currie, R.; Sawyer, B., compilers, 1987, Bathymetry—Northern Juan de Fuca Ridge: Canada Geological Survey Marine Geophysical Maps of Western Canada, Map 6, 1 sheet, scale 1:250,000.

Davis, E.; Currie, R.; Sawyer, B., compilers, 1987, Bathymetry—Southern Vancouver Island margin: Canada Geological Survey Marine Geophysical Maps of Western Canada, Map 7, 1 sheet, scale 1:250,000.

Davis, E.; Currie, R.; Sawyer, B., compilers, 1987, Bathymetry—North central Juan de Fuca Ridge: Canada Geological Survey Marine Geophysical Maps of Western Canada, Map 8, 1 sheet, scale 1:250,000.

Davis, E.; Currie, R.; Sawyer, B., compilers, 1987, Bathymetry—South central Juan de Fuca Ridge: Canada Geological Survey Marine Geophysical Maps of Western Canada, Map 9, 1 sheet, scale 1:250,000.

Davis, E.; Currie, R.; Sawyer, B., compilers, 1987, Acoustic imagery—Explorer Ridge: Canada Geological Survey Marine Geophysical Maps of Western Canada, Map 12, 1 sheet, scale 1:250,000.

Davis, E.; Currie, R.; Sawyer, B., compilers, 1987, Acoustic imagery—Northern Vancouver Island margin: Canada Geological Survey Marine Geophysical Maps of Western Canada, Map 13, 1 sheet, scale 1:250,000.

Davis, E.; Currie, R.; Sawyer, B., compilers, 1987, Acoustic imagery—Northern Juan de Fuca Ridge: Canada Geological Survey Marine Geophysical Maps of Western Canada, Map 14, 1 sheet, scale 1:250,000.

Davis, E.; Currie, R.; Sawyer, B., compilers, 1987, Acoustic imagery—Southern Vancouver Island margin: Canada Geological Survey Marine Geophysical Maps of Western Canada, Map 15, 1 sheet, scale 1:250,000.

Davis, E.; Currie, R.; Sawyer, B., compilers, 1987, Acoustic imagery—North central Juan de Fuca Ridge: Canada Geological Survey Marine Geophysical Maps of Western Canada, Map 16, 1 sheet, scale 1:250,000.

Davis, E.; Currie, R.; Sawyer, B., compilers, 1987, Acoustic imagery—South central Juan de Fuca Ridge: Canada Geological Survey Marine Geophysical Maps of Western Canada, Map 17, 1 sheet, scale 1:250,000.

Dyke, A. S.; Prest, V. K., 1987, Paleogeography of northern North America, 18,000—5,000 years ago: Canada Geological Survey Map 1703A, 3 sheets, scale 1:12,500,000.

Dyke, A. S.; Prest, V. K., 1987, Late Wisconsinan and Holocene retreat of the Laurentide ice sheet: Canada Geological Survey Map 1702A, 1 sheet, scale 1:5,000,000.

Yorath, C. J.; Clowes, R. M.; MacDonald, R. D.; and others, 1987, Marine multichannel seismic reflection, gravity and magnetic profiles—Vancouver Island continental margin and Juan de Fuca Ridge: Canada Geological Survey Open File 1661, 26 p., 7 plates.

## OTHER REPORTS OF INTEREST

Association of State Floodplain Managers, 1987, Realistic approaches to better floodplain management; proceedings of the 11th annual conference: University of Colorado Natural Hazards Information Center Special Publication 18, 322 p.

Biggs, D. L., editor, North-central Section of the Geological Society of America: Geological Society of America DNAG Centennial Field Guide 3, 448 p.

Brown, E. H.; Blackwell, D. L.; Christenson, B. W.; Frasse, F. I.; Haugerud, R. A.; Jones, J. T.; Leiggi, P. A.; Morrison, M. L.; Rady, P. M.; Reller, G. J.; Sevigny, J. H.; Silberberg, D. S.; Smith, M. T.; Sondergaard, J. N.; Ziegler, C. B., 1987, Geologic map of the northwest Cascades, Washington: Geological Society of America Map and Chart Series MC-61, 10 p., 1 pl., scale 1:100,000.

Building Seismic Safety Council, 1985, NEHRP recommended provisions for the development of seismic regulations for new buildings; 1985 edition: U.S. Federal Emergency Management Agency Earthquake Hazards Reduction Series 17, 18, and 19, 120 p.

Building Seismic Safety Council, 1986, Guidelines for preparing code changes based on the NEHRP recommended provisions (1985 edition): U.S. Federal Emergency Management Agency Earthquake Hazards Reduction Series 21, 120 p.

Geological Society of America Committee for the Magnetic Anomaly Map of North America, 1987, Magnetic anomaly map of North America: Geological Society of America DNAG Continent-scale Map 003, 4 sheets, scale 1:5,000,000.

King County Parks, Planning and Resources Department, 1987, Sensitive areas map folio, King County, Washington: King County Parks, Planning and Resources Department, 1 v.

Northwest Petroleum Association, 1987, Symposium, program and abstracts: Northwest Petroleum Association, 1 v.

Peterson, Donald; Conklin, Allen; Jeffries, Aileen; Melby, Lynn; Ziegler, Gordon, 1987, Special investigation report by the Department of Social and Health Services Iodine-129 Task Force: Washington Department of Social and Health Services, 59 p.

Ruddiman, W. F.; Wright, H. E., Jr., editors, 1987, North America and adjacent oceans during the last glaciation: Geological Society of America DNAG Geology of North America, v. K-3, 501 p., 2 plates.

U.S. Forest Service, 1987, Proposed land and resource management plan, Mt. Baker-Snoqualmie National Forest: U.S. Forest Service, 1 v.

U.S. Forest Service, 1987, Public summary, draft environmental impact statement, proposed land and resource management plan, Mt. Baker-Snoqualmie National Forest: U.S. Forest Service, 65 p., 14 plates.

Washington Department of Emergency Services, 1984, Proceedings of the 1983 National Seismic Policy Conference, November 1-3, 1983, Seattle, Washington: Washington Department of Emergency Services, 1 v.

# Division Releases "Selected Papers on the Geology of Washington" and Three Open-File Reports

The Division of Geology and Earth Resources announces the publication of its Bulletin 77, "Selected Papers on the Geology of Washington". J. Eric Schuster is editor of this volume. The 406-page book is a collection of technical papers derived from a symposium presented at the Cordilleran Section meeting of the Geological Society of America in 1982. Not all talks given at the symposium are represented in the volume, and several papers on related topics have been added to those from the symposium. Virtually all papers have been updated within the last year. The 19 papers cover topics ranging from geochronology to tectonics and from the Priest River metamorphic complex to the Columbia River basalts to recent deposits at Mount St. Helens.

The publication is available from the Division's Olympia office; its address is given on page 2 of this newsletter. The price is $14.84 + 1.16 tax (Washington residents) = $16.00. Please add $1 to each order for postage and handling.

Connie Manson, Division librarian, has compiled literature about landslides in western Washington. Open File Report 88-1, which is 58 pages long, is titled "Landslides of western Washington—A preliminary bibliography and index". The index is arranged primarily by county or geographic area.

A second bibliography, also compiled by Connie Manson, covers literature for Ferry County. Open File Report 88-2, "Bibliography of the geology and mineral resources of Ferry County, Washington, 1900-1987" is 58 pages long. It contains a subject index, and the bibliographic entries are also listed by geologic age of the described materials.

Open File Report 87-17 is a series of geologic maps of the Twisp River-Chelan Divide region of the North Cascades of Washington. The author of this report is Robert B. Miller of San Jose State University. A summary map is at 1:100,000-scale, and 11 component maps are at 1:24,000.

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