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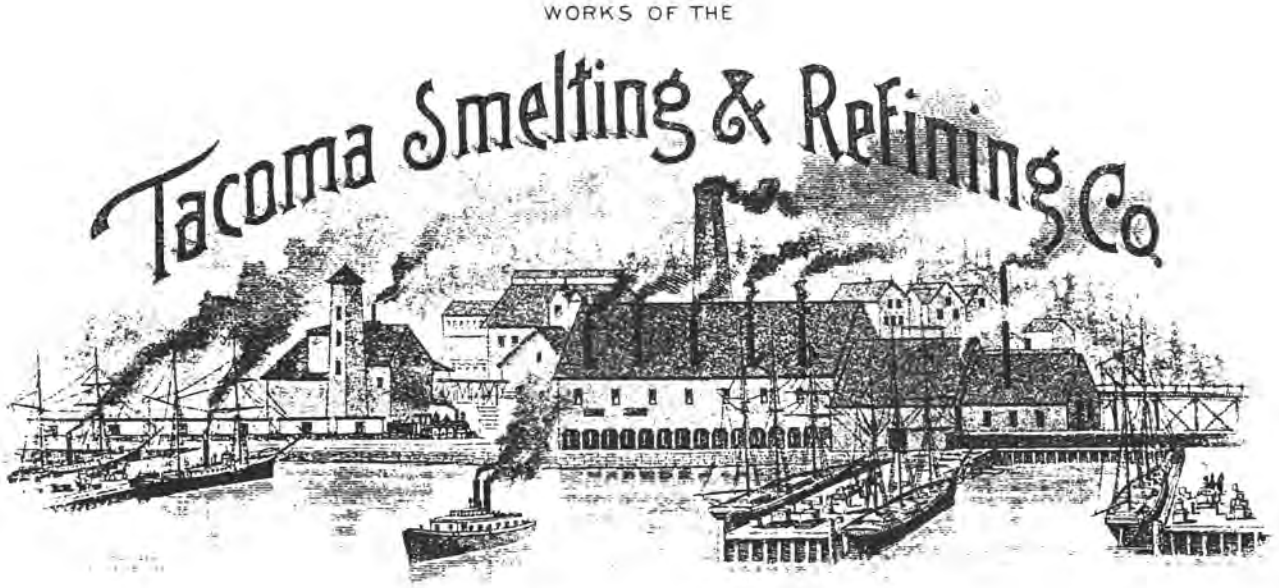

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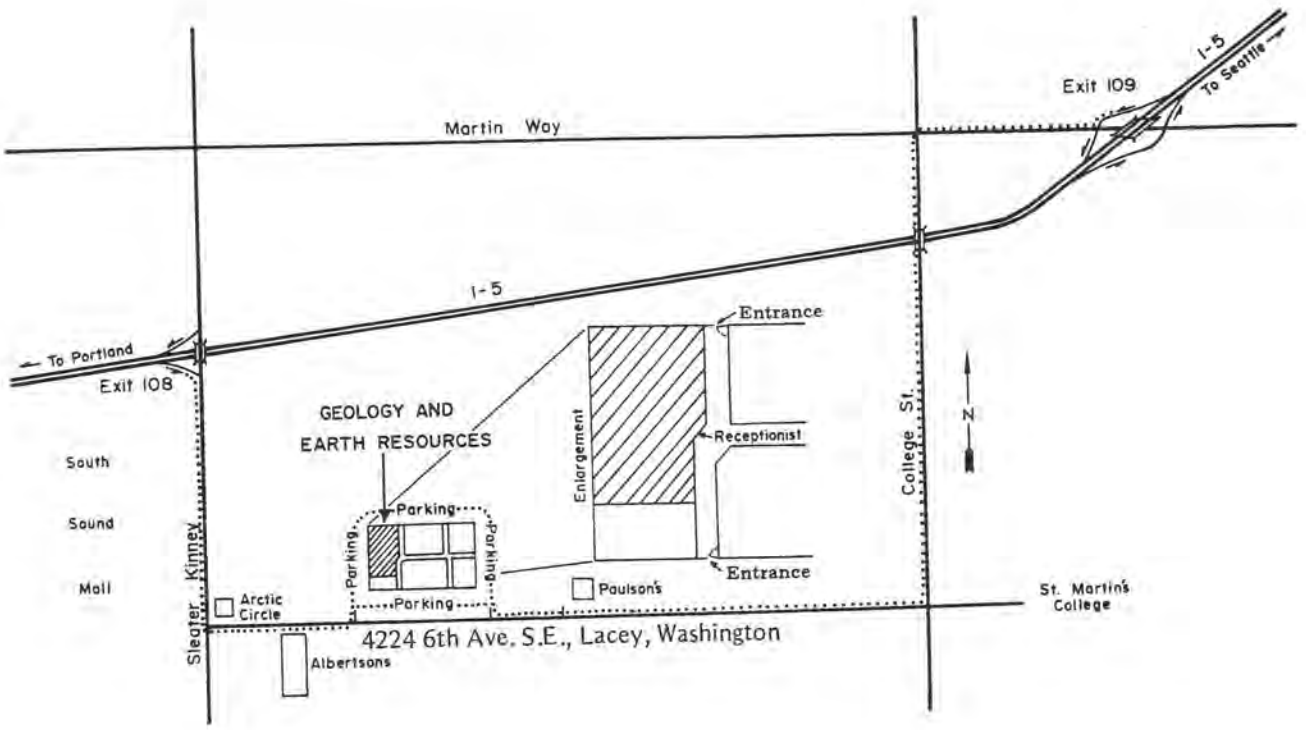

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The Washington Geologic Newsletter, a quarterly report of geologic articles, is published by the Division of Geology and Earth Resources, Department of Natural Resources. The newsletter is free upon request.

The division also publishes bulletins, information circulars, and geologic maps. A list of these publications will be sent upon request.

WASHINGTON'S MINERAL INDUSTRY, 1983

By Bonnie B. Bunning*

Data for the 1983 summary of mineral activity was voluntarily supplied on a Division of Geology and Earth Resources questionnaire mailed to the mining companies.

Private investment in Washington's metallic mineral resources totalled $13,664,300 in 1983 — four times higher than the 1982 figure. The dramatic increase was due primarily to advanced development of three mining projects around the state. Predevelopment exploration was funded at essentially the same level as in 1982 ($3,660,300), although 25 percent more firms (68) contributed to the effort in 1983.

Reported exploration expenditures for industrial minerals declined slightly, from $1,228,500 in 1982 to $1,050,200 in 1983. At the same time, the number of exploration projects increased significantly. A few producers noted improvement in market conditions this year, while others saw no change from the depressed economy of 1982. Altogether, 90 firms produced minerals or carried out exploration in Washington in 1983.

Revenues from mining, prospecting, and quarrying on state land ($578,574) increased significantly from fiscal year 1982, but remained well below the 1981 high of $656,542 (fig. 1). The 1983 increase was due to substantial recovery in sales of crushed stone, sand, and gravel. Rentals and royalties from mining activities continued a 2-year decline, while the number of prospecting leases and mining contracts jumped 300 percent,

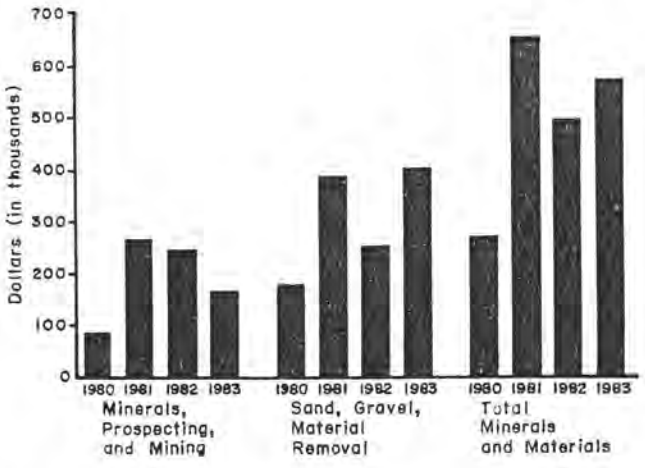

FIGURE 1. — Trends in revenue from minerals and materials on state lands.

from 352 in 1982 to 1,158 in 1983. The monetary impact of this activity will be reflected in the 1984 figures.

Oil and gas leases (1,163) returned $527,516 in fees and royalties to the state. Royalties and lease-option agreements for coal on state lands netted $26,200. Total state-land's revenue from the mineral and energy industry in Washington was $1,132,263.

It is to be emphasized that the following data come from questionnaires completed and returned to us voluntarily by mining companies. As such, this summary is certainly incomplete. Most particularly, there are approximately 900 permitted surface mines in Washington, producing mostly sand and gravel and rock, that are not mentioned in this report.

METALLIC MINERAL ACTIVITY

Nine mining projects were under production or development in 1983 (table 1) — more than twice the number of active properties reported for 1982. New ventures include the Flodelle Creek project, the Gold Dike mine, the Deer Trail mine, and the Cannon mine. Flodelle Creek, an open-pit uranium mine, was brought onstream in November. Plans call for a 2½-year project life, producing 100,000 pounds of yellow cake annually. At the Gold Dike mine near Danville, 100,000 tons of ore were mined from a new open pit during the summer. Gold Dike ore is crushed to minus 3/8 inch and leached to recover gold and silver. The Deer Trail mine near Fruitland officially began production on October 7th. To date, the underground mine has produced approximately 240 tons of silver concentrate containing approximately 185 oz/ton silver, 27 percent zinc, and 21 percent lead from the new Madre workings. Discovery of gold reserves in Wenatchee spurred advanced development of the new Cannon mine. Extensive drilling there has outlined significant tonnages of gold ore, which will be mined underground beginning in 1985.

A minimum of 68 exploration companies were active in Washington this past year (table 2). Most of these companies (60) listed gold and silver as the commodity of interest. Numerous other firms and individuals held land in the Wenatchee gold play, but did not reveal their level of interest. Fourteen firms explored for lead and zinc; thirteen looked for copper; six targeted molybdenum;

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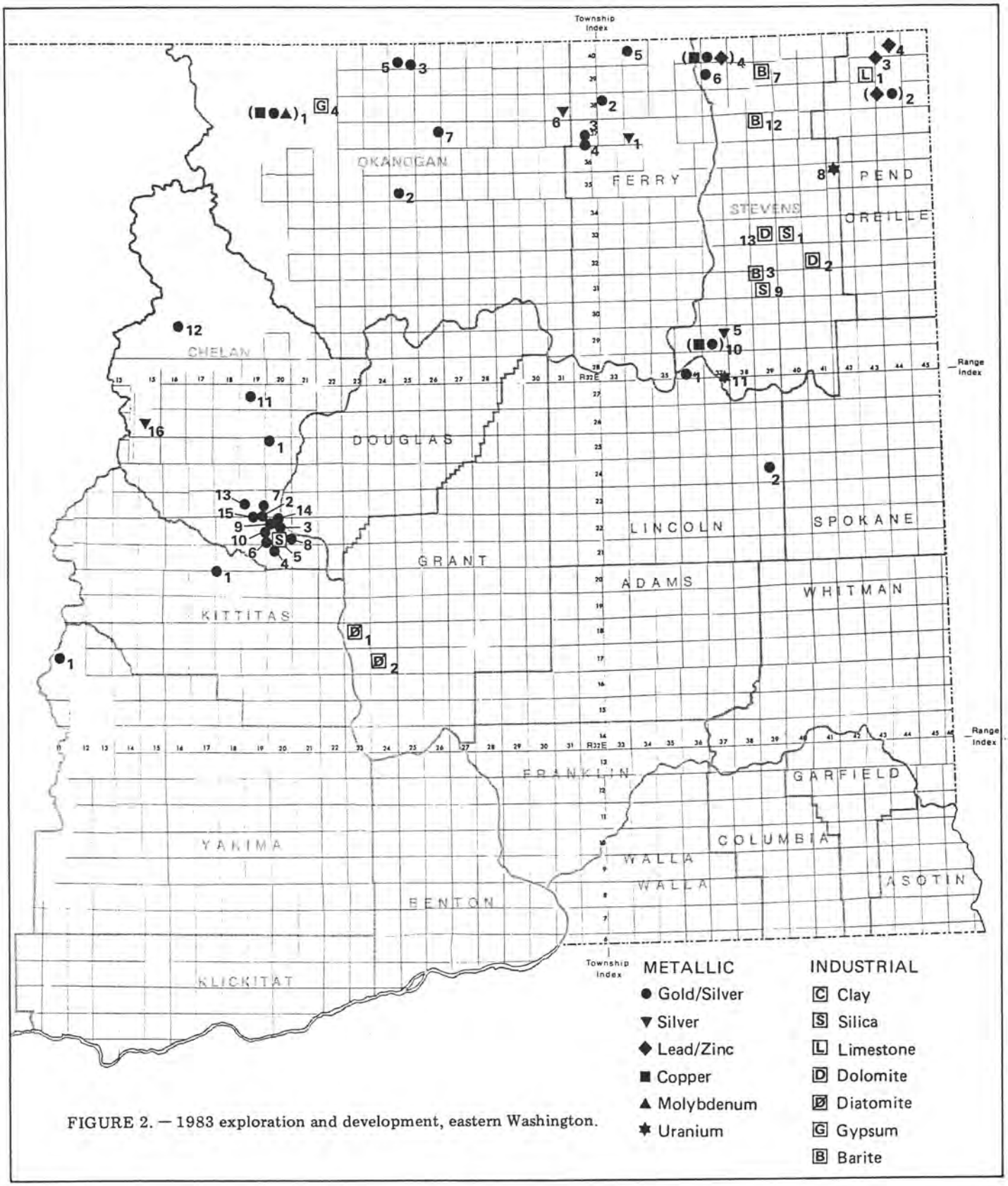

FIGURE 2. — 1983 exploration and development, eastern Washington.

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6. H-2 property - Cove Energy Corp. and Petrogold Resources Corp.
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Grant County

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Kittitas County

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2. Junction Reef - Rexcon, Inc., and Veronex Resources Ltd.

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6. Silver Bell mine - Rocky Mines Co.
7. Turtle Lake prospect - L. F. Baum and Associates

Pend Oreille County

1. Lehigh cement quarry - Lehigh Portland Cement Corp.
2. Noisy Creek claims - George Costa
3. Pend Oreille mine - Pintlar Corp.
4. Slate Creek area - La Sota-Jones Lead-Zinc Corp.

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1. Blue Creek silica quarry - Northwest Alloys, Inc.
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8. Flodelle Creek mine - Joy Mining Co.
9. Lane Mountain silica quarry - Lane Mountain Silica Co.
10. Orazada mine - Orazada Mines, Inc.
11. Sherwood mine - Western Nuclear, Inc.
12. Uribe deposit - C-E Minerals, Combustion Engineering, Inc.
13. West dolomite pit - Northwest Alloys, Inc.

Yakima County

1. Morse Creek area - Ardic exploration and Development Ltd., Inc.

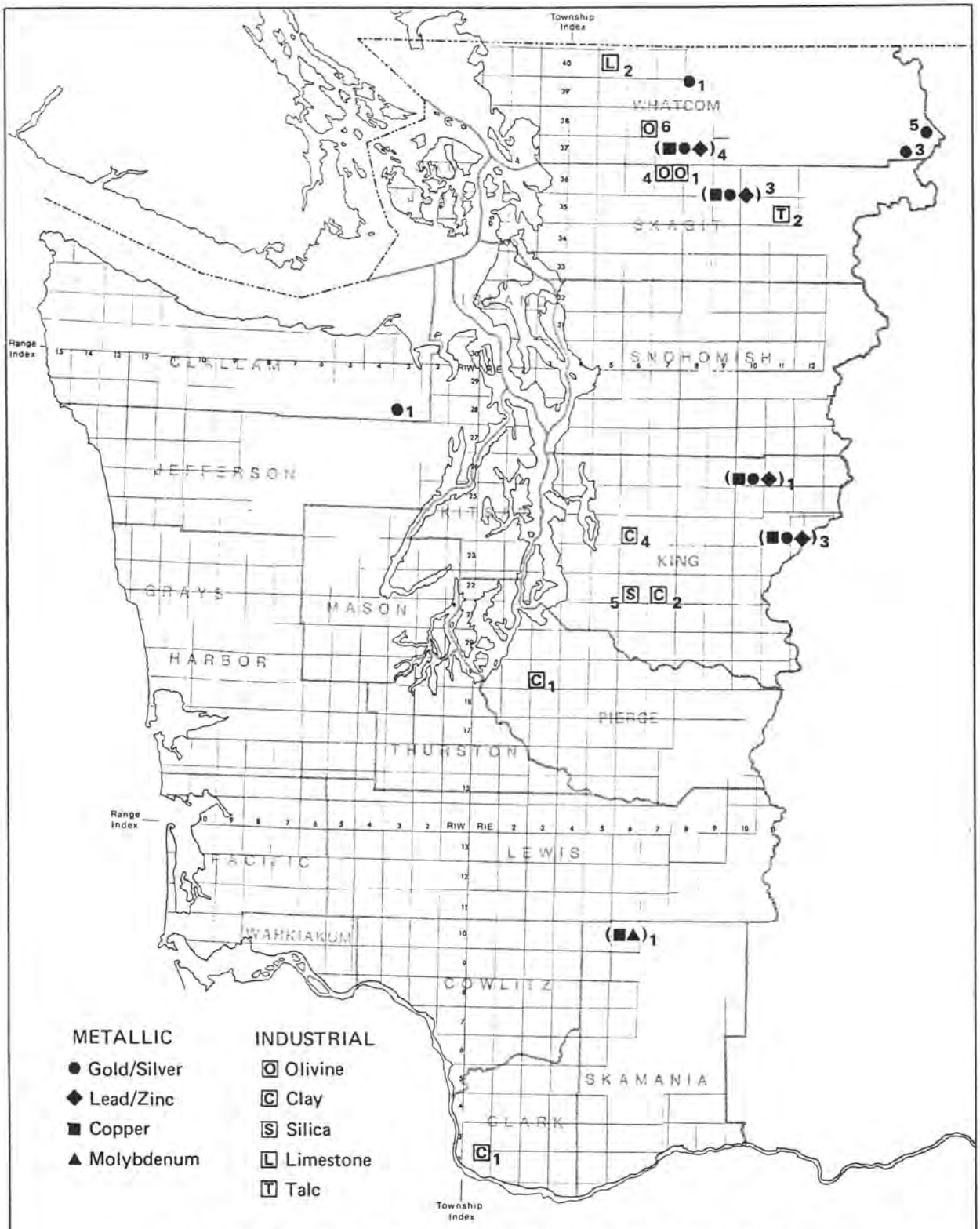

FIGURE 3. — 1983 exploration and development, western Washington.

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1. Slab Camp Creek - Savercool Mining and Consulting Co.

Clark County

1. Hidden deposit - Hidden Brick Co.

King County

1. Damon and Apex mines - CSS Management Corp.
2. Elk pit - Mutual Materials Co.
3. Gilbreath Middle Fork properties - United Cascade Mining Inc.
4. Harris clay mine - North American Refractories Co.
5. Ravensdale silica sand mine - Industrial Mineral Products

Pierce County

1. Clay City pit - Mutual Materials Co.

Skagit County

1. IMC olivine property - IMC Olivine
2. Londonderry deposit - United Cascade Mining Inc.
3. Sauk Mountain area - Chevron Resources Co.
4. Twin Sisters quarry - IMC Olivine

Skamania County

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Whatcom County

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2. Kendall quarry - Columbia Cement Corp.
3. Minnesota mine - Seattle-St. Louis Mining Corp.
4. Mount Baker area - Chevron Resources Co.
5. Slate Creek district - Ardic Exploration and Development Ltd., Inc.
6. Swen Larsen quarry - Olivine Quarry

TABLE 1. — *Active metal mines in Washington, 1983*

County	Project Name	Company	Commodity	Production Data
Chelan	Cannon mine	Asamera, Inc. Breakwater Resources, Ltd.	Au, Ag	Advanced development
King	Apex and Damon mines	CSS Management Corp.	Au, Ag	700+ tons +0.10 oz/ton Au +10.0 oz/ton Ag
Ferry	Gold Dike mine	Vulcan Mountain, Inc.	Au, Ag	100,000 tons 0.10 oz/ton Au 0.15 oz/ton Ag
	Knob Hill mine - Republic unit	Hecla Mining Co.	Au, Ag	60,000 tons 0.23 oz/ton Au 1.23 oz/ton Ag
	Seattle mine	Crown Resource Corp.	Au, Ag	Production data unavailable
Okanogan	Silver Bell mine	Rocky Mines, Inc.	Ag	800 tons 10-12 oz/ton Ag
Stevens	Deer Trail mine	Madre Mining, Ltd.	Ag (Cu,Pb,Zn)	Approx. 240 tons silver concentrate containing approx. 185 oz/ton Ag, 27% zinc, 21% lead
	Flodelle Creek mine	Joy Mining Co.	U	Mine start-up Nov. 1983
	Sherwood project	Western Nuclear, Inc.	U	204,284 tons 0.08% U_3O_8

six continued exploration for uranium; and four explored for tungsten. Tin, cobalt, antimony, gallium, and manganese were each mentioned once in this year's poll. Activity was concentrated in Chelan, Ferry, Stevens, and Okanogan Counties. Kittitas, Whatcom, Lincoln, King, Skagit, and Clallam Counties also received attention for precious-metal exploration.

Overall, 1983 registered slight gains in mining and exploration activity around the state. Spokane's mining industry remained stable relative to recent years, and several major projects were initiated. While recovery is not yet in full swing, these factors indicate a significant improvement in economic outlook for 1983.

Chelan County

Last year (1982) only two companies reported to the Washington Division of Geology and Earth Resources about active gold exploration in Chelan County. That number jumped to 19 in 1983, when spectacular drilling results were announced by Asamera, Inc. and Breakwater Resources Ltd. from what is now the Cannon mine near Wenatchee. At least 45 other companies are known to hold land positions in the area (*Canadian Mines Handbook*, 1983). More than half of the money spent for gold and silver exploration in the state was invested in Chelan County. Through October 31st, Asamera, Inc. expended $6 million to develop 4 to 6 million tons of ore grading 0.20 oz/ton gold. More than a mile of new underground workings are currently in progress at the mine. A new decline, initiated from the B-Reef workings, is being driven northeast through stable rhyolite of the Wenatchee Dome. The tunnel will eventually turn northwest to test the new find in Dry Gulch. At the same time, a 22-foot diameter shaft is being sunk from the surface. The first quarter of 1985 is targeted for initial mine production.

Control Energy Corp., 51 percent owned by Breakwater Resources, Ltd., intersected in an angle drill hole 10 feet of 0.196 oz/ton gold on their Meyer's project located in sec. 7, T. 22 N., R. 20 E., between Number One and Number Two Canyons in the Wenatchee area. Drilling will continue to delineate the find.

Drilling plans were announced this fall on two other projects in the Wenatchee area. Joint-venture partners — Cumo Resources, Ltd., Starburst Energy Corp., and Altar Gold Resources — began drilling at the Sleepy Hollow project in October. Prior exploration outlined four anomalies on the property, where past drilling is reported to have intersected significant gold values in one shallow drill hole.

Weaco Resources was slated to begin drilling for gold in September on their property located near South Hills Drive and Red Apple Road. The Weaco prospect,

TABLE 2. — *Index of mining and mineral exploration for metallic commodities, 1983*

County	Company	Commodity
Chelan	Altar Gold Resources	Au, Ag
	Asamera, Inc.	Au, Ag
	Breakwater Resources, Ltd.	Au, Ag
	Control Energy Corp.	Au, Ag
	Cove Energy Corp.	Au, Ag
	Cumo Resources, Ltd.	Au, Ag
	De Baca Resources	Au, Ag
	E & B Exploration, Inc.	Au, Ag
	EXVENCO	Au, Ag
	Feldslite Corporation of America	Ag, Ga
	Heron Resources, Ltd.	Au
	Leader Resources, Inc.	Au
	Lincoln Resources, Inc.	Au, Ag
	Northern Energy	Au
	Pedersen Northwest Mining Services	Au, Ag
	Petrogold Resources Corp.	Au, Ag
	Starburst Energy Corp.	Au, Ag
	Teck Resources (U.S.) 1983 Inc.	Au, Ag, Pb, Zn
	Templar Mining Corp.	Au, Ag
	Trojan Energy	Au
	Weaco Resources	Au
Clallam	Savercool Mining and Consulting Co.	Au, Ag
Ferry	Amoco Minerals Co.	Au, Ag
	Canorex International, Inc.	Au, Ag, Pb, Zn
	Crown Resource Corp.	Au, Ag
	EXVENCO	Au, Ag
	Gold Leaf Mining Corp.	Ag
	Hecla Mining Co.	Au, Ag
	Vulcan Mtn., Inc.	Au
King	CSS Management Corp.	Au, Ag, Cu, Pb, Zn
	United Cascade Mining, Inc.	Au, Ag, Cu, Mo, Pb, Zn
Kittitas	EXVENCO	Au, Ag
	Savercool Mining and Consulting Co.	Au, Ag
	St. Joe American Corp.	Au, Ag
Lincoln	Rexcon, Inc.	Au
	Veronex Resources Ltd.	Au
	Western Exploration, Inc.	Ag, Au
Okanogan	Ardic Exploration & Development Ltd., Inc.	Au
	L. F. Baum and Associates	Au, Ag
	Crown Resource Corp.	Au, Ag
	EXVENCO	Au, Ag
	Goldstar Resources, Inc.	Ag, Au
Okanogan	Kaaba Resources Inc.	Ag
	Rocky Mines Co.	Ag
	Rocky Mountain Energy	U
	Sunshine Valley Minerals, Inc.	Au, Ag, Cu, Mo
Pend Oreille	George Costa	Au, Ag, Co, U, W, Pb, Zn, Mo, Cu, Sb, Mn
	LaSota-Jones Lead-Zinc Corp.	Ag, Pb, Zn
	Pintlar Corp.	Pb, Zn
Skagit	Chevron Resources Co.	Au, Ag, Cu, Pb, Zn
Skamania	Duval Corp.	Cu, Mo
Stevens	David Beck	Au, Ag, U
	Canorex International, Inc.	Au, Ag, Pb, Zn
	Chewelah Eagle Mining Co.	Au, Ag, Cu
	EXVENCO	Au, Ag
	Joy Mining Company	U, Ag
	Madre Mining Ltd.	Au (Pb, Zn)
	Minexco Inc.	Au, Ag, Cu, Pb, Zn
	Orazada Mines, Inc.	Au, Ag, Cu
	Rocky Mountain Energy	U
	Vanhorn and Watson Mining Co.	Au, Ag, Cu, Pb, Zn
	Western Nuclear, Inc.	U
Whatcom	Ardic Exploration & Development Ltd., Inc.	Au
	Chevron Resources Co.	Au, Ag, Cu, Pb, Zn
	Seattle St. Louis Mining Co.	Au, Ag
	U.S. Borax and Chemical Corp.	Au, Ag
Yakima	Ardic Exploration & Development Ltd., Inc.	Au
Statewide Reconnaissance	American Copper and Nickel Co., Inc.	Unspecified commodity
	L. F. Baum and Associates	Mo, U, W
	Boise Cascade Corp.	Au, Ag, Cu, W, Pb
	Callahan Mining Corp.	Au, Ag
	Cominco American Inc.	Au, Ag, Pb, Zn
	Getty Mining Co.	Au, Ag, Cu, Pb, Zn
	Nord Resources	Au, Ag
	Phelps Dodge Corp.	Au, Ag, Cu, Mo, W, Sn
	Placer Amex, Inc.	Unspecified commodity
	Sunshine Mining Co.	Unspecified commodity

comprised of state and private leases, adjoins gold-bearing ground held by Asamera, Inc. in Dry Gulch to the south.

Lincoln Resources, Inc., a Canadian mining company, joined with other exploration firms to support an airborne magnetics survey of the Wenatchee area. Lincoln Resources is currently exploring for gold in the Burch Mountain area, on property acquired from Pederson Northwest Mining Services, a local placer gold mining firm.

Northern Energy (Canada) mapped, sampled, and trenched their Canyon Two property near Wenatchee in the search for precious metals. Another Canadian firm, Trojan Energy, joined them in exploration of the 1A-2A leases near Entiat.

"Wenatchee Gold" was also the target of exploration for Leader Resources, Inc. The British Columbia-based firm is working with Teck Resources (U.S.) 1983, Inc. to develop their property 3 kilometers south of the new Cannon mine.

Cove Energy Corp., in joint venture with Petrogold Resources Corp., is ready to drill two anomalous zones on the H-2 gold property southwest of Wenatchee. The two zones were delineated by soil geochemistry.

Considerable work was done this year by Teck Resources (U.S.) 1983, Inc. on their holdings in the Wenatchee area. Ground VLF and EM surveys accompanied geological mapping and geochemical sampling.

Three properties near Wenatchee were the exploration target of Templar Mining Corp. – the Neel mine, and Jacobsen and Hill properties in T. 22 N., R. 20 E. and T. 23 N., R. 19 E.

Plans were announced by De Baca Resources to begin a two-phased exploration program on their lease northwest of Wenatchee. The firm plans to include an I.P. survey, detailed geochemistry, and drilling in the later phases of work.

Heron Resources, Ltd., mapped and sampled for gold at the Palmer property near Entiat.

E & B Exploration, Inc., rehabilitated the old workings on Red Mountain in northern Chelan County. Additional effort was spent prospecting and sampling in the area.

Feldslite Corp. of America has reportedly developed a new process to extract silver and gallium from biotite. The company plans to process large biotite veins that were found while drilling the Wenatchee Ridge feldspar deposit.

EXVENCO reports gold exploration in Chelan County at an unspecified location.

Wenatchee Silica Products, Inc. also got involved in the local gold boom this year. They report extensive exploration of their Dry Gulch property by Asamera, Inc. and have sold mineral rights on 80 acres to Weaco Resources for gold exploration.

Clallam County

Savercool Mining and Consulting Corp. of Kent targeted the Red Limestone Member of the Crescent Formation for their 1983 gold-silver exploration. The favorable rocks were also mapped and sampled as a guide to potential massive-sulfide mineralization in venting centers of the Crescent Volcanics.

Ferry County

Vulcan Mtn., Inc., brought the Gold Dike mine into production this year near Danville. The ore, averaging 0.10 oz/ton gold and 0.15 oz/ton silver, is taken from a pyritic syenite dike of the Shasket Creek alkalic complex. To date, 100,000 tons of ore have been prepared for cyanide-leach recovery.

In the Republic area, Hecla Mining Co. produced 13,800 ounces of gold and 73,800 ounces of silver from the old Knob Hill mine. Late in November, the company announced they had exhausted known reserves and anticipated mine closure by mid-1984. Exploration in the Republic district will continue after mining operations have ceased.

Near the Knob Hill, Crown Resource Corp. began producing gold and silver from the old Seattle mine, an epithermal vein system localized in tuffaceous sediments. The company also explored for gold at the South Penn and Granny properties.

Amoco Minerals Co. drilled their Empire Creek property near the western margin of the Republic graben. Permian to Triassic greenstones in the prospect area have been intruded by Cretaceous(?) granitic rocks and Oligocene andesite porphyry dikes.

Gold Leaf Mining Corp. of Seattle mapped and sampled for silver in the Cooke Mountain area east of Curlew Lake. Cooke Mountain is underlain by Permian to Triassic sedimentary rocks intruded by the Scatter Creek Rhyodacite (Eocene).

Gold and base-metals activity was also reported by Canorex International, Inc., and EXVENCO in Ferry County.

The Colville Confederated Tribes continued to seek an operating partner for their Mount Tolman molybdenum deposit near Keller. Several firms are reported to be seriously evaluating the project.

King County

Two hundred feet were added to the Apex mine's haulage tunnel in 1983. CSS Management Corp. produced 700 tons of ore grading more than 0.10 oz/ton gold and 10 oz/ton silver from the Apex and Damon workings. With help from the U.S. Bureau of Mines Reno Research Center, CSS has installed pressure-leaching equipment in their mill to help treat the complex sulfide ore without pollution.

Assessment-level drilling was carried out at the Gilbreath Middle Fork property (Au, Ag, Cu, Mo, Pb, Zn) by United Cascade Mining Co., Inc., of Seattle.

Kittitas County

Although numerous state sections were leased for prospecting in the county this year, only three companies report active gold-silver exploration. St. Joe American Corp. explored their several hundred claims in the Morning Star Group this season. The gold claims are located in an area of Swauk Sandstone near Liberty, Washington. Savercool Mining and Consulting Co. was active in the same area, mapping and sampling structures in the Swauk Formation for sandstone-hosted, Carlin-type gold deposits. EXVENCO geologists also considered the gold potential of Kittitas County.

Lincoln County

Lincoln County drew a lot of attention from investors this year when Veronex Resources Ltd. announced their discovery of gold on Magnison Butte, south of Reardan. Mapping, sampling, and trenching of the quartz-cemented phyllite breccia and surrounding altered

rocks revealed several anomalous zones and visible gold in a few places. Follow-up work is continuing by Rexcon, Inc., geologists for Veronex Resources.

Western Exploration, Inc., was reported to have optioned the Fouress mine after finding gold and silver in the old dumps. The mine is located on the north side of Pitney Butte in quartz veins cutting fine-grained quartz monzonite of Cretaceous(?) age (*Engineering and Mining Journal*, August 15, 1983, p. 3).

Okanogan County

Of the nine companies exploring for metals in Okanogan County this year, all but one sought gold and silver.

Rocky Mountain Energy reports reconnaissance-level mapping and sampling for uranium in the county, along with their more detailed work in parts of Stevens County.

Rocky Mines Co. produced nearly 800 tons of ore from the Silver Bell mine. The ore, which was milled by Hecla Mining Co. in Republic, graded between 10 and 12 ounces of silver to the ton. In addition, mine-site exploration uncovered a small tonnage of material reportedly running as much as 700 oz/ton silver. Further drilling is planned to delineate the new zone.

The Ruby Silver mine in the Nighthawk District was sampled extensively this year by Kaaba Resources, Inc. Geologic mapping and sampling, both on the surface and underground, accompanied underground diamond drilling. Historically, the mine has produced ore averaging 10 oz/ton silver from a 3-foot (average) shear zone in granodiorite.

Elsewhere in the district, Gold Star Resources, Inc., of Oroville acquired the King Solomon and Prize mines this past year and began surface exploration of the two properties. The Prize mine is developed on a quartz vein and breccia in greenstone country rocks. Lead, gold, silver, and copper values are carried in the vein. The King Solomon was reportedly worked for gold, silver, and copper. Gold Star also began drilling their Silver Bluff mine in the Conconully area. The Silver Bluff mine, which produced until the early 1920's, exploits a quartz vein carrying argentite and chalcocite.

Sunshine Valley Minerals, Inc. of Manson, reports exploration and mine development on their Billy Goat and Buckhorn projects this year. Both properties are predominantly copper-molybdenum deposits which carry values in gold and silver.

Gold and silver were also the object of exploration by L. F. Baum and Associates. The company focused attention on the Turtle Lake prospect in the Galena mining district west of Tonasket.

Two other companies, Crown Resource Corp. and EXVENCO, sought precious metals in the county.

Pend Oreille County

The Pintlar Corporation, formerly The Bunker Hill Co., continued to develop potentially significant tonnages of shallow Yellowhead (pyritic) ores in the vicinity of the Pend Oreille mine. Detailed geologic mapping of the district and surface core drilling comprise their ongoing research program. The Pend Oreille mine itself remains idle and the company plans to shut off the underground pumps and let the mine start flooding in December.

To the north in the Slate Creek area, La Sota-Jones Lead-Zinc Corp. maintained their lead, zinc, and silver properties with assessment-level exploration.

Forty-eight claims on the southwest flank of Hall Mountain along Noisy Creek were the target of trenching and shallow drilling by George Costa of Ione. Costa reports showings of gold, silver, cobalt, uranium, tungsten, molybdenum, copper, zinc, cadmium, antimony, magnesium, and manganese.

Skagit County

Gold, silver, copper, lead, and zinc in upper Paleozoic intermediate volcanics were the target of exploration by Chevron Resources Co. in the Sauk Mountain area of the north Cascades.

Skamania County

Duval Corp. reports only assessment-level exploration at their Margaret property, a copper-molybdenum porphyry system northeast of Mount St. Helens.

Stevens County

The first shovel of bog muck was loaded late this year at Joy Mining Co.'s new Flodelle Creek uranium mine. The geologically young uranium (Pleistocene to Recent) is filtered out of enriched surface water by the organic constituents of the bog's soil horizon. Grades average 0.09 percent U_3O_8. The ore will be milled on site and the yellow cake sold to buyers overseas.

Western Nuclear, Inc. reports their mill on the Spokane Indian Reservation was back in production in March, and the mine resumed limited production in May. Mining and milling had been suspended in July of 1982 at the Sherwood project. The Midnite mine operated by Dawn Mining Co. remained completely shut down for the year.

Exploration for uranium on the Orient property was continued at a low level by Rocky Mtn. Energy. The company also reports conducting mapping and sampling programs near Camas, southwest of Sprindale, and on

property within the Spokane Indian Reservation boundary.

Underground production began in October from the Deer Trail mine near Fruitland. The silver vein system is being developed by Madre Mining Ltd., Vancouver, B. C. This year's underground mining on the new Madre tunnel has delineated two areas at the Hoodoo and Madre levels with a total of 40,000 tons of ore grading an average of 20 oz/ton silver. Subsidiary values in lead, zinc, and copper will be recovered. Madre plans to keep 6 months of reserves ahead of the mill by continuous underground drilling and exploration. In 1982, the mine produced 70,000 ounces of silver, 4,600 pounds of copper, 38,000 pounds of lead, and 40,000 pounds of zinc from tailings left by the early-day miners. The concentrates are shipped to Trail, B. C. for smelting. As of November 6, 1983, approximately 240 tons of silver concentrate containing approximately 185 oz/ton silver, 27 percent zinc, and 21 percent lead has been mined from the new workings.

Mine development of the Copper Penny and Gold Nugget claims was reported by Vanhorn and Watson Mining Co. in the Summit Mountain area of northern Stevens County.

Canorex International, Inc., explored 15 different properties in Stevens and Ferry Counties this year.

Near Chewelah, exploration continued on the Eagle Group of claims owned by Chewelah Eagle Mining Co.

To the south, Orazada Mines, Inc., proceeded with exploration at the Orazada mine, where values in silver, gold, lead, and zinc are found in narrow shear zones in argillite and limestone.

The Huckleberry Mountains were the focus for stream-sediment and soil-geochemical surveys by Minexco, Inc., a Spokane company exploring for gold, silver, copper, lead, and zinc.

EXVENCO and Joy Mining Co. also explored for precious metals in Stevens County this year.

Whatcom County

A new firm, Ardic Exploration and Development, Ltd., Inc., of New York City, conducted an extensive surface and underground evaluation of the New Light mine in the Slate Creek district.

Elsewhere in the district, small-scale exploration, consisting of shallow trenching and underground sampling, was carried out by Seattle-St. Louis Mining Co. at the Minnesota mine.

Chevron Resources Co. is presently exploring the Mount Baker area for gold, silver, copper, lead, and zinc deposits in upper Paleozoic intermediate volcanic rocks.

Only assessment work was reported for the Excelsior silver mine, owned by U.S. Borax and Chemical Corp.

Yakima County

Ardic Exploration and Development Ltd., Inc., acquired the Morse Creek property late in the year. Sampling is in progress on the porphyry system with potential for bulk tonnages of gold and silver.

Statewide Reconnaissance

Around the state, companies were seeking various commodities on a reconnaissance basis. Two companies with extensive timber-land holdings — Boise Cascade Corp. and Meridian Land and Mineral Co. — continued evaluation of their lands for metallic and industrial mineral potential.

Base and precious metals were the target of Callahan Mines Corp., Cominco American, Inc., Phelps Dodge Corp., Getty Mining Co., Nord Resources, and L. F. Baum and Associates. Limited property examinations were reported by American Copper and Nickel Co., Inc., Placer Amex, Inc., and Sunshine Mining Co.

INDUSTRIAL MINERALS

Thirty-one companies produced and explored for industrial commodities in 1983, about the same number that reported work in 1982. On the bright side, limestone, clay, and dolomite producers all note significant improvement in economic outlook over last year (table 4). The limestone industry increased production by more than 50 percent. Clay production increased 20 percent and silica and dolomite output were up 15 and 11 percent, respectively.

Demand for barite, talc, and olivine remained depressed and producers shipped primarily from pre-existing stockpiles. No change was reported in production of gypsum and diatomite.

While slightly fewer dollars were invested in exploration this year (according to data supplied to the Washington Division of Geology and Earth Resources), many more companies were looking for new nonmetallic deposits (table 5). And, for the first time, traditional metal-mining companies joined in the search for industrial minerals.

Chelan County

In 1983, Wenatchee Silica Products, Inc., produced approximately 102,322 tons of silica for use as a fluxing agent and as a component of cement and ferrosilicon

TABLE 3. —*Index of mining and mineral exploration for industrial minerals and stone/crushed rock*

County	Company	Commodity
Chelan	Wenatchee Silica Products, Inc.	Silica
Clallam	Ideal Basic Industries, Inc.	Clay
	Savercool Mining and Consulting Co.	Crushed rock
Clark	Hidden Brick Co.	Clay
Grant	Witco Chemical Corp.	Diatomite
King	Industrial Mineral Products, Inc.	Silica
	Mutual Materials Co.	Clay
	North American Refractories Co.	Clay
	Palmer Coking Coal Co.	Crushed rock
Okanogan	Agro Minerals, Inc.	Gypsum
	Sunshine Valley Minerals, Inc.	Silica, diatomite
Pend Oreille	LaSota-Jones Lead-Zinc Corp.	Barite
	Lehigh Portland Cement Co.	Silica, limestone
Pierce	Mutual Materials Co.	Clay
Skagit	Cascade Talc, Inc.	Talc
	IMC Olivine	Olivine
	International Mining and Chemical Corp.	Olivine
	B. Sterling	Olivine
Spokane	Interpace Corp.	Clay
Stevens	David Beck	Barite
	C-E Minerals, Combustion Engineering, Inc.	Barite
	Chewelah Eagle Mining Co.	Dolomite
	Lane Mountain Silica Co.	Silica
	Nanome Aggregates, Inc.	Dolomite
	Northwest Alloys, Inc.	Dolomite, silica
Whatcom	Columbia Cement Corp.	Limestone
	Olivine Corp.	Olivine
	B. Sterling	Talc
Statewide Reconnaissance	L. F. Baum and Associates	Silica, diatomite, olivine, barite
	Boise Cascade Corp.	Silica, barite
	Cominco American Inc.	Barite, limestone
	Meridian Land and Mineral Co.	Crushed rock, industrial minerals

TABLE 4. —*Production of industrial minerals in Washington, 1983*

County	Project	Company	Commodity	Net production (tons)
Chelan	Dry Gulch silica	Wenatchee Silica Products, Inc.	Silica	102,322 (SiO_2)
Clallam	Twin River quarry	Ideal Basic Industries Inc.	Clay	120,000
Grant	George area pits	WITCO Chemical Corp.	Diatomite	65,000
King	Ravensdale silica sand mine	Industrial Minerals Products, Inc.	Silica	90,000
	Elk pit (King Co.) and Clay City pits (Pierce Co.)	Mutual Materials Co.	Clay	70,000
	Harris clay mine	North American Refractories, Co.	Clay	7,000
Okanogan	Poison Lake mine	Agro Minerals, Inc.	Gypsum	3,850
Pend Oreille	Lehigh quarry	Lehigh Portland Cement Co.	Silica, limestone	200,000
Pierce	Clay City pits (Pierce Co.) and Elk pit (King Co.)	Mutual Materials Co.	Clay	70,000
Stevens	Chopot barite	David Beck	Barite	300
	Flagstaff Mountain mine	C-E Minerals, Combustion Engineering, Inc.	Barite	---
	Chewelah Eagle claims	Chewelah Eagle Mining Co.	Dolomite	400
	Lane Mountain mine	Lane Mountain Silica Co.	Silica	146,174
	Various quarries	Nanome Aggregates, Inc.	Dolomite	16,000
	West dolomite pit	Northwest Alloys, Inc.	Dolomite	500,547 (1.38% SiO_2)
	Blue Creek quartzite quarry	Northwest Alloys, Inc.	Silica	65,956 (averaging 1.2% Al_2O_3)
Whatcom	Kendall quarry	Columbia Cement Corp.	Limestone	500,000
	Swen Larsen quarry	Olivine Corp.	Olivine	---

TABLE 5. — *Comparison of industrial mineral companies reporting exploration and development 1982 and 1983*

Commodity	1982	1983
Barite	5	6
Clay	2	5
Diatomite	1	3
Dolomite	3	3
Gypsum	1	1
Limestone, Marble	5	4
Olivine	2	5
Rock (crushed)	ND	4
Silica	8	8
Talc	1	2

manufacturing. The silica is mined from particularly pure (+98 percent SiO_2) sandstone beds in the Wenatchee Formation of Oligocene age.

Clallam County

The Twin River quarry near Port Angeles on the Olympic Peninsula produced 120,000 tons of clay. The clay is shipped to Seattle by barge for use in making cement. Considerable effort was also expended for exploration and development by Ideal Basic Industries Inc. in the quarry area.

Savercool Mining and Consulting Co. explored the Olympic Peninsula for diabase dikes suitable for use as crushed rock.

Clark County

The Hidden Brick Company produced 67 tons of clay from the Hidden deposit, an open-pit operation within the Vancouver, Washington, city limits.

Grant County

In Grant County, WITCO Chemical Corporation's Inorganic Specialty Division mined 65,000 tons of diatomite from their two pits near George. WITCO spokesmen report a continual program of exploration for additional diatomite deposits both inside and outside of the state. In 1982, WITCO was one of only four diatomite producers in the nation.

King County

Clay was mined from the Elk pit in King County by Mutual Materials Co. of Bellevue. Mutual's operations in King and Pierce counties produced 70,000 tons of finished product.

Another clay producer, North American Refractories Co., took 7,000 tons from the Harris clay mine. Unfavorable business conditions were responsible for the minimum production reported there.

Palmer Coking Coal Co. investigated the potential for crushed rock in King County this year.

Okanogan County

The state's only gypsum mine produced 3,850 tons of granulated gypsum for use primarily as a soil amendment. Agro Minerals, Inc., has been mining gypsite from the Poison Lake mine since 1948. In past years, Agro has also produced magnesium sulfate from the deposit, which is located near Tonasket.

Pend Oreille

Lehigh Portland Cement Corp. quarried 250,000 tons of limestone and quartzite from quarries in the Metaline Falls area. Both commodities are used in the production of portland cement.

La Sota-Jones Lead-Zinc Corp. reports maintenance-level exploration for barite and metallic commodities in the Slate Creek area in northern Pend Oreille County.

Pierce County

In Pierce County, Mutual Materials, Co. continued working the Clay City clay pits. Seventy thousand tons of washed clay were produced from both their Pierce and King County localities.

Skagit County

Two hundred and eighty tons of industrial-grade talc was crushed and shipped from the Londonderry deposit in the county this year. No new material was mined in 1983. IMC Olivine was one of two firms that produced olivine in Skagit County. Both IMC Olivine and International Mining and Chemical Corp. (Twin Sisters quarry) milled olivine from previously-stockpiled material. IMC Olivine reports a minimum of exploration conducted to fulfill assessment requirements.

B. Sterling of Bellingham, Washington also reports only assessment-level activity on the Olivine and White Elephant claims this year.

Spokane County

The sole exploration effort in Spokane County this year took place at the Mica mine owned by Interpace Corp. Activity was limited to drilling and development of accessible high-grade clay for use in Interpace's face-brick production plant at Mica.

Stevens County

Industrial minerals continued to play a significant role in the economy of Stevens County. C-E Minerals, Combustion Engineering, Inc., produced an unspecified amount of barite from the Flagstaff Mountain deposit near Northport. They also report pre-mine development at their Uribe barite deposit on Bruce Creek.

Northwest Alloys, Inc., took 500,547 tons of dolomite grading 1.38 percent SiO_2 from their West dolomite pit. They also mined 65,956 tons of silica grading 1.20 percent Al_2O_3 from the Blue Creek quartzite quarry. Production from both quarries is consumed by their ferrosilicon and magnesium operation in Addy. At no time did Northwest Alloys operate to full capacity in 1983.

Nanome Aggregates, Inc. mined 16,000 tons of dolomite in Stevens County this year. Of the total, 400 tons was taken from property leased from Chewelah Eagle Mining Co. of Chewelah. Nanome, based in Valley, operates 14 dolomite and marble quarries in the area, and reports exploration is continuing.

Chewelah Eagle Mining Corp. also reported exploration for industrial minerals in 1983.

Lane Mountain Silica Co. had a slightly better business year in 1983 than they had in 1982. Through October 31st, Lane Mountains's operations had sold 146,174 tons of high-purity silica used primarily to manufacture glass. Other uses for the material include sand blasting and fabrication of fiberglass, foundry molds, roofing, and high-stress concrete. The silica is mined from a particularly friable section of the Addy Quartzite. No exploration was carried out by Lane Mountain this year.

Whatcom County

Columbia Cement Corp. quarried 500,000 tons of limestone from the Kendall quarry in 1983. The only other industrial mineral produced was olivine, mined from the Swen Larson quarry by Olivine Corporation. Both firms are based in Bellingham, Washington.

Assessment-level work was reported on the Rainbow talc property, operated by B. Sterling of Bellingham.

Statewide Reconaissance

Boise Cascade Corp. continued an intensive mineral evaluation of their timber lands in Washington. In addition to metallic commodities, Boise Cascade was particularly interested in potential deposits of silica and barite.

Meridian Land and Mineral Co. investigated industrial minerals this year.

Cominco American, Inc., also reports exploration for the industrial commodities, barite and limestone, at unspecified sites in the state.

COAL ACTIVITY IN WASHINGTON, 1983

By Henry W. Schasse*

Interest in Washington coal resources was strong during 1983. At least nine companies were involved in a variety of exploration, mining, and research and development projects (fig. 1). No new coal mining operations were started this past year. However, two companies, Kennecott Minerals Co. and Meridian Land and Mineral Co., operating under large exploration budgets, actively explored the state's coal resources. Several other companies were also conducting coal exploration and developing new methods for mining or alternate forms of energy production from coal.

Kennecott Minerals Co. of Salt Lake City in a joint venture with GCO Minerals Co., a subsidiary of International Paper Co., continued its large-scale exploration program for coal in southwest Washington. Kennecott has been drilling throughout the area since 1980. It has outlined a belt between Curtis and Vader in western Lewis County which contains significant reserves of lignite. Kennecott performed bulk sample tests earlier this year. The company has begun environmental baseline studies for federal, state, and local government permit applications. It also opened a local field office in Centralia. Kennecott is continuing its exploratory drilling program both regionally as well as within areas it has under lease.

In the Centralia area, Washington Irrigation and Development Co. (WIDCO) continued confirmation drilling and seam characterization on its reserve holdings in the Tono basin. During 1983 it produced 3,880,000 short tons of coal from its Centralia strip mine. Current year production represents a decline from the 4.2 million tons produced last year. WIDCO attributes the decline to general conservation and a surplus of hydroelectric power resulting from greater than normal precipitation this year.

Research and development of the underground coal gasification (UCG) process continued at WIDCO's Centralia mine. A CRIP (Controlled Retracting Injection Point System) test was performed over a 29-day period during the fall of 1983. This test represented one of extended duration over previous tests. The test was designed to burn 2,000 tons of coal employing a retracting ignition point whereby five burn cavities and four CRIP retractions were attempted. Data collected will be used to confirm design and operational parameter relationships determined during the large block tests performed last year and to provide design data for a commercial scale CRIP test. A briefing on the results of the experiment will be given to the U.S. Department of Energy (DOE) by the contractor, Lawrence Livermore National Labora-

* Geologist with Division of Geology and Earth Resources.

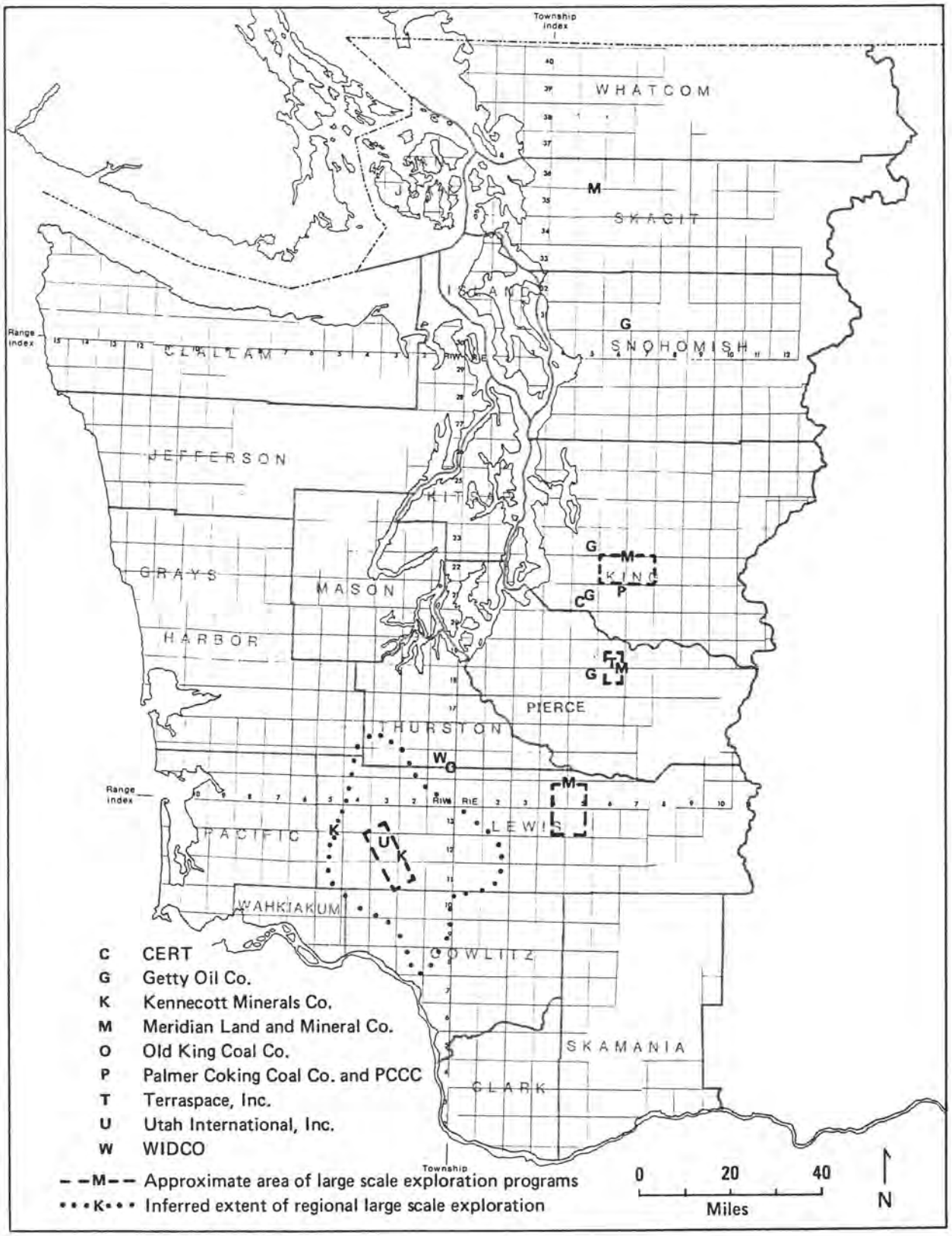

FIGURE 1. — Approximate location of coal exploration and mining activities in Washington, 1983.

tory (LLNL), in California in mid-February, 1984. The UCG tests conducted by LLNL are jointly sponsored by DOE, the Electrical Power Research Institute, and industry (WIDCO, Pacific Power and Light Co., Washington Water Power Co., and Meridian Land and Mineral Co.).

Old King Coal Co., Inc. continued its secondary coal operation at Centralia where it salvages coal from material rejected by the larger-scale beneficiation process at the WIDCO wash plant. During 1983 it produced 17,683 short tons which it sells to state institutions and local residences for space heating.

Meridian Land and Mineral Co. continued a significant core drilling program, which began last year, on its mineral holdings in the Wilkeson-Carbonado area of north central Pierce County. Meridian also extended its drilling program to include its holdings in the Green River area of southwestern King County. The company also performed preliminary surface investigation and sampling on holdings in the Mineral-Morton area of east-central Lewis County and in the Cokedale area of northwestern Skagit County during the past year.

Meridian's activities in 1983 also included preliminary studies for conducting an underground coal exploration program for the old Skookum mine east of Wilkeson. The studies involve plans for dewatering the flooded mine, constructing ancillary surface facilities and rehabilitating the underground workings in order to drill the coal seams. Plans also include geochemical testing and limited bulk sampling of coal if the dewatering and rehabilitation phases prove successful. The company has contracted for environmental studies, literature searches, and on-site investigations and has prepared an environmental checklist for review under the State Environmental Policy Act. Meridian has opened offices in Bellevue and Enumclaw to handle its Washington coal exploration program.

Terraspace Inc. of Rockville, Maryland, under contract with the U.S. Bureau of Mines, has completed the first phase of its potential site evaluation and technical and economic feasibility study of hydraulic coal mining in the Wilkeson-Carbonado coal field. The objective of the program was to design an economically viable underground hydraulic coal mining system for moderate to steeply dipping bituminous coalbeds. A draft of their report was submitted to the U.S. Bureau of Mines for review. According to Terraspace, the final report should be completed by the end of January, 1984.

Palmer Coking Coal Co. produced 7,800 short tons of coal from its stripping operations on the McKay and Big Dirty seams near Black Diamond in King County. Palmer sells its coal to state institutions and local residential customers for space heating.

Pacific Coast Coal Co. (PCCC), which announced plans last year to develop a new open-pit mine (John Henry No. 1) northeast of Black Diamond, had planned to break ground this year. PCCC has had to push back its schedule because of resistance by a local citizen group and slower than expected progress in the federal and county permitting process. Once the necessary permits are granted, PCCC hopes to begin producing at a rate of 80 to 90 thousand tons per year before reaching its planned capacity of 250,000 tons per year by 1987.

Utah International, Inc. of Salt Lake City continued to explore for coal in western Washington. Its exploration efforts for 1983 included drilling and mapping in western Lewis County.

The Council of Energy Resource Tribes (CERT) of Englewood, Colorado, is scheduled to drill two 2,500 feet holes for the Muckleshoot Indian Tribe in southwestern King County. CERT, working under a contract with the U.S. Department of Energy, is attempting to establish the existence of coal methane resources in the area.

Getty Oil Co., also of Salt Lake City, drilled four holes totalling approximately 7,000 feet in King, Pierce, and Snohomish Counties during 1983. Getty is currently reviewing its drilling results before committing to further exploration.

On May 13, 1983, the federal Office of Surface Mining (OSM) officially took over the administration of surface coal mining and reclamation in Washington. In December, OSM opened a field office in Olympia from which it will carry out inspections. Surface coal mine regulation formerly was handled by the state through the Department of Natural Resources.

OLYMPIA NOW HAS A FEDERAL OFFICE OF SURFACE MINING

The federal Office of Surface Mining is responsible for the permitting and regulation of surface coal mines. On December 12, an office was established in Olympia staffed by Robert Flowers. The address is U.S. Department of the Interior, Office of Surface Mining, 2625 Parkmont Lane, SW., Bldg. B-3, Olympia, WA 98502, phone (206) 753-9440.

COAL FOUND ON WHIDBEY ISLAND

by Timothy J. Walsh*

The U.S. Geological Survey, Water Resources Division, unexpectedly intercepted coal-bearing rocks in a deep water well in the northern part of Whidbey Island (fig. 1). Bedrock was encountered at a depth of 624 feet, or 224 feet below sea level. Geophysical logs and drill cuttings indicate probable coal intercepts centered at

* Division of Geology and Earth Resources geologist.

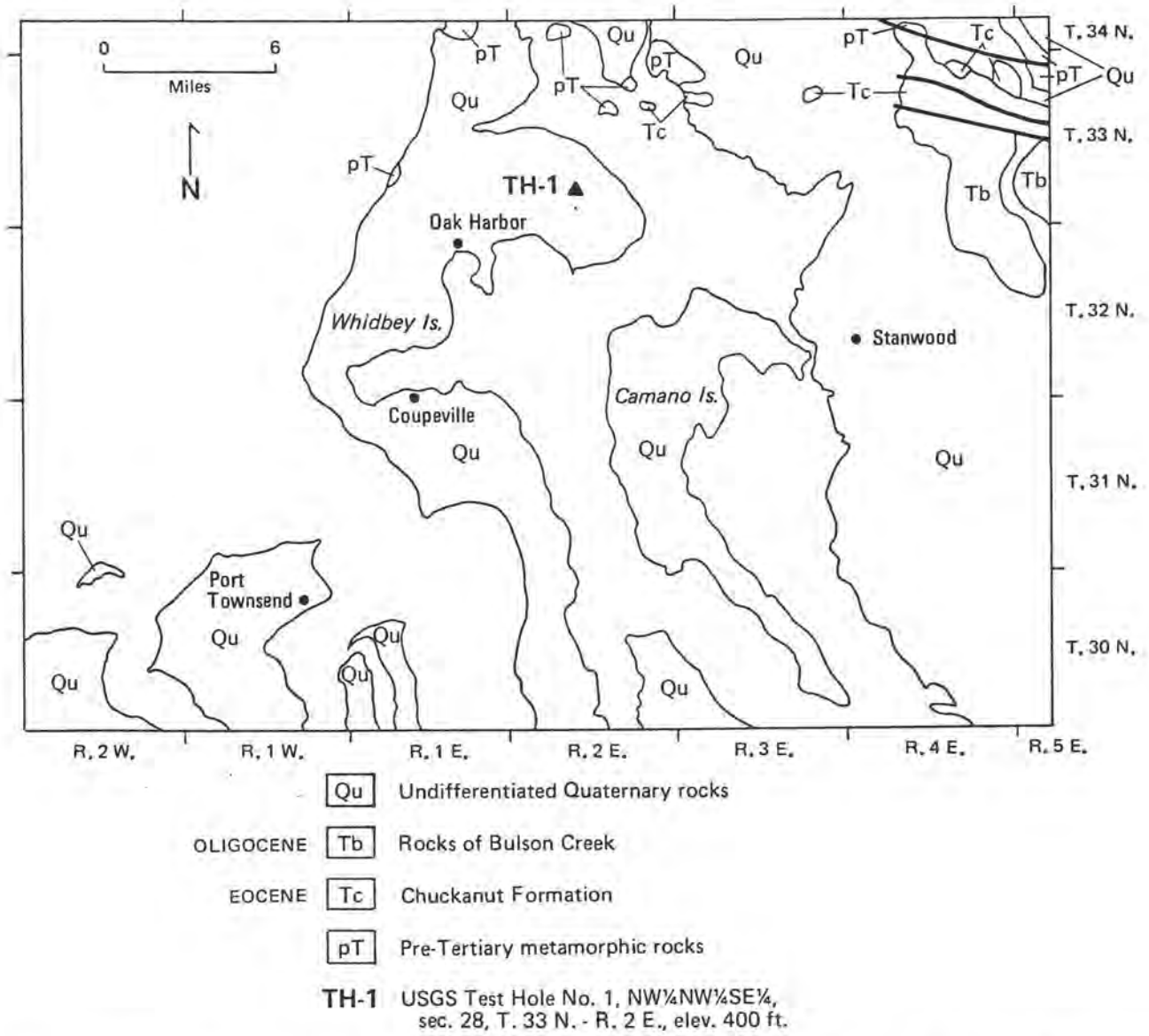

FIGURE 1. — Geologic map of vicinity of U.S. Geological Survey test hole no. 1 (modified from Huntting and others, 1961).

depths of approximately 634, 666, 690, and 728 feet. Abundant coal was returned from cuttings between 766 feet, the maximum depth of geophysical logging, and the total depth of 820 feet. Samples of drill cuttings and the logs of the hole were kindly supplied by Dave Sapik of the U.S. Geological Survey.

A lump of coal from a depth of 634 feet had a moist, mineral-matter-free BTU of 10,662, which is either high volatile C bituminous or subbituminous A in rank (ASTM Standard B 338-77). Vitrinite reflectance analysis was performed on coal cuttings from the interval 720 to 800 feet by Dr. Franklin F. Foit, of Washington State University. Mean reflectance in oil (R_o) is 0.56%$\pm$ 0.04, n = 50, which indicates that the coal is high volatile C or high volatile B bituminous in rank (Castano and Sparks, 1974; McCartney and Teichmuller, 1972). Some of the telinite, a coal maceral derived from wood, contains framboidal pyrite infilling plant tissue, suggesting a possible marine influence. In hand specimen, massive pyrite is visible on some cleat surfaces. Specific gravities of larger chips of coal (3/8 inch to 1½ inches) were deter-mined on a Jolly balance to be 1.34, 1.34, 1.36, 1.56, and 1.58 gm/cc for coal from a depth of 634 feet. Microfossils were not observed in the interseam rocks, which are mostly siltstone, so the age of these rocks is presently not known.

Eocene coal-bearing rocks of the Chuckanut Formation are exposed approximately 20 miles to the north-northeast. Sandstones exposed as close as 4 miles to the northeast on Ika Island have been referred to the Chuckanut Formation (Bechtel, Inc., 1979). Chuckanut Formation coals range in rank from high volatile C bituminous

near Bellingham to anthracite near Mount Baker (Walsh and Phillips, 1983). Oligocene coal-bearing rocks, known informally as the rocks of Bulson Creek (Loveseth, 1975), are exposed as close as 11 miles to the east (Marcus, 1981). Data are sparse and poorly documented, but coals from the Bulson Creek rocks are reported to be subbituminous in rank.

Because the coal on Whidbey Island is apparently of higher rank than subbituminous, and because coal rank in the vicinity increases to the east (Walsh and Phillips, 1983), it is inferred that the Whidbey Island coal is more probably of Eocene age than Oligocene, and therefore, may be referrable to the Chuckanut Formation.

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THE JUNCTION REEF GOLD PROSPECT, LINCOLN COUNTY, WASHINGTON

By Bonnie B. Bunning*

INTRODUCTION

The Junction Reef prospect, located 4 miles south of Reardan (T. 24 N., R. 39 E.), drew a lot of attention as a new gold find in 1982 (fig. 1). The property, discovered in 1980, is being explored by Veronex Resources, Ltd. of Vancouver, B. C. and Rexcon, Inc. of Spokane. The area was known to local prospectors in the 1930's, but no record of the discovery exists in the literature. The prospect is geologically interesting as a potentially mineralized basement high surrounded by Columbia River basalt flows.

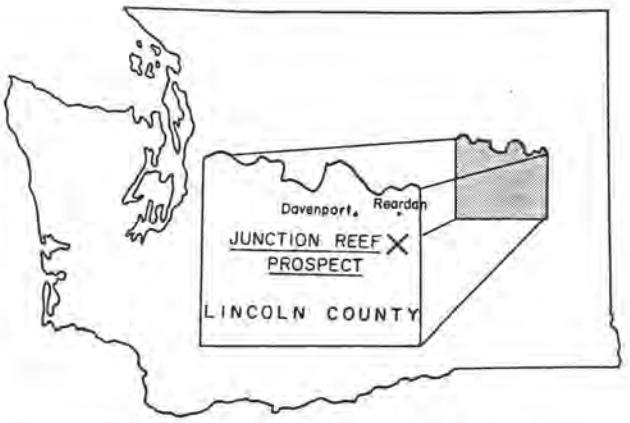


FIGURE 1. — Location map, Junction Reef prospect, Lincoln County, Washington.

GEOLOGY

Precambrian metasediments, Cretaceous(?) granite, and Eocene(?) dike rocks exposed on Magnison and Hanning Buttes are surrounded by loess-covered Columbia River basalt (fig. 2). The buttes sit on a broad topographic high within a semicircular feature observed on high-altitude aerial photos. Regional tectonic, gravity, magnetic, and photographic evidence indicates the presence of several convergent linears as well. One major linear trend is the southeast projection of the Enterprise Valley-Spokane River fault and graben, believed to be a volcanic subsidence feature related to Eocene magmatism. This major trend runs along the 12-mile long, straight, northwest-trending segment of the Spokane River and projects northwest into the Enterprise Valley, which is located about 7 miles south of Hunters.

* Geologist with the Division of Geology and Earth Resources field office in Spokane.

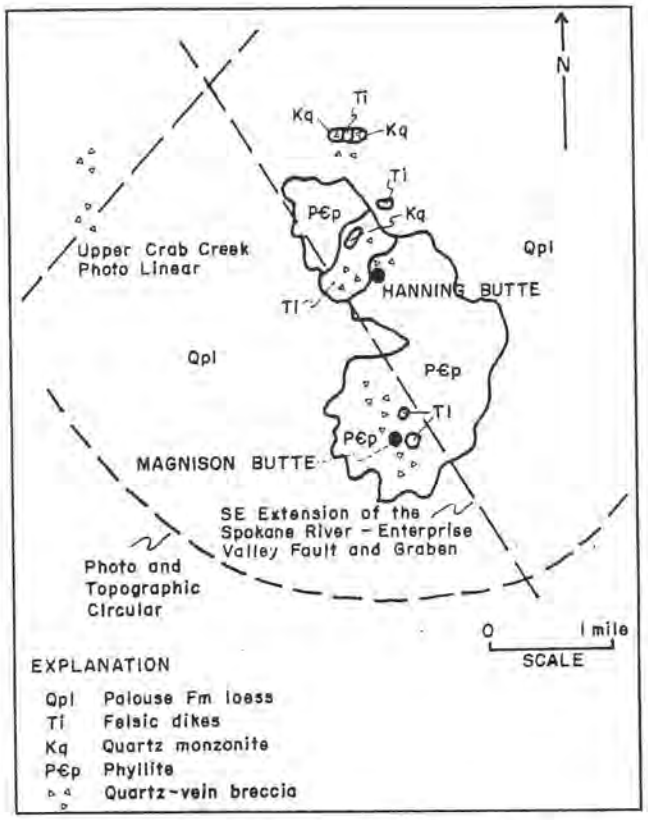


FIGURE 2. — Geologic map of the Junction Reef prospect, Lincoln County.

Siltstone and phyllite, cut by felsic dikes, underlie most of Magnison Butte. Along the axis of Magnison Butte, brecciated phyllite, cemented by at least three stages of quartz, is exposed discontinuously as outcrop and boulders for 2,500 feet on a northwest trend. Isolated occurrences of vein quartz, separated by younger cover flanking the buttes, may extend the trend several miles along strike.

ALTERATION

In the sparse outcrops, phyllite is bleached and sericitized on the hanging-wall side of the Magnison Butte vein trend. In trench exposures, phyllite-vein contacts are locally silicified. Recent trenching also exposes intense clay alteration of felsic dikes. Adjacent phyllite wall rocks are usually intensely bleached and argillized in the vicinity of the thicker dikes, but may show no alteration adjacent to thin, clay-altered dikes.

GEOCHEMISTRY

To date, a few specks (0.25 mm) of native gold have been found near the top of Magnison Butte and a nearby sample of the vein assayed 0.22 oz/ton gold. Anomalous gold values have been obtained from sedimentary rocks and from clay zones interpreted as either altered dikes or fault gouge, but to date the one high surface assay has not been duplicated elsewhere on the Butte. Geochemically, the prospect is characterized by anomalous gold, arsenic (up to 1,500 ppm), and molybdenum (up to 300 ppm). Scattered areas show elevated silver, antimony, fluorine, mercury, and manganese. Base metals are near background levels.

TARGET

The Junction Reef prospect is targeted as both a fracture-controlled vein system and a disseminated or stockwork system, mineralized during the waning stages of volcanic activity. So far, however, Junction Reef is just a prospect. Years of exploration lie ahead to prove the potential of its multiple targets.

CORE SAMPLES AVAILABLE FOR STUDY

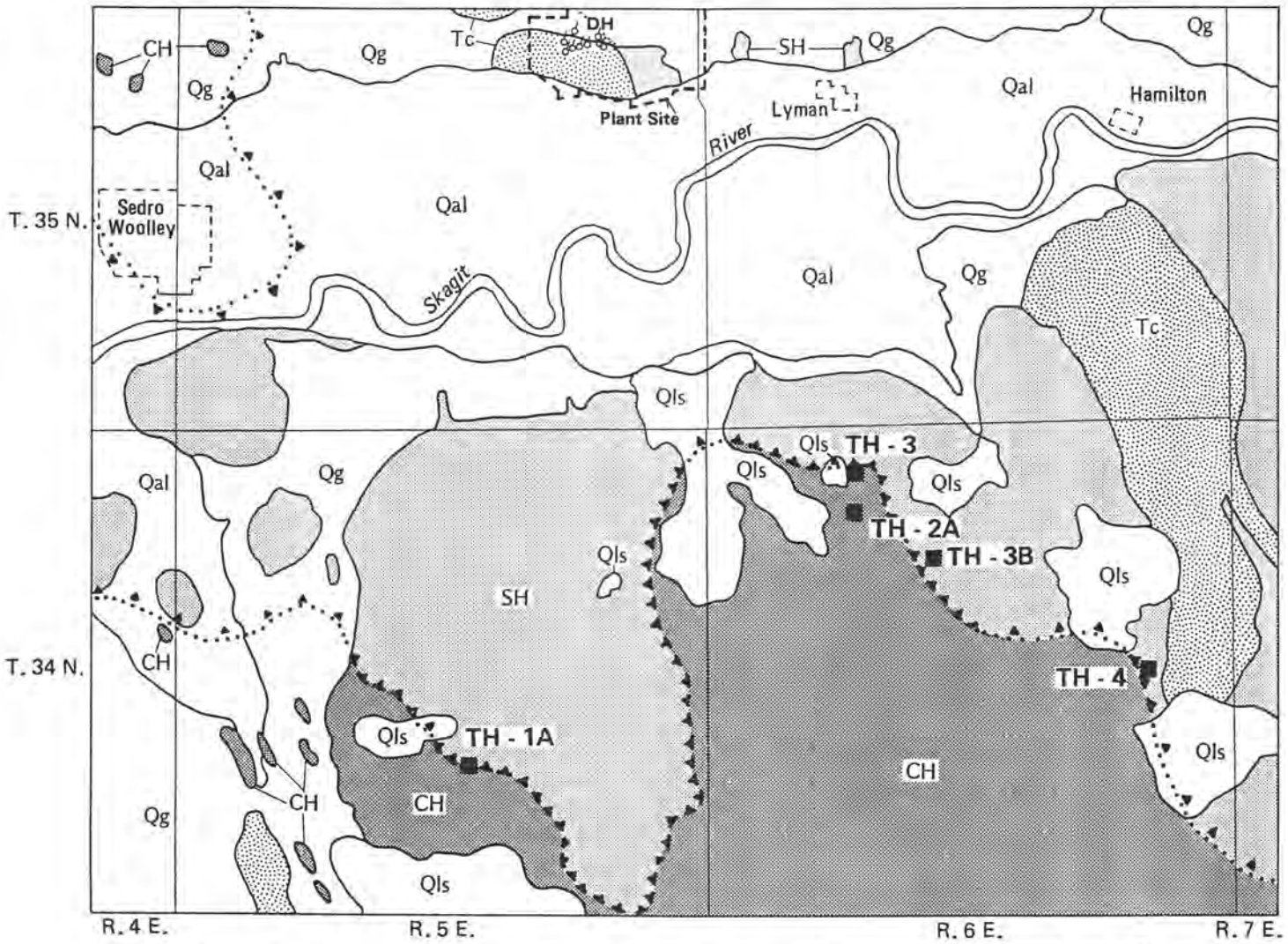
By Timothy J. Walsh*

The Division of Geology and Earth Resources has acquired some of the core samples collected by Puget Sound Power and Light Co. (Puget Power) in connection with its Skagit Nuclear Power Project site investigations. This has been accomplished through the efforts of Jim Kearns of Puget Power.

Puget Power collected core samples in three different areas for two different purposes. Core holes were drilled near Cultus Mountain and near Haystack Mountain for the purpose of determining the orientation and tectonic stratigraphy of the Shuksan Thrust (fig. 1). These holes were designated TH for "test hole." Other holes were drilled at the proposed nuclear plant site for the purpose of determining the stratigraphy of the Chuckanut Formation and testing foundation conditions. These holes were designated DH for "drill hole." All drill sites are located in Skagit County.

From the "test holes" we acquired core from five holes with a total footage of 5,180. Core recovery from these holes was essentially 100 percent. From the "drill holes" we acquired core from nine holes with a total footage of 2,376. These holes represent approximately 1,500 feet of Chuckanut section. Core recovery of these holes averaged 95.8 percent, and most of the lost core was in, or adjacent to, coal seams. The aggregate thickness of coal seams greater than 3 feet thick is 38 feet, or approximately 2.5 percent of the section represented by the drill holes. The coal from this area ranges in rank from high volatile A bituminous to medium volatile bituminous (Phillips and others, 1982). The Division has also received thin sections cut both from the core and from outcrop samples in the area.

* Division of Geology and Earth Resources geologist.



	Qal	Alluvial stream channel and terrace deposits, minor colluvium
	Qls	Landslide debris, areas of significant mass movement; bedrock locally exposed
All contacts are approximate	Qg	Undifferentiated glacial deposits
	Tc	Chuckanut Formation: sandstone, siltstone, conglomerate, local coal seams
	SH	Shuksan Thrust Plate: phyllite, phyllitic slate, greenschist, schistose metagraywacke
	CH	Church Mountain Thrust Plate: greenstone, serpentinite, gabbroic rock, metasediments
		Shuksan Thrust Fault - sawteeth on upper plate; dashed where approximate, dotted where buried or concealed.
	TH	Test hole location
	DH	Angled drill hole locations 7, 9, 10, 15, 17, 23, 35, 36, 84

FIGURE 1. — Geologic map of Skagit Nuclear Power Project site and vicinity (modified from Bechtel, Inc., 1979).

Details about the core can be found in reports by Puget Power (1974) and Bechtel, Inc. (1979). The reports are available for inspection at the Division office in Olympia. Cores and thin sections are available for geologic research by any investigators on a nonproprietory basis. For further information contact Timothy J. Walsh or William M. Phillips at the Division of Geology and Earth Resources, Olympia, telephone 206-459-6372.

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GEOLOGY OF THE GOLD DIKE MINE, FERRY COUNTY, WASHINGTON

By Melvin Herdrick and Bonnie B. Bunning*

INTRODUCTION

The Gold Dike mine is a new gold and silver producer located in the Danville mining district of northern Ferry County (secs. 7 and 8, T. 40 N., R. 34 E.); (fig. 1). The Gold Dike is new to the geologic literature, although three other mines in the district are noted for their production of copper, gold, and silver prior to World War II. The open pit mine, operated by Vulcan Mtn., Inc. of Lamona, Washington, came onstream in the summer of 1983, producing 100,000 tons of ore with an average grade of 0.10 oz/ton gold, and 0.15 oz/ton silver. Metals will be recovered by heap leaching.

GEOLOGY

Permian to Triassic sedimentary and volcaniclastic rocks crop out near Danville in the northern portion of the Republic graben (fig. 2). Near the Gold Dike mine, interbedded units of argillite, siltite, limestone, and quartzite have been recrystallized to the hornblende hornfels metamorphic facies by later intrusion of Cretaceous(?) alkalic rocks of the Shasket Creek complex. Plastic deformation of the sediments and calc-silicate mineral development in local blocks and lenses of limestone are also credited to the intrusive activity.

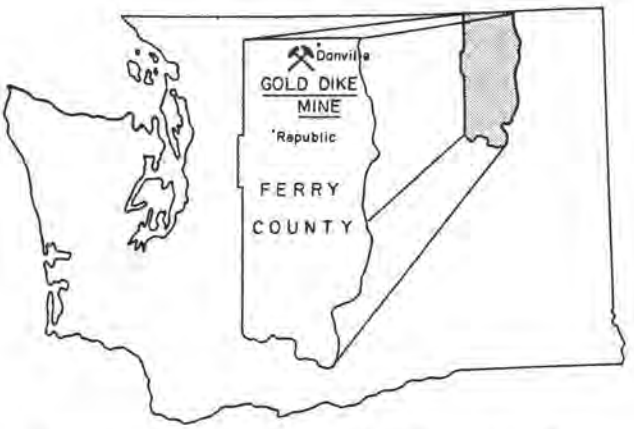

FIGURE 1. — Location map, Gold Dike mine, Ferry County, Washington.

The Shasket Creek alkalic complex was originally mapped by Parker and Calkins (1964) as two phases – monzonite to shonkinite (with possible nepheline syenite), and syenite porphyry (a more leucocratic phase with orthoclase phenocrysts). In the mine area these two phases can be further divided into four texturally and compositionally distinct units – monzonite, shonkinite, trachytic syenite, and syenite porphyry, in order of abundance. Trachytic syenite, which hosts copper mineralization at the adjacent Comstock mine, crops out as a small stock near the Gold Dike orebody. Within the stock, chill margins and crosscutting relationships are evidence that several separate cooling units form this otherwise homogeneous body. Preliminary mapping suggests that the gold-bearing syenite porphyry dike of the Gold Dike mine may also be composed of several intrusions, all localized within an east-west trending fault zone. Rhyodacite dikes of the Scatter Creek Formation crosscut the zone of faulting and mineralization and in one place rhyodacite is associated with a 20- to 30-foot offset of the entire zone.

ORE CONFIGURATION

East-west faulting controlled emplacement of both the Gold Dike orebody and the syenite porphyry dike with which gold is spatially associated. Early faulting first localized intrusion of syenite porphyry. Repeated movement along the fault provided a conduit for later gold mineralization. Mineralized breccia found in the ore zone is interpreted as evidence of this period of faulting between episodes of intrusion and mineralization. Some time after the gold was deposited, the fault was reactivated. It now forms the southern border of

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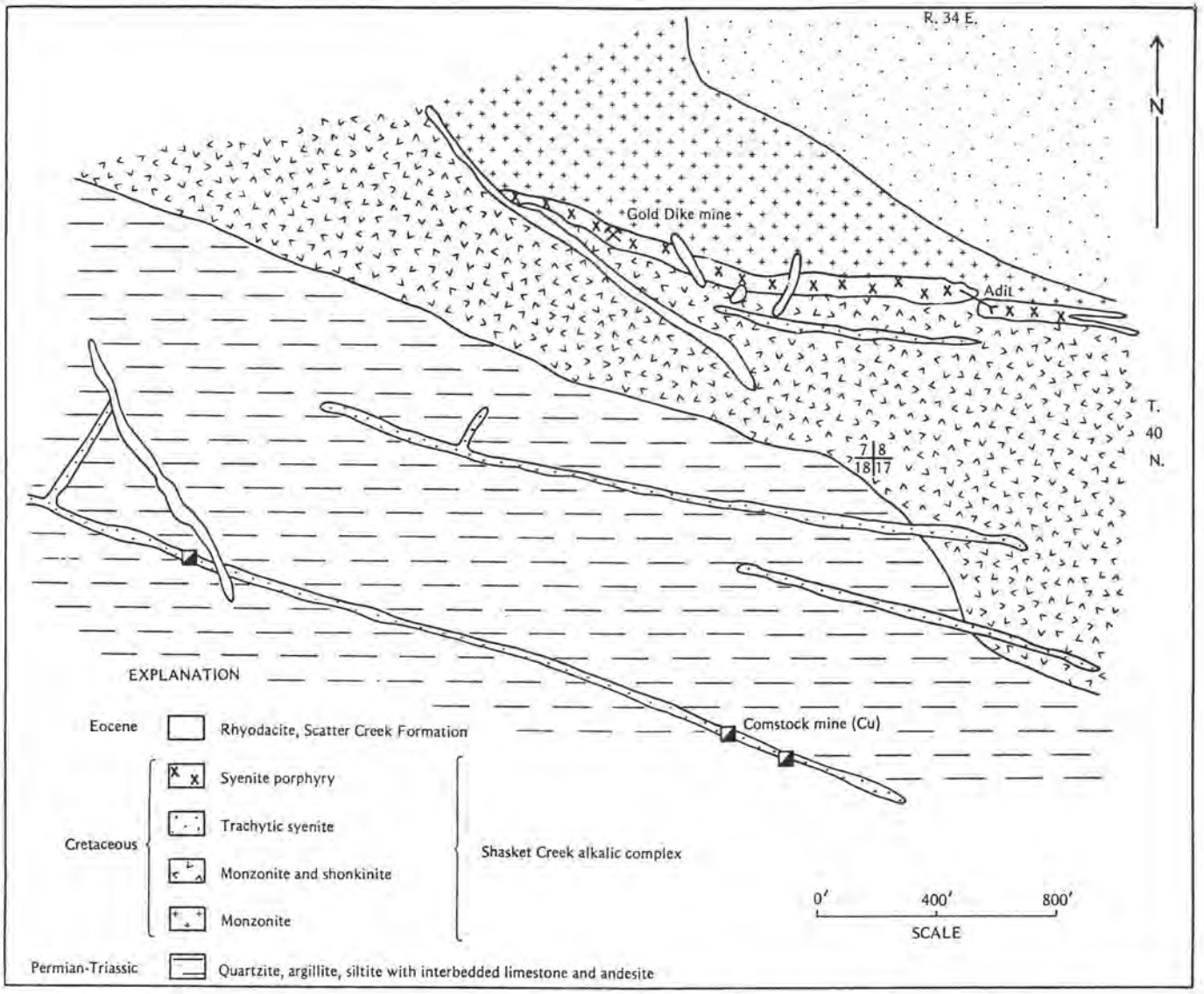

FIGURE 2. — Geologic map of the Gold Dike mine, Ferry County, Washington.

most of the ore zone. A tabular dike of shonkinite, which parallels the syenite porphyry, also forms the southern contact of the ore zone in a few places. Neither syenite porphyry nor shonkinite carry ore grade material south of the fault. On the north contact of the syenite porphyry dike with monzonite, ore grade values are carried 5 to 15 feet into monzonite wall rock. Minable widths of 60 to 80 feet in both rock types extend for more than 1,000 feet of strike length.

MINERALIZATION

Three types of mineralization — disseminated auriferous pyrite (most common), quartz-pyrite veinlets, and pyritic fractures — are found in the Gold Dike ore zone. Total pyrite in ore ranges from 1 to 15 percent. The gold and silver content of ore varies independently with respect to pyrite, but pyrite is always present where there is gold and silver. Other minerals associated with ore are calcite, ferroan calcite, quartz, specularite, orthoclase, and chlorite. Chalcopyrite and magnetite are zoned around the gold-bearing area.

GEOCHEMISTRY

Geochemically anomalous quantities of gold, silver, copper and tungsten occur in the ore zone. Weakly anomalous fluorine, antimony, arsenic, and mercury are also associated with the deposit. The maximum tellurium content of the auriferous pyrite from the Gold Dike and chalcopyrite from the Comstock mine run 10 and 35 parts per million, respectively. Analyses of chalcopyrite reveal anomalous amounts of platinum and palladium, and sulfur isotopes of magmatic derivation with some contamination from sedimentary sources. (Personal communication, Robin Finch, Felix Mutschler, and Spencer Shannon, 1983).

CONCLUSIONS

The geochemical signature of the Gold Dike orebody — high gold, silver, copper, platinum, palladium and tellurium — and the geologic setting in alkalic rocks indicate an affinity with the alkaline porphyry copper-precious metals class of deposits proposed by Finch and others (1983). The evidence suggests that ore development is most likely related to evolution of the alkalic complex and is probably part of the same system as the nearby Comstock mine, worked primarily for copper in the twenties and thirties. A geologic analog to the Gold Dike might be found in the North Mocassin district of Montana where calcareous sediments intruded by syenite are mineralized with gold (Nordstrom and Ikramuddin, 1983).

MINING AND MILLING

Open pit mining by contract with N. A. Degerstrom, Inc., includes crushing the mined rock to minus 3/8 inch size. The crushed ore, piled 20 feet deep on a PVC-lined pad is sprinkled with a lime-rich dilute cyanide solution to slowly leach gold, silver, and copper from the rock. The pregnant solution is pumped through activated carbon filter columns which remove the metals. The barren solution is recirculated to the pile in a continuous circuit. Carbon in the filters is commercially processed to recover the metals, and recycled to the columns as many as 15 times. About 75 percent of the contained metals are recovered by the leaching process. Projected mine life is 4 to 6 years.

SELECTED REFERENCES

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Shannon, S. S., Jr.; Finch, R. J.; Ikramuddin, Mohammed, Mutschler, F. E., 1983, Possible sedimentary sources of sulfur and copper in alkaline-suite porphyry-copper systems [abstract]: Geological Society of America Abstracts with Programs, v. 15, no. 6, p. 684.

STATE GEOLOGIC MAP PROGRAM GRADUATE STUDENT MAPPING PROJECT

by J. Eric Schuster*

As reported in the October 1983 issue of this Newsletter, the long process of preparing a new state geologic map for Washington has begun. One feature of the state geologic map program which was not mentioned in the October article is the graduate student mapping project. This project is intended to serve three purposes: (1) to provide good quality geologic source maps for use in compiling the new geologic map of Washington on a more cost-effective basis than would be possible by hiring additional staff geologists, (2) to form closer working relationships with the graduate students and faculties of Pacific Northwest university geology departments to facilitate the process of geologic mapping in Washington, and (3) to provide monetary support to encourage graduate student thesis projects that include geologic mapping at a time when other sources of such funding are at a low ebb.

We have allocated $30,000 for fiscal year 1985 (July 1, 1984, to June 30, 1985) to support this project,

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and we will continue to support graduate student mapping at comparable levels for several years into the future if our financial resources permit. A request for proposals was circulated in October to all universities in Washington and Oregon which have graduate degree programs in geology, as well as to the University of Idaho and selected California universities. Proposals are due by January 13, 1984, for mapping projects to begin as soon as July 1, 1984. Funds will be awarded for one year only — projects of longer duration will require submission of additional proposals in future years.

Any graduate student who plans to do geologic mapping in Washington as a part of his or her graduate degree program is eligible to compete for these funds. During this first year of the graduate student mapping project we will give first preference to proposals for mapping in the southwest quadrant of the state (south of 47°15' N. and west of 120°30' W.). Second priority will be given to proposals for the northeast quadrant (north of 47°15' N. and east of 120°30' W.), and third priority to proposals for mapping in other parts of the state. These priorities are designed to provide mapping on a schedule suited to the order of publication of the 1:250,000-scale state map quadrants (southwest quadrant in June, 1986, northeast quadrant in 1988). Within any quadrant, priority will be given to mapping proposals (1) for geographic areas where existing geologic maps are least adequate, (2) that emphasize bedrock geologic mapping as opposed to mapping of unconsolidated surficial deposits or other special-purpose maps, and (3) where the proposed map will show the extent of outcrops, location of mapping traverses, and concealed contacts.

Proposals will be selected competitively and projects will be funded through 1-year contracts awarded directly to the selected proposers. Awards will be intended primarily to cover the costs of doing field mapping, and potential proposers are encouraged not to submit proposals that call for funding of extensive on-campus activities.

RECENT U.S. GEOLOGICAL SURVEY PUBLISHED REPORTS ADDED TO OUR DIVISION LIBRARY

The following reports are now available for inspection in our division library. If you wish to purchase any of these published reports, please contact the U.S. Geological Survey, Public Inquiries Office, Room 678, U.S. Court House, 1020 Riverside, Spokane, WA 99201; (509) 456-2524.

Evarts, R. C.; Frisken, J. G.; Bishop, K. R.; Benham, J. R., 1983, Mineral resource potential map of the Long Swamp roadless area, Okanogan County, Washington: U.S. Geological Survey Miscellaneous Field Studies Map MF-1550, 4 p., 1 plate, scale 1:48,000.

Haeni, F. P., 1983, Sediment deposition in the Columbia and lower Cowlitz Rivers, Washington-Oregon, caused by the May 18, 1980 eruption of Mount St. Helens: U.S. Geological Survey Circular 850-K, 21 p.

Minard, J. P., 1983, Geologic map of the Kirkland quadrangle, Washington: U.S. Geological Survey Miscellaneous Field Studies Map MF-1543, 1 sheet, scale 1:24,000.

Shipley, Susan; Sarna-Wojcicki, A. M., 1983, Distribution, thickness, and mass of late Pleistocene and Holocene tephra from major volcanoes in the northwestern United States — A preliminary assessment of hazards from volcanic ejecta to nuclear reactors in the Pacific Northwest: U.S. Geological Survey Miscellaneous Field Studies Map MF-1435, 27 p., 1 plate, scale 1:2,500,000.

U.S. GEOLOGICAL SURVEY OPEN-FILE REPORTS ADDED TO OUR DIVISION LIBRARY

The following U.S. Geological Survey Open-File Reports are now available for inspection in our Division library. However, if you wish to purchase any of these reports, please write or call:

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Evarts, R. C.; Church, S. E.; Mosier, E. L., 1983, Mineral resource potential of the Tatoosh roadless area, Lewis County, Washington: U.S. Geological Survey Open-File Report 83-471, 16 p.

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Sherrard, M. S.; Flanigan, V. J., 1983, Bouguer gravity anomaly map of the Glacier Peak wilderness and vicinity — Chelan, Skagit, and Snohomish Counties, Washington: U.S. Geological Survey Open-File Report 83-595, 26 p., 1 plate, map scale 1:100,000.

Waitt, R. B., Jr., 1983, Tens of successive, colossal Missoula floods at north and east margins of channeled scabland: U.S. Geological Survey Open-File Report 83-671, 30 p.

THESES ADDED TO OUR DIVISION LIBRARY

We have recently acquired the following theses in our Division library where they are now available for reference work.

Barnosky, C. W., 1983, Late-Quaternary vegetational and climatic history of southwestern Washington: University of Washington Doctor of Philosophy thesis, 201 p.

Cochran, M. P., 1982, Geophysical investigation of eastern Yakima Ridge, south-central Washington: Washington State University Master of Science thesis, 143 p., 4 plates.

Crandall, Robert, 1983, Diatoms and magnetic anisotropy as means of distinguishing glacial till from glaciomarine drift: Western Washington University Master of Science thesis, 62 p.

Hatfield, D. M., Jr., 1983, Net shore-drift of Thurston County, Washington: Western Washington University Master of Science thesis, 120 p., 1 plate.

Hauptman, J. L., 1983, The sedimentology of the Wenatchee Formation — Late Paleogene fluvial and lacustrine strata of the east-central Cascade Range, Washington State: University of Washington Master of Science thesis, 164 p.

O'Loughlin, C. L., 1972, An investigation of the stability of the steepland forest soils in the Coast Mountains, southwest British Columbia: University of British Columbia Doctor of Philosophy thesis, 148 p.

Sevigny, J. H., 1983, Structure and petrology of the Tomyhoi Peak area, north Cascade Range, Washington: Western Washington University Master of Science thesis, 203 p., 3 plates.

Shipley, Susan, 1983, Erosional modification of the downwind tephra lobe of the May 18, 1980, eruption of Mount St. Helens, Washington: University of Washington Master of Science thesis, 73 p.

Wells, R. E., 1982, Paleomagnetism and geology of Eocene volcanic rocks in southwest Washington — Constraints on mechanisms of rotation and their regional tectonic significance: University of California at Santa Cruz Doctor of Philosophy thesis, 229 p., 1 plate. (Note: Map previously issued as USGS OF 81-674.)

RECENTLY PUBLISHED REPORTS BY THE DIVISION OF GEOLOGY AND EARTH RESOURCES NOW AVAILABLE

Copies of these publications may be obtained by writing to the Department of Natural Resources, Division of Geology and Earth Resources, Olympia, WA 98504.

Please send $1 to cover our Handling and Distribution charge for your total publication order.

Bulletin 76

Manson, C. J.; Burnetti, Debbie, 1983, Bibliography and index of the geology and mineral resources of Washington, 1963-1980: Washington Division of Geology and Earth Resources Bulletin 76, 398 p. Price $4.75.

Every year the amount of bibliographic materials available to the geologic community has grown more voluminous. Bulletin 76 contains almost 6,000 references to the geology and mineral resources of Washington and intends to list and index every published report, thesis, abstract, journal article, conference paper, open-file report, map, and all other pertinent materials on Washington for the years 1963 - 1980. The bibliography section was compiled by Connie J. Manson, Washington Division of Geology and Earth Resources librarian; the subject index was prepared by Debbie Burnetti of the American Geological Institute, on the GeoRef data base. The preparation of this report was funded in part by the U.S. Bureau of Mines.

Information Circular 76

Logan, R. L.; Manson, C. J., 1983, Mount St. Helens — Annotated index to video archives: Washington Division of Geology and Earth Resources Information Circular 76, 51 p. Price $1.50.

A Mount St. Helens video archive has been established at the Washington Division of Geology and Earth Resources. The primary purpose of the archive is to

preserve video tape documentation of the 1980 and subsequent eruptions of Mount St. Helens. With funds provided by the National Science Foundation, the video tape files of five television stations serving the Seattle and Portland areas were reviewed for footage covering all events concerning Mount St. Helens and its activity. Selection of tapes was based on both historic and scientific significance. Information Circular 76 is a listing of the video tapes in chronological order, with a brief description of the events included on each tape segment from March 1980 through May 1982. The archives will be updated as tapes become available. The Division of Geology and Earth Resources authors are Robert Logan, geologist, and Connie J. Manson, librarian. The collection is available for viewing at the Division of Geology and Earth Resources office at 4224 Sixth Ave., SE., Lacey, Washington. The archive tapes are intended to serve research purposes and their use for entertainment or commercial ventures is prohibited.

RECENT PERMITS FOR OIL AND GAS DRILLING

Operator	Permit no.	County	Well name	Location	Ground elevation (feet)	Estimated total depth (feet)	Spud date	Date permit issued
Shell Oil Co.	340	Grant	BN 1-9	965 FWL and 1,869 FNL* sec. 9 (15-25E)	2,400	20,000	12-21-82	5-22-81
Voyager Petroleums**	353	King	Black Diamond No. 4-13	514.17 FWL and 704.31 FSL sec. 4 (21-7E)	818	6,500	6-22-83	5-16-83
AMOCO Prod. Co.	354	King	Enumclaw Mill No. 1-34	1,430 FNL and 1,370 FWL sec. 34 (20-7E)	1,447	2,500		5-16-83
				Oil and Gas Stratigraphic Tests				
AMOCO Prod. Co.	356	Pierce	Buckley No. 1	1,990 FWL and 2,033 FSL sec. 11 (19-6E)	755	1,800		7-26-83
AMOCO Prod. Co.**	357	Lewis	Storm King Offset No. 1	1,758 FSL and 1,261 FWL sec. 29 (14-5E)	1,915	2,000	11-15-83	7-26-83
AMOCO Prod. Co.**	358	King	Enumclaw Mill Offset No. 1	1,831 FEL and 503 FSL sec. 20 (20-7E)	1,052	2,000	10-4-83	7-26-83
AMOCO Prod. Co.**	359	King	Enumclaw Mill Twin No. 1	2,014 FNL and 1,091 FWL sec. 34 (20-7E)	1,448	2,000	10-1-83	7-26-83
AMOCO Prod. Co.	360	King	Fall City Twin No. 1	1,217 FNL and 925 FEL sec. 7 (24-8E)	975	1,500		7-26-83
AMOCO Prod. Co.	361	Pierce	National No. 1	968 FSL and 2,228 FEL sec. 28 (15-6E)	1,610	2,000	11-23-83	7-26-83
AMOCO Prod. Co.	362	King	Snoqualmie Mill Offset No. 1	1,489 FNL and 1,297 FWL sec. 25 (24-7E)	842	1,500		7-26-83
AMOCO Prod. Co.	363	King	Snoqualmie Mill Twin No. 1	1,779 FWL and 601 FSL sec. 19 (23-8E)	2,190	1,500		7-26-83
AMOCO Prod. Co.	364	Lewis	Storm King Twin No. 1	2,005 FSL and 2,569 FEL sec. 23 (14-5E)	1,835	1,500		7-26-83
AMOCO Prod. Co.	365	Lewis	WC-83-12	488 FWL and 2,212 FSL sec. 7 (14-5E)	1,515	2,000		12-15-83

* Land description indicates that the location is 965 ft from the west line and 1,869 ft from the north line of sec. 9, township 15 north, range 25 east, Willamette meridian.

** Plugged and abandoned.

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