January 1983 Volume 11 Number 1

WASHINGTON GEOLOGIC NEWSLETTER

Coal miners – Cle Elum mine, 1957

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NEW DEVELOPMENTS IN MINERALS AND ENERGY IN WASHINGTON, 1982

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Data for the 1982 summary of mineral and energy activity was voluntarily supplied on a Division of Geology and Earth Resources questionnaire mailed to mining companies throughout the United States and Canada. Twenty-seven percent of those questioned responded. This year's total (78) of active companies (table 1) compares favorably to the number reported in the previous 2 years. During the past 3 years, the number of major U.S. mining and exploration companies working in the state has declined in favor of individual prospectors, small local companies, and Canadian exploration firms.

A minimum of $3,426,000 was invested by private companies for exploration and development of metallic commodities in Washington. An additional $1,228,500

Table 1. — *Active mining and exploration companies — Metallic and industrial commodities, 1982*

1. Ace Parker Mines and Minerals Corp., Ltd.
2. American Copper & Nickel Co., Inc.
3. Amoco Minerals Co.
4. Arbor Resources Corp.
5. Arriva Resources Ltd.
6. Asamera, Inc.
7. Atlas Minerals Division - Atlas Corp.
8. Azure Resources Ltd.
9. L. F. Baum and Associates
10. Beck, David
11. Boise Cascade Corp.
12. Bristol Northwest Silica
13. The Bunker Hill Co.
14. C-E Minerals Combustion Engineering, Inc.
15. CSS Management and Cleopatra Mining Co.
16. Canorex International, Inc.
17. Cascade Talc Inc.
18. Chevron Resources Co.
19. Chewelah Eagle Mining Co.
20. Columbia Cement Corp.
21. Cominco American Inc.
22. Consolidated Mining Resources, Inc.
23. Costa, George
24. Crown Resources Corp.
25. Dillon Exploration Inc.
26. Duval Corp.
27. Erdosh, George
28. Exploration Ventures Co.
29. Feldslite Corp. of America
30. Gold Bond Mining Co.
31. Gold Fields Mining Corp.
32. Gold Leaf Mining Corp.
33. Hallauer, Wilbur
34. Hansen, Spenst
35. Hecla Mining Co.
36. Houston International Minerals Corp.
37. IMC Olivine
38. Ideal Basic Industries
39. Industrial Mineral Products, Inc.
40. Jones Quarry
41. Joy Mining Co.
42. Knox, Kaufman Inc.
43. Lane Mt. Silica Co.
44. LaSota-Jones Lead-Zinc Corp.
45. Lehigh Portland Cement
46. George Maddox & Associates
47. Madre Mining Ltd.
48. Meridian Land & Minerals Co.
49. Milchem, Inc.
50. Mining & Investments Co.
51. Montana Barite Co.
52. Mutual Materials Co.
53. Namone Aggregates, Inc.
54. Nord Resources Corp.
55. Northwest Alloys Inc.
56. Olivine Corp.
57. Orazada Mines Inc.
58. Bill Palmer - Mine Evaluation & Development
59. Palmer Coking Coal
60. Placer Amex, Inc.
61. Plexus Resources Corp.
62. Rexcon, Inc.
63. Rocky Mountain Energy Co.
64. Seattle-St. Louis Mining Co.
65. Seymour Resources Inc.
66. Shell Oil Co. - Mining Exploration
67. Silver King Mining and Milling Co.
68. Smith Limestone
69. Sunshine Mining Co.
70. Tacoma Lime
71. U.S. Borax & Chemical Corp.
72. United Cascade Mining Co., Inc.
73. Utah Mines Ltd.
74. Van Horn and Watson Mining Co.
75. Vulcan Mountain Inc.
76. Wenatchee Silica Products, Inc.
77. Western Nuclear, Inc.
78. Witco Chemical Corp.

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was expended to develop industrial mineral commodities.

On state lands, 352 prospecting leases and mining contracts returned $245,138 to the trust accounts for the period 7-1-81 to 6-30-82. This figure is down slightly from the previous fiscal year ($266,108). Revenues from oil and gas leasing were up dramatically this fiscal year – from $945,834 to $4,624,337, due principally to substantial gains from oil and gas bonus bidding. There were 1,110 leases for oil and gas held on state lands in the 1981-1982 fiscal-year period. Sand, gravel, and other industrial materials returned $256,512 to the state, while coal leasing and royalties provided $6,960. Both figures record distinct reductions from the 1980-1981 year.

In December, the Bureau of Land Management announced it was turning over a record $582,035 to the state from mineral leasing on federal lands in Washington – 11 times the revenue generated for Washington in 1981.

METALLIC MINERAL EXPLORATION AND MINING

Mineral exploration and development in 1982 was again concentrated in the northeastern part of the state in Ferry, Stevens, Okanogan, and Pend Oreille Counties. Scattered properties along the Cascade Range in Pierce, King, Chelan, Whatcom, Clark, Skamania and Yakima Counties also saw activity during the 1982 season (figs. 1-4). Precious metals dominated exploration and development, as prices were generally depressed for all metallic commodities. Of the total 55 active companies, 50 firms reported they were seeking gold and silver; 19 continued work on copper and molybdenum projects; 11 looked for lead and zinc; 7 reported an interest in tungsten or tin, while only 4 companies continued to explore for uranium (table 2). One consultant reported grass-roots exploration for cobalt in scattered counties throughout the state.

In addition to the work on specific properties reported below, first-pass exploration, prospect examination, and nonspecific reconnaissance surveys were conducted in the Okanogan Highlands, Cascade Mountains, Olympic Peninsula, the northern Columbia Basin, and the Willapa Hills areas. Bill Palmer, Mine Evaluation and Development, ran general reconnaissance for precious metals in Pacific, Grays Harbor, Jefferson, and Clallam Counties. Boise Cascade Corp. initiated a minerals inventory program for their lands across the state. They were particularly interested in gold, silver, lead, zinc, tungsten, copper, molybdenum, and tin, as well as industrial minerals and oil and gas. Among others, Chevron Resources Co. explored statewide for base and precious metals, with plans for a continuing program in 1983.

At least 5 companies closed their Spokane offices this year and several others pared Spokane office staffs to a single geologist.

Chelan

A significant development is taking place at the Lovitt Gold mine (Gold King), 3 miles south of Wenatchee. On December 2, 1982, the operator, Asamera, Inc., announced an $18 million preproduction program, with scheduled initial production at 1,000 tons of ore per day by mid-1984. Asamera's joint venture partner is Breakwater Resources. Prior to 1982, announced reserves were estimated at 1.5 million tons, averaging 0.164 oz Au/ton. During 1982, the mineralized zone was drilled underground at 50-ft intervals by two drills. The 1982 discovery by Asamera could add several million tons to the already known reserves. From 1949 to 1957 the Lovitt mine produced 446,025 tons of ore containing 189,404 oz of gold and 217,328 oz of silver.

The Gold Bond Mining Co. of Reardan, Washington, leased their mining claims in the Blewett district to Montana d'Oro, Inc. who continued to develop the precious metal potential there.

Clark

The October issue of *Engineering and Mining Journal (E&MJ)* reports that Plexus Resources Corp. continued development drilling at their Silver Star property in 1982. "Earlier work outlined 7 million short tons of mineral averaging 1.1 percent copper, .15 oz/short ton silver and 0.039 percent molybdenum." A higher grade core within the deposit contains a reported 2.179 million short tons of 2.02 percent copper.

Ferry

The Colville Confederated Tribes are actively seeking to interest a major mining company in developing the Mount Tolman molybdenum deposit. Since AMAX left the scene, the deposit has been entirely under the control of the Colville Confederated Tribes.

Azure Resources Ltd. of Vancouver, B. C. drilled the Lone Star mine near the Canadian border for gold and copper. Azure Resources leases the property from Wilbur Hallauer of Oroville.

Vulcan Mountain Inc. was also at work in northern Ferry County, running a small-scale heap leach operation for gold and silver.

Silver King Mining and Milling Co. reportedly drilled for precious metals in Ferry County at an unspecified location.

In the Republic district, Hecla's Republic unit processed 56,000 tons of ore, grading .25 oz/ton gold and 1.5 oz/ton silver from the old Knob Hill mine (table 3). Nearby, Crown Resources Corp. continued exploration at the Flag Hill mine.

FIGURE 1. – Exploration and development activity, Okanogan, Chelan, and Grant Counties, 1982.

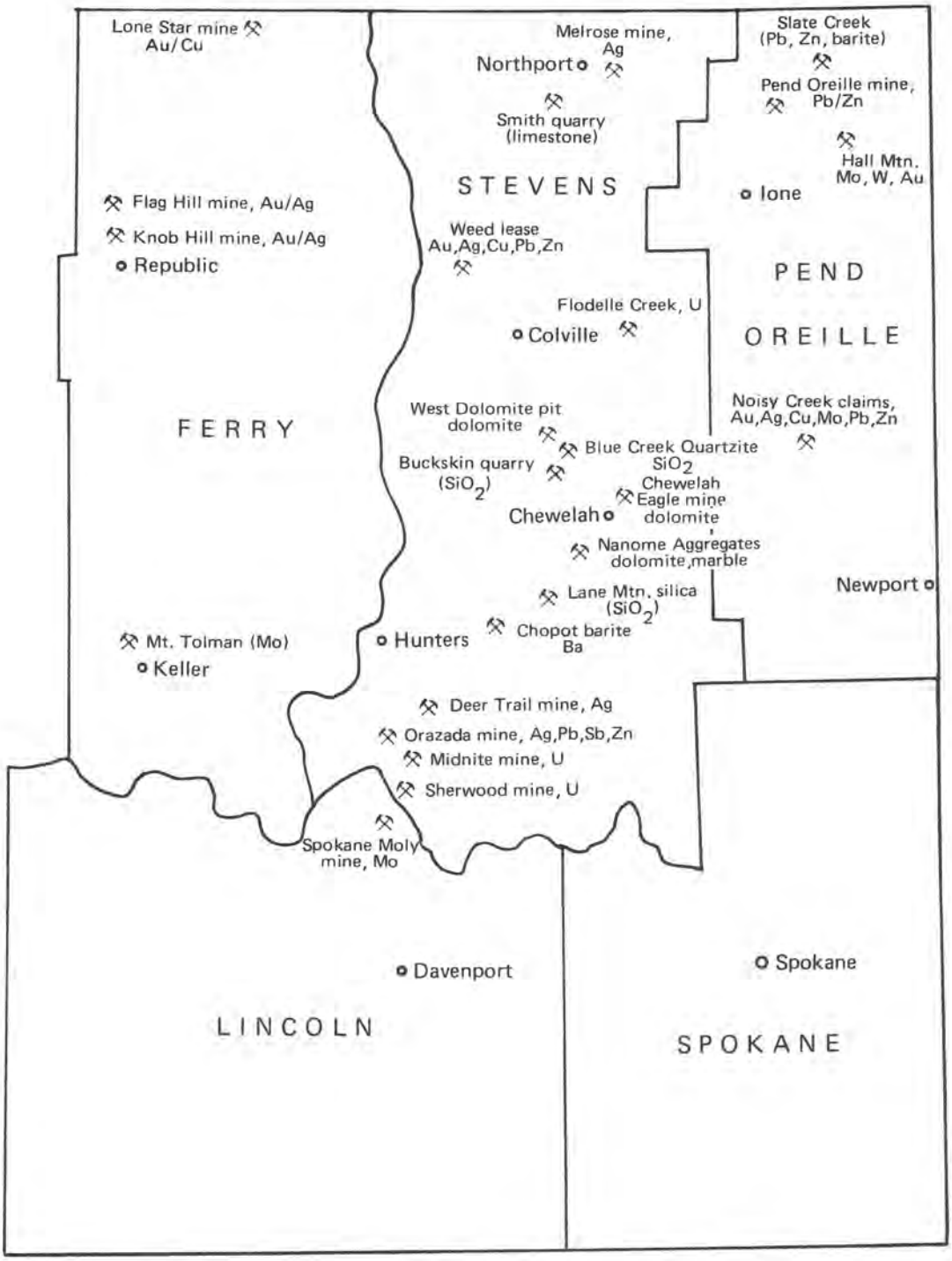

FIGURE 2. – Exploration and development activity, Ferry, Stevens, Pend Oreille, and Lincoln Counties, 1982.

FIGURE 3. – Exploration and development activity, Whatcom, Skagit, Snohomish, and King Counties, 1982.

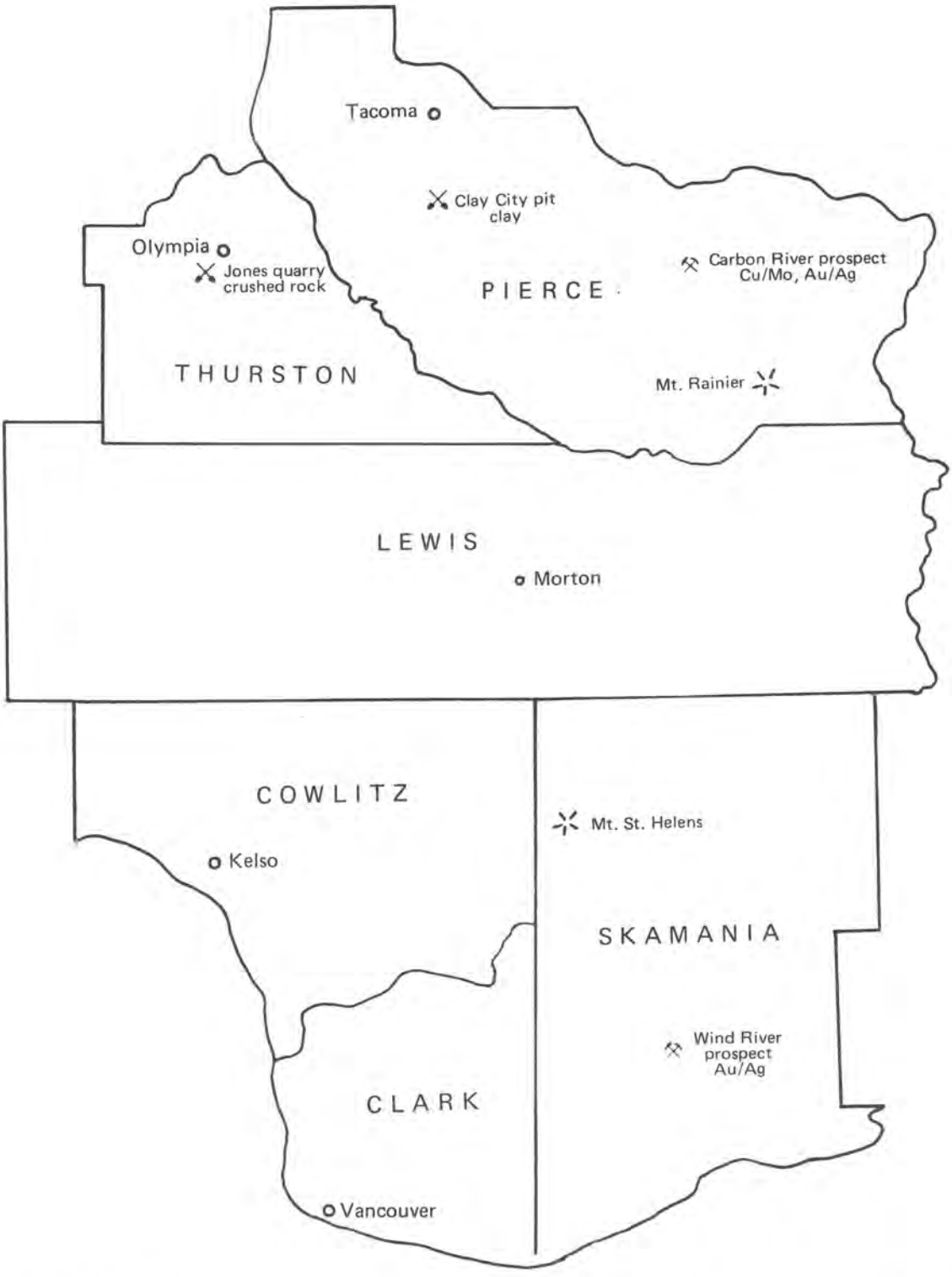

FIGURE 4. – Exploration and development activity, Thurston, Pierce, and Skamania Counties, 1982.

TABLE 2. — *Index of mining and mineral exploration for metallic commodities, 1982*

County	Company	Commodity
Chelan	Asamera, Inc.	Au,Ag
	Exploration Ventures Co.	Au,Ag
	Gold Bond Mining Co.	Au,Ag
Clallam	Bill Palmer - Mine Evaluation & Development	Au,Ag
Clark	Exploration Ventures Co.	Au,Ag
	Plexus Resources Corp.	Au,Ag,Cu,Mo
Ferry	Ace Parker Mines and Minerals Corp., Ltd.	Au,Ag,Cu,Mo
	Azure Resources Ltd.	Au,Cu
	Canorex International, Inc.	Au,Ag,W,Sn,Pb,Zn
	Consolidated Mining Resources, Inc.	Au,Ag
	Crown Resources Corp.	Au,Ag
	George Erdosh, Consultant	Au,Ag,W,Sn,Co
	Exploration Ventures Co.	Au,Ag
	Gold Leaf Mining Corp.	Au,Ag
	Wilbur Hallauer	Au,Ag,Cu,Mo
	Hecla Mining Co.	Au,Ag
	Houston International Minerals Corp.	All metallic minerals
	Shell Oil Co. - Mining Exploration	Au,Ag
	Silver King Mining and Milling Co.	Au,Ag,U
	Vulcan Mountain Inc.	Au,Ag
Grays Harbor	Bill Palmer - Mine Evaluation & Development	Au,Ag
Jefferson	Bill Palmer - Mine Evaluation & Development	Au,Ag
King	CSS Management and Cleopatra Mining Co.	Au,Ag
	United Cascade Mining Co., Inc.	Au,Ag,Cu,Mo,Pb,Zn
Kittitas	Exploration Ventures Co.	Au,Ag
Lewis	Duval Corp.	Au,Ag,W,Sn,Cu,Mo, Pb,Zn
	Exploration Ventures Co.	Au,Ag
Lincoln	Exploration Ventures Co.	Au,Ag
	U.S. Borax & Chemical Corp.	Mo,Cu
Okanogan	L.F. Baum and Associates	Au,Ag
	David Beck	Au,Ag,U
	Duval Corp.	Au,Ag,W,Sn,Cu,Mo, Pb,Zn
	Exploration Ventures Co.	Au,Ag
	Wilbur Hallauer	Au,Ag,Cu,Mo
	Spenst Hansen	Au,Ag,Cu,Mo
	Houston International Minerals Corp.	All metallic minerals
	Meridian Land & Minerals Co.	Au,Ag
	Mining & Investments Co.	Au,Ag,Cu,Mo
	Rocky Mountain Energy Co.	U
	Shell Oil Co. - Mining Exploration	Au,Ag
Pacific	Bill Palmer - Mine Evaluation & Development	Au,Ag
Pend Oreille	The Bunker Hill Co.	Pb,Zn
	George Costa	Au,Ag,Cu,Mo,Pb, Zn,U,Co,Pb,Cd
	Exploration Ventures Co.	Au,Ag
	LaSota-Jones Lead-Zinc Corp.	Pb, Zn
	Placer Amex, Inc.	Au,Ag,W,Sn
	Rexcon, Inc.	Au,Ag,U,W,Sn
	Shell Oil Co. - Mining Exploration	Au,Ag
Pierce	Amoco Minerals Co.	Au,Ag,Cu,Mo
Skagit	Duval Corp.	Au,Ag,W,Sn,Cu,Mo, Pb,Zn
	Exploration Ventures Co.	Au,Ag
	Houston International Minerals Corp.	All metallic minerals
Skamania	Atlas Minerals Division - Atlas Corp.	Au,Ag
	Duval Corp.	Au,Ag,W,Sn,Cu,Mo, Pb,Zn
	Exploration Ventures Co.	Au,Ag
Snohomish	Exploration Ventures Co.	Au,Ag
Stevens	Arbor Resources	Au,Ag
	Arriva Resources Ltd.	Au,Ag
	David Beck	Au,Ag,U
	Canorex International, Inc.	Au,Ag,W,Sn,Pb,Zn
	Chewelah Eagle Mining Co.	Au,Ag
	George Erdosh	Au,Ag,W,Sn,Co
	Exploration Ventures Co.	Au,Ag
	Gold Fields Mining Corp.	Au,Ag
	Houston International Minerals Corp.	All metallic minerals
	Joy Mining Co.	U
	George Maddox & Assoc.	Au,Ag,Pb,Zn
	Madre Mining Ltd.	Au,Ag
	Orazada Mines Inc.	Au,Ag,Cu,Mo
	Placer Amex, Inc.	Au,Ag,W,Sn
	Rocky Mountain Energy	U
	Shell Oil Co. - Mining Exploration	Au,Ag
	Van Horn and Watson Mining Co.	Au,Ag,Cu,Pb,Zn
	Western Nuclear Inc.	U
Whatcom	Duval Corp.	Au,Ag,W,Sn,Cu,Mo, Pb,Zn
	Houston International Minerals Corp.	All metallic minerals
	Seattle-St. Louis Mining Co.	Au,Ag
	U.S. Borax & Chemical Co.	Ag
Yakima	Exploration Ventures Co.	Au,Ag
	Seymour Resources Inc.	Au,Ag,Cu
Unspecified Location	American Copper & Nickel Co., Inc.	Au,Ag
	Boise Cascade Corp.	Au,Ag,W,Sn,Cu,Mo, Pb,Zn
	Chevron Resources Co.	Au,Ag
	Cominco American Inc.	Au,Ag,Pb,Zn
	Dillon Exploration Inc.	Unspecified commodity
	Knox, Kaufman, Inc.	Au,Ag,W,Sn,Cu,Mo
	Nord Resources Corp.	Au,Ag
	Sunshine Mining Co.	Au,Ag
	Utah Mines Ltd.	Au,Ag

TABLE 3. — *Production of metals and uranium in Washington, 1982*

Mine	County	Operator	Commodity	Production	Grade
Republic unit (Knob Hill mine)	Ferry	Hecla Mining Co.	Gold and silver	56,000 tons ore	0.25 oz/ton Au 1.5 oz/ton Ag
Apex-Damon mine	King	CSS Management and Cleopatra Mining Co.	Gold and silver	3,000 tons ore	.2 oz-1.0 oz/ton Au 3 oz-22 oz/ton Ag
Deer Trail mine	Stevens	Madre Mining Ltd.	Silver (gold)	Production data withheld	
Sherwood mine	Stevens	Western Nuclear Inc.	Uranium	204,679 tons	0.101 percent U_3O_8

Gold Leaf Mining Corp. reports their 1982 geological exploration in the Republic district will be followed by a 1983 geochemical program.

King

CSS Management and Cleopatra Mining Co. produced 3,000 tons of ore grading between 0.2 oz and 1.0 oz/ton gold and between 3 oz and 22 oz/ton silver from the Apex-Damon mine in King County. The wide veins of the Apex and Damon claims contain arsenolite, arsenopyrite, chalcopyrite, and galena in a gangue of quartz in granodiorite.

United Cascade Mining Co., Inc. retained the Middle Fork Gilbreath properties with assessment level development in 1982. Various holdings of the company in King County carry values in gold/silver, copper/molybdenum, and lead/ zinc.

Lincoln

U.S. Borax & Chemical Corp. acquired the Spokane Molybdenum mine this year from Silver Seal, Inc. which has owned the mine since 1970. Geological exploration and drilling by a U.S. Borax subsidiary, Pacific Coast Mines, was reported in the "Exploration Roundup" column of *E&MJ* (October 1982).

Okanogan

Azure Resources Ltd. continued work at the Starr mine, a sizable deposit of molybdenum under lease from Wilbur Hallauer of Oroville.

Near Tonasket, L. F. Baum and Associates explored the Turtle Lake gold-silver property.

Mining & Investments Co. was looking to produce copper, molybdenum, gold, and silver at the Billy Goat mine in northwestern Okanogan County.

Spenst Hansen explored for gold/silver and copper/molybdenum at his Loup Loup property west of Okanogan.

Meridian Land & Minerals Co. drilled a few holes at their Gold Hill precious metal prospect near Loomis.

Pend Oreille

The Bunker Hill Co. reports that minor drilling and basic upkeep maintained the underground workings at the Pend Oreille mine during 1982.

George Costa drilled the Noisy Creek mine in Pend Oreille County, a property reported to contain 40 oz/ton silver and 1.5 oz/ton gold.

Rexcon, Inc. explored their Hall Mountain property near Sullivan Lake by geological mapping and geochemical sampling. Hall Mountain carries values in tungsten, molybdenum, and gold and was discovered in 1981 by the U.S. Geological Survey while they were mapping and sampling the Sandpoint 2-degree quadrangle.

Silver King Mining and Milling Co. explored for uranium, gold, and silver in an unspecified location in Pend Oreille County.

Pierce

Amoco Minerals, Co. continued exploration drilling at their Carbon River property, southeast of Enumclaw in the Cascade Mountains. The property contains gold, silver, copper, and molybdenum mineralization.

Skamania

Atlas Minerals Division of Atlas Corp. explored the Wind River property for its precious metal potential during the past year.

Stevens

Arbor Resources Corp. maintained their interest in the Melrose Silver mine — a quartz vein-hosted deposit of tetrahedrite, galena, and sphalerite in argillite near Northport.

Van Horn and Watson Mining Co. worked on a copper prospect in the Orient mining district which is

reported to run 8 to 10 percent copper with a small amount of gold. The mineralization is found in one 40-foot adit and several open cuts.

According to the *Engineering and Mining Journal* (October 1982), Shell Oil Co's. mineral division obtained the rights to the First Thought gold mine near Orient from Champion Gold and Silver Inc., and drilled the mineralized fault breccia. Shell reportedly controls the land surrounding the First Thought mine as well.

Early in the year Madre Mining Ltd. of Vancouver, B.C., and Sacramento, California, began producing silver from the dumps of the many claims in the Deer Trail district. With current underground exploration at the Deer Trail mine, Madre plans to develop new reserves for future mining, both from old stopes with high former cut-off grades and from new extensions of past-producing veins. The ore is shipped to Trail, B.C. for final processing.

Joy Mining Co. proceeded with plans to extract uranium from bog material in Flodelle Creek, east of Colville. The estimated 100,000 lbs. of U_3O_8 contained in the deposit will be processed on site over a 2- to 3-year period. The permitting process is underway and Joy plans to begin mining in the summer of 1983.

On the Spokane Indian Reservation, Orazada Mines, Inc. continued exploration under tribal permit at the Orazada mine, a silver-lead-antimony-zinc occurrence in a gangue of quartz, barite, and calcite.

Uranium mining on the Reservation ceased entirely at both the Midnite and Sherwood mines in 1982. Dawn Mining had been producing from stockpiles at the Midnite mine, but shut down completely this year to wait for an improvement in market conditions. Western Nuclear, Inc. produced 204,679 tons of uranium ore grading 0.101 percent U_3O_8 from the Sherwood mine before all activity was suspended there in June.

Whatcom

The Seattle-St. Louis Mining Co. conducted small-scale exploration at the Minnesota mine, reopening old adits and trenching to sample for gold values.

U.S. Borax & Chemical Corp. continued to explore the Excelsior mine, a breccia-controlled occurrence of silver mineralization in northern Whatcom County.

Yakima

Seymour Resources Inc. reports that they drilled their Morse Creek copper-gold-silver property in the Summit mining district.

INDUSTRIAL MINERALS MINING AND EXPLORATION, 1982

The 29 industrial mineral producers who responded to our questionnaire reported a significant downturn in their industry in 1982 (table 4). For some, the situation resulted in major reductions in employment, production, and sales. At least one important exploration program was shelved because of budget restrictions. While 1982 was slow, several companies were optimistic that conditions would improve in 1983.

Eight firms mined silica this year (table 5). Six were interested in barite, five in limestone, and three producers worked with dolomite or marble. Two producers of olivine, two of clay, and two of rock and stone reported an active year. The state's only diatomite mine continued in operation as well. An unusual grass-roots exploration program for diamonds was reported in Ferry County. Properties are located on figures 1 - 4.

Chelan

Feldslite Corp. of America continued exploration and development drilling on the Wenatchee Ridge Feldspar deposit. Their 52 claims cover an occurrence of albite feldspar, which has been under investigation by Feldslite since 1962.

Wenatchee Silica Products, Inc. produced 60,000 tons of silica sand (Dry Gulch Canyon mine) and alumina clay in what they report was a "very slow year due to poor economic climate, but 1983 is expected to increase considerably."

Clallam

Ideal Basic Industries worked their Twin Rivers clay quarry on the Straits of Juan de Fuca, producing 120,000 tons of raw material.

Grant

Witco Chemical Corp. of Quincy, Washington, mined 65,000 tons of diatomite from their mine in the Frenchman Hills near George.

King

Industrial Mineral Products, Inc. mined and milled 125,000 tons of silica from the Ravensdale Silica Sand mine in 1982. They state that "the downturn in construction didn't affect sales until late in the year."

Forty-five thousand tons of clay was taken from the Section 31 and Elk pits in King County and the Clay City pit in Pierce County by Mutual Materials Co. this year.

TABLE 4. — *Index of mining and mineral exploration for industrial minerals and stone/crushed rock*

County	Company	Commodity
Chelan	Feldslite Corp. of America	Feldspar
	Wilbur Hallauer	Silica
	Wenatchee Silica Products, Inc.	Silica,aluminum,stone/ crushed rock
Clallam	Ideal Basic Industries	Clay
Grant	Witco Chemical Corp.	Diatomite
King	Industrial Mineral Products, Inc.	Silica
	Mutual Materials Co.	Clay
	Palmer Coking Coal	Stone/crushed rock
Pend Orielle	LaSota-Jones Lead-Zinc Corp.	Barite
	Lehigh Portland Cement	Silica, limestone
	Milchem, Inc.	Barite
Pierce	Mutual Materials Co.	Clay
	Tacoma Lime	Lime
Skagit	Cascade Talc Inc.	Talc, soapstone
	IMC Olivine	Olivine
Stevens	David Beck	Barite
	Bristol Northwest Silica	Silica
	C-E Minerals Combustion Engineering, Inc.	Barite
	Chewelah Eagle Mining Co.	Dolomite
	Lane Mt. Silica Co.	Silica
	Milchem, Inc.	Barite
	Montana Barite Co.	Barite
	Nanome Aggregates, Inc.	Dolomite, marble
	Northwest Alloys	Silica, dolomite
	Smith Limestone	Limestone
Thurston	Jones Quarry	Crushed rock
Whatcom	Columbia Cement Corp.	Limestone
	Olivine Corp.	Olivine
Unspecified Location	Boise Cascade Corp.	Silica,barite,limestone
	Meridian Land & Minerals Co.	Industrial minerals, sand and gravel

TABLE 5. — *Production of industrial minerals, 1982*

Commodity	Production (tons)	No. of producers reporting
Talc	8,000	1
Soapstone	20	1
Silica	438,467	8
Barite	3,400	5
Dolomite and(or) marble	450,354	3
Olivine	15,000	2
Clay	165,000	2
Limestone	500,500	5
Diatomite	65,000	1

Ferry

In a shift from the traditional commodities, Ace Parker Mines and Minerals Corp., Ltd. of Calgary, Alberta, did grass-roots exploration in the county for diamonds.

Pend Oreille

LaSota-Jones Lead-Zinc Corp. drilled 15 holes on the Slate Creek (Lead Hill) property near Metaline Falls to delineate mineralization and establish grade on this lead, zinc, and barite occurrence.

Milchem, Inc. looked at various properties in Pend Oreille and Stevens Counties as part of a multi-year exploration program for barite in Washington. Due to budget constraints, the program has been discontinued for 1983.

Pierce

Mutual Materials Co. of Bellevue produced clay from the Clay City pit in Pierce County.

Skagit

Walter Yaude of Cascade Talc Inc. reports production of 20 tons of carving grade soapstone, along with 8,000 tons of commercial grade talc from the Londonderry deposit. He reports that the material hasn't been moved from the mine yet, but should be shipped to a grinding plant before the end of the year.

IMC Olivine continued development and milling activities at the Twin Sisters quarry in the Mount Baker mining district. IMC is one of two active producers of olivine in the state.

Stevens

Bristol Northwest Silica shipped 1,600 tons of metallurgical grade silica from the Buckskin quarry near Addy in 1982.

Chewelah Eagle Mining Co. produced 600 tons of dolomite from the Chewelah Eagle mine.

David Beck of Nine Mile Falls reports that the Chopot Barite deposit produced 300 tons of +90 percent barite ore in Stevens County in 1982.

Montana Barite Co. reports mining 3,100 tons of Washington State barite in 1982 from an unspecified location.

The Moning claims of Lane Mt. Silica Co. produced 190,000 tons of silica sand from the Addy quartzite near Valley, Washington.

Fourteen quarries in the Chewelah area were worked by Nanome Aggregates Inc., for marble and dolomite; 14,500 tons of material were removed.

Production from the Blue Creek Quartzite quarry of Northwest Alloys Inc. (a subsidiary of Alcoa) was 61,867 tons of high purity silica through October of 1982. The West Dolomite pit produced a total of 435,254 tons of low silica dolomite in the same period. Northwest Alloys reports, "Dolomite production was curtailed approximately 45 percent in March, April, and May and will be curtailed 25 percent in November and December (1982)." Plans were made late in the year to cease quartzite operations entirely for 5 to 7 months. The reduced output of silica and dolomite reflects the declining demand for magnesium produced at the Addy plant for Alcoa and other magnesium consumers.

The Smith quarry near Northport quarried 200 tons of limestone in the past year.

Whatcom

One-half million tons of limestone was produced at the Kendall quarry run by Columbia Cement Corp. of Bellingham this year.

On one upbeat note, Olivine Corp. reported the olivine business is "growing! Even with the tough economics, the market is growing." They produced 15,000 tons of olivine from the Twin Sisters Dunite in the Swen Larsen quarry.

Other

Meridian Land & Minerals Co. reported that they pursued an aggressive program on Burlington Northern lands for industrial minerals and aggregate.

In a similar program, Boise Cascade Corp. initiated a minerals inventory on their lands, seeking silica, barite, and limestone, and other metallic and energy commodities.

OIL AND GAS EXPLORATION, 1982

Shell completed testing on all three of their wildcat oil and gas exploratory wells in Kittitas County, and plugged and abandoned all of them this year. Two were located near the Roza Dam; one went to a total depth of 16,199 ft and the other to 5,600 ft. The third well, located on top of Whiskey Dick Mountain, was drilled to a total depth of 14,965 ft.

Fairview Oil & Gas drilled an oil and gas exploratory well near Port Angeles to a total depth of 7,158 ft before plugging and abandoning it. Columbia Hydrocarbon drilled a shallow well south of Prosser, in Benton County, then plugged and abandoned it.

In spite of the above dry wells, leasing continues, both east and west of the Cascades. The Department of Natural Resources has applications pending on over 230,000 acres of state lands, which should be auctioned off in April 1983. There is also a large number of lease applications pending on federal land.

Geophysical seismic surveying activity increased in the state during 1982. Vibroseis was active on roads in Lewis, Grays Harbor, Thurston, Mason, Jefferson, Clallam, Pierce, King, Kittitas, Yakima, Grant, and Benton Counties. Deep seismic surveys, requiring the drilling of shot holes, were conducted in Grant and Yakima Counties.

WASHINGTON'S COAL – FUTURE DEVELOPMENT POTENTIAL

by Ray Lasmanis and Henry W. Schasse*

INTRODUCTION

Coal is one of the most valuable mineral resources known to occur in Washington. Our coal has the potential to not only supply the needs of Northwest industry, but also to be a valuable export product to Pacific Rim Countries, such as Japan, Taiwan, and Korea. At one time, coal exceeded in value all other minerals produced annually in the state. Then, it lost its leading position to industrial minerals as the country switched to less costly oil and gas.

The Arab Oil Embargo of 1973 put an end to cheap oil and gas, limiting their future as fuels for electrical generating purposes and increasing the potential for coal. As a result, a renewed interest in the state's coal resources was shown by both U.S. and Canadian exploration companies. The state, recognizing the need to again evaluate this valuable resource, initiated a coal program to first look at its own holdings on the 2.9 million acres of state land managed by the Department of Natural Resources. The program was expanded to evaluate the coal resources in other areas as well. This effort was to provide informa-

* Revision of a talk given by Ray Lasmanis, State Geologist, at the Northwest Mining Association 88th annual convention, in Spokane; Henry W. Schasse is a Washington Division of Geology and Earth Resources geologist.

tion which would be useful to exploration companies looking for coal deposits to mine, and to planners as a basis for making decisions on urban growth and development.

This article discusses the current status of mining and exploration, the coal program of the Washington Division of Geology and Earth Resources, and the future development potential of Washington's coal resources.

COAL RANK AND RESERVES

The rank of Washington's coal ranges from lignite in the southwestern part of the state to anthracite in the Glacier field in north-central Whatcom County (fig. 1). In general, the rank increases with age: early to middle Eocene deposits are bituminous rank coals, most late Eocene deposits are subbituminous rank coals, and Oligocene deposits are lignites. The anthracite occurrences are found only in small areas of intense deformation.

The coal reserves of Washington remaining in the ground as of January 1, 1960 were estimated to be 6,185 million short tons (Beikman, and others, 1961). Of that total, about 5 million tons was anthracite, 1,869 million tons bituminous, 4,194 million tons subbituminous coal, and 117 million tons lignite. Since that time, mining has removed 54 million tons[1/] of subbituminous and 2 million tons[2/] of bituminous coal. However, new reserves have been reported by Moen (1969) and Vonheeder (1976) that increase the remaining reserves of bituminous coal in Whatcom County by approximately 53 million tons. Additional coal resources have also been reported for the Green River District of King County (Morris and Ames, 1980) that increase the in-place reserve of bituminous coal by 179 million tons. These totals are summarized in table 1.

The resulting in-place reserves, based on published information, are 6,361 million tons of coal. Additional reserves have been developed in recent years but the companies wish to keep the data confidential.

Table 1. – *Coal reserves of Washington, 1981, by rank (in millions of tons)*

Anthracite	5
Bituminous	2,099
Subbituminous	4,140
Lignite	117
TOTAL	6,361

EXPLORATION AND DEVELOPMENT

Whatcom and Skagit Counties

Recent interest has been shown by several major mining and energy companies in the area north of Bellingham. Amax Coal Co. of Denver has been exploring throughout western Washington for the past several years. In 1981, Amax completed a drilling project between Bellingham and Lynden in the Whatcom basin. Approximately 15,000 ft of drilling in 11 drill holes was completed. Amax was actively involved in a leasing program in 1981, and they hope to resume further exploration efforts in 1983.

North American Exploration Co. was reported to have drilled 1,300 ft during the summer of 1980 in Whatcom County for a major Oklahoma petroleum company.

Utah International, Inc. of Salt Lake City has been engaged in active exploration of Washington coal for the past several years. They were engaged in exploratory drilling in Whatcom and Skagit Counties this past summer.

King County

Palmer Coking Coal Co. is the only producer presently mining in King County. Palmer is currently strip mining underground mine barrier pillars in the McKay and Franklin No. 12 seams. Palmer also mined the Franklin No.'s 10 and 12 seams by underground methods as recently as 1974, and the Landsburg beds as recently as 1976. Palmer has been producing approximately 5,000 tons of coal annually for the past 3 years. Production for 1982 is estimated at 7,200 short tons. Their coal is used for local institutional and residential heating.

In a press release on August 5th of last year, the Pacific Coast Coal Co. announced plans to develop a new coal mine near Black Diamond on lands leased from Palmer Coking Coal Co. The mine is to be an open-pit type operation with a design production capacity of 250,000 clean tons per year. The coal produced will compete directly with comparable coal from Utah and Wyoming presently being consumed by Washington industry and various federal and state institutions. Estimated mine life at full production is 16 years. Pacific Coast Coal Co. anticipates that underground mining may once again be economical by the 1990's and could extend the mine life. The new mine will be named the John Henry No. 1.

1/ Based on production of clean coal reported to the Division of Geology and Earth Resources (recovery factor of 80 percent, commonly used for strip mining, included).

2/ A recovery factor of 50 percent was used based on reported tonnage of clean coal, most of which was mined by underground methods.

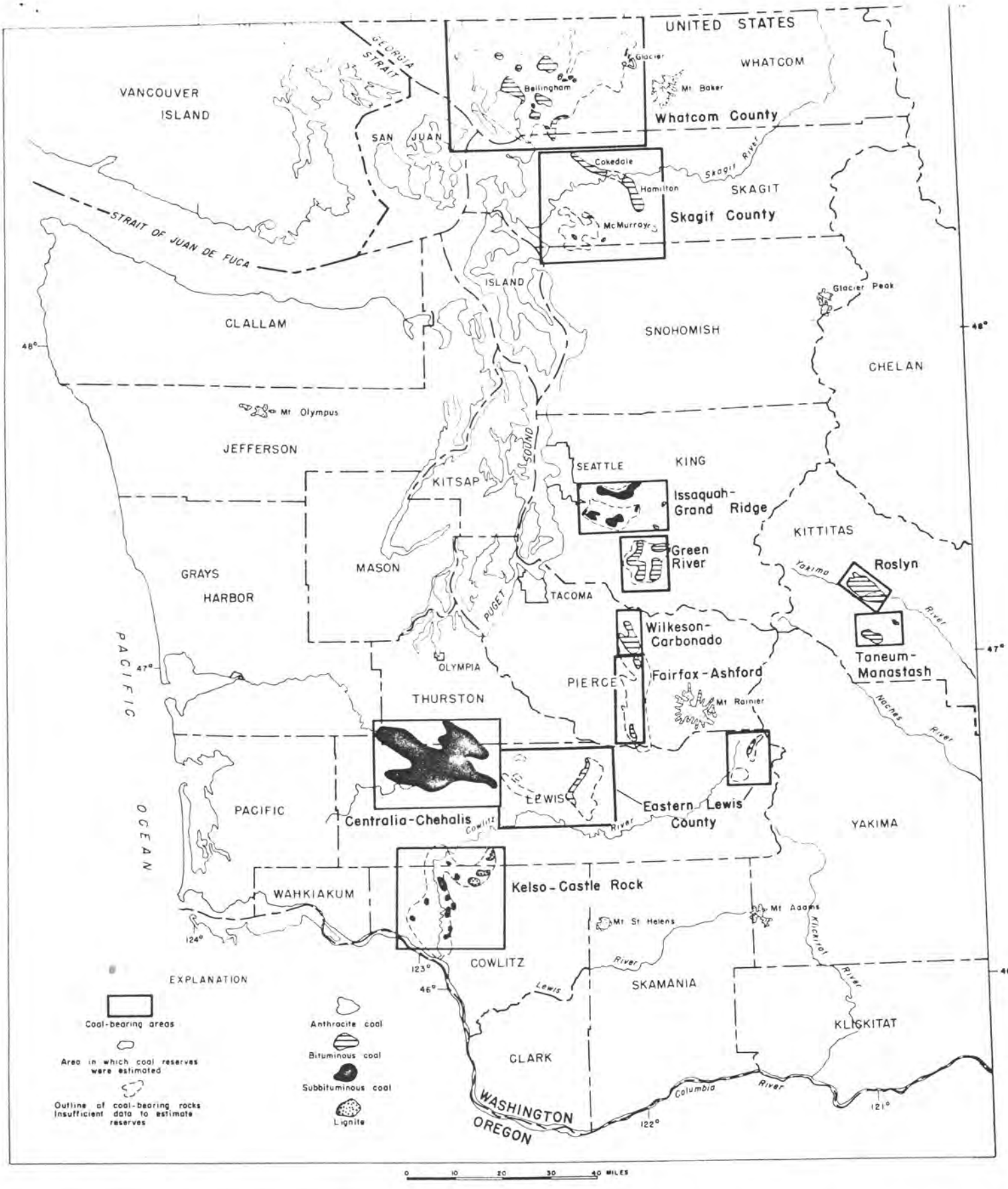

FIGURE 1. – Map of western Washington showing major coal-bearing areas (modified from Beikman, and others, 1961).

Meridian Land and Minerals Co., a Burlington Northern subsidiary, drilled six holes in their mineral holdings in the Green River area to establish reserves during the summers of 1980 and 1981.

Kittitas County

Although coal occurs in the Taneum and Manastash areas of Kittitas County, the only area of importance in the past, or which offers much likelihood for future development, is the Roslyn field. This field has seen a fair amount of exploratory drilling in the past decade or so. The more recent activities include 31 boreholes drilled by Burlington Northern in 1978. Three holes were drilled by Amax Coal Co. in 1979. AMCA/Luscar, based in Kentucky, recently evaluated the coal reserves on an area under lease by Petrominerals of Santa Ana, California, in the Roslyn and Cle Elum area and believes there is a potential reserve base of 30 to 35 million tons. The Roslyn district is one of the few areas in Washington where underground mechanized mining has been successfully employed in the past.

Pierce County

Currently, Meridian Land and Minerals Co. (Burlington Northern) is involved in a core drilling program to evaluate their mineral holdings in the Wilkeson to Fairfax area. Also, Terraspace, Inc., of Rockville, Maryland, has taken over a project initially started by Gulf Resources and Chemicals Exploration Co. to do a technical and economic feasibility study of hydraulic coal mining in the Wilkeson-Carbonado coal field. The first phase of this project, the potential site evaluation, is due to be completed by July of 1983. The contract is with the U.S. Bureau of Mines. The objective of the program is to design an economically viable underground hydraulic coal mining system for moderate to steeply pitching bituminous coalbeds.

Southwestern Washington Coal Fields

The southwestern Washington coal fields include the Centralia-Chehalis area, the Kelso-Castle Rock area, and the Vader area.

Washington Irrigation and Development Co. (WIDCO) continued confirmation drilling and seam characterization on its reserve holdings in the Tono basin where it produces between 4 and 5 million tons a year from the Centralia strip mine located in the Centralia-Chehalis district. Production for 1982 is estimated at 4,161,000 short tons of coal. Reserves are estimated to be adequate for another 35 years.

A unique secondary coal recovery operation has been conducted by Old King Coal Co., Inc. on mine waste produced by WIDCO. Coal, uneconomical to recover by large equipment, is salvaged in a satellite operation. A further example of energy conservation is Old King Coal Co.'s plan to recover 65,000 tons of coal fines from the old Stoker mine waste area. During 1982, Old King Coal Co. sold 34,228 clean short tons of coal to customers other than WIDCO and an additional 6,500 tons to WIDCO for power generation.

Kennecott Minerals Corp. of Salt Lake City, is currently involved in exploratory drilling of the Curtis-Vader-Ryderwood area of western Lewis and northwestern Cowlitz Counties. Kennecott has explored the area for the past 2 years. They are involved in a joint venture with GCO Minerals Co., a subsidiary of International Paper Co. According to Kennecott's public relations officer – Kennecott has a land base of 9,000 acres; GCO has a much larger base reported to be in the vicinity of 40,000 acres. Drilling is being done to block out reserves and to determine coal quality. The project is still in its early stages.

Asotin County

Lignite occurs in southeastern Asotin County within sedimentary strata that are interbedded with flows of Yakima Basalt of Miocene age. Minor amounts of lignite were produced for local use in the early part of the century. No further mining has occurred since that time. However, the area is again receiving consideration. Utah International, Inc. began drilling in 1977. They drilled 10 to 12 holes, totaling approximately 2,000 lineal feet. The company is reported to be actively exploring on the Oregon side of the lignite field. Kemmerer Coal Co. (now part of Gulf Resources) drilled 10 to 11 holes totaling 2,500 to 3,000 ft in 1980 and 1981.

Several other mining and energy companies, not mentioned here, continue to evaluate existing data in office studies prior to committing funds for exploration and drilling. Some of the companies are listed in table 2.

Table 2. – *Companies active in coal exploration in Washington, 1982*

Cominco American, Inc.
Getty Oil Co.
Kennecott Minerals Corp.
Meridian Land & Minerals Co.
North American Coal Corp.
Shell Oil Co.
United States Steel Corp.
Utah International, Inc.
Washington Irrigation and Development Co.

COAL ACTIVITIES OF THE DIVISION OF GEOLOGY AND EARTH RESOURCES

The Division of Geology and Earth Resources (DGER) of the state's Department of Natural Resources has been conducting studies of Washington's coal resources since 1974. With renewed interest in the nation's coal resources as a result of the energy shortage, the state became interested in learning more about coal on state-administered lands. A program was initiated, concentrating on Whatcom County, where the greatest amount of state land underlain by coal-bearing rocks occurs. Initially, a compilation of all available data relating to the geology and coal resources of Whatcom County was generated. In addition, a series of reports which outline the areas of coal-bearing rocks, computed coal reserves, and locations of state-owned lands for all the major coal areas of the state (except King County) was produced. A coal-sampling program was also underway during this time period.

Results of the coal-sampling program were released as an open-file report (Phillips, Walsh, and Schasse, 1982) in July of 1982. The report presents analyses for 135 coal samples from 89 sampling localities in nine Washington counties. Stratigraphic sections, measured and recorded at 37 of the sampling localities, are also included in the report. In 1977 the coal program was expanded to include all of Washington's coal deposits.

In 1978 a project was initiated in the Roslyn-Cle Elum area resulting in a DGER open-file report (Walker, 1980) containing information on coal quality, coal reserves, and 25 separate maps illustrating the geology, geologic structure of the major coal beds, mining conditions, stratigraphic relationships of the coal measures and surrounding rocks, seam thickness, and overburden thickness.

A project was begun in 1980 to study the Miocene lignite occurrences in Asotin County in the southeast corner of the state. A program that involved reconnaissance mapping, data collection, and sampling of basalts and lignite was carried out during 1980. The results of the first season's field work were presented in a DGER open-file report (Stoffel, 1981) released in September, 1981. A second season of field work was conducted to answer questions raised during the first half of the project. A final report on the results of the project is currently being prepared and will be available in 1983.

Projects to study the coal resources in the Newcastle-Tiger Mountain area and the Green River district of King County were also initiated in 1980. A similar project to study the coal resources of the Wilkeson-Carbonado coal field in Pierce County was begun in 1981. The King and Pierce County studies should be completed by late 1983.

FUTURE DEVELOPMENT POTENTIAL OF WASHINGTON COAL

Washington's coal development has been hampered by the limited size of individual coal fields, their variable composition, and by hard-to-mine steeply dipping beds. These factors coupled with the considerable thickness of overburden over many areas make them unsuitable for low-cost, open-pit mining operations (the Centralia coal field is an exception). Historically, the high cost of mining Washington coal has made it very difficult for Washington coal producers to compete in markets within the state, and virtually impossible for them to compete in out-of-state markets. However, with the recent surge of interest shown by exploration companies over the past decade or so, the potential exists for the discovery of new reserves, particularly in frontier areas which could also be amenable to economically competitive mining methods.

The currently established coal reserves in Washington underlie an area of only about one-third of the known area of coal-bearing rock in the state (fig. 1). Possibly, other large areas of coal-bearing rocks are concealed beneath a mantle of glacial drift or alluvium. The principal areas where such conditions exist are north of Enterprise in northwestern Whatcom County, between the Skagit and King County areas, between the Issaquah-Grand Ridge and Green River coal fields of King County, between the King and Pierce County areas, and between the Centralia-Chehalis coal district and the Kelso-Castle Rock area. There is good reason to believe that many of these areas contain potentially significant coal deposits within 3,000 ft of the surface. There are large areas in Chelan and Kittitas Counties and smaller areas in Snohomish and eastern King Counties underlain by potentially coal-bearing rocks of Cretaceous or lower Tertiary sedimentary rocks of the Swauk Formation.

Progress has been made utilizing hydraulic techniques in underground mining by the Canadians, the Japanese, and the Russians. In Canada, Kaiser Resources, Ltd. has been successfully employing hydraulic mining at its Sparwood, British Columbia operations since the early 1970's. Kaiser's underground hydraulic mining operation produces approximately 1 million tons of raw coal per year. In a 50-foot-thick seam that dips 25-50°, Kaiser has increased recovery from 10 to 12 percent, where conventional underground mining had been formerly employed, to 55 to 60 percent with hydraulic mining. Productivity also increased significantly to between 25 to 30 tons per worker shift. Similar successes have been experienced by the Japanese and Russians in seams with dips as steep as 60 to 80°.

As mentioned earlier, a company is currently

operating under a grant from the U.S. Bureau of Mines to do a feasibility study of hydraulic mining of the steeply dipping coal seams in the Wilkeson-Carbonado area of Pierce County. They will be investigating methods similar to those employed by Kaiser Resources. Hopefully, these efforts will develop techniques that will eventually allow state coal producers to be more competitive in the regional and the international marketplace.

Concerns brought on by the energy crisis have brought in-situ or underground coal gasification (UCG) into consideration as an alternate energy source. Underground coal gasification is one of the most promising of the various processes to produce clean fuels from coal. With this method both low and medium BTU product gas have been obtained by air and steam/oxygen injection, respectively. If successful, underground coal gasification would quadruple the proven U.S. reserves of coal. Costs of fuels produced by UCG are projected to be 65 to 75 percent of those produced by conventional surface coal-conversion processes. Through this technique lignites and other low-grade coals, uneconomical to mine through conventional means, could be developed as a commercial energy source. Steeply dipping and tectonically disturbed seams, ignored in the past as being uneconomical to mine, could be gasified.

At least 18 UCG field tests have been conducted in the U.S. since 1973. The U.S. Department of Energy and Gas Research Institute jointly sponsored a series of tests being conducted by Lawrence Livermore National Laboratory (LLNL) in cooperation with the Washington Irrigation and Development Co. (WIDCO) in the Tono basin about 5 miles northeast of Centralia. During the past year, a series of five large block field experiments were performed within the Big Dirty coal seam. The blocks were later excavated so that burn cavity geometry could be studied, as well as the cavity growth process response to changes in varying amounts of steam/oxygen and air which were injected during the tests. The tests were successful and indicated that the Big Dirty seam is suitable for in-situ gasification. Further tests are scheduled for the summer of 1983. A budget of $2,700,000 has been proposed for a large-scale test that will consume about 2,000 tons of coal.

The ultimate goal of these experiments is the successful gasification of multiple seams approximately 600 ft below ground level in the Tono basin, 2 miles east of the WIDCO mine and powerplant complex. A successful experiment would allow a transfer of UCG technology to many of Washington's coal seams that are presently uneconomical to mine. Ultimate use of the generated gas would probably be a boiler feedstock for electrical power generation. A consensus of opinion indicates that the UCG process can be commercial within the next 10 years.

Another factor that would increase the development potential of Washington's coal would be the establishment of a deep-water coal port in the Puget Sound region. Pacific Rim countries, such as Japan, Korea, and Taiwan, are switching to steam coal for electric generation and for heat in the cement and the pulp and paper industries. Forecasts of the East Asian steam coal market show a 21 percent per year growth rate for the 1985-1990 period (fig. 2). This graph shows the lowest estimate of demand by 1985 to be 40 million tons, and 100 million tons by 1990. However, the current recession has dampened considerably such optimistic forecasts. Reports are stating that Japanese demand, in fact, may be only half or less what was previously expected.

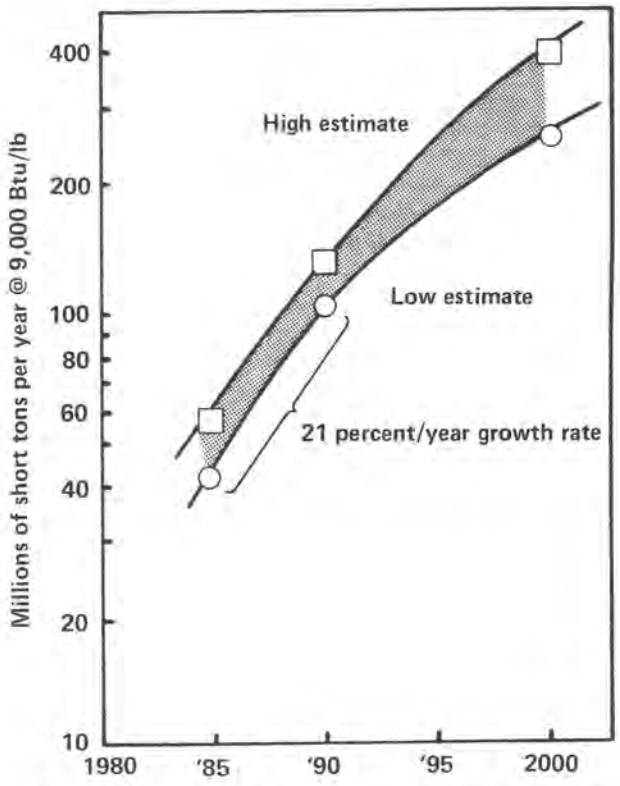

FIGURE 2. — East Asian steam coal market outlook (Swift, and others, 1980).

One barrier to expanded exports to Japan has been the higher price of western U.S. coal due to transportation problems and limited port loading facilities on the Pacific coast. Japan will most likely be supplied by four countries: Australia, South Africa, Canada, and the United States. Currently the U.S. is the highest cost producer because of the long distances involved from mine to port. In spite of the higher costs of its coals, the U.S. can reasonably expect to capture 10 to 20 percent of the

East Asian export market, because a concern of Pacific Rim buyers is stability of supply.

The quality of coal required by Pacific Rim buyers at least until 1990-1995 should have the following minimum specifications: 10,800 BTU's per pound heating value; 10 percent ash, 10 percent moisture, and less than 1 percent sulfur. Coals of this quality are found in southwest Wyoming, northeast Utah, northwest Colorado, southwest Utah, and parts of the San Juan River and Raton Mesa regions of Colorado and New Mexico. Washington also has coals that meet the specifications mentioned above, although current production is very small and comes from one mine in King County.

At least 11 possible coal port terminal sites have been proposed for Washington. The only port facility in the advanced stages of the development process in Washington is at Kalama on the Columbia River. The likelihood that a deep-water port will be built on Washington's coast or in the Puget Sound region, at least within the next decade, is slim.

An increased demand for steam coal in East Asia, and some technological advances will allow lower BTU coal to be used. Then the geographic area which can supply coal will expand to include the Powder River basin area of Wyoming and Montana. This will increase the possibility for a deep-water coal port in the Puget Sound region of Washington to handle these coals. With a coal port located within the state, Washington's coal would become attractive by virture of its location.

In order to take full advantage of economic recovery in the future, exploration of Washington coal fields should be initiated as rapidly as possible. The Division of Geology and Earth Resources of the Department of Natural Resources is doing everything possible to assemble and make data available so that new coal development becomes a reality in Washington.

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DON FORD RETIRES

Donald (Don) M. Ford announced his pending retirement to be effective February 1, 1983. Don served the Department of Natural Resources Division of Geology and Earth Resources as Assistant State Geologist from 1970 to 1983. During this period, he was responsible for the administration of the Surface Mined Land Reclamation Act involving coordination between state and county agencies, dealing with the public and coordinating and training area personnel. He served as Deputy Oil and Gas Supervisor in the implementation of the Oil and Gas Conservation Act. The revised oil and gas and the geothermal resources drilling regulations were largely the handiwork of Don. In addition, he was involved in the supervision of the Environmental Geology and Operations section of the division.

Representing the State of Washington, Don worked with other states in the establishment of the National Association of State Land Reclamationists, an organization of states designed to coordinate state reclamation activity, to serve in a liaison capacity with the federal government, and to provide input to legislation. He later served as national chairman and on the executive board.

During the past 4 years, he has represented the division and the department on the Geologic Overview Committee of the Basalt Waste Isolation Project by Rockwell Hanford Operations and the U.S. Department of Energy.

Prior to transfer to the Geology Division in 1970, Don served as Mineral Lands Supervisor with the Lands Division of the department. In this division Don had the responsibility of handling oil and gas and mineral leasing of state-owned lands and the sale of valuable mineral materials. During his time with the Lands Division, he assisted in the acquisition of two Twin Beech aircraft for the department. His flight log book shows that he logged approximately 300 hours flying for the department in administrative and fire control activities. Don's flying interest dates back to World War II days when he flew B-24's over Europe. He continued his interest in military flying by participating in the Air Force Reserves. This resulted in his being recalled to active duty for 1½ years in 1968-69 when he flew C-124's with the Military Airlift Command.

Don has been with the department for 25 years. He has indicated that he will miss the department and the challenges of dealing with people on difficult issues.

BEDROCK GEOLOGIC MAP OF THE OKANOGAN RANGE AVAILABLE FOR PURCHASE

Dr. Fred J. Menzer, Jr., has prepared a "Bedrock Geologic Map of the Central Okanogan Range, Washington," in conjunction with an article he has written for a Geological Society of America bulletin [in press]. The map can be purchased from the Western State College Foundation, 120 N. Blvd., Gunnison, CO, 81230. The map, with gravity lines, is available for $5 and is accompanied by "A Note on the Gravity of the Central Okanogan Range, Washington," by Chandler, A. Swanberg. A limited number of the same map, without gravity lines, is available for $4. The map location is T. 33-36 N., R. 21-26E.; scale 1:63,360. A copy of the map is available for reference at the Division of Geology and Earth Resources library.

THESES ADDED TO DIVISION LIBRARY

The following theses were recently added to our division library where they are now available for reference work:

Cruver, S. K., 1981, The geology and mineralogy of bentonites and associated rocks of the Chuckanut Formation, Mount Higgins area, north Cascades, Washington: Western Washington University M.S. thesis, 105 p., 2 plates.

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RECENT GEOLOGIC REPORTS ADDED TO OUR DIVISION LIBRARY

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RECENT 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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Prepayment is required. Open-file reports are announced, with price, in the monthly list, "New Publications of the Geological Survey." A free subscription to the list may be obtained on application to: Mailing List Unit, U.S. Geological Survey, 329 National Center, Reston, VA 22092.

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