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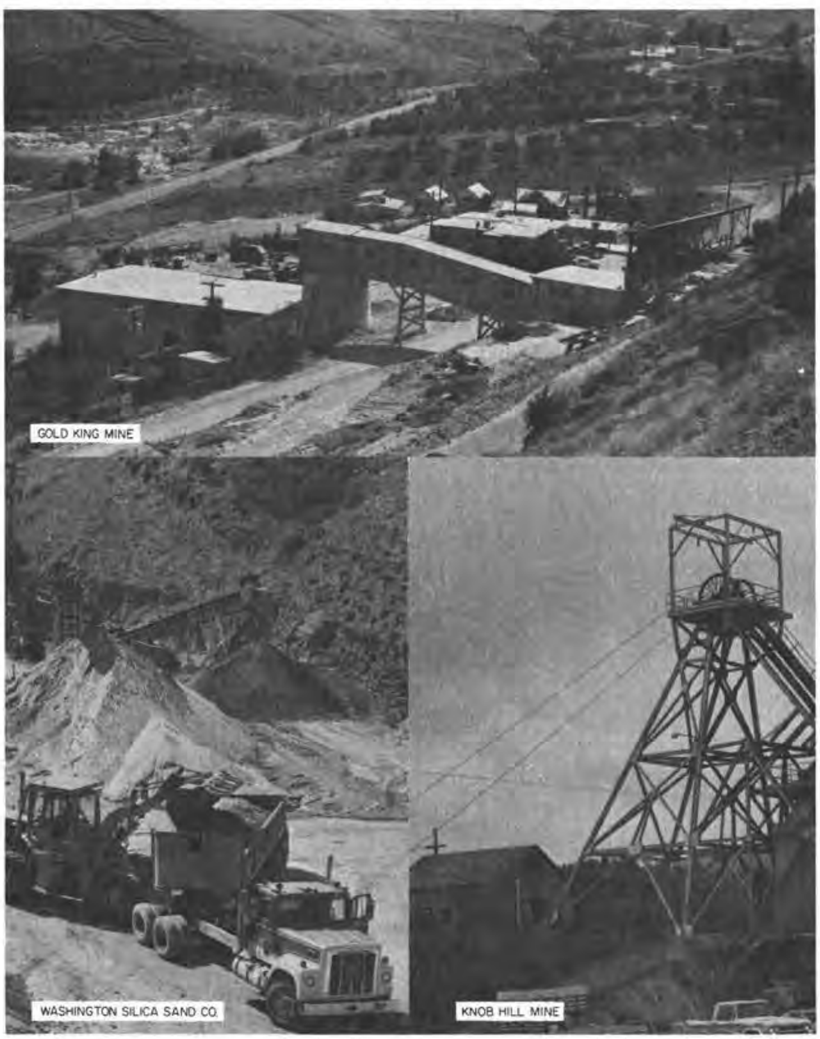


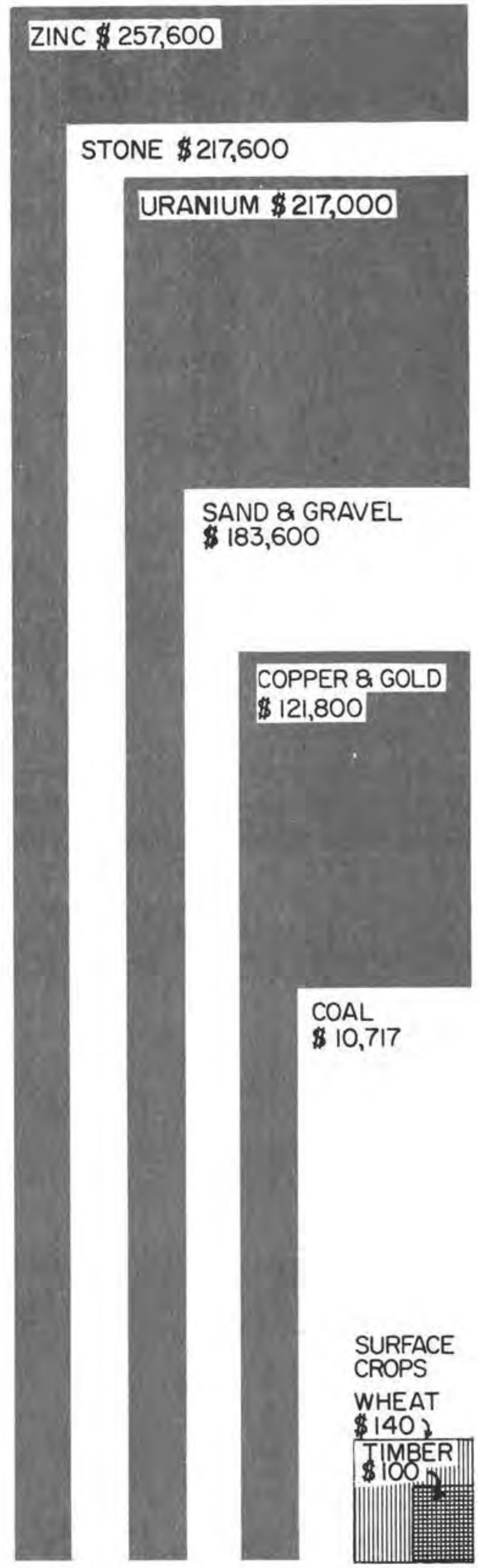
GOLD KING MINE

WASHINGTON SILICA SAND CO.

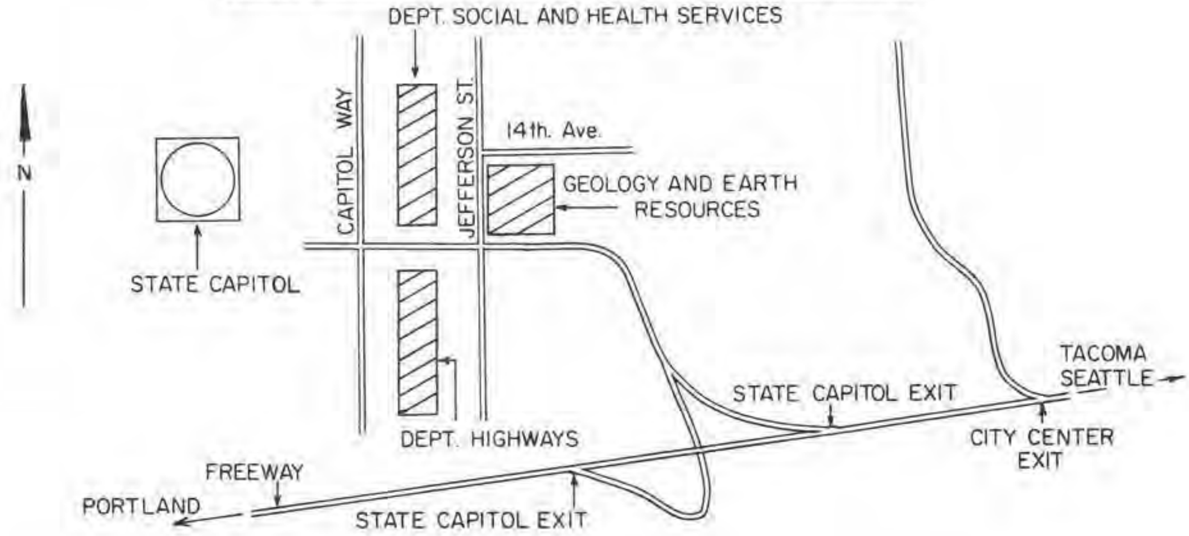
KNOB HILL MINE

MAJOR MINES OF WASHINGTON

Yield per acre per year



LOCATION MAP. DIVISION OF GEOLOGY AND EARTH RESOURCES



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THE MINES OF WASHINGTON—THEIR OVERLOOKED WORTH

By Wayne S. Moen

In the course of a year, as a minerals geologist for Washington State, I am frequently asked if Washington has any valuable mines. In answer to this question I emphatically reply that Washington does have valuable mines and has had since the turn of the century. Considering most people couldn't care less where metals come from, I have never thought of this as an unusual question. However, I have often wondered what really determines the value of a mine. Obviously, its value is related to metals it produces. To the owner of a mine, metals mean dollars; to a child, metals may mean a cherished toy or a bicycle; to an adult, metals may mean home conveniences or a car. But in all cases, whether they be monetary or intrinsic, certain values are placed on metals by man.

In terms of dollars, which is what most people relate value to, the mines of Washington have to date produced metals and nonmetals in excess of several billion dollars at present-day metal prices. Currently, Washington's mineral production is at an all-time yearly high of $181,000,000. In its short life a single mine may produce as much as one-half billion dollars, or in excess of $25 million yearly, which contributes significantly to the economy of a mining community. However, if the value of a mine is related to benefits that man derives from its metals or minerals, it becomes impossible to attach a dollar value to its worth. As an example, at the Centralia mine in western Washington, coal mined in 1 day and converted into electrical energy could supply all homes in the neighboring communities of Centralia and Chehalis with electricity for 5 months, or would be sufficient to supply electricity to all the homes in Seattle for 2 days. Uranium mined at the Midnite mine in eastern Washington, when converted into electrical energy, is utilized in thousands of homes along the Atlantic coast. Copper from the Holden mine in central Washington, if used in copper wire, was enough to wire over 800,000 homes. A single year's production of lead from the Pend Oreille mine in northeastern Washington, when used in car batteries, makes it possible for nearly 200,000 cars to operate. Silver from Washington mines is utilized by the electronics and film industries, whereas Washington gold may have been used in the first space craft that landed on the moon. It would be impossible to point out all benefits man derives from metals produced in Washington, because a single metal may have several hundred uses. However, if each metal had but a single use, man would be dependent upon it.

Metals and minerals have always been considered natural resources, and as such, it seems reasonable to express the productivity of a mine in yield per acre per year, as is done with surface crops such as wheat and timber. To illustrate the productivity of Washington mines, nine major mines have been selected (table 1). As can be seen in table 1, five past-producing mines yielded $592.95 million from 1,095 acres, three present-day operating mines have produced $820.42 million to date from 3,147 acres; and one property, that has yet to be placed into production, contains $560 million within 172 acres. Thus, the mineral wealth of 4,414 acres overlying the deposits is valued at $1,973 billion, for an average worth of $446,986 per acre. To illustrate the tremendous yield per acre per year of metal mines, it is best to consider specific properties. In the case of the Van Stone mine of Stevens County, this property, in 18 years produced $71 million from 15.4 acres. With an annual yield of $3.96 million, each acre of land overlying the mineral deposit yielded $256,962 per year. In the case of the Sherwood uranium deposit in Stevens County, this property, when placed into production will yield $560 million from 172 acres in a 15-year period. Thus, the per acre per year yield of uranium amounts to $217,000. The yield per acre of a low-cost mineral commodity

TABLE 1.—Production and mineral value of major Washington mines

Property	Chief product	Production[a] (millions)	Acres[b]	Years of production	Value per acre (millions)	Yield per acre per year
			Past producers			
Gold King	Gold	$ 53.34	30	18	$1.780	$ 98,777
Grandview	Lead-zinc	67.78	124	32	0.546	17,082
Holden	Copper-gold	243.60	100	20	2.436	121,800
Van Stone	Lead-zinc	71.23	15.4	18	4.625	256,962
Bellingham	Coal	157.00	826	38	0.190	5,002
			Present producers			
Midnite	Uranium	400.00[c]	500	17	0.800	47,059
Pend Oreille	Lead-zinc	273.81	367	40	0.746	18,652
Centralia	Coal	146.61[c]	2,280	6	0.064	10,717
Pit site[d]	Sand and gravel	0.918	5	1	0.184	183,600
Quarry site[d]	Basalt	0.544	2.5	1	0.218	217,600
			Future producer			
Sherwood	Uranium	560.00	172	15	3.256	217,000

[a] Production corrected to current metal and mineral prices.
[b] Acres of land overlying mineral deposit.
[c] Estimated production.
[d] Unidentified western Washington property.

such as coal is even impressive. At the Centralia coal mine in western Washington, coal valued at \$146.6 million has been produced in 6 years from 2,280 acres with an average yearly yield of \$10,717 per acre. Sand and gravel deposits produce as much as \$183,600 per acre per year, whereas stone quarries have produced in excess of \$200,000 per acre per year. As can be seen in table 1, in no case has a major metal mine in Washington yielded less than \$17,000 per acre per year, or contained less than \$546,000 per acre in metals.

It is revealing to compare an acre of mineralized land with an acre of wheat or timber land. Considering the nine major mines in table 1, the average yield per acre per year amounts to \$49,665. Average wheat land in Washington yields but \$140 dollars per acre, whereas prime timber land yields only around \$100 per acre per year. The extreme potential of mineralized land becomes readily apparent when the production of several of the state's major mines is compared with the yield in wheat or timber. In table 2, the number of years of timber growing equal to the total production of a specific mine is shown in column A. Column B of table 2 shows the dollar value for wheat grown on acreage equal to that overlying a mineral deposit for the life of the mine. In the case of the Sherwood mine, timber would have to be grown and harvested for 32,560 years to equal the value of uranium that will be produced at this property in only 15 years. Should equal acreage be planted in wheat, the land in 15 years would yield \$361,200 compared to \$560 million in uranium. Expressed in another manner, uranium produced at the Sherwood mine in 4 days will exceed

TABLE 2.—Comparative yield of wheat and timber for Washington mines

Property	Production (millions)	Years of production	A Comparative yield[a] in timber (years)	B Comparative yield[b] in wheat
Gold King	$ 53.34	18	17,780	$ 75,600
Grandview	67.78	32	5,466	555,520
Holden	243.60	20	24,360	280,000
Midnite	400.00	17	8,000	1,190,000
Pend Oreille	273.81	40	7,460	2,055,200
Sherwood	560.00	15	32,558	361,200
Van Stone	71.23	18	46,253	38,808
Bellingham	157.00	38	1,900	4,394,320
Centralia	146.61	6	640	1,915,200
Sand and gravel pit[c]	0.918	1	9,180	700
Stone quarry[c]	0.544	1	5,440	350

a/ Number of years of timber harvest on acreage overlying mineral deposit to equal total mine production. Assuming 600 board feet per acre per year.

b/ Value of wheat grown on acreage overlying mineral deposit for lifespan of mine. Assuming 47.4 bushels of wheat per acre per year.

c/ Unidentified western Washington property.

the value of wheat grown on equal acreage for 15 years.

In no way do I wish to imply that all land is more valuable for minerals than for surface crops, such as wheat and timber, for probably less than 1 percent of the land area of Washington contains valuable mineral deposits. I merely wish to stress the fact that, when placed into production and considered on the dollar yield per acre per year, the mineral resources of Washington are without doubt the state's most valuable exploitable natural resource.

In this brief discussion I have pointed out the value of Washington's mines in terms of benefits man derives from metals and minerals, as well as the dollar value of these materials compared to wheat and timber, which represent the state's major surface crops. However, the ultimate value of a mine should not be measured in terms of profits and losses, but rather in the worth man places on metals and minerals from mines when utilized by him.

MOSES COULEE FLASH FLOOD

By J. Eric Schuster

On August 6, 1976, a flash flood originating on the east side of Moses Coulee washed out all three lanes of U.S. Route 2 east of Waterville and west of Coulee City where it enters Moses Coulee. According to Robert Spratt, maintenance engineer for the Washington State Department of Highways District 2 office in Wenatchee, the flood washed out an estimated 100,000 cubic yards of fill material and pavement. Traffic relocation and repair costs were approximately $1.2 million.

The damaged section was repaired and opened to traffic on June 2, 1977. This section of highway is located in the $E\frac{1}{2}$ sec. 3, T. 24 N., R. 25 E., where U.S. Route 2 enters Moses Coulee by way of a steep-walled rockcut in the east wall of the coulee and a long section of fill on which the highway descends to the floor of the coulee. The small, generally dry stream channel down which the flood waters rushed extends eastward from the coulee for about 4 miles and drains an area of 6 or 7 square miles.

As it enters Moses Coulee, U.S. Route 2 is three lanes wide, with a gabion-lined drainage channel along the north side of the highway fill. Gabions are rock-filled wire baskets that can be wired together into large units and used to stabilize fill embankments or as a replacement for riprap.

As the floodwaters approached Moses Coulee from the east, they overtopped the highway and ran down both sides of the road. Those waters that flowed along the existing channelways on the north side of the highway overflowed and eroded fill material from behind the gabion walls, causing the wall's collapse. There was also considerable damage to the westbound lane of the highway. Floodwaters on the south side of the highway removed much of the outside eastbound lane of the highway, and, when restricted by a rock buttress, flowed across to the north side of the road and washed out all three lanes of the highway and a large section of fill (fig. 1).

The accompanying photographs were taken on August 20, 1976, at which time repair work was getting underway and traffic had been routed to the old highway located in Sulphur Canyon, about one-half of a mile north of the damaged section of U.S. Route 2.

FIGURE 1.—Flash-flood damage to eastbound lanes, and washout of pavement and 50-foot-deep fill, U.S. Route 2. Looking southwest into Moses Coulee

FIGURE 2.—Flash-flood damage to westbound lane, gabion-lined drainage channel, and washout of all three lanes and 50-foot-deep fill. East wall of Moses Coulee, looking southwest.

ADMIRALTY TILL (PLEISTOCENE)
OR
THE RISE AND FALL OF A ROCK STRATIGRAPHIC NAME

By Kurt Othberg

Original reference:

Bailey Willis, 1898, Drift Phenomena of Puget Sound, Geological Society of America, v. 9, p. 152.

For his description of "Admiralty till and clay," Bailey Willis quoted I. C. Russell (no citation). There was no specific type locality, rather, he referred to characteristic exposures along the shores of Admiralty Inlet. Although Admiralty Inlet now refers only to a narrow inlet between the Olympic Peninsula and Whidbey Island, it appears from Willis' entire discussion that he had in mind sea-cliff exposures in the Tacoma-Seattle area. The description is as follows:

> A thick deposit of stiff, blue clay, usually in evenly stratified beds, but occasionally changing gradually to a well characterized till filled with subangular stone and gravel, together with occasional boulders, some of which are glaciated. This deposit is frequently exposed about the immediate shores of the Sound, and forms precipices from a few feet to fully one hundred feet high.
>
> The upper surface of the lower till is irregular in many places and sometimes deeply eroded. For this reason it is not seen at some localities where it might be expected to occur, its place being taken by stratified sands and gravel.

In 1913, J Harlen Bretz described stratified material resting in a few localities on an older till sheet. For the till he used Willis' Admiralty till, and he named the overlying stratified material Admiralty sediments. His Admiralty sediments consisted of several lithologies, such as clay, sand, gravel, and in a few places, intercalated till.

Newcomb (1952) described Admiralty clay as bedded silt and clay and a few sand and gravel beds. One of his measured sections of Admiralty clay included an intercalated gravelly till.

Sceva (1957) described Admiralty Drift as consisting principally of massive blue clay and silt, but containing till, peat, sand, and some gravel.

Crandell, Mullineaux, and Waldron (1958, p. 396) chose not to use "Admiralty till and clay" nomenclature because it could not be successfully correlated with their Puyallup Valley stratigraphic units. Furthermore, Crandell and others strove to choose rock units that enabled them to establish glacial climatic units; that is, glaciations and interglaciations. They interpreted lithologies included within the "Admiralty till and clay" as representing both glacial and nonglacial conditions. Therefore, it was not suitable for the new glacial climatic stratigraphy.

In the wake of Crandell, Mullineaux, and Waldron's initiative, subsequent geologists mapping in the Puget Lowland area have also abandoned Admiralty nomenclature, reflecting their attempts to subdivide the stratigraphy into glaciations and interglaciations. The sum of all the work indicates that the Admiralty till and its offsprings—Admiralty sediments, Admiralty clay and Admiralty drift—may each consist of more than one formation (assemblage of mappable lithologies) and probably represents more than one glacial and(or) interglacial event. For this reason Admiralty till and other Admiralty units have ceased to be used, and probably ought to be formally redefined or abandoned.

However, this is not to suggest that recent work has clearly established the glacial-interglacial history of the Puget Lowland. As Bretz (1913, P. 175) states in his description of the three tills in the Possession Point section: "Its suggestion of three glaciations . . . is not borne out by a study of the sea cliff exposures elsewhere in Puget Sound." With due respect for the four glaciations of the Puyallup Valley stratigraphy, what Bretz is saying is that more than two glaciations are not clearly demonstrated by the bulk of the Puget Lowland sea cliff exposures. In order to prove or disprove Bretz' contention, study, as careful as that accomplished by Crandell and others in the Puyallup Valley, will be required.

Although Admiralty nomenclature may have oversimplified the stratigraphy, it symbolizes the difficulties in making stratigraphic correlations and in interpreting Quaternary geologic history in the Puget Lowland.

Selected References

Bretz, J Harlan, 1913, Glaciation of the Puget Sound region: Washington Geological Survey Bulletin No. 8, p. 173-194.

Crandell, D. R.; Mullineaux, D. R.; Waldron, H. H., 1958, Pleistocene sequence in southeastern part of the Puget Sound Lowland, Washington: American Journal of Science, v. 256, No. 6, p. 384-397.

Garling, M. E.; and others, 1965, Water resources and geology of the Kitsap Peninsula and certain adjacent islands: Washington Division of Water Resources Water Supply Bulletin No. 18, p. 27.

Newcomb, R. C., 1952, Ground-water resources of Snohomish County Washington: U.S. Geological Survey Water-Supply Paper 1135, p. 13-18.

Sceva, J. E., 1957, Geology and ground-water resources of Kitsap County Washington: U.S. Geological Survey Water-Supply Paper 1413, p. 14-15, 37-38.

NWMA CONVENTION TO BE HELD IN SPOKANE ON DEC. 2-3

J. Allen Overton, Jr., president, American Mining Congress, will chair the Opening General Session of the Northwest Mining Association 83rd annual convention. "The theme of the Northwest Mining Association's convention—Mining at the crossroads—reflects the uncertainty the mining industry feels today," said Overton. "These major uncertainties involve the way the Senate and House of Representatives view resources exploration and the development of public lands, and how they see prospective changes in our mining laws," he continued.

John C. Balla, Manager of the Northwest Exploration Division of ASARCO has been appointed chairman of the NWMA convention, which will be held on December 2 and 3 at the Davenport Hotel in Spokane.

J. Allen Overton, Jr., president, American Mining Congress, will chair Opening General Session

John C. Balla, mgr., NW Exploration Div. ASARCO, NWMA 1977 convention chairman

Speakers at the convention include Michael Harvey, chief consel for the Senate Committee on Energy and Natural Resources; William Shafer, staff member of the House Committee on Interior and Insular Affairs; and Vincent McKelvey, director of the U.S. Geological Survey.

Registration materials for the convention may be obtained from the NWMA, W. 1020 Riverside Ave., Spokane, WA 99201, (509) 624-1158.

USGS SLOPE STABILITY MAP ON HOOD CANAL AREA NOW AVAILABLE

Relative slope stability of the southern Hood Canal area, Washington, by Mackey Smith and R. J. Carson. USGS Miscellaneous Investigations Series, Map I-853-F. Prepared in cooperation with Division of Geology and Earth Resources. 1977. Scale 1:62,500, map and text on 1 sheet.
Map I-853-F may be purchased for $1.50 from: Branch of Distribution, U.S. Geological Survey, Box 25286, Federal Center, Denver, CO 80225.

U.S. GEOLOGICAL SURVEY OPEN-FILE REPORTS

The following open-file reports and maps by the USGS are now available for inspection in the division library in Olympia:

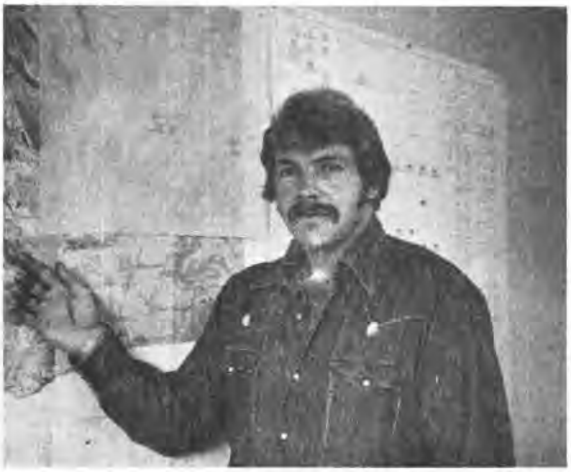
Geology of the Midnite uranium mine area, Washington—maps, descriptions, and interpretation, by J. Thomas Nash, 1 fig., 3 pls., 39 p. Open-file Report No. 77-592.

Interim report on petroleum resources potential and geologic hazards in the Outer Continental Shelf—Oregon and Washington Tertiary province, by P. D. Snavely, J. E. Pearl, and D. L. Lander. With a section on Resource appraisal estimate, by Edward W. Scott. 64 p. Open-file Report No. 77-282.

Preliminary geologic map of the Wenatchee 1:100,000 quadrangle, Washington, by R. W. Tabor and others, 1 pl., 24 p. (Division library has reproducible). Open-file Report No. 77-531.

Thermal surveillance of active volcanoes using the Landsat-1 data collection system. Part 3: Heat discharge from Mount St. Helens, Washington, by J. D. Friedman and David Frank, 6 figs., 30 p. Open-file Report 77-541.

DIVISION HIRES NEW STAFF MEMBERS



The Division of Geology and Earth Resources has added four new geologists to the staff; two of the geologists will work in energy resources (uranium and coal), and two will provide geologic assistance to ERDA.

Clint Milne was hired to work with the uranium resources in the state. He comes to us from Deterra Mines Corp., of Reno, where he worked as the mine geologist and assistant mine manager. Clint has worked as an exploration geologist for Exploration Resources, Inc., in Reno, and for Resource Associates, Fairbanks, Alaska, and as an assistant state environmental geologist for the New York Geological Survey. He obtained his B.S. from St. Lawrence University in New York (1969) and his M.S. from the University of Rhode Island (1972).

Charles W. (Buzz) Walker will work in coal resources. He has worked for the New Mexico Bureau of Mines and Mineral Resources; the Materials Evaluation Lab., in Baton Rouge; for Texaco, in Houston; and recently for W. K. Summers & Associates of Socorro, New Mexico, as a chief project geologist in charge of geologic and hydrologic field studies. Buzz received his M.S. from the University of Mississippi (1968) and his Ph.D. from Louisiana State University (1972).

Glennda Tucker and James Rigby will initially compile the existing geologic mapping in the Columbia Basin as part of ERDA's (Energy Research and Development Admin.) evaluation of the potential for storing solid nuclear wastes in the Columbia River basalt. Later, they will map the geology of the deposits overlying the Columbia River basalt and those bordering the basalts on the north and west. Also, they will compile certain kinds of land use interpretive maps.

Glennda has a B.S. from the University of Missouri (1971) and a M.S. from the University of Washington (1977). She has worked for the New

James Rigby

Jersey Bureau of Geology compiling land use, geologic, drainage, water resource, and demographic maps.

Jim got his B.S. from the University of Akron (1969) and has pursued graduate studies at Ohio University and the University of Idaho. He worked for the U.S. Bureau of Mines in Spokane, where he conducted field studies of proposed wilderness areas to determine economic mineral potential.

YOUR STATE GEOLOGIST REPORTS

For those of you who might be interested I thought I might give a brief resume of what happened to us during the last legislative session. We started out asking for a substantial increase in manpower to help meet the growing need for mineral fuel information in the state. This proposal budget went through our department with only slight modification. The governor's budget people, however, rejected the whole package and cut our program by one man-year. Our department management then took the fight to the legislature where we scaled down our request to four new people to work exclusively in mineral fuel development. The House of Representatives agreed with our request and included it in their revision of the budget. The Senate did not consider our request in their revision of the budget. Because the two budgets differed, the final budget was built in a joint conference committee where the House revision was accepted so far as our program was concerned. At that point, I felt pretty good—it looked like we had finally made a giant step forward in energy work. Hold on though, the allotments had yet to be figured out. After much deliberation, we concluded that we had actually been given authority to hire one new person but had been mandated to work four people in energy. You might say, "How can that happen, the budget clearly stated we were to get four new people". Well, after a couple of weeks of investigation we found that the wrong current level had been used by those who prepared the budget figures. Well, there you have the whole story in a nutshell. One learns to be philosophical in this job.

Ted Livingston

U.S. GEOLOGICAL SURVEY $7\frac{1}{2}$-MINUTE TOPOGRAPHIC QUADRANGLES
(Maps received in the division library since July 1, 1977)

Name	Year	Latitude (indicates southeast corner)	Longitude (indicates southeast corner)	County
Benton City	1974	46°15'00"	119°22'30"	Benton
Blakely Island	1973	48°30'00"	122°45'00"	San Juan
Chattaroy	1973	47°52'30"	117°15'00"	Spokane
Cypress Island	1973	48°30'00"	122°37'30"	Skagit
Dartford	1973	47°45'00"	117°22'30"	Spokane
Foothills	1973	47°45'00"	117°07'30"	Spokane
Greenacres	1973	47°37'30"	117°07'30"	Spokane
Iowa Flats	1974	46°22'30"	119°30'00"	Benton
Little Falls	1973	47°45'00"	117°52'30"	Lincoln, Stevens
Long Lake	1973	47°45'00"	117°45'00"	Stevens, Lincoln, Spokane
Maiden Spring	1974	46°22'30"	119°45'00"	Benton, Yakima
Mead	1973	47°45'00"	117°15'00"	Spokane
Mount Kit Carson	1973	47°52'30"	117°07'30"	Spokane
Nine Mile Falls	1973	47°45'00"	117°30'00"	Spokane, Stevens
Shaw Island	1973	48°30'00"	122°52'30"	San Juan

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