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INCREASED VOLCANIC ACTIVITY OF MOUNT BAKER, WASHINGTON[1/]

On March 11, 1975, the U.S. Geological Survey office in Tacoma, Washington received reports of increased steam activity on Mount Baker, a quiescent volcano located about 26 km south of the Canadian border in northwestern Washington. The activity, which was first observed March 10, 1975, included a greatly increased emission of steam from a known fumarole field in Sherman Crater (on the south side of the mountain about 300 meters below the crest), the appearance of several new fumaroles where none had been before, and a discoloration of the steam and the snow around and in the crater. Steam discharges from this crater and one other locality on the flank of the mountain had been known since the mid-1800's. Some increases in perforation of the snow due to steam discharge were noted in photographs taken during the period 1940-1956; however, the present increased steam discharge probably represents the greatest volcanic activity on the mountain during at least the last 84 years.

Mount Baker (3,285 m) towers some 1,500 m (meters) over the immediate Cascades. Possibly, several eruptions of Mount Baker occurred in the middle 19th century. In 1843, Mount Baker reportedly erupted simultaneously with Mount St. Helens, covering the Cascades with a light cover of volcanic ash. In 1854, the nearly perfect andesitic cone of Mount Baker was obscured by rolling clouds of steam and gas, which reached some 600 m above the summit. In 1859, bright flashes of light and explosive sounds from Baker were reported.

On March 31, 1975, a team of university and federal scientists was lifted to the flank of the mountain by helicopter to observe conditions first hand and

[1/] Data was generously supplied to the Division of Geology and Earth Resources by the U.S. Geological Survey office in Tacoma.

View of steam emission from Mount Baker. U.S. Geological Survey photo by Austin Post, May 28, 1975.

to install a telemetering seismometer at the rim of the crater. Reports from these and other observers in late March indicated:

> The steam discharge from the crater is roughly 10 times as much as it was before March 10, with over half of the total discharge now coming from 2 new clusters of fumaroles and much of it from one single fumarole.
>
> The discoloration of the steam and snow is from a medium-gray clayey material, which is derived from older hydrothermally altered rock and carried upward by fumarolic gases.

The greatly increased heat output from the crater is accompanied by increased crevasse formation, increased exposure of bare rock (especially for winter conditions), and increased subglacial melting and subsidence of ice in the center of the crater. Components of gas from a fumarole as measured by geologists from Eastern Washington State College show a 20 times increase in H_2S.

On May 27, the fumaroles were putting

Steam vents due to increased steam discharge on Sherman Crater visible in upper center and upper right-hand corner. U.S. Geological Survey photo by Dan Miller, April 21, 1975.

out about 1,300 kg per hour of sulfur, according to measurements by the Cloud and Aerosol group at the University of Washington.

The seismometer is recording many small events, which may be attributed to near-surface volcanic processes and to movements of the glaciers; also recorded is a high level of background noise, which may be due to the venting of steam. The seismic data are telemetered to the geophysics program at the University of Washington.

Boulder Creek, the stream that drains Sherman Crater, has apparently become much more acid (pH measured 11 km east of the crater was 3.7 to 3.8), and may have increased in flow. Boulder Creek flows into upper Baker Lake, a reservoir for power generation and the upstream one of a pair of such reservoirs. At present, the acidity of the inflowing Boulder Creek water is being chemically buffered by water and sediment in Baker Lake. However, if large amounts of acidic water continue to pour in from Boulder Creek, the buffering capability of the lake is likely to be exhausted, and the lake water can be expected to acidify progressively.

Through June, 1975, ice breakup has increased and fumarolic activity has continued at least the same level. Airphoto surveys and ground investigations through June also show that a shallow, hot lake (about 11,000 m^2 and 34°C on June 11) has formed in the bottom of a 40 m ice pit in the center of the crater.

The major potential hazards from increased activity and possible eruption of Mount Baker are rock avalanches, mudflows, and floods along valley floors. Other potential hazards from an eruption are the fallout of volcanic ash in areas downwind from Mount Baker, pyroclastic flows, and lava flows. Possible lava flows probably would not extend beyond the present flanks of Mount Baker, but mudflows and floods could be caused by rapid melting of snow and ice by such lava.

Recent studies[2/] have shown that small debris avalanches in at least the last 17 years have moved down from Sherman Crater an average of once every 2-4 years. Large mudflows from the same area have reached as far as the Baker River valley (about 11 km) at least twice in the past few hundred years; the most recent forms the surface where a campground is now located. The largest postglacial mudflow at Mount Baker occurred about 6,000 years ago, moved at least 29 km down the middle fork of the Nooksack River and, at a point about 17 km from the volcano, filled the 0.8 km-wide valley with at least 100 m of debris.

The potential hazards from the activity of the present level are avalanches, mudflows, and floods down the east side of the mountain, especially along the course of Boulder Creek. A moderate-size mudflow down this course might destroy a highway bridge and a small campground. If the volcanic activity increased, then a greater probability of hazard would exist. The greatest likely hazard from mudflow activity would occur if a large mudflow entered Baker Lake while that reservoir was at a relatively high stage, filling the reservoir more rapidly than it could be drained. In such a situation some of the water would overtop Baker Dam and spill into Lake Shannon. If the mudflow were sufficiently large, and fast moving, and if the surge of water were large enough, a flood could be generated that would progress down the Skagit River valley. In brief, with a volcanic eruption, avalanches, mudflows, floods,

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2/ References:

Frank, David; Post, Austin; Friedman, J. D., 1975, Recurrent geothermally induced debris avalanches on Boulder Glacier, Mount Baker, Washington: U.S. Geological Survey Journal of Research, v. 3, no. 1, p. 77-87.

Hyde, J. H.; Crandell, D. R., 1975, Origin and age of postglacial deposits and assessment of potential hazards from future eruptions of Mount Baker, Washington: U.S. Geological Survey Open-file Rept. 75-286, 22 p. [Available for inspection in the Division of Geology and Earth Resources library.]

ash falls, pyroclastic flows, or lava flows might be expected.

The mountain and nearby areas most likely to be affected by volcanic activity are within the U.S. Forest Service's Mount Baker-Snoqualmie National Forest. Acting upon information supplied by the U.S. Geological Survey, the U.S. Forest Service issued closures to entry without special permit for Sherman Crater, the Boulder Creek drainage, and the Baker Lake area. The area of closure has recently been updated and enlarged. Information on closed areas may be obtained from the U.S. Forest Service.

OIL AND GAS IN WASHINGTON

By
Weldon W. Rau

Over 75 percent of the total energy consumed in the United States comes from petroleum products. According to National Petroleum Council studies, our nation's requirements for energy will double by 1985. Obviously, in this period of time, the need for petroleum will be greatly increased. Several options may be followed in order to cope with these demands: (1) import more foreign oil at the risk of endangering our national security; (2) cut back on our consumption by changing our life style; or (3) increase domestic exploration for petroleum. The latter option was highly recommended by the National Petroleum Council (1973). Regardless of which one or combination of the three options is followed, it is indisputable that there is a definite need to fully explore all possible domestic sources of petroleum.

Washington State, a substantial user of petroleum products, has not yet become a contributor to the supply. Although exploration has been conducted in the state in a modest way over the past 70 years, and over 400 holes have been drilled in search for petroleum with little or no commercial success, only about one-fourth of the holes were located by the use of modern technology.

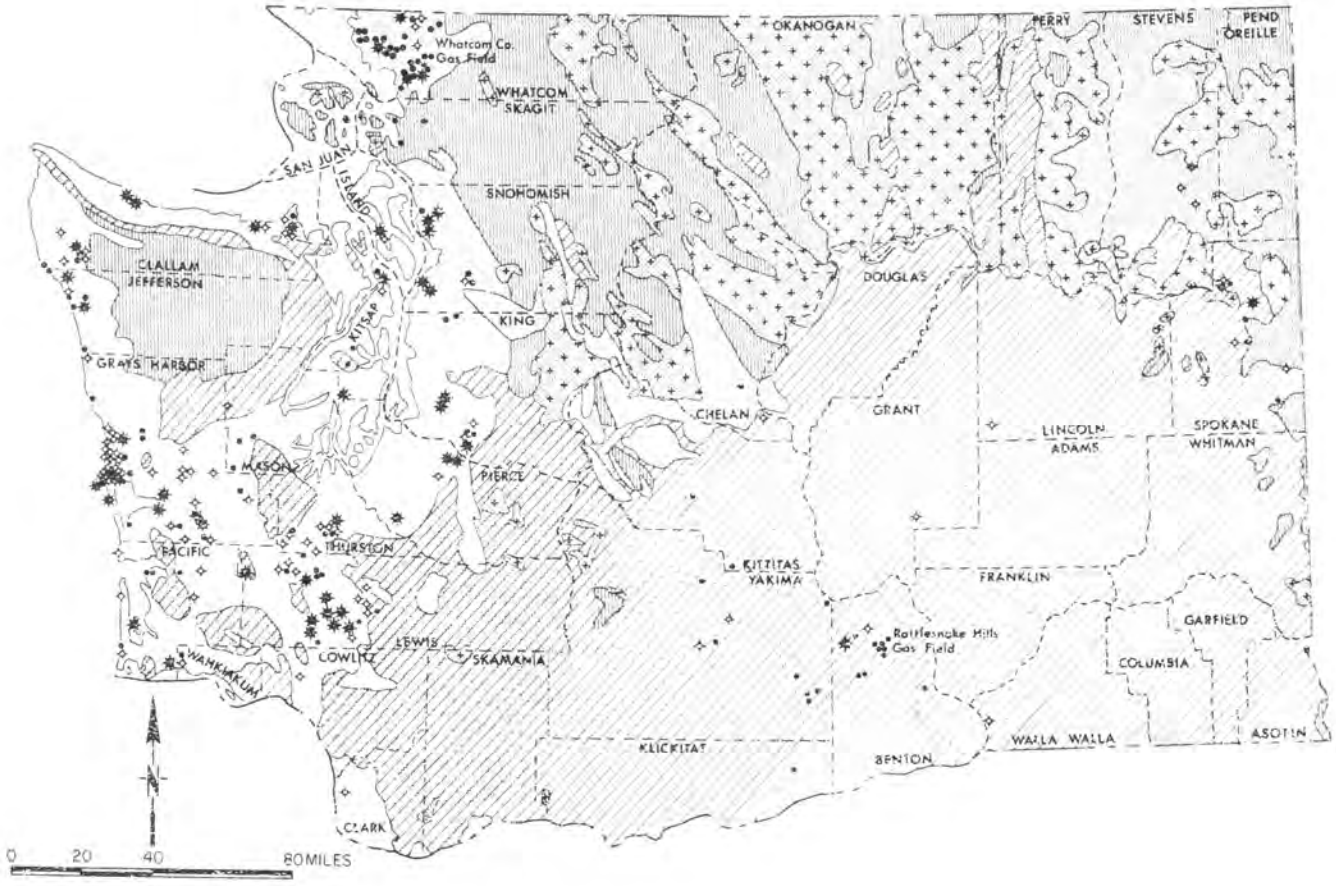
Considering the size of the areas within the state and on the adjacent Continental Shelf that are regarded as favorable for the occurrence of oil and gas, it can be calculated that less than one test well for every 200 square miles has been drilled. Because of the complex structures and poor exposures in Washington, much closer spacing of exploration drilling must be done before the favorable areas have been adequately tested.

Several sizable areas within Washington State and its Continental Shelf possess all of the major geologic characteristics that are required for the accumulation of commercial quantities of petroleum; for example, source rocks, reservoir rocks, and proper structures and(or) stratigraphy.

One of the most promising areas is the Continental Shelf, which includes both state and federal lands. Continuous seismic profiling surveys indicate that structural and stratigraphic conditions are favorable in many places in this large area where very little drilling has taken place.

The Grays Harbor basin has received moderate exploration, and significant shows of petroleum have been found in the moderately folded and faulted Tertiary sandstone and siltstone sequence of that area. Several major structures have been generally outlined, but they have yet to be adequately tested by drilling.

The Puget Lowland, including much of the area between the Olympic Mountains and the Cascade Range, has for some time been regarded as potentially favorable for oil and gas production. Nonmarine Tertiary sandstone in the eastern part of the basin and marine Tertiary sandstones and siltstones on the west flank of the basin interfinger—this relationship has intrigued geologists and encouraged exploration in this area. Unfortunately, much of the Puget basin is covered with glacial drift, thus making explora-



EXPLANATION

EXPLORATORY WELLS: ✱ Greater than 5,000 feet deep ✧ 2,000 feet to 5,000 feet deep • Less than 2,000 feet deep; core holes and most wells less than 500 feet not shown

FAVORABLE
Tertiary sedimentary rocks

Areas in which most commercial oil and gas discoveries will be made; underlain by thick sequences of Tertiary marine and nonmarine strata (stipple = nonmarine); includes Continental Shelf, Juan de Fuca Strait, and Puget Sound

FAVORABLE AND UNFAVORABLE UNDIFFERENTIATED
Tertiary volcanic rocks

Areas in which sedimentary rocks of possible petroleum potential or metamorphic and igneous rocks of no potential are covered by surficial volcanic rocks of variable thickness (stipple = pre-middle Miocene volcanic rocks)

UNFAVORABLE
Metamorphic and intrusive rocks

Areas in which it is extremely unlikely that oil and gas will be found (vertical line pattern = strongly or weakly metamorphosed sedimentary and igneous rocks, mainly of pre-Tertiary age; dense screen pattern with + = large bodies of granitic, dioritic, and basic intrusive rocks)

Generalized geologic map of Washington showing the locations of wells drilled for petroleum between 1900 and 1973, and areas classified according to their petroleum potential.

tion difficult. However, new techniques are being developed that will help to solve this problem. More exploration is required in this potentially favorable area also before it will have been adequately tested.

The north flank of the Olympic Peninsula, including the Strait of Juan de Fuca, is another area with promising potential. A thickly folded and faulted sequence of Tertiary marine sandstones and siltstones exists in this area. Some of these rocks are potential source beds or reservoir rocks for petroleum. A few wells have properly tested some of these rocks and have had shows of petroleum, but the area as a whole has by no means been adequately evaluated.

Although the four above-mentioned areas are considered by some workers as having the greatest potential for commercial quantities of oil and gas in this state, other areas in Washington that are thought to be less favorable should not be overlooked.

For more information see Division of Geology and Earth Resources Information Circular No. 50, "Energy Resources of Washington."

STAFF GEOLOGIST ATTENDS GEOTHERMAL SYMPOSIUM

The Second United Nation's Symposium on the development and use of geothermal resources was recently concluded in San Francisco. Over 1,000 delegates were registered for the two-week meeting, representing over 60 countries.

Don Ford, division geologist, attended the second week of the session, when presentations were made on geothermal drilling and production technology, reservoir evaluation, environmental factors and waste disposal, electricity production, space heating, other single and multipurpose developments, and economic, legal, and institutional problems. Field trips to geothermal plants were available to delegates, including The Geysers in California, and Cerro Prieto in Mexico.

ZACHE NAMED EXECUTIVE DIRECTOR FOR NWMA

Robert J. Zache has been selected as the first full-time executive director of the Northwest Mining Association, in Spokane, and will assume his duties on July 1. He previously worked for the Arizona Mining Assoc. in Phoenix and, before that, as a newspaper reporter for the Phoenix Gazette.

The NWMA had an interesting item in their latest news bulletin that bears repeating . . .

> 99.9 PERCENT PURE . . . . By U.S. Bureau of Mines estimate (I.C. 8642), mining has disturbed 0.16 percent of the U.S. land surface of which an estimated 40 percent has been reclaimed. That makes the country 99.9 percent untouched or essentially free of the vestiges of mining. If such a fact were of broad knowledge, the environmental attack on mining would be put into perspective. No other segment of society can compare with the contribution of mining in having done so much with so little.

THE MINERAL INDUSTRY OF WASHINGTON IN 1974[1/]

The value of mineral production in Washington in 1974 was $131.5 million, 15 percent over that of 1973. The production of masonry cement, sand and gravel, diatomite, lime, olivine, and uranium increased. Output of coal, lead, stone, zinc, gold, silver, and talc declined. Production of peat and pumice were unchanged.

Although aluminum ore was not produced in the state, the state produced 1.17 million tons of primary aluminum valued at almost $684 million, which represents an increase of 12 percent in quantity and 33 percent in value. The state produced 24 percent of the nation's primary aluminum. The ore used in the production of aluminum came from foreign sources.

1/ From U.S. Bureau of Mines, Mineral Industry Surveys.

MINERAL PRODUCTION IN WASHINGTON [1]

	1974[p]	
	Quantity	Value (thousands)
Cement:		
Portland ----------thousand short tons---	1,245	$ 32,200
Masonry ----------do--------	6	202
Clays[2] ----------do--------	285	660
Coal (bituminous) ----------do--------	3,264	24,480
Gem stones ----------	NA	160
Lead (recoverable content of ores, etc.)----------short tons-----	1,100	495
Peat ----------thousand short tons---	21	102
Pumice ----------do--------	1	1
Sand and gravel ----------do--------	29,331	31,677
Stone ----------thousand short tons---	10,532	19,503
Zinc (recoverable content of ores, etc.) ----------short tons-----	6,370	4,574
Value of items that cannot be disclosed:		
Clays (fire clay), copper, diatomite, gold, gypsum, lime, olivine, silver, talc, tungsten, and uranium ----------	XX	17,452
Total ----------	XX	$131,505

p/ Preliminary. NA Not available. XX Not applicable.

1/ Production as measured by mine shipments, sales, or marketable production (Including consumption by producers).

2/ Excludes fire clay; included with "Value of items that cannot be disclosed."

GEOLOGICAL SURVEY NOW SELLING USGS BOOKS

Direct-mail book sales by the Geological Survey, supplementing the Superintendent of Documents sales in Washington, D.C., is a new featured service.

To order USGS books through the mail, the customer should include the series, number, and complete title. Send order, accompanied by check or money order payable to the U.S. Geological Survey, to the Branch of Distribution, U.S. Geological Survey, 1200 South Eads St., Arlington, VA, 22202.

Maps may be ordered at the above address and also from Bldg. 41, Federal Center, Denver, CO, 80225.

MINE-TO-MARKET ROAD ACT REPEALED

The 1975 session of the Washington State Legislature repealed the Mine-to-Market Road Act first passed in 1939. The program has been inactive for some 25 years, with no funds having been appropriated for road development since the late 1940's. Senate Bill 2132 (now C.139 L75E1) went through

the hearings and both houses of the legislature with no opposition.

GEOLOGIC RESEARCH PROJECTS IN PROGRESS

Dr. Wilbert R. Danner, Assistant Dean of Science at the University of British Columbia, is working on various geologic projects in Washington.

Geology of the San Juan Islands and adjacent areas in Skagit and Whatcom Counties (includes petrography, stratigraphy, structure, and paleontology).

Stratigraphy of the Chilliwack Group of northwestern Washington and southwestern British Columbia.

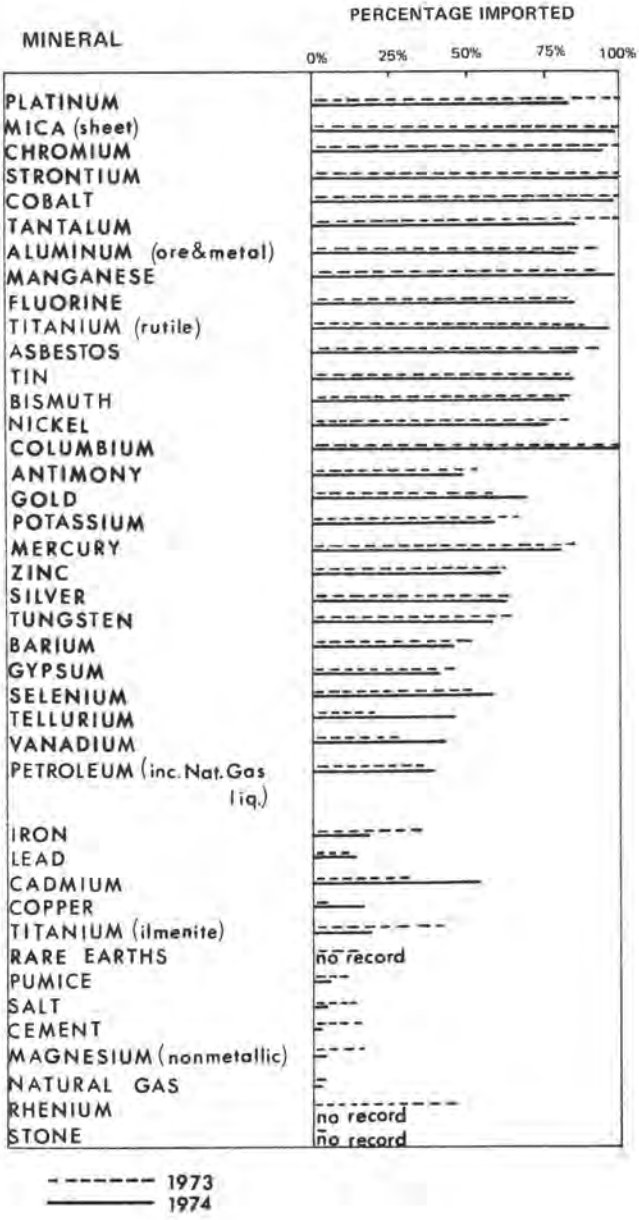
Paleontological studies of Devonian, Pennsylvanian, and Permian faunas in western Washington. Others involved in this project are Dr. Merlynd Nestell, Univ. of Texas at Arlington, and Dr. Kimiyoshi Sada, Univ. of Hiroshima, Japan.

Paleontological studies of Terebellina in the Olympic Peninsula and Cascade Mountain foothills; Tertiary faunas and floras of the Pilchuck Creek-Mount Vernon area, Skagit and Snohomish Counties (with Dr. Glenn Rouse of the Univ. of British Columbia and Warren Addicott, U.S. Geological Survey); and fauna of the Bear River limestone of Pacific County (with Warren Addicott and Japanese paleontologists).

Stratigraphic studies of the Paleozoic and Mesozoic rocks along the northern border of the "Columbia Embayment" from Vancouver Island southeastward into the Snoqualmie River area of Washington.

Geology of the Point Roberts Peninsula, Whatcom County.

COMPARISON OF MINERAL IMPORTS FOR THE UNITED STATES



U. S. BUREAU OF MINES (import-export data from U. S. Bureau of the Census)

U.S. GEOLOGICAL SURVEY ACTIVITIES IN WASHINGTON, 1975

MINERAL RESOURCES ACTIVITIES

Northern Okanogan Highlands, C. D. Rinehart. Complete geologic mapping of the Aeneas quadrangle, and limited reconnaissance mapping of the Alameda Flat, Nespelem, and Keller quadrangles. Reports on the geochemistry of parts of Tiffany Mountain and Horseshoe quadrangles; geology and mineral resources of the Oroville quadrangle; mineral resources appraisal of the Colville Indian Reservation; and the petrographic study of Tiffany Mountain quadrangle are in preparation.

Togo Mountain quadrangle, R. C. Pearson. Fieldwork includes checking geology of Togo Mountain quadrangle and begin a study of mineral zoning, alteration, and minor-element distribution in Sugar Loaf-St. Kevin mining district.

ENERGY RESOURCES ACTIVITIES

Trace element geochemistry related to coal usage and disposal, Peter Zubovic. A detailed study will be made of all coals used in coal burning utilities and coal conversion facilities in operation under this new project. Studies will be made at the Centralia Power Station of the Pacific Power and Light Company and its adjacent mine.

Geochronology of uranium ores and their host rock, K. R. Ludwig. Fieldwork this year will be mostly collecting samples from the Midnite Mine area. In order to determine the time of formation of major uranium ore bodies, studies will be conducted about the source and mechanisms of uranium mineralization, as well as the time of mineralization.

Midnite uranium mine studies, J. T. Nash. Complete the mapping and core logging in the mine area and begin mapping a 10-square-mile area near the mine. Compile data on orebody geometry and grade distribution and begin studies of halos and pathfinder elements; study the geochronology of igneous rocks and ore and disequilibrium in ores.

Oregon-Washington continental margin, P. D. Snavely, Jr. Studies continue on synthesis and interpretation of offshore seismic refraction, magnetic, gravity, and proprietary subsurface data and conducting of high-resolution seismic-reflection surveys. Complete reports in progress for publication.

Pacific Coast sedimentology, H. E. Clifton. Continue analysis of the depositional facies in Willapa Bay by comparing modern facies with those in the Pleistocene terraces that fringe the bay and examine sediments in the upper estuary. The nearshore bar-and-trough system along the southern Washington coast will be investigated to depths of two meters to determine the processes operating at times of high wave energy.

ENVIRONMENTAL GEOLOGY ACTIVITIES

Eastern Olympic Peninsula, W. M. Cady. The geologic map compilation and the computer-based program of structural analysis of the core rocks continues in preparation for a final report.

Cape Flattery area, P. D. Snavely, Jr. Reconnaissance studies of selected areas, detailed sedimentological study of Oligocene turbidites, interpretation of aeromagnetic data, and completing geologic map of the Cape Flattery area.

Puget Sound urban studies, H. D. Gower. A tectonic map at 1:250,000 scale of northwest Washington from aerial and ERTS photography is to be completed. Slope-stability studies in King County and mapping surficial deposits in Hood Canal continue. A detailed stratigraphic and structural study of Quaternary deposits will begin and reports on volcanic hazards of Mount Baker, and coastal processes

of Whatcom and Skagit Counties will be completed.

Volcanic hazards, D. R. Crandell. A broader scope of studies is being undertaken by this project which will tie in with the National Overview Program. Fieldwork on tephra and the potential hazards report of Mount St. Helens, and the postglacial volcanism report of Mount Baker will be completed in the current year.

Cenozoic stratigraphic paleontology, Pacific Coast, W. O. Addicott. Includes completing a report naming and defining Neogene macroinvertebrate stages for Oregon and Washington. Biostratigraphic and taxonomic studies of Tertiary marine invertebrate faunas continue.

GEOCHEMISTRY AND GEOPHYSICS

Genesis of basalt, T. L. Wright. The correlation of chemical composition of lavas with three stratigraphic and geographic positions in the lava field has been accomplished, and a major study is planned on the chemical composition of feeder dikes and other vent areas to specify the source areas of the Columbia River lavas.

Columbia River basalt, D. A. Swanson. Includes completing a field and lab study of intracanyon flows along the Snake River. Sample two thick sections of basalt from the Wallowa Mountains, and continue petrographic and petrochemical studies.

Geodimeter studies of Cascade Volcanoes, D. A. Swanson. Depending on availability of a geodimeter, establish strain networks on Mt. Rainier and Mt. Hood. Remeasure the network on Mt. St. Helens, and monitor the networks already installed on Mt. Baker and Mt. Adams.

Washington aeromagnetic cooperative, J. R. Henderson. Obtain 3,600 square miles of aeromagnetic coverage in northeastern part of Washington and prepare for publication. Compile aeromagnetic coverage in the southern Cascades area and finalize for publication.

Geophysical research in uranium exploration, T. W. Offield. Current year investigations for this new project include induced polarization, resistivity, and ground magnetic and truck-borne gamma-ray spectrometer surveys, and regional and detailed gravity mapping in the Spokane area.

Geochemistry of food plants, H. T. Shacklette. Statistical studies will begin when plant-sample analyses are completed sometime during the year.

EARTHQUAKE STUDIES

Newport Observatory, Leonard Kerry. Plans are under consideration to telemeter seismic data to NEIS and from Tucson Observatory to Newport. Upon implementation, Newport will provide input to the Tsunami Warning Service from both Tucson and Newport. [The Washington base station network is interconnected with Oregon's.]

Seismic risk (FDAA), A. M. Rogers. A report for potential damage in Seattle is nearing completion.

Hanford microearthquake network, J. H. Pfluke. A network of 24 short-period seismometers operating in the Hanford Works region is being expanded to 32. Locate and map structures generating microearthquakes. Continue to evaluate the likelihood of a major earthquake and use of large quarry blasts to study the crustal structure.

Earthquake-induced structures in sediments, J. D. Sims. Complete examination of cores from Lake Washoe and complete work in Puget Sound area. Begin planning for apparatus to experimentally form structures in sediments generated by simulated earthquake shocks.

Reports recently published are as follows:

Addicott, W. O., 1975, Provincial age and correlation of the Clallam Formation, northwestern Washington [abstract]: Geological Society of America Abstracts with Programs, v. 7, no. 3, p. 289.

Addicott, W. O., 1974, Recognition and distribution of Mytilus condoni Dall, a unique Pliocene and Pleistocene bivalve from the Pacific Coast: Veliger, v. 16, no. 4, p. 354-358.

Churkin, Michael, Jr., 1974, Paleozoic marginal ocean basin-volcanic arc systems in the Cordilleran foldbelt. In Dott, R. H., Jr.; Shaver, R. H., eds., Modern and ancient geosynclinal sedimentation: Society of Economic Paleontologists and Mineralogists Special Publication 19, p. 174-192.

Crandell, D. R.; Miller, R. D., 1975, Quaternary stratigraphy and extent of glaciation in the Mount Rainier region, Washington: U.S. Geological Survey Professional Paper 847.

Crandell, D. R.; Mullineaux, D. R.; Rubin, Meyer, 1975, Mount St. Helens volcano. Recent and future behavior: Science, v. 187, no. 4175, p. 438-441.

Fox, K. F.; Rinehart, C. D.; Engels, J. C., 1975, K-Ar age of the Similkameen batholith and Kruger Alkalic Complex, Washington and British Columbia: U.S. Geological Survey Journal of Research, v. 3, no. 1, p. 39-43.

Friedman, J. D.; Frank, D. G., 1974, Thermal activity at Mount Baker volcano, Washington [abstract]: EOS, v. 55, no. 4, p. 488.

Griggs, A. B., 1974, Geologic map of the Spokane quadrangle, Washington, Idaho, and Montana: U.S. Geological Survey Map I-768.

Gualtieri, J. L.; Thruber, H. K.; Miller, M. S.; McMahan, A. B.; Federspiel, F. F., 1975, Mineral resources of additions to the Alpine Lakes study area, Chelan, King, and Kittitas Counties, Washington: U.S. Geological Survey Open-file Report 75-3.

Harrison, J. E.; Griggs, A. B.; Wells, J. D., 1974, Tectonic features of the Precambrian Belt basin and their influence on post-Belt structures: U.S. Geological Survey Professional Paper 866.

Miller, F. K.; Clark, L. D., 1975, Geology of the Chewelah-Loon Lake area, Stevens and Spokane Counties, Washington, with a section on Potassium-argon ages of the plutonic rocks, by Engels, J. C.: U.S. Geological Survey Professional Paper 806.

Miller, R. D., 1975, Map showing relative compressibility of earth materials in part of west-central King County, Washington: U.S. Geological Survey Map I-852-C.

Mullineaux, D. R., 1974, Pumice and other pyroclastic deposits in Mount Rainier National Park, Washington: U.S. Geological Survey Bulletin 1326.

Simmons, G. C.; Noy, R. M.; Zilka, N. T., 1974, Mineral resources of the Cougar Lakes-Mount Aix study area, Yakima and Lewis Counties, Washington, with a section on Interpretation of aeromagnetic data, by Davis, W. E.: U.S. Geological Survey Open-file Report 74-243.

Tabor, R. W., 1974, Structure of the core rocks of the Olympic Mountains, Washington: a case for subduction? [abstract]: In Northwest Scientific Association Annual Meeting, 47th, May 9-11, 1974, University of British Columbia, Vancouver, B. C., Program and Abstract, p. 26.

Thompson, G. A., 1975, Aeromagnetic and Bouguer

gravity map of Twin Sisters dunite, northwestern Washington: U.S. Geological Survey Map GP-901.

Tubbs, D. W., 1974, Landslides and associated damage during early 1972 in part of west-central King County, Washington: U.S. Geological Survey Map I-852-B.

Weissenborn, A. E., 1974, Zinc in northeastern Washington: Material handed out following meeting of Pacific Northwest Metals and Minerals Conference, April 26, 1974.

Weissenborn, A. E., 1974, Geologic map of the Mount Spokane quadrangle, Washington and Idaho: U.S. Geological Survey Open-file Report 74-211.

In addition to these reports, summaries of significant results of many other current projects are contained in U.S. Geological Survey Professional Paper 900. Scientific notes and summaries of Survey investigations in geology, hydrology, and related fields are contained in the bimonthly volumes of the Journal of Research of the U.S. Geological Survey.

YOUR STATE GEOLOGIST REPORTS

The Division of Geology and Earth Resources will undertake another "first-time" activity this summer. About a year ago, Eric Schuster, one of our staff geologists, made an application for a RANN (Research Applied to National Needs) grant from the National Science Foundation to do heat-flow work related to geothermal exploration in the Southern Cascades. The grant was finally approved in April 1975, and we are currently doing the preliminary work and gearing up for the summer activities. The program will consist of drilling about six NX-size core holes to about 500 feet. Geothermal gradients will be measured in each hole and the thermal conductivity of the rock will also be measured. From this data, heat flow will be calculated.

The drilling will take place in an area that was mapped geologically by Paul Hammond, of Portland State University; the gravity was done by Claude Strickland, of the University of Puget Sound. The area is also covered by aerial magnetometer survey done cooperatively by the division and the U.S. Geological Survey.

The project supervisor will be Eric Schuster; Marshall Huntting will be the well-site geologist; and David Blackwell, of Southern Methodist University, will do the heat-flow work.

I am enthused about this project and hope it is just the first of a series that will lead to the discovery of geothermal energy in our state. Eric Schuster is to be complimented on the excellent presentation to the N.S.F. that lead to the granting of funding to carry out this project.

Ted Livingston

DIVISION RELEASES NEW PUBLICATIONS

The following reports were recently published by the Division of Geology and Earth Resources:

Bulletin 68 - Geology of the Methow Valley, Okanogan County, Washington, by Julian D. Barksdale, 17 figs., 1 plate (geologic map), 72 p. Price, $2.00.

Information Circular 53 - Compilation of earthquake hypocenters in western Washington, by Robert S. Crosson, 6 figs., 26 p. Price, 75 cents.

These publications may be purchased from the Department of Natural Resources, Division of Geology and Earth Resources, Olympia, WA 98504.

Several Out-Of-Print Reports Now Available Again

The Division had the following two reports reprinted in June:

Bulletin 66 - Geology of the Washington coast between Point Grenville and the Hoh River, Washington, by Weldon W. Rau, 1973, 72 figs., 58 p. Price, $3.00.

GM-11 - Complete Bouguer gravity anomaly map of Washington, by W. E. Bonini, D. W. Hughes, and Z. F. Danes, 1974, scale: 1:500,000. Price $2.50. (rolled or folded copies)

U.S. GEOLOGICAL SURVEY 7½-MINUTE TOPOGRAPHIC QUADRANGLES

(New maps received in the division library since September 1, 1974)

Name	Latitude (indicates southeast corner)	Longitude	County
Alpowa Ridge	46°22'30"	117°22'30"	Garfield, Asotin
Chinook Pass	46°45'00"	121°30'00"	Pierce, Lewis, Yakima
Fields Spring	46°00'00"	117°07'30"	Asotin
Glaciate Butte	46°15'00"	121°22"30"	Yakima
Golden Lakes	46°52'30"	121°52'30"	Pierce
Green Mountain	46°15'00"	121°30'00"	Skamania, Yakima
Harlon Ridge	46°07'30"	117°15'00"	Asotin
Jennies Butte	46°22'30"	121°15'00"	Yakima
Kennewick	46°07'30"	119°07'30"	Benton, Franklin
Meeks Table	46°45'00"	121°00'00"	Yakima
Mount Adams West	46°07'30"	121°30'00"	Skamania, Yakima
Mount Wow	46°45'00"	121°52'30"	Pierce
Mountain View	46°00'00"	117°15'00"	Asotin
Mowich Lake	46°52'30"	121°45'00"	Pierce
Pasco	46°17'30"	119°00'00"	Benton, Franklin, Walla Walla
Peola	46°15'30"	117°22'30"	Garfield, Asotin
Pinkham Butte	46°07'30"	117°22'30"	Garfield, Asotin
Pizarro	46°52'30"	118°22'30"	Adams
Potter Hill	46°15'00"	117°15'00"	Asotin
Ralston	46°52'30"	118°15'00"	Adams
Saddle Butte	46°00'00"	117°22'30"	Asotin, Garfield
Timberwolf Mountain	46°45'00"	121°07'30"	Yakima
Washtucna North	46°45'00"	118°15'00"	Adams
Washtucna Southwest	46°45'00"	118°22'30"	Adams

OPEN-FILE MAPPING

Preliminary geologic mapping of the Sherman Pass quadrangle, Ferry County, Washington, by Dr. Charles D. Campbell, of Washington State University, is now on open file in the Division of Geology and Earth Resources library. The mapping may be inspected in the division library, but it cannot be copied at the present time.

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