APRIL 1979 VOLUME 7 – NUMBER 2

A PUBLICATION OF THE DEPARTMENT OF NATURAL RESOURCES

WASHINGTON GEOLOGIC NEWSLETTER

SUMMER FALLS

Summer Falls occupies an old scabland channel that runs from the Coulee City area to the Crab Creek channel at Stratford. The channel was originally cut when the Grand Coulee and Lower Coulees were forming. As the water spread out at the mouth of Grand Coulee, part of it went over Dry Falls and part of it developed other channels. Summer Falls is one of those other channels. The falls is about 90 feet high and developed originally where melt water plunged over the south flank of the Soap Lake anticline. The falls is only active during the summer when water is being withdrawn from Banks Lake for irrigation in the Columbia Basin. Part of the scabland channel is used as a canal.

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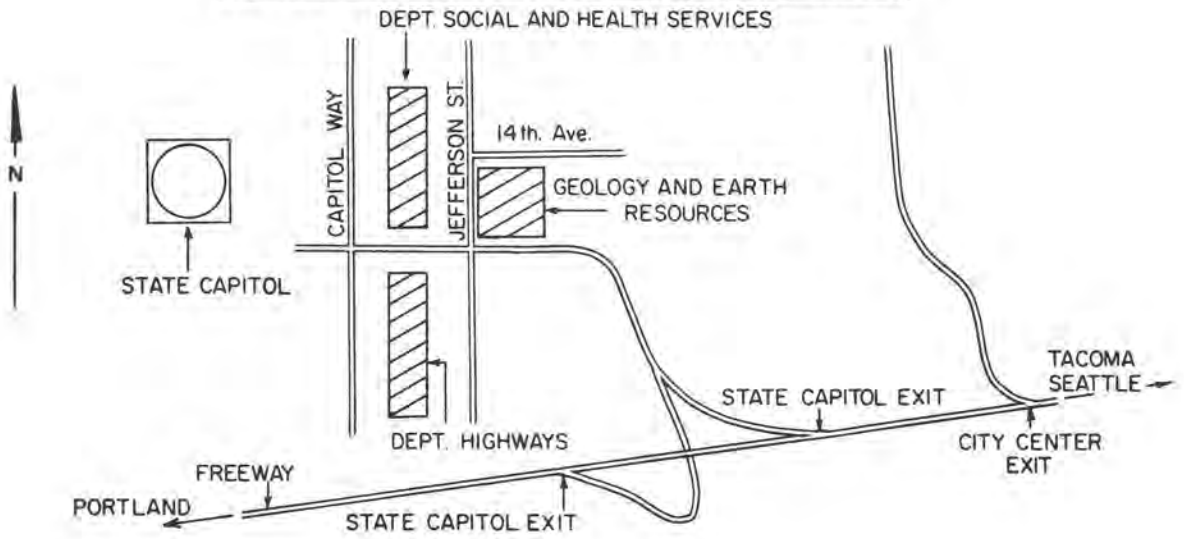
LOCATION MAP: DIVISION OF GEOLOGY AND EARTH RESOURCES



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Oil and Gas Conservation Act

Geothermal Resources Act

STRATIGRAPHY OF PRE-FRASER QUATERNARY SEDIMENTS APPLIED TO THE EVALUATION OF A PROPOSED MAJOR TECTONIC STRUCTURE IN ISLAND COUNTY, WASHINGTON

By Keith Stoffel

INTRODUCTION

Puget Sound is a seismically active area. In the last 40 years, four damaging earthquakes (magnitude 5.8 - 7.1) have shaken the lowland. These four quakes, plus scores of smaller ones, have raised interest in Puget Sound tectonics (location and history of movement of faults). Numerous people are presently involved in geologic projects to better delineate the tectonic structures proposed by previous workers. Ultimately, the verification and accurate location of these structures could have a beneficial effect on the land use planning of the Puget Lowland. Pinpointing of these structures will lead to further studies concerning possible tectonically induced landsliding, liquefaction, alteration of ground water flow patterns, and sea level changes within Puget Sound, and numerous other effects of seismic activity upon the land.

Although the Puget Lowland is a tectonically active region, few instances of surface ground breakage by faults are known. Reasons for the lack of recognizable faults may be that (1) earthquake foci are usually rather deep in the Puget Lowland, (2) the Puget Lowland is largely covered by a thick mantle of Quaternary sediments that may absorb movement along faults before such movement reaches the surface, or (3) most of the lowland is covered by drift deposited during the latest, the Fraser, glaciation (10,000 to 20,000 years B.P.) (fig. 1). This suggests that evidence of any surface ground breakage that may have occurred prior to the Fraser Glaciation has been obliterated by the glacier or covered by its deposits.

Geologic mapping of Quaternary deposits has been in progress for over 15 years, and maps exist

		GEOLOGIC CLIMATE UNITS	ROCK STRATIGRAPHIC UNITS
QUATERNARY Period	PLEISTOCENE Epoch	Fraser Glaciation	Numerous Fraser glacial and glaciomarine sedimentary units
		Olympia Interglaciation	Unnamed nonglacial sediments
		Possession Glaciation	Possession Drift
		Whidbey Interglaciation	Whidbey Formation
		Double Bluff Glaciation	Double Bluff Drift

FIGURE 1.—Pleistocene stratigraphic sequence in Island County, Washington (after Easterbrook, 1968).

for most of the Puget Lowland. The general absence of identified faults in the area suggests that future efforts to document faulting through careful mapping of Fraser Glaciation deposits will have a low probability of success.

Although efforts to locate faults at the earth's surface have been largely unsuccessful, there is evidence that differential crustal movements have occurred in the Puget Lowland, and that such movements may have continued well into the Quaternary. Rogers (1970) interpreted gravity and magnetic data to show the existence of five major structural blocks in the southern part of the Puget Lowland. He called these, from south to north, the Tacoma low, south Kitsap high, Seattle low, Port Gamble-Cathcart high, and Marysville low (fig. 2). Rogers interprets these structural units as relatively uplifted and depressed crustal blocks that are bounded either by faults of considerable vertical displacement or by monoclinal folds with steep flexures.

Later investigators (personal communications: D. B. Braislin, 1973, D. D. Hastings, 1973, and H. D. Gower, 1978) have incorporated additional data, including seismic reflection, and have somewhat modified the interpretations of Rogers and other earlier investigators (Stuart, 1961; Daneš and others, 1965). However, their data continue to support the concept of elevated and depressed structural blocks separated by faults (or possibly monoclinal folds), with major vertical displacements.

Although these inferred structures are not clearly relatable to present seismic activity (Crosson, 1974, 1975; Crosson and Millard, 1975; Crosson and Noson, 1978a, 1978b), the structures have probably been active well into the Quaternary. This is suggested by the difference in thickness of unconsolidated sediments, which conforms in a general way to the inferred pattern of uplifted and down-dropped structural blocks (Hall and Othberg, 1974). The uplifted blocks have a thinner cover of unconsolidated sediments than the down-dropped blocks. Since some, and perhaps most, of these sediments are Quaternary, and since they vary in thickness from zero on upthrown blocks to 3,600 feet on down-thrown blocks, the basins in which the sediments were deposited must have been subsiding at the time of deposition.

When considered over a longer period of time, relative displacements between Puget Lowland crustal blocks may be very large. For example, between the Seattle low and south Kitsap high, one interpretation of gravity and magnetic data suggests relative subsidence of the Seattle low of as much as ten kilometers since the Oligocene (Othberg and Daneš, 1975).

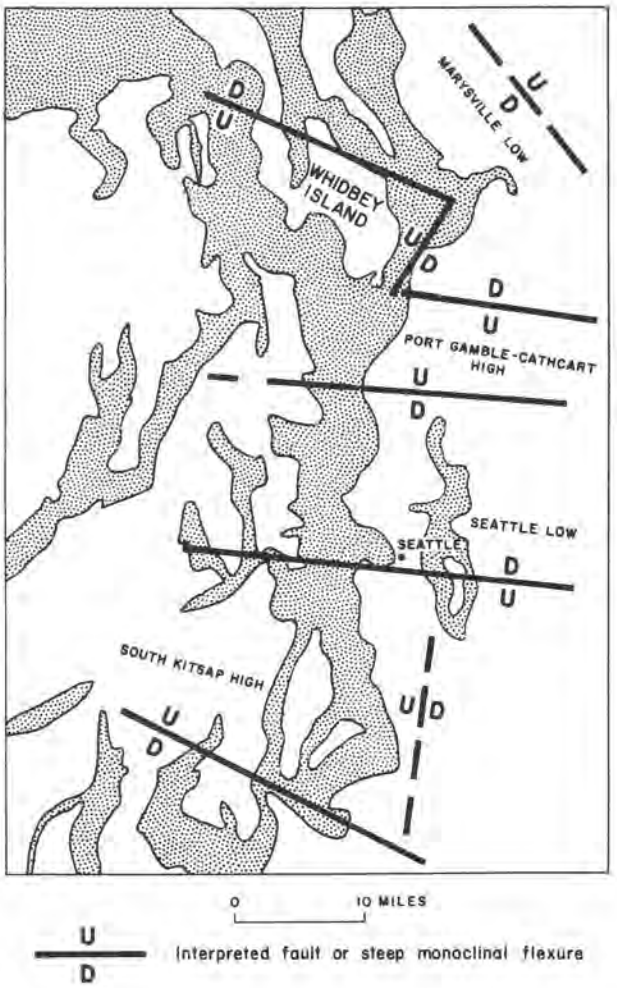

FIGURE 2.—Map of Puget Sound region showing the locations of structural blocks suggested by Rogers (1970).

PRESENT INVESTIGATION

Since detailed mapping of Fraser Glaciation deposits has led to the discovery of very few faults, older Quaternary (pre-Fraser) deposits must now be examined for evidence of Quaternary fault activity. If pre-Fraser deposits can be correlated so that thin sedimentary units of the same age can be identified at several localities, then an estimate of the relative uplift (if any) between the correlated sections can be made.

After considering all of the pre-Fraser stratigraphic units present in the area, the Whidbey Formation (fig. 1) was chosen for study because it is the youngest extensive nonglacial unit of pre-Fraser age. Also, since Whidbey sediments are presumed to have been deposited in a floodplain environment (Easterbrook, 1968), sediments of equivalent age should have been deposited at nearly the same elevation (elevation differences affected only by the stream gradient). Apparent relative offsets among correlative stratigraphic units may then be attributed to tectonics and(or) to gradient-elevation changes in the river system that deposited the sediments.

Land use geologists in the Division of Geology and Earth Resources, with the aid of a grant from the U.S. Geological Survey National Earthquake Hazards Reduction Program, are measuring and describing the sections of pre-Fraser deposits on Whidbey Island, Island County, Washington (fig. 3). Whidbey Island was selected as the study area for the following reasons:

1. Most earlier investigators have suggested a major fault(s) cutting through the island somewhere between Double Bluff and Lake Hancock (fig. 3). This structure separates the Port Gamble-Cathcart high from the Marysville low of Rogers (1970).

2. The Whidbey Formation, the major pre-Fraser nonglacial unit found in the sea cliffs of the northern Puget Lowland, is well exposed at its type locality near Double Bluff (Easterbrook, 1968) and fairly well exposed at several other localities on Whidbey Island.

3. Division geologists, who have been mapping Island County since 1974, are familiar with the local geology.

4. A few outcrops of the Whidbey Formation on Whidbey Island are known to be faulted or folded although the cause of the deformation is unknown.

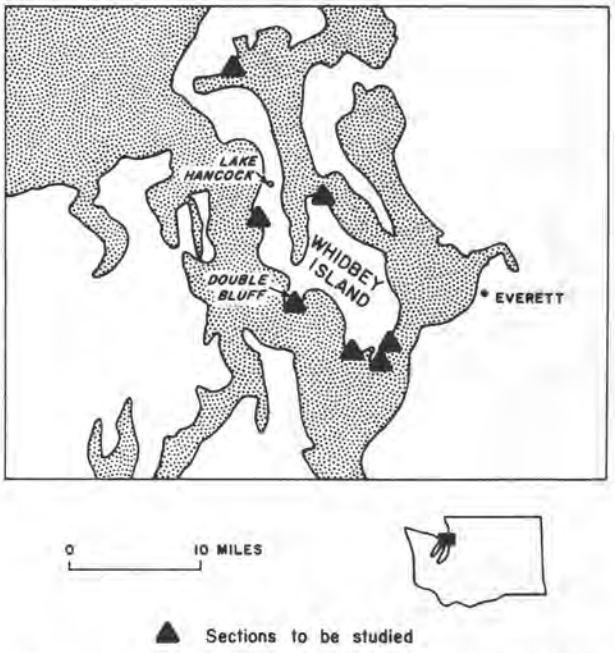

FIGURE 3.—Index map of southern Whidbey Island, showing locations of sections.

Difficulties Anticipated

Lithologic similarity and complex stratigraphic relationships combine to complicate the identification of, and distinction between, stratigraphic units. Following are some of the difficulties anticipated during mapping:

1. Previous workers have identified the presence of an unconformity at the top of the Whidbey Formation (Easterbrook, 1968). If the amount of section removed by erosion differs from place to place, then outcrops on sea cliffs in different areas will expose different stratigraphic segments of the Whidbey and correlation will be more difficult.

2. If the Whidbey was deposited by streams with a significant gradient, the present elevation of a measured section may depend not only on tectonic

activity, but also on distance from the mouth of the depositing stream. However, if considerable tectonically produced elevation changes occurred, the relatively minor elevation differences due to paleogradients would be overshadowed.

3. If the Whidbey Formation does not contain distinctive sedimentary units or sequences of units, correlation may not be possible.

4. If facies changes occur in covered areas between measured sections, correlation will be complicated.

Project Plans

Mineralogical, physical property, and age-dating laboratory analyses are presently being run on samples from the Whidbey Formation. Upon completion correlations will be made between the various measured sections. The elevations of correlated units will then be compared with patterns of known deformation, a depositional environment model, and with current tectonic hypotheses. This will help to identify possible tectonic offset.

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Hall, J. B.; Othberg, K. L., 1974, Thickness of unconsolidated sediments, Puget Lowland, Washington: Washington Division of Geology and Earth Resources Geologic Map GM-12, scale 1:250,000, map accompanied by 3 pages of text.

Othberg, K. L.; Daneš, Z. F., 1975, Delimitation of a buried structure across the Puget Lowland, Washington: Geological Society of America, Abstracts with Programs, v. 7, no. 3, March 25-27, 1975, p. 360.

Rasmussen, Norman, 1967, Washington State earthquakes 1840 through 1965: Seismological Society of America Bulletin, v. 57, no. 3, p. 463-476.

Rogers, W. P., 1970, A geological and geophysical study of the central Puget Sound Lowland: University of Washington Ph. D. thesis, 123 p.

Stuart, D. J., 1961, Gravity study of crustal structure in western Washington: U.S. Geological Survey Professional Paper 424-C, p. C273-C276.

UNDERGROUND COAL GASIFICATION IN WASHINGTON

By Ellis Vonheeder

The feasibility of gasifying coal in place in steeply dipping seams, or from seams where the coal is too deep to recover by conventional mining methods, was the topic of discussion on March 8th in Olympia.

Government energy representatives who attended the meeting were from the Governor's Office, the State Energy Office, the Department of Natural Resources, and the U.S. Department of Energy.

Industry had representatives from New Mexico, Oregon, Colorado, Pennsylvania, and Washington. They included the following: Washington PUD association, Burlington Northern, Snohomish County PUD, Seattle City Light, Bonneville Power Administration, Puget Power, Portland General Electric, Washington Public Power Supply System, Associated Resources Analysts, Pacific Power & Light, and the Gulf Resource and Development Co.

At the meeting, plans for in-situ gasification research in Washington State were considered. Funds for such research were made available during the Second Session of the 95th Congress. The $800,000 designated for research projects in Washington is a part of the $2,500,000 funding allowed for in-situ gasification projects in the nation.

In addition to the planned Washington State demonstration, four other projects are underway in Wyoming and Texas. None of the projects have been commercialized.

Edward Burwell and Cyril Draffin, from the U.S. Department of Energy in Washington, D.C., William Noll, Coal Gasification Project Manager from DOE's Denver Operations Office, and Lewis Bartel, of Sandia Laboratories in Albuquerque, New Mexico, presented details of the program and emphasized the need for full cooperation between federal, state, and industrial representatives. Underscoring the need for cooperation is the fact that there are only 14 months in which to undertake and accomplish preliminary investigations, to survey potential sites, to select and characterize a site, and to define and design an Underground Coal Gasification (UCG) experiment to fit the selected site.

Phase 1, preliminary investigations, includes a gas market analysis, procurement of the various environmental permits, and a survey and collection of literature. The latter will be conducted by the author, and Lew Bartel of Sandia Labs in Albuquerque. Phase 2, site selection, will be accomplished by mid-June, 1979. Site characterization, the third phase, will emphasize environmental, as well as geologic aspects, and will include drilling and geophysical, hydrologic, and subsidence studies. Phase 4, the design stage, will be accomplished by August or September of 1980. The next step in the program will be a small-scale field test. If successful, follow-on larger scale field tests would be undertaken. A UCG pilot plant would be the last step before the process becomes commercial in this state.

DIVISION OPEN-FILE REPORTS NOW AVAILABLE

The following reports have recently been added to our Division library:

Coal mining history of Pierce County, Washington, 1860-1962, by Joseph Daniels. Open-File Report OF 79-1, 161 p.

The Chumstick and Wenatchee formations—fluvial and lacustrine rocks of Eocene and Oligocene age in the Chiwaukum graben, Washington, by Randall L. Gresens, Charles W. Naeser, and John T. Whetten, University of Washington. Open-File Report, 42 p.

RECENT USGS OPEN-FILE REPORTS ADDED TO OUR DIVISION LIBRARY

The following reports are now available for inspection in our division library:

Aeromagnetic map of Pendleton and vicinity, Oregon and Washington. U.S. Geological Survey Open-File Report 79-278, scale 1:125,000.

Communicating earthquake hazard reduction information: National Earthquake Hazards Reduction Program, Conference V, May 22-24, 1978, Proceedings. U.S. Geological Survey, Office of Earthquake Studies, Open-File Report 78-933, 426 p.

Methodology for identifying seismic gaps and soon-to-break gaps: National Earthquake Hazards Reduction Program, Conference VI, May 25-27, 1978, Proceedings. U.S. Geological Survey, Office of Earthquake Studies, Open-File Report 78-943, 924 p.

Geologic map of the Cape Disappointment-Naselle River area, Pacific County, Washington. U.S. Geological Survey Open-File Report 79-389, scale 1:48,000.

Tectonic map of the Puget Sound region, Washington, showing locations of faults, principal folds, and large-scale Quaternary deformation, by H. D. Gower. U.S. Geological Survey Open-File Report 78-426, 1 pl., 21 p.

Columbia Glacier progress report—December 1977, by M. F. Meier, A. Post, C. S. Brown, F. David, et al. U.S. Geological Survey Open-File Report 78-264, 56 p.

Map of Washington RARE II mineral resource potential, by K. F. Fox, Jr., T. H. Kilsgaard and A. E. Weissenborn. U.S. Geological Survey Open-File Report 78-889, 1:1,000,000.

Evaluation and design of a streamflow-data network in Washington, by M. E. Moss and W. L. Haushild. U.S. Geological Survey Open-File Report 78-167, 1 pl., 43 p.

GEOLOGIC RESEARCH PROJECTS

Geologic research projects in Washington State now in progress at our colleges and universities are listed below:

Green River Community College

Faculty Research Project

Western extent of the Shuksan and Church Mountain thrusts in Whatcom, Skagit, and Snohomish Counties. G. M. Miller.

North Seattle Community College

Quaternary geology of the northwestern Olympic Peninsula. A. D. Horn.

Petroleum potential of Washington State. A. D. Horn and R. W. Windecker.

Eastern Washington University

Faculty Research Projects

Behavior of major and trace elements in metamorphic rocks at the contacts of igneous intrusions. Mohammed Ikramuddin.

Geochemistry of granitic rocks of northeastern Washington. Mohammed Ikramuddin.

Permian bryozoans of the carbonate units of the Mission Argillite, northeastern Washington. Ernest H. Gilmour.

Fumarole and geothermal ice cave monitoring, Mounts Rainier and Baker. Eugene P. Kiver.

Quaternary geology of the northeastern Columbia plateau. Eugene P. Kiver.

Compilation of computer data base of whole-rock chemical analyses of igneous rocks from Washington. Felix E. Mutschler.

Major element chemistry of "porphyry" molybdenum, tin-tungsten systems. Felix E. Mutschler.

Geologic map of Ichelium quadrangle, Washington. James R. Snook.

The occurrence of olivine nodule-bearing alkalic basalts in northern Washington and southern British Columbia. William L. Wilkerson and Harold Lucas (student).

The mineralogy and petrography of olivine nodule-bearing basalts in northern Washington and southern British Columbia. William L. Wilkerson and Harold Lucas (student).

Student Research Projects

The relationship between fluorine and uranium in rocks from northeastern Washington. Robert K. Pernsteiner.

Geochemistry of metapelites and calc-silicate hornfelses associated with uranium mineralization at Midnite Mine, northeastern Washington. Gin Chou.

Petrology of porphyry molybdenum systems. Ernest G. Wright.

Geochemistry of the Loon Lake quartz monzonite and its relation to uranium mineralization at the Midnite Mine, northeastern Washington. Kirk P. Kinart.

Geochemistry of granitic rocks from Newport quadrangle, northeastern Washington. Abebe Kassaye.

Behavior of volatile elements in the rocks at the contact of some igneous intrusions of northeastern Washington and its relation to ore mineralization. Louis B. Schipper.

Geochemistry of alaskite and quartz monzonite of Mount Spokane, northeastern Washington, and its relation to uranium mineralization. Roy Bongiovanni.

Geologic hazards in the Spokane quadrangle. Tom Davis.

Patterned ground in the Spokane area. Lee Tallyn.

Palynology of the Badger Lake area, Washington. Rudy Nickmann.

Geology of Turnbull National Wildlike Refuge, Cheney. Christopher E. Sheldon.

Chemistry of the Loon Lake batholith. Walter Nijak.

Genesis of uranium ore deposits at the Gillis lease, Spokane Indian Reservation. Lee C. Nesbit.

Prospecting for magmatic and hydrothermal deposits of uranium and associated elements by computer evaluation of the chemistry and petrogenesis of igneous source rocks. Dennis D. Finn.

Chemical classification of granitic rocks. Granites as paleo-stress gauges. James S. Johnston.

University of Washington

Faculty Research Projects

Structural and petrologic evolution of the San Juan Island and adjacent areas. Darrel S. Cowan and John T. Whetten.

Structure, stratigraphy, and sedimentology of the Chiwaukum graben. John T. Whetten.

Origin of chaotic rocks in the San Juan Islands. Darrel S. Cowan.

Stratigraphy, metamorphism, and tectonic evolution of the San Juan Islands. Joseph A. Vance.

Tertiary stratigraphy and structure of the area between Darrington and Skykomish. Joseph A. Vance.

Fission track geochronology of the Tertiary volcanic rocks of the Washington Cascades and Oregon. Joseph A. Vance.

Chronology of neoglacial moraines at Mount Rainier. Stephen C. Porter.

Regional Cenozoic tectonic patterns and geologic hazards of the Skagit nuclear power site. Eric S. Cheney.

Stratigraphy and structure and ore deposits of the Okanogan Highlands. Eric S. Cheney.

Structure and origin of the Twin Sisters Dunite. Nikolas I. Christensen.

Physical properties of Olympic Peninsula graywackes. Nikolas I. Christensen.

The origin of Washington State ophiolites. Nikolas I. Christensen.

Gravity studies south and southwest of Mount Baker. Nikolas I. Christensen.

Review of geologic conditions at proposed nuclear plant sites in Washington. Howard A. Coombs.

Petrology of ultramafic hornfelses, Icicle Creek, central Cascades. B. R. Frost.

Stratigraphy, structural geology, and regional interpretation of the Wenatchee Formation. Randall L. Gresens.

Marblemount 15' quad. Geology by Peter Misch 1949-1967. Peter Misch. In press.

Mount Baker 15' quad., being compiled by Peter Misch from 1949-1975 field data.

Mount Shuksan 15' quad., compilation under preparation. Peter Misch.

Metamorphic facies and petrogenesis of Shuksan Greenschist. Peter Misch.

Petrology of Cascade River Schist and its associated metaplutonic rocks. Location: largely in Marblemount 15' quad., but includes part of Eldorado Peak, Cascade Pass and Sonny-boy Lakes $7\frac{1}{2}$' quads. Peter Misch.

Metasomatic progressive metamorphism of ultramafic rocks in Skagit Metamorphic Suite (Skagit Gneiss and Cascade River Schist). Peter Misch.

Geology, geochemistry and origin of the Golden Horn batholith. With R. T. Stull. Includes parts of Crater Mtn., Azurite Peak, Slate Peak, Mount Arriva, Washington Pass, Silver Star Mountain, $7\frac{1}{2}$' quads., etc. Peter Misch.

Outline of the petrology of the Yellow Aster Complex (the pre-Devonian basement of the northwestern Cascades). Peter Misch.

Stratigraphy and structure of rocks in the Hoh River—Clearwater River area, western Olympic Peninsula. Richard J. Stewart.

Carbon-14 and carbon-13 analysis of Douglas Fir trees from western Washington as an indicator of carbon reservoir changes. Minze Stuiver.

Enrichment carbon-14 dating of late Quaternary glacial events, Olympic Peninsula, Washington. Minze Stuiver.

Sunspot activity as monitored by C-14 changes in Pacific Northwest trees. Minze Stuiver.

Stratigraphy and structure of Mesozoic and Tertiary rocks of the western Cascades. John T. Whetten.

Minor and trace element geochemistry of Mesozoic oceanic volcanic and plutonic rocks in northwestern Washington. Joseph A. Vance.

Geochemistry of the Easton blueschists and greenschists. Joseph A. Vance.

Ecological distribution of dinoflagellates in Recent sediments of Puget Sound. Barbara L. Whitney.

Quaternary evolution of the Willapa Bay estuary. Barbara L. Whitney, V. Standish Mallory, and Sandra R. Leo.

Correlation of stratigraphic units of Washington and western Oregon. V. Standish Mallory.

Stratigraphy and paleontology of Lower Cretaceous sediments of the northern Methow Valley. Julian D. Barksdale and V. Standish Mallory.

Petrology and metamorphic history of the Chiwaukum Schist in the Stevens Pass area. Bernard W. Evans.

K-Ar dating of Tertiary igneous rocks of the Wenatchee area. Randall L. Gresens.

Sources and fate of sediment from forested basins, Olympic Mountains. Thomas Dunne and Leslie Reid.

Graduate Program

Bedrock geology of the northwest [part] of the Kachess Lake quadrangle, Washington. James Ashleman.

The paleoecology and biostratigraphy of the Kulshan glaciomarine drift, northwestern Washington. Maria A. Balzarini.

Palynology of Davis Lake, Lewis County, Washington. Small mammals and pollen of the Jeppson Mammoth Site, Richland, Washington. Cathy Barnosky.

Late Quaternary volcanic stratigraphy and concomitant volcanic hazards at Glacier Peak, Washington. Interrelationships of late Fraser volcanic and glacial stratigraphy near Glacier Peak, Washington. James Beget.

The structural geology and petrology of pre-Tertiary rocks on southern San Juan Island in northwestern Washington. Mark T. Brandon.

Holocene glacier fluctuations on Mount Rainier and their correlations with climate. Doug Burbank.

Volcanic and glacial stratigraphy of the Goat Rocks area, central Cascade Mountains. Geoffrey Clayton.

Mechanics of river meanders, Sinlahekin River. William Dietrich.

Hydrothermal clay and thermal activity in source areas of debris avalanches at Mount Rainier and Mount Baker. David Frank.

Pollen analysis of Quaternary sediments from two lakes in the southern Puget Lowland. Dennis Hibbert.

Late Quaternary evolution of western Washington coast. A. Dan Horn.

Sedimentology, petrology, and structure of Mesozoic strata in the northwestern San Juan Islands, Washington. Sam Y. Johnson.

Petrology of pelitic and ultramafic hornfels north of Icicle Creek, Washington. B. Keith Kaneda.

Stratalogic analysis of the intra-Miocene Ochoco unconformity in Washington-Oregon. Sandra Leo.

Fossil vertebrates from the Clarendonian and Hemphillian of northern Oregon and Washington. James Martin.

The paleoecology of the upper Eocene Cowlitz Formation and its associated coalbeds, southwestern Washington. Dann Joseph May.

Stratigraphy and economic geology of Buckhorn Mountain, Okanogan County, Washington. David D. McMillen.

Structure and petrology of the Ingalls complex and associated pre-Tertiary rocks near Mount Stuart, central Cascades. Robert Miller.

Geology and porphyry copper mineralization of the Fawn Peak intrusive complex, Methow Valley, Washington. Brock Riedell.

Paleontology, paleoecology and biostratigraphy of the type Cowlitz Formation, southwestern Washington. Jan (Jay) R. Yett.

Factors affecting the oxygen-18 composition of Douglas Fir tree rings from western Washington. Robert L. Burk.

The structure and petrology of the Quartz Mountain area, Kittitas County, Washington. Sherree A. Goetsch.

Glacial and volcanic stratigraphy of the White Pass region. Evaluation of the geothermal resource potential of the southern Cascade Range, Washington. Geoffrey Clayton.

Washington State University

Faculty Research Projects

Geophysical investigations of Washington groundwater resources in central Columbia Basin. James W. Crosby, III.

National uranium resources evaluation (ground-water base) in northeastern Washington. James W. Crosby, III.

Mineralogy of alkaline lake sediments in Washington.
Franklin F. Foit, Jr. and Philip E. Rosenberg.

Stratigraphy and petrogenesis of Columbia River basalt in southeast Washington.
Peter R. Hooper.

Age, sediments, microfossils and tefra of cores from the Scabland Lakes of the Cheney-Palouse Tract.
Peter J. Mehringer

Late glacial plant macrofossils and pollen, manis, mastedon site, Sequim, Washington.
Peter J. Mehringer and K. L. Peterson

Geology and mineral deposits of black shale belt, northeast Washington.
Joseph W. Mills.

Sulfur isotope study of ore deposits of northeastern Washington.
Joseph W. Mills.

Sulfide-bearing black shales of northern Washington State.
Joseph W. Mills

Cretaceous stratigraphy, San Juan Islands; beach erosion in the San Juan Islands, San Juan County, Washington.
W. Frank Scott.

National geologic landmarks, Columbia Plateau.
W. Frank Scott

Mapping of late Cenozoic sediments in southeastern Columbia Plateau.
Gary D. Webster

Student Research Projects

Borehole geophysical investigation of Hanford Reservation.
Ilene Poeter.

Mineralogy of the sediments of Wildcat Lake, Whitman County, Washington.
Clarence Johnson.

Ore deposits of the Yellowhead Horizon, Pend Oreille mine, Metaline mining district, Washington.
Michael Bemski.

The Metaline-Ledbetter contact in northeastern Washington.
Bruce Hurley.

Sulfide-bearing metasedimentary rocks of the Boundary Mountain area, Ferry County, Washington.
Diane Lane.

Ore deposits of the Ruby Hill area, Okanogan County, Washington.
Donald Lance.

Geology of the Schminsky molybdenum prospect. Colville Reservation, Washington.
Randall White.

Geology and mineral deposits of upper Paleozoic metasedimentary rocks, northern Stevens County, Washington.
Francis Beka

Geology and mineral deposits of Nespelem mining district, Colville Indian Reservation, Washington.
Michael Broch.

Petrochemistry of granites, northeastern Washington.
Don Orazulike.

Detailed analysis of folding in the basalts, Columbia River Plateau.
William Saur.

Structural analysis and detailed mapping of the China Bend region.
Donald Minkel.

Friability of Addy Quartzite, Stevens County, Washington.
Gale Knutsen.

Gravel deposits in the Clarkston area, southeastern Washington.
Gail Waggoner.

Sheet gravels near the mouth of the Snake River.
Lance Richman.

Older gravel deposits in the Snake River Canyon below Clarkston, Washington.
Mark Wheeler.

Structural analysis and control of ore deposits, Red Top Mountain, Washington.
Monica O'Keefe.

Analysis of fold interference patterns, Cedar Lake, Stevens County, Washington.
Paul Ginther.

Structural mapping in the Kettle Dome, Washington.
Joseph Wilson.

Strain analysis in the Kootenay Arc.
Michael Ellis.

Whitman College

Department of Geology

Quaternary faults of southeastern Olympic Peninsula.
Joe Wilson, Gardner-Webb College: M. J. Bartholomew, Longwood College; and R. J. Carson.

Quaternary geology of the Skokomish area, Mason County. R. J. Carson; and William Long, U.S. Forest Service.

Reinterpretation of the Skokomish Gravel, southwestern Puget Lowland. R. J. Carson

Age of Lena Lake, southeastern Olympic Mountains. William Long, U.S. Forest Service; and R. J. Carson.

Quaternary and environmental geology of the eastern Olympic Peninsula. R. J. Carson.

IMPORTANT NOTICE FOR MINING CLAIM OWNERS

Recording unpatented mining claims with the Federal Government is required by the Federal Land Policy Management Act. If your unpatented lode or placer claim, or mill and tunnel site is located on any Federal lands, including lands where the Federal Government owns only the minerals, then you must record the claim. If you located a mining claim BEFORE October 22, 1976 . . .

you have until October 21, 1979, to file with the Bureau of Land Management:

1. A copy of the notice of location recorded in the county records.
2. A statement providing the legal description, indicating township, range, meridian, state, section, and quarter section.
3. A map showing the survey or protraction grids on which is depicted the location of the claim.
4. A $5 service fee for each claim.

Mining claims in Oregon-Washington are filed at:

Mining Claim Recordation Office
Bureau of Land Management
729 NE Oregon St.
P. O. Box 2965
Portland, Oregon 97208
(telephone: 503-234-3361)

Complete instructions may be obtained by contacting the above Recordation Office.

If your mining claim was located after October 21, 1976, you have 90 days to file with BLM.

U.S. GEOLOGICAL SURVEY 7½-MINUTE TOPOGRAPHIC QUADRANGLES
(Maps received in the division library January 15, 1979)

Name	New edition	Photo revised	Latitude (indicates southeast corner)	Longitude	County
Bruce	1954	1978	46°45'00"	119°00'00"	Adams
Columbia Point	1978	---	46°15'00"	119°07'30"	Franklin; Benton
Deception Pass	1978	---	48°22'30"	122°37'30"	Skagit; Island
Ellensburg South	1958	1978	46°52'30"	120°30'00"	Kittitas
Lummi Island	1978	---	48°37'30"	122°37'30"	Whatcom; Skagit; San Juan
Lyle, Washington-Oregon	1978	---	45°37'30"	121°15'00"	Klickitat
Moses Lake North	1956	1978	47°07'30"	119°15'00"	Grant
Mount Tabor, Oregon-Washington	1961	1970;1978	45°30'00"	122°30'00"	Clark
Richardson	1977	---	48°22'30"	122°52'30"	San Juan
Richland	1978	---	46°15'00"	119°15'00"	Benton; Franklin
Sieler	1956	1978	47°00'00"	119°07'30"	Grant
Slide Peak	1950	1978	47°52'30"	123°52'30"	Clallam; Jefferson

Department of Natural Resources
Division of Geology and Earth Resources
Olympia, WA 98504

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