GEOLOGY
FOR THE DECADE
1980 - 1990

September 27, 1983
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GEOLOGY & EARTH RESOURCES DIVISION

HISTORY

Washington became a state in 1889, and in 1890, the first State Legislature established a State Mining Bureau and appointed George A. Bethune to the position of State Geologist. By the end of this decade, the geology division will celebrate its 100th anniversary.

STATE GEOLOGIST

1890-1892 — George A. Bethune, State Geologist
1901-1920 — Henry Landes, State Geologist
1920-1925 — Solon Shedd, Supervisor
1925-1945 — Harold E. Culver, Supervisor
1945-1957 — Sheldon L. Glover, Supervisor
1972-1981 — Vaughn E. Livingston, Jr., State Geologist
1982-Present Raymond Lasmanis, State Geologist

TITLE OF OFFICE

1890-1900 — State Mining Bureau (inactive from 1893-1900 due to lack appropriations)
1901-1920 — Washington Geological Survey
1920-1945 — Department of Conservation and Development, Division of Geology
1945-1968 — Department of Conservation and Development, Division of Mines and Geology (name was changed to Department of Conservation in 1957)
1968-1973 — Department of Natural Resources, Division of Mines and Geology
1974-Present Department of Natural Resources, Geology & Earth Resources Division
## GEOLOGY & EARTH RESOURCES DIVISION

### STAFF LEVELS - HISTORICAL

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Level and number of positions will vary with project and budget requirements.
Staff Levels
Geology & Earth Resources Division
Department of Natural Resources
rev. 9/19/83

Field FTE
Technical & Clerical
Professional

Full Time Staff
GEOLOGY & EARTH RESOURCES DIVISION

PERSONNEL - FY 1984

Ray Lasmanis - Resource Manager VII
Eric Schuster - Resource Manager V
Jerry Thorsen - Geologist IV
Carl McFarland - Geologist IV
(Vacant) - Economic Geologist IV
Hank Schasse - Geologist III
Mike Korosec - Geologist III
Bonnie Bunning - Geologist III
Bill Phillips - Geologist II
Keith Stoffel - Geologist II
Tim Walsh - Geologist II
Connie Manson - Senior Librarian
Weldon Rau (1) - Biostratigrapher
Keith Ikerd - Cartographer II
Don Hiller - Cartographer II
Arnold Bowman - NRRT II
Pam Whitlock - Secretary II
Laura Bray - Editorial Assistant
Wanda Walker - Clerk Typist III
Barb Preston - Clerk Typist III
Loretta Andrake - Clerk Typist II
Janet Miller - Clerk Typist II
Alberta Lopez(2) - Clerk Typist II

(1) Permanent Part Time (2) Temporary
# GEOLOGY & EARTH RESOURCES DIVISION

## TOTAL EXPENDITURES - HISTORICAL

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<td>790,115</td>
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<td>853,408</td>
<td>1,365,644</td>
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## EXPENDITURES BY FUNCTION

| Geology/Geothermal/etc. | 482,734 | 639,454 | 750,973 | 694,909 | 1,172,355 | 1,174,106 | 1,011,146 | 868,822 | 1,034,933 |
| Regulatory | 136,947 | 150,661 | 138,478 | 158,499 | 193,289 | 214,190 | 188,552 | 214,138 | 275,553 |

## EXPENDITURES IN 1975 DOLLARS

| General Fund | 446,736 | 594,131 | 615,921 | 518,391 | 577,059 | 537,416 | 471,852 | 470,869 |
| **TOTAL FUNDS** | 584,979 | 685,820 | 697,330 | 595,679 | 794,805 | 720,526 | 581,854 | 507,908 |
Expenditures (Actual)
Geology & Earth Resources Division
Department of Natural Resources
rev. 9/19/83

Thousands of Dollars
Expenditures (Actual)
Geology & Earth Resources Division
Department of Natural Resources
rev. 9/19/83

Federal Funds & Grants
General Funds
Regulatory Funds

Thousands of Dollars
Expenditures (1975 Dollars)
Geology & Earth Resources Division
Department of Natural Resources

rev. 9/19/83

Thousands of Dollars

Federal Funds & Grants
General Funds
GEOLOGY & EARTH RESOURCES DIVISION

STATEMENT OF PURPOSE

Public service is provided through program objectives of the Geology and Earth Resources Division. The mission is education, assistance, promotion of mineral development and protection of the environment. This is accomplished through the following program elements:

A. Economic Geology including Strategic Minerals

B. Energy Investigations
   1. Coal
   2. Geothermal
   3. Oil and Gas

C. Columbia Basin Mapping

D. Land use or Environmental Geology

E. State Geologic Map

F. Library

G. Regulation
A. Economic Geology including Strategic Minerals

Studies in economic geology and strategic minerals have been carried out by two staff geologists: Bonnie Bunning in the Spokane office and Wayne Moen in Olympia. Other staff members advise the public via telephone and through personal consultation. Wayne Moen has retired leaving the Spokane office as a keystone to our minerals program. However, plans are under way to fill the above vacancy.

The Spokane office is uniquely situated to interact on a daily basis with major offices of the U.S. Geological Survey, U.S. Bureau of Mines, U.S. Bureau of Land Management, Rockwell-Hanford, the Indian reservations, universities, Northwest Mining Assn., and numerous mineral and energy companies, most of which have no western Washington counterparts. Many of our projects have been undertaken through cooperative efforts with eastern Washington universities, public, and private agencies. The Spokane office is strategically placed, as the northeast part of the state has a long mining history and the greatest potential in the state for further mineral development.

As representatives of the Department, Spokane-based geologists take an active and visible part in the regional geologic community through participation in the Northwest Mining Assn. and the American Institute of Mining and Metallurgical Engineers. In addition, the office works with the Area offices, the Lands Division of DNR on an advisory basis, and serves as an information outlet for the public in eastern Washington.

During the last biennium certain objectives have been accomplished. They are:

- a. Publication of a state-wide mining directory
- b. An annual review of exploration activity in the state (now in a 3rd printing)
- c. Geologic report and maps for Monitor and Wenatchee Quadrangles - scene of current gold rush
- d. History of the state's mineral industry
- e. Reprinting of popular publications on state's silver and gold deposits

Certain DNR program objectives will be met in FY '84. Specifically, negotiations were successful with the Colville Confederated Tribes for the Geology Division to produce a joint bulletin on the world class Mt. Tolman molybdenum deposit. Research has been completed on all uranium occurrences in Washington State and the report is in editing stage. An open file will be forthcoming on tin, tungsten and molybdenum geochemistry of northeast Washington. A joint publication with the U.S. Bureau of Mines detailing federal land status and mineral potential will also be published this year. We will keep abreast of developments in the Wenatchee gold belt and are planning to revise Bulletin 37 - Part II - Inventory of Washington Metallic Minerals.
B. (1) Energy Investigations - Coal Program

The principal function of the Division of Geology and Earth Resources coal program is to conduct research and compile and disseminate information on the coal resources of Washington. This is accomplished through reports, public presentations, and direct one-on-one assistance to the public, government, and industry representatives in both office and field settings. Over the past biennium the coal program geologists have:

a. Produced six open-file reports which have included: Analyses and measured sections of 176 coal seams from 9 Washington counties; a comprehensive catalog and indexing of over 900 original coal mine maps; a preliminary report on the lignite deposits of Asotin County (A final report to be published as a Report of Investigations - in press); a report (in-press) on the geology and coal potential of the Taneum-Manastash Area, Kittitas County (generated as a result of DGER thesis support for two graduate students at state universities; a comprehensive coal bibliography with map indexes for prospective and known coal-bearing areas, and the Directory of Washington Mining Operations.

b. Made public presentations or authored papers given at two national professional meetings and two regional mining conventions; authored 3 newsletter articles on coal geology, coal research, and coal development in the state; given talks to a local professional energy organization and local rock club; conducted a field trip for the Pacific Northwest section of the National Association of Geology Teachers.

c. Provided assistance to numerous energy representatives in the office and in the field which led to their funding of exploration projects resulting in the Division acquiring valuable geologic data; looked at and diagnosed abandoned mine hazards - acting as a liaison with the Federal Office of Surface Mining in the reclamation of several dangerous coal mine-related hazards. Also provided testimony before the King County Council on coal mine hazards. Coal program geologists also provided 75% of the effort for the Division's mineral and rock identification service which is offered to the public.

Current and Future Projects 1983-1985

There are three ongoing coal resource projects which are scheduled for completion in late 1983 and early 1984 and will be presented as open-file reports. They include the Newcastle-Tiger Mountain area, central King County, the Green River area, southeastern King County, and the Wilkeson-Carbonado-Fairfax area, Pierce County. A reprinting of the almost depleted Coal Reserves of Washington (Bulletin 47) is also scheduled for this calendar year. The bulletin will be reprinted with minor modifications. There is currently a proposal to the Federal Office of Surface Mining to produce an inventory of the coal mine hazards of Western Washington. This project would utilize the newly organized and inventoried coal mine map collection. The coal program effort will be reduced to a 1 FTE as the work on the new state geologic map commences.
Heatflow Drilling: Eleven 500 ft. holes were drilled for temperature gradient and heat flow measurements: Scenic (2), Snoqualmie (2), White River, Tieton, White Pass Area (2), Wind River Area (2) and Klickitat. (OFR 81-8 and OFR 83-7)

Spring Sampling & Analysis: Thermal and mineral springs at Goldmeyer, Scenic, Garland, Baker, Little Rattlesnake, Government, Klickitat, Rock Creek, Bonneville, St. Martins-Carson, Shipherds, Ahtanum, Bumping River, and for several wells (OFR 82-3 and OFR 83-7)

Gravity Measurements: Gravity measurements were made throughout the central and northern Cascades. Maps were compiled for the South and North Cascades (OFR 81-4 and GM-27) and various residual maps were worked on.

WELL THERM: All available temperature information for wells in the state were compiled and placed in a computer file. (OFR 82-2)

Temperature Gradient Measurements: Measured in numerous water wells throughout eastern Washington.

Geohydrology: Detailed geologic-hydrologic study of the warm water aquifers in the Yakima area (OFR 81-7), and identification and discussion of known low temperature geothermal resource areas of eastern Washington. (OFR 82-1 and OFR 83-7)

Geologic Mapping: Continuation of the mapping in the White Pass - Bumping Lake Area; mapping of the lower Wind River Valley area.

Quaternary Volcanic Modeling: Study of the Quaternary volcanic fields of the southern Cascades, including age dating and rock chemistry (OFR 83-7)

7/83 to 12/83: During the current fiscal year three more 500 ft. geothermal heat flow test wells will be drilled and tested in the Green River and Mt. Baker areas. Our studies of warm wells in the state in conjunction with W.S.U. will continue. The Wind River geology report will be finalized. The southern Cascades will be modeled using petrochemical data and residual gravity. Funding of the program will terminate with the release of a final report.
Figure 1. Geothermal Resources of Washington

- AREAS OF ASSESSMENT ACTIVITY
- VOLCANOES
B.(3) Energy Investigations - Oil & Gas

The geology division's role in the development of oil and gas data has been limited. There is no full-time professional on staff researching petroleum geology. However, we continue to provide consultation to energy companies and the U.S. Geological Survey through the services of Weldon Rau - biostratigrapher. After retirement, Weldon was retained on a 2 days per week personal services contract. His knowledge is invaluable to all our clients. As time allows, field work has continued in Grays Harbor County to produce geologic maps of areas with oil and gas potential. This work has been assisted by Carl McFarland.

During the last biennium Shell Oil Co. initiated deep drilling in the Columbia Basin. This started a leasing rush and caught the attention of the public and the legislature. To satisfy the need for up-to-date information on all wells drilled in the state, our comprehensive Information Circular on Oil & Gas Exploration in Washington was updated in 1981, went out of print, was further updated at the end of 1982 and reprinted.

Two reports containing results of original research have been completed during the last biennium. This work involves the identification of fossil faunal zones in sedimentary rocks in western Washington. Energy companies can use this knowledge to develop exploration targets in the state. One report on "Coastal Wells of Washington" was published by the Division and the other report, as part of a national program, was published by Oregon Department of Geology and Mineral Industries.

During the current biennium our level of service will remain the same. Weldon Rau's part-time activities will involve consultation to our publics, basic research in faunal correlation and completion of a geologic map of the Aberdeen area.
C. Columbia Basin Mapping

The Columbia Basin geologic mapping program was begun in 1981 at the request of the U.S. Department of Energy (USDOE) and their Hanford Reservation operating company, Rockwell Hanford Operations. Many areas in the Columbia Basin containing potentially important faults and folds were inadequately mapped. USDOE desired to upgrade geologic mapping in these areas and publish the results through a recognized publisher of geologic materials. These areas of faults and folds in the Columbia Basin are considered important because renewed movement on geologic structures might compromise the integrity of a future nuclear waste storage facility on the Hanford Reservation. In addition, the design of adequate "seismic hardening" in a waste storage facility cannot be done without information on the maximum likely earthquake that could be generated by renewed movement along faults or folds in the area.

The Columbia Basin mapping program has, to date, had a total budget of about $70,000, and areas mapped are listed below. It is probable that the contract will be extended beyond the original four years. All geologic mapping to date has been carried out by personal services contractors, mainly university professors, and personnel of Rockwell Hanford Operations.

Map Areas

- Ellensburg and Yakima Quadrangles. Published 1983. Bentley, Central Washington University, and Campbell, Yakima Valley College.


- Logy Creek, Poisel Butte, & Bluelight Quadrangles. Being mapped by Bentley and Campbell.

1984 - Yakima East and Black Rock Spring Quadrangles by Bentley and Campbell.
- Startup of cooperative agreement for USDOE/Rockwell mapping and Division printing of a series of 7½ minute geologic maps covering the Pasco Basin.
I. Introduction

The following plan sets out the basic schedule, organization, definition of tasks, work assignments, and budget for the upcoming State Geologic Map program. Many planning details remain to be formulated. Early committee and team meetings as well as map compilation work will identify and resolve these details.

The following materials are the result of many one-on-one discussions and at least three staff meetings which were held during the past year.

II. Organization

a. General Description

The state map project will be organized as shown below.

The purpose of using a state map committee and working teams instead of having one person in charge of all aspects of the project is to spread the workload and responsibility while still retaining consistent and high-quality products. Details on committee and team responsibilities, membership, etc., follow in later sections.
II. Organization (Cont.)

b. Files

The state map project is going to generate a large volume of data, correspondence, notes, and other information. If we use a committee and team approach, it will be very important to file these data in such a way that anyone or any group within the division can quickly learn about decisions made, compilation progress, involvement of "outside" geologists, status of field mapping and many other subjects by turning to the files. I propose a filing system using the following main headings.

Southwest Quadrant

State Map Committee
Nomenclature and Correlations Team
Structure Team
Analytical Data Team
Field Mapping Team
Cartography Team
Quaternary Geology Team

1:100,000 Sheets (by quadrangle name and responsible geologists)

This file structure will be repeated for each state map quadrant.

III. Responsibilities and Duties

a. State Geologist -- Has veto authority and may make mandatory suggestions. Serves as the "court of last resort" in resolving disputes and providing muscle to acquire geologic mapping and other forms of cooperation from outside individuals and organizations. Not involved in the day-to-day operations on the state map project.

b. State Map Committee -- Sets overall policies and procedures. Reviews and coordinates the actions of teams. Schedules activities, plans, and allocates resources. Assures overall uniformity, consistency and accuracy of work. Assigns remedial work if necessary. Keeps a complete file of actions and decisions and informs teams and geologists. Arranges for formal review of the 1:100,000 series as a whole. Prepares the explanation, legend, index of sources, and other materials to accompany the state map 1:250,000 quadrant by combining and simplifying the materials generated for the 1:100,000 sheets. During preparation of the 1:100,000 scale maps the state map committee serves as an oversight committee, but after that series is finished it serves as a working committee to produce the state map. Has authority to direct the actions of teams and, as necessary, individual geologists. Also responsible for liaison with other states and British Columbia. State Geologist will hold state map committee chairperson accountable for state map progress and other related matters.
III. Responsibilities and Duties (Cont.)

c. Library -- Librarian responsible for keeping up-to-date geologic map indexes on hand for the state map quadrant(s) being worked. Also serves as a publications resource person and will order materials as needed. Temporary helpers will be hired to help with the state map related workload if and when the need is clearly defined.

d. Teams

Common duties -- All teams are to serve as working groups within the subject areas implied by their names. They are responsible for reviewing work by individual geologists and insuring accuracy and consistency among the different 1:100,000 map sheets. Teams may direct the work of individual geologists when such direction regards matters for which policies and procedures have already been developed. In new subject areas teams are to develop and recommend courses of action to the state map committee. They may adjudicate disputes among geologists. They will keep complete files of decisions made and actions taken. They will transmit such information to the geologists and to the state map committee. All actions are subject to review by the state map committee. When the 1:100,000 series is finished for a quadrant teams go out of business and the state map committee takes over to guide production of the 1:250,000 map. Teams are expected to work together whenever their respective areas of responsibility overlap. They may choose to work together or be requested to work together by the state map committee.

1. Nomenclature and Correlations Team -- Reviews stratigraphic columns and descriptions of geologic units proposed by individual geologists for 1:100,000 sheets. Determines and assigns symbols for geologic units to be used on 1:100,000 sheets. Determines stratigraphic names to be used. Reviews and standardizes correlations of geologic units among 1:100,000 sheets. Plans and writes a stratigraphic column, description of map units, list of symbols, index map, and references for the 1:100,000 series as a whole (for SW quadrant). Uses materials submitted by geologists for each of the 1:100,000 sheets to do this. Reviews 1:100,000 sheets from the standpoint of stratigraphy.

The nomenclature and correlations team should be very active in feeding back to the geologists the information they will need to be sure that their 1:100,000 map sheets are accurate as to stratigraphic nomenclature and consistent in stratigraphic usage and correlation with other maps of the 1:100,000 series.

2. Structure Team -- Reviews literature for latest plate tectonic or other interpretations and mechanisms relating to Washington geology and geologic history. Acquires all pertinent geophysical data (aeromag., gravity, seismic, etc.) and remote sensing data (ERTS, SLAR, etc.). Reviews these data in a regional sense. Makes individual geologists aware of the existence of these data for their use in compiling 1:100,000 sheets. Formulates recommendations as to how the data and interpretations should be reflected in the state geologic map. Reviews 1:100,000 sheets for consistency and thrust (no pun intended) of structural data portrayed. Provides geologists with a preferred structural model against which they can evaluate and edit source geologic maps. This will be a sort of "think tank" team. The job will be difficult but I think necessary if the state map is to project some kind of uniform structural theme.
III. Responsibilities and Duties (Cont.)
d. Teams (Cont.)

3. Analytical Data Team -- Accumulates from our geologists and the literature all available data on rock geochemistry, radiometric dates, and dates from fossils. Evaluates and screens data and presents it in a standard tabular format. This is for easy reference by other state map team members and for possible publication. Reviews and prioritizes requests and proposals from geologists for age dating and rock geochemical work. Schedules in-house analytical work and recommends actions to state map committee regarding outside (commercial) analytical work. Develops written procedures and protocols for field sampling and documentation of age dating and geochemical samples.

4. Field Mapping Team -- Reviews and prioritizes proposals for field mapping by staff. Recommends mapping projects to state map committee. Develops and enforces field mapping standards (when is enough enough?). Reviews and evaluates field mapping. Sees that outside mappers who are mapping at the request of the division receive appropriate guidance and field visitation.

5. Cartography Team -- Develops map layout, design, and cartographic standards for 1:100,000 sheets and 1:250,000 state map quadrants. Schedules final drafting of maps. Acquires base maps and other related materials for geologists. Serves as liaison with state or outside printers. Reviews 1:100,000 sheets for conformance to design standards and cartographic accuracy. Assigns open-file report numbers to 1:100,000 sheets.

6. Quaternary Geology Team -- Develops overall strategy showing Quaternary geology at both 1:100,000 and 1:250,000 scales. Reviews compilations for consistency and accuracy and advises compilers on how to solve Quaternary geologic problems that may arise.

e. Geologists -- Acquire geologic map data including, in order of priority (1) published maps, (2) unpublished maps (mostly theses), (3) contributions from mappers whose work is in progress or finished but never released, (4) new mapping done by professors, graduate students, USGS, or others by arrangement with the division, either free or paid, and (5) mapping by division staff (generally yourself). Compile geology at 1:100,000 scale using scale-stable materials. Formulate stratigraphic column, description of map units, references, index map, age dates, dates from fossils, and geochemistry. Familiarize self with geology of your 1:100,000 sheet(s) on the ground by: (1) arranging ad hoc field trips with mappers who have worked in the area, (2) participating in organized field trips (GSA, for example), (3) self-led field trips, (4) conducting at least reconnaissance level geologic mapping where necessary, and/or (5) spending time in the field with mappers whose services the division has arranged. Use all pertinent geophysical and remote sensing data to help formulate structural interpretation to be portrayed on 1:100,000 sheets. Review professor and/or graduate student or other mapping proposals. Keep records of progress, problems, decisions, outside contacts, reviews, field trips, etc., and file in central files. Refer materials, as appropriate, to teams for review and incorporation into the full scheme of things. Arrange for outside review of your 1:100,000 sheet(s) or recommend outside reviewers. Propose correlations with adjoining 1:100,000 sheets. Accept direction from teams and state map committee.
III. Responsibilities and Duties (Cont.)

f. Spokane Office -- The Spokane Office will not initially work through such an elaborate organization as will the Olympia office. They will work directly through the state map committee and their primary responsibilities until June 30, 1985 will be to gather geologic data and compile 1:100,000 sheets. Identify areas that need work as early as possible. Special effort to acquire maps and make contact with investigators on Colville Reservation. After June 30, 1985, the organization outlined above will become operational in the NE quadrant, using accumulated data to get a head start. At that time the make-up of state map committee and teams will be changed as appropriate.

IV. Schedule

a. Fall and Winter 1983 to June 30, 1985 --

Compile 1:100,000 geologic maps and formulate an overall explanation, description of map units, etc., for SW quad. Open-file 1:100,000 sheets. Spokane office gathers data and compiles selected 1:100,000 sheets for NE quad.

During the late 1983 to June 30, 1985 time period, each geologist will need to accomplish the following tasks for each assigned 1:100,000 sheet:

1. Acquire available geologic data and make contact with mappers who have worked or are working in the area.
2. Formulate a preliminary stratigraphic column and description of units. Tabulate geochemical and age data.
3. Draw up a preliminary geologic compilation.
4. Become familiar with the geology of the area by field review.
5. Review available geophysical and remote sensing data as an aid in structural interpretation.
6. Do field mapping, age dating, and geochemistry as directed by state map committee and cognizant working teams.
7. Draw up 1:100,000 sheet for review.
8. Internal and external review.
9. Incorporate needed changes.
10. Cartographers draft final 1:100,000 map.
11. 1:100,000 sheet is open-filed.

These activities need not occur in the order given, and several may be worked on concurrently. Final open-file maps must pass from the geologists to the cartographers over at least a six month time period (January through June, 1985) in order to avoid a cartographic overload. It is the responsibility of each senior author to propose a schedule for each of their 1:100,000 sheets. Proposed schedules should be submitted to the State Map Committee by October 14, 1983.
IV. Schedule (Cont.)

b. June 30, 1985 to January 1, 1986 -- State Map Committee reduces and simplifies 1:100,000 sheets and explanatory material for SW quad. to 1:250,000 for publication.

c. June 30, 1985 -- Olympia geologic staff turns its attention, part time, to NE quad. New working teams and State Map Committee are named and new 1:100,000 sheets are assigned.

d. January 1 to March 31, 1986 -- Cartographic work on 1:250,000 state map SW quadrant.

e. January 1, 1986 -- Olympia geologic staff turns full attention to NE quad.

f. April 1, 1986 -- SW quad. to printers.

g. June 30, 1986 -- SW quad. printed and distributed.

V. 1:100,000 Quadrangle Assignments

a. 1:100,000 sheets, SW quad -- see attached map (Figure 1.) USGS 1:100,000 sheets that have recently been done will not be redone.

b. State Map Committee and Teams, membership:

1. State Map Committee:

   Eric, Chair
   Ray, ex-officio
   Bonnie
   Don
   Jerry

   Bill
   Mike
   Tim
   Weldon

   NOTE: Team leaders automatically become members of the state map committee.

2. Nomenclature and Correlations Team:

   Weldon, Leader
   Tim
   Laura

   Mike
   Bonnie

3. Structure Team:

   Tim, Leader
   Bonnie
   Hank

4. Analytical Data Team:

   Mike, Leader
   Bill

5. Field Mapping Team:

   Bill, Leader
   Josh

   Hank
   Keith S.
## State Geologic Map, Southwest Quadrant

### 1:100,000 Quadrangle Assignments

#### Figure 1

<table>
<thead>
<tr>
<th>Quadrangle</th>
<th>Senior Author</th>
<th>Junior Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copalis Beach, S1/2 Westport</td>
<td>Josh Logan</td>
<td>Tim Walsh</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hank Schasse</td>
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<td>Ilwaco</td>
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<td></td>
<td>Josh Logan</td>
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<tr>
<td>Shelton, S1/2</td>
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<td>Astoria</td>
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<tr>
<td>Centralia</td>
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<tr>
<td>Mount St. Helens Vancouver</td>
<td>Bill Phillips</td>
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</tr>
<tr>
<td>Snoqualmie Pass, S1/2</td>
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<td>Mount Rainier</td>
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<td>Mount Adams</td>
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<td>Hood River</td>
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<td>Wenatchee, SW1/2</td>
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<td>Yakima, W1/2</td>
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<tr>
<td>Toppenish, W1/2</td>
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<tr>
<td>Goldendale, W1/2</td>
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</table>

- **47°15'**
- **120°30'**
V. 1:100,000 Quadrangle Assignments (Cont.)

6. Cartography Team:

   Don, Leader
   Laura
   Keith I.

7. Quaternary Geology Team:

   Jerry, Leader
   Josh
   Keith S.

VI. FTE Allotments

The following estimated people months have been allotted to the state map project (Program 184):

<table>
<thead>
<tr>
<th>Name</th>
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<th>FY85</th>
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<tbody>
<tr>
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<tr>
<td>Bonnie</td>
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<td>Don</td>
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<td>Hank</td>
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<td>Keith S.</td>
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<td>Tim</td>
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<tr>
<td>Pam</td>
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   40.5 mo. 66 mo.

Mike, Josh, Bill, Hank, and Tim, the SW quad. 1:100,000 sheet compilers, will have a total of about 53 people-months to spend, exclusive of team and committee work, before June 30, 1985. With about 10.8 1:100,000 sheets in the SW quad, that works out to 4.9 people-months per 1:100,000 sheet.

VII. Budget

<table>
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<tr>
<td>Full time</td>
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<td>Temporary; Natural Resource Aides,</td>
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<tr>
<td>2 positions @ 3 mo. each/year</td>
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<td>Cartographer, 6 mo. @ $1,462/mo.</td>
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   subtotal $ 94,464 $164,949
VII. Budget (Cont.)

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<td>for Spokane Office</td>
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<td>USGS Cooperative Mapping;</td>
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<td>Increase motor pool</td>
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<td>Analyses (rock geochemistry)</td>
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<td>Age Dating</td>
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<td>Library materials</td>
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<td>K &amp; E Map Projector</td>
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<tr>
<td><strong>Benefits:</strong></td>
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<td><strong>TOTAL</strong></td>
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</table>

VIII. Description of Products

a. 1:100,000 sheets -- Open-file maps with explanation of map units, legend, index map of sources, references, and tabulated geochemistry, age dates, and dates from fossils. Each map will have its own explanation of map units (and stratigraphic column?), instead of using a standardized explanation. These will, of course, be consistent from map to map. Formations will be the fundamental map unit, with greater detail shown where map scale and geologic data permit. A "master" explanation will be formulated for the whole 1:100,000 series. This will serve as the starting point for the 1:250,000 map explanation and simplification of 1:100,000 sheet geologic data.
b. State Map Quadrant -- Each state map quadrant will, likewise, have its own explanation, formulated especially for it. We will, to be sure, coordinate the general scheme of colors, patterns, and symbols so that there will be consistency among the quadrants. Publication of each quadrant at 1:250,000 scale, in color, with accompanying sheet of explanation, sources, index map, references, and legend.

I have received a package of information from Charles Jennings regarding the California Division of Mines and Geology state mapping program. It contains much information of value to us. It is in the conference room for your perusal.
Prior to the last biennium the Environmental Geology Section at times had as many as six staff geologists, as well as professors and graduate students hired for special projects. In addition to our regular services as consultants on geohazards to the public and local and state agencies we engaged in geologic mapping and the production of various interpretive maps. Much of this mapping effort was supported by USGS, EPA, and USDOS grants. Loss of these grants, budget cuts, and shifting priorities have resulted in a current staff level of two geologists and curtailment of mapping activities. This staff reduction has been accompanied by a gradual increase in DNR needs for geotechnical services. This increase took a spurt with the disastrous debris avalanches resulting from the January 10, 1983 storm in Whatcom County. By the end of the biennium we were averaging the equivalent of about one full time position for DNR in-house consultation.

In-house consulting generally ranges from, for example, answering a geological question by phone to a field investigation and report. Some examples of the latter activities during the last biennium were:

- Lower Matheney Creek slide, waterhole study (Olympic Area)
- Stevenson slide, Norway Bluffs timber sale (SW Area)
- Touts Coulee slide (DNR - USFS) (NE Area)
- Ahtanum Creek road route evaluation (SE Area)
- Woodworth Pit slope stability (S. Puget Area)
- Bremer Mountain (Forest practices vs. domestic water) (Central Area)
- Camano (Forest practice), Lower Hathaway timber sale (NW Area)

In the process of these and other studies the Environmental Geology Section has consulted with (or for) the offices of Forest Land Management, Lands, the Attorney General, Engineering, Private Forestry and Recreation, and Timber Sales. Some in-house consulting, such as the Whatcom County storm damage study have (and will) require large blocks of time. In the latter case Jerry Thorsen has been working with DNR and insurance and timber company attorneys, and with a team of consultants in the field. Our total commitment here could approach a man year by the time all lawsuits are settled.

Our traditional role of providing surficial geology and geohazards information and advice to the public, government agencies, and consulting firms has shifted somewhat in response to manpower losses. For example, routine visits to selected county governments were discontinued during the last biennium when U.S. Geological Survey funding ran out. We continued to respond to specific requests for help from local governments as time permitted. Informal consulting services for other state agencies have continued, with most requests from Ecology and Parks. In addition we have worked closely with Emergency Services, mainly in relation to their seismic hazard responsibilities and possible FEMA grants.

Some long-term projects completed during the last biennium were the Mount St. Helens Videotape Archive, funded by a National Science Foundation grant, and a study of the petrography and geochemistry of the 1980 Mount St. Helens pyroclastic flow deposits. The former was completed in order to preserve valuable historic and scientific information on the Mount St. Helens eruption and has already been used by researchers. The latter was initiated to provide information on the evolution of eruptive activity on Mount St. Helens, information that may be useful in volcanic hazard mitigation planning. Plans for the Environmental Geology Section include participation in the new state geologic mapping project as well as continuing our traditional service functions. We will be working with Central Area on an extensive project to locate and evaluate quarry sites in the Capitol Forest. A current project with Private Forestry to help local managers recognize and evaluate slope stability should be completed soon. We hope to complete a booklet on earthquakes and faulting in the state in cooperation with the University of Washington and may compile a map of the landslides of the state if USGS funding materializes.
F. Library Services

The geological library was established by statute and now consists of 25,000 volumes pertaining to the geology and mineral resources of the state. The collection is managed by our Senior Librarian, Connie Manson. Beyond being merely an important resource for the Geology Division staff, the library is heavily used by corporations, the general public and state agencies. Since it is the most complete collection on the state's geology, academia are frequent users. During the last fiscal year (FY '83) there is a 65% increase in the use of our library by corporations and consulting firms. The register shows a 46% increase by federal and state agencies using our library. Library use is commonly combined with geological consultation.

The two principal functions of the librarian are the maintenance of the collection and the maintenance and publication of the indexes -- they go hand in hand -- neither can be fully utilized without the other.

Major Accomplishments, 1981-1983

a) The Bibliography and Index of the Geology and Mineral Resources of Washington, 1963-1980. Through a grant, we prepared the comprehensive 6000-item bibliography, as compiled and indexed on the GeoRef data base. We added almost 2000 citations previously unknown to GeoRef, and then fully re-edited their final citations to bring them to publication standard. This is now in press, with expected release in October 1983.


c) Theses on Washington Geology. This was first published in 1980, with annual updates in 1981, 1982, and 1983.

d) Special projects. The librarian prepares other works as needed. Recently, she has compiled two comprehensive map indexes: for the southwest and northeast quadrants of the state (in preparation for the state geologic map). In conjunction with the environmental section, an annotated bibliography on landslides of Washington and index to surficial mapping of the Puget Lowland was compiled.

Current and Future Projects, 1983-1985

a) Maintain the library and all the updates to the various indexes and bibliographies.

b) In August 1983, the Division received an IBM PC XT personal computer, to be used primarily in the library for the maintenance and publication of the various indexes and bibliography. Bill Phillips and Connie Manson have worked extensively on the design of this system. Bill is now completing the customized programming of the library systems.
The Geology and Earth Resources Division is responsible for implementation of the following laws: Surface Mined Land Reclamation Act (RCW 78.44/WAC 332.18); Oil & Gas Conservation Act (RCW 78.52/WAC 344.12); Geothermal Resources Act (RCW 79.76/WAC 332.17).

In the previous biennium the regulatory staff in Olympia consisted of two professionals and one clerk typist. By far, a large proportion of the workload consists of processing permits under the Surface Mined Land Reclamation Act. Currently there are 951 active permitted surface mines in the state. Enforcement and inspection is accomplished through DNR area offices. The program has been plagued with administrative problems. There were no consistent state wide procedures. This resulted in confusion within DNR and delays for companies.

The prime achievement in the mining program was the development of a "Surface Mining Permit Process and Responsibilities" flow chart. After review and discussion at two management meetings, the procedures were adopted department wide. The objective was to increase efficiency thus allowing for staff reduction in Olympia and more time for field inspections.

Even with the above improvements, it was felt that the intent of the legislature was not being carried out. Field inspections had fallen to less than one per year per permit. Therefore, going into the current biennium field FTE's were increased from 5.0 to 6.25.

Additional efficiency measures are being undertaken. Beginning in November, the operator will be billed by machine; he will also receive three copies of the annual report form (the billing and annual reclamation report have been combined on a single form). The only address on any of the forms will be the Area office involved eliminating many of our past problems. A time savings of 300 to 400 percent should result.

On May 13, 1983 the Federal Office of Surface Mining assumed regulatory authority over surface coal mines in the state. There is a desire by the industry to have the state assume primacy. During the current fiscal year states with such a program will be canvassed for advice. Extensive legislative action would be required to satisfy OSM.

Oil and gas activity has been fairly constant over the years with several wells being drilled each year. As exploration for hydrocarbons extends into areas with deep glacial or basalt cover, more applications are being received for permits to conduct shot hole seismic surveys and stratigraphic drilling. Guidelines have been developed on lead agency determination for SEPA between the Lands Division and the Geology Division.

An outstanding achievement of the last biennium is a major revision of the Oil & Gas Conservation Act of 1955. After many days of testimony before a select committee, the Senate and House Natural Resource Committees, and public workshops, Substitute Senate Bill 3483 was passed by the legislature and signed by the Governor. It too effect July 12, 1983. Although new rules and regulations were promulgated on July 1, 1982, during the current biennium additional changes will have to be made. The most significant of these will be the appointment of new members to the Oil & Gas Conservation Committee by the Governor.

There is nothing significant to report in the way of regulatory activities under the Geothermal Resources Act.
SURFACE MINING PERMIT PROCESS RESPONSIBILITIES

APPLICANT

STEP 1 File application packet and $25.00 fee with Area Office. ($25.00 fee does not apply to S.O.T.)
   A. Application (SRW RES-10-1991) including mining and reclamation plan
   B. Environmental checklist, unless other agencies have acted as lead agency and have made the final declaration.
   C. County or Municipality threshold determination if they are lead agency
   D. County or Municipality approval (SRW RES-10-1992) (SRW not required of S.O.T. permits)
   E. Authorization from landowner if other than applicant
   F. Copies of County or other permits if applicable

STEP 2 Upon receipt of application packet submitted by applicant.
   A. If incomplete or inadequate, return to applicant with notice of deficiencies.
   B. Check RWS system for any alerts.
   C. If there are alerts, write appropriate agency for their comments.
   D. Make an inspection of site and complete an IML, noting any alerts found in the RWS system.
   E. Upon completion of inspection and reclamation plan acceptance, the bond amount is set. Applicant is advised and supplied with bond forms. (No bond required for state and local agencies.)

STEP 3 Furnish bond (not required of counties or state agencies).

STEP 4 Send complete packet (including original of bond) to the Olympia-Geology office.
   (Olympia will issue permit and enter information into computer.)

STEP 5 Review application:
   A. If incomplete or inadequate, notify Area.
   B. Secure approval of the bond from Attorney General.
   C. Prepare a declaration of significance or non-significance, based on the environmental checklist and inspection report.
   D. If a declaration of significance is necessary, notify the applicant and the Area that the EIS is needed.
   E. If a declaration of non-significance is made, a copy of the proposed declaration with a copy of the environmental checklist is sent to Operations Research who will complete the EROS process by posting the declaration with checklist with other agencies that may be involved. (No declaration will be made if another agency acted as lead agency.)

STEP 6 Upon receipt of permit, operations may begin.

STEP 7 Annual billing and annual inspection (SRW RES-19-2561) are sent to the operator 30 days prior to the anniversary date of the permit.

STEP 8 Annual requirements:
   A. Pay $25.00 annual fee.
   B. Fill out annual inspection (SRW RES-19-1991) and send to Area.

STEP 9 Upon receipt of the annual report and annual fee:
   A. Inspect site
   B. If more than 30 acres was disturbed in preceding 12 month period, obtain $5.00 per acre for each acre over 30 in addition to the $25.00 basic fee.
   C. If mining has been completed on any segment of permit area for 2 years or more and reclamation is not begun, the operator and area of his intentions for the future must be reported to the Area that an EIS is needed.
   D. If mining has been completed on any segment of permit area for 2 years or more, the operator and area of his intentions for the future must be reported to the Area that an EIS is needed.
   E. If mining has been completed on any segment of permit area for 2 years or more, the operator and area of his intentions for the future must be reported to the Area that an EIS is needed.

STEP 10 Check annual inspection (SRW RES-19-2561) and annual payment and log any changes onto computer.

ÓLYMPIA-GEOLoGY OFFICE

STEP 11 Upon completion or cessation of mining and reclamation, operator advises Area.

STEP 12 Upon notification of termination by the operator, the Area will inspect the site to ensure reclamation is complete in accordance with the permit.
   A. If reclamation is not satisfactory, Area advises operator in writing of deficiencies with a copy to Olympia-Geology.
   B. If reclamation is satisfactory, Area advises Olympia.

STEP 13 Geology terminates permit, releases Bond, advises Financial Services and makes changes on computer.

NOTE:
A. Letters or phone calls concerning problems received by Olympia will be referred to Areas for response. Areas will send copies of correspondence concerning problem to Olympia-Geology.
B. Bond cancellation notices will be acknowledged by Geology and then sent to the Area. Area will determine if change to bond amount is required and advise the operator to supply a new bond.
C. Areas will maintain complete files on systems.
D. Copies of permits, correspondence and billings will be sent to Areas.
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* Mt. St. Helens information - free pamphlets

** Mt. St. Helens slide sets - 2,505 sold
### GEOLOGY & EARTH RESOURCES DIVISION
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**FY 82 and FY 83**

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-32-
SO WHAT'S THE WORTH OF A GEOLOGIC REPORT?

In a recent article, Arthur A. Socolow, state geologist of Pennsylvania, has taken a look at criteria for measuring the worth of geological publications (Pennsylvania Geology, v. 13, no. 5, October 1982).

With his permission, we are reprinting his thought-provoking article.

Recently a highly dedicated watchdog of space and dollars suggested we dispose of our stock of published geologic reports because many of them are more than two years old. People who publish are supposed to know that it's all over for a book after a year and a half. I tried to explain that while Pennsylvania has undergone numerous geological upheavals over the millions of years, our geological reports would still be valid and useful after several decades. Our efficiency expert didn't give up. How come, said he, most of the geologic reports we have issued only sell 20 to 50 copies a year—how important can they be?

Good question: How important is a geologic report? How much is the report worth if it enables the highway department to pick a route that saves millions of dollars in construction costs? What's the value if the report identifies the location of mineral deposits needed to provide lime for the farmers, clay for the brickmakers, or coal for the steel industry? To justify its existence, how many copies of a geologic map must be sold which shows the location of geologic faults hazardous to nuclear power plants, and the location of sinkholes hazardous to schools and dams? How do you assess the value of a geologic report which identifies the location of groundwater needed to locate a new glass factory employing hundreds, or a sprawling, new multimillion dollar bottling operation? If our reports lead to natural gas occurrences that heat our homes, and dam sites that keep them from being flooded, must we sell as many copies as Gone With the Wind to justify their existence? Among those who tunneled the Turnpike, designed routes 80 and 81, engineered the renewal of Philadelphia, developed water wells for thirsty Lehigh, Bucks, and Chester Counties, rehabilitated the stripped lands of Western Pennsylvania, none of those eager users of our geologic reports were less thankful because the reports were done 10 years ago and the sale of the publications did not make the Times' best seller list.

To those who concern themselves over cost benefit ratios, turnover, and timeliness, we who issue geologic reports say: Rest easy. Be assured the value of the report is not measured by its $4.75 price (plus tax); nor does its 1962 date relegate it to the uselessness of a vintage phone book; nor does its annual sale of 47 copies measure real need. Whether they provide mineral raw materials for our industries, locate the waters needed for our survival, identify the geologic hazards that can ruin us, or assist the roadbuilders, farmers, and recreation planners, our geologic reports measure up well to the test of time and value.

Arthur A. Socolow
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<td>&quot;Geologic Map of the Ellensburg Quadrangle&quot;</td>
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" " 82-6  "Low Temperature Geothermal Resource and Stratigraphy of Portions of Yakima County"
" " 83-1  "Principal Facts and a Discussion of Terrain Correction Methods for the Complete Bouguer Gravity Anomaly Map of the Cascade Mountains"
" " 83-2  "Geophysical Logs from Water Wells in the Yakima Area"
" " 83-3  "Landslides of Washington - An Annotated Bibliography through 1982"
" " 83-4  "Preparation of Residual Gravity Maps for the Southern Cascade Mountains, WA using Fourier Analysis"

Popular Publications Reprinted:
Bulletin 69  "Silver Occurrences of Washington"
Inf. Circ. 33  "Fossils of Washington"
Inf. Circ. 57  "Handbook for Gold Prospectors in Washington"

Papers Presented at:
Northwest Mining Association
Geological Society of America

Cooperative publication
Oregon Dept. of Geology and Mineral Industries
Oil & Gas Investigation 7

Miscellaneous publications
Publications List
Newsletter (quarterly)
Informational pamphlets
GEOLOGY OF THE
WENATCHEE AND MONITOR QUADRANGLES,
CHELAN AND DOUGLAS COUNTIES, WASHINGTON

By
Randall L. Gresens

BULLETIN 75

1983
OIL AND GAS EXPLORATION IN WASHINGTON
1900-1981

By
Carl R. McFarland
OIL AND GAS EXPLORATION IN WASHINGTON, 1900–1982

By
Carl R. McFarland

1983
A CROSS SECTION OF A NEVADA-STYLE THRUST
IN
NORTHEAST WASHINGTON

By
J. R. SNOOK,
H. E. LUCAS,
and
M. J. ABRAMS

1981
COASTAL WELLS OF WASHINGTON

By
GEOLOGY OF THE PULLMAN, MOSCOW WEST, COLTON, AND UNIONTOWN 7 1/2 MINUTE QUADRANGLES, WASHINGTON AND IDAHO

By

PETER R. HOOPER AND GARY D. WEBSTER

Prepared in cooperation with U.S. Department of Energy Contract DE-AC06-81RL10297

1982
STATE OF WASHINGTON
DEPARTMENT OF NATURAL RESOURCES
Brian Boyle, Commissioner of Public Lands
Art Stearns, Supervisor

DIVISION OF GEOLOGY AND EARTH RESOURCES
Raymond Lasmanis, State Geologist

GEOPHYSICAL MAP GM-27

COMPLETE BOUGUER GRAVITY ANOMALY MAP,
CASCADE MOUNTAINS, WASHINGTON

By
Z.F. DANES AND W.M. PHILLIPS

Prepared in cooperation with
U.S. Department of Energy
Contract DE-AC03-79ET27014

1983

For sale by the Department of Natural Resources
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DIVISION OF GEOLOGY AND EARTH RESOURCES
RAYMOND LASMANIS, State Geologist

GEOLOGIC MAP GM-28

GEOLOGIC MAP OF THE
ELLENSBURG QUADRANGLE, WASHINGTON

By
R. D. BENTLEY AND NEWELL P. CAMBELL

Prepared in cooperation with
U.S. Department of Energy
Contract DE-AC06-81-R10297

1983
GEOLOGIC MAP GM-29

GEOLOGIC MAP OF THE
YAKIMA QUADRANGLE, WASHINGTON

By
R. D. BENTLEY AND NEWELL P. CAMPBELL

Prepared in cooperation with
U.S. Department of Energy
Contract DE-AC06-81-RL10297

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BIBLIOGRAPHIES OF THE GEOLOGY AND VOLCANIC HAZARDS
OF THE CASCADE RANGE VOLCANOES OF WASHINGTON AND MOUNT HOOD, OREGON

by

James G. Rigby

Open-File Report 81-5

August 1981
PRELIMINARY REPORT ON THE GEOLOGY OF THE GRANDE RONDE LIGNITE FIELD, ASOTIN COUNTY, WASHINGTON

by

Keith L. Stoffel

Open-File Report 81-6

September 1981
STATE OF WASHINGTON
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND EARTH RESOURCES
OLYMPIA, WASHINGTON 98504

THE LOW TEMPERATURE GEOTHERMAL RESOURCE
OF THE YAKIMA REGION - A PRELIMINARY REPORT

by

John H. Biggane

Open-File Report 81-7

September 1981
PRELIMINARY REPORT
ON
HEAT-FLOW DRILLING IN WASHINGTON DURING 1981

by

J. Eric Schuster and Michael A. Korosec

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

Open-File Report 81-8
November, 1981
The Low Temperature Geothermal Resources of Eastern Washington

Open File Report 82-1

by,
Michael A. Korosec
William M. Phillips
J. Eric Schuster

Prepared under U.S. Department of Energy Contract DE-AC07-79ET27014

Division of Geology and Earth Resources
Department of Natural Resources
Olympia, Washington
May, 1982
WELLTHERM:
TEMPERATURE, DEPTH, AND GEOTHERMAL GRADIENT DATA FOR WELLS IN WASHINGTON STATE

BY
Michael A. Korosec
and
William M. Phillips

OPEN FILE REPORT 82-2

Department of Natural Resources
Division of Geology and Earth Resources
Olympia, Washington

June 1982
Table of Chemical Analyses for Thermal and Mineral Spring and Well Waters Collected in 1980 and 1981

by

Michael A. Korosec

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

Open File Report 82-3
June, 1982

Prepared Under U.S. Department of Energy Contract
No. DE-AC07-79ET27014
ANALYSES AND MEASURED SECTIONS OF WASHINGTON COALS

by

William M. Phillips,

Timothy J. Walsh,

and

Henry W. Schasse

Open File Report 82-5

Washington Division of Geology and Earth Resources

July 1982
The Low-Temperature Geothermal Resource
and Stratigraphy of Portions of Yakima County, Washington

by

John Biggane

Prepared for
Washington State Department of Natural Resources
Under Contract No. DE-AC07-79ET27014
with the U.S. Department of Energy

Washington Division of Geology and Earth Resources
Open File Report 82-6

Geological Engineering Section
Washington State University
Pullman, Washington
July 30, 1982

WSU College of Engineering Research Report 82/15-7
PRINCIPAL FACTS AND A DISCUSSION OF TERRAIN CORRECTION METHODS FOR THE COMPLETE BOUGUER GRAVITY ANOMALY MAP OF THE CASCADE MOUNTAINS, WASHINGTON

by

Z. F. Danes
and
William M. Phillips

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

Open-File Report 83-1

February 1983
GEOPHYSICAL LOGS FROM WATER WELLS IN THE
YAKIMA AREA, WASHINGTON

by

John H. Biggane
Washington State University
College of Engineering
Geological Engineering Section
Pullman, WA 99164

Logs include: Natural gamma, gamma gamma, neutron neutron,
neutron gamma, caliper, fluid temperature, fluid resistivity,
wall resistivity, spontaneous potential, and flow meter.

This report accompanies: Biggane, J. H., 1981, The low-
temperature geothermal resource of the Yakima region - a
preliminary report: Washington Division of Geology and

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

Open-File Report 83-2
1983

This report was prepared under U.S. Department of Energy Contract No. DE-
AC07-79ET27014
LANDSLIDES OF WASHINGTON — AN ANNOTATED BIBLIOGRAPHY
THROUGH 1982

By
Connie J. Manson and Gerald W. Thorsen

In cooperation with the U.S. Geological Survey
1983
PREPARATION OF RESIDUAL GRAVITY MAPS FOR THE SOUTHERN CASCADE MOUNTAINS, WASHINGTON USING FOURIER ANALYSIS

by

Debra McLean Dishberger

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

Open-File Report 83-4

April 1983
SILVER OCCURRENCES

of

WASHINGTON

By Wayne S. Moen

WASHINGTON DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND EARTH RESOURCES
BULLETIN NO. 69
1976
FOSSILS IN WASHINGTON

By

VAUGHN E. LIVINGSTON, JR.

1959

Reprinted 1983
HANDBOOK FOR GOLD PROSPECTORS
IN
WASHINGTON

By

WAYNE S. MOEN and MARSHALL T. HUNTTHING

1975
Reprinted 1983
WASHINGTON'S COAL — HISTORY AND FUTURE DEVELOPMENT POTENTIAL

by

Raymond Lasmanis, State Geologist

and

Henry W. Schasse, Geologist

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

Presented at the 88th Annual
Northwest Mining Association Convention
Spokane, Washington
December 11, 1982
RANK OF EOCENE COALS IN WESTERN AND CENTRAL
WASHINGTON STATE: A REFLECTION OF CASCADE PLUTONISM?

WALSH, Timothy J.; and PHILLIPS, William M., Washington Department
of Natural Resources, Division of Geology and Earth Resources,
Olympia, WA 98504

Coal rank, ranging from lignite to anthracite, is contained in lower
to upper Eocene strata of Washington. The coals crop out or are known
from mine workings in the eastern and western foothills of the Cascade
Mountains. Distribution of coal rank in six coalfields of the region
was determined using trend-surface analysis of fixed carbon (dry, min-
eral-matter free) and BTU (volatile, mineral-matter free) data from fresh,
underground mine samples. For the Roslyn and Centralia-Chehalis fields,
rank data are from single, areally extensive seams. For the Whatcom
County, Newcastle, Green River, and Wilkeson-Carbonado fields, data are
from stratigraphic sequences up to 1.2 km thick. Results of trend-
surface analysis were similar for all fields: coal rank increases sys-
tematically toward the crest of the Cascades. On both flanks of the
Cascades, zones 15-25 km wide are present in which lateral coal-rank
gradients increase sharply toward the mountain crest. Within these
zones, coal rank is independent of structural trends and stratigraphic
position and rank gradients of up to 1.5% fixed carbon/km are observed.
Patterns of coal rank distribution imply sharply greater burial
depths and/or higher geothermal gradients during burial time for Eocene
sediments close to the Cascades. From Eocene through Miocene time,
the Cascade range was the locus of igneous activity resulting in em-
placement of numerous plutons and accumulation of 5-8.5 km of volcanic
rocks. We propose that high regional geothermal gradients induced by
Eocene-Miocene Cascade plutontes upgraded coal rank throughout much of
the coal-bearing Eocene section of western and central Washington, well
beyond the previously recognized extent of the Cascade thermal aureole.
This model has important implications for fossil fuel exploration and
interpretation of fission-track dates in the region.

Host: Department of Geology and Geophysics
University of Utah
Salt Lake City, Utah

May 2-4, 1983
Salt Palace Center
Salt Lake City, Utah

Volume 15, Number 5, March 1983
STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
1005 State Office Building
Portland, Oregon 97201

in cooperation with

WASHINGTON DEPARTMENT OF NATURAL RESOURCES,
GEOLOGY AND EARTH RESOURCES DIVISION

OIL AND GAS INVESTIGATION 7

CORRELATION OF CENOZOIC STRATIGRAPHIC UNITS
OF WESTERN OREGON AND WASHINGTON

Project Coordinators:

J. M. Armentrout
Mobil Oil Corporation

D. A. Hull and J. D. Beaulieu
Oregon Department of Geology and Mineral Industries

and

W. W. Rau
Washington Department of Natural Resources,
Geology and Earth Resources Division

Conducted in conformance with ORS 516.030

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