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GEOLOGY AND EARTH RESOURCES DIVISION
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STATE OF WASHINGTON
DEPARTMENT OF
NATURAL RESOURCES

Brian Boyle
Commissioner of Public Lands

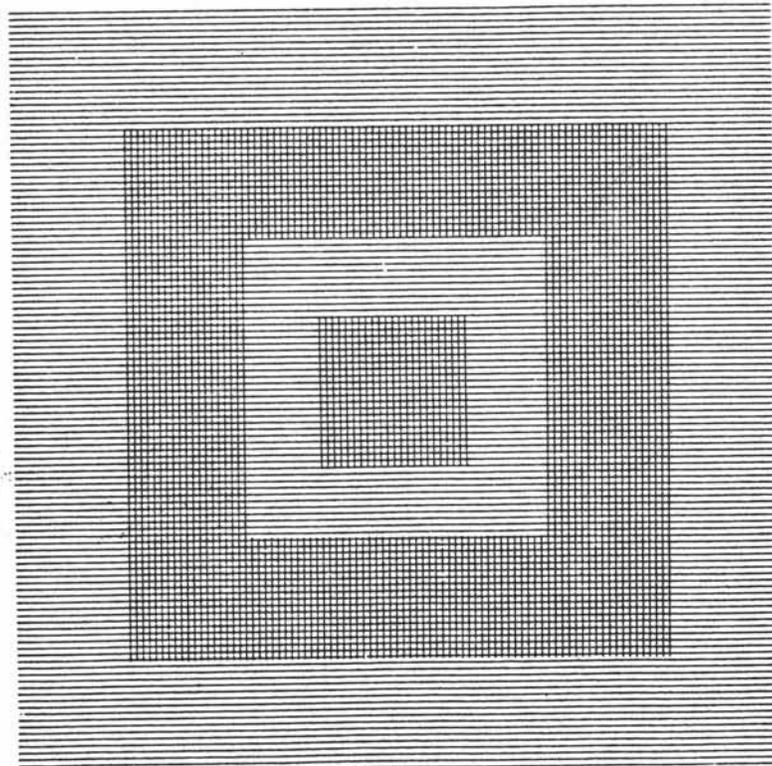
Art Stearns
Supervisor

DIVISION OF GEOLOGY AND EARTH RESOURCES
RAYMOND LASMANIS, State Geologist

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
1957-1971 — Marshall T. Huntting, 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

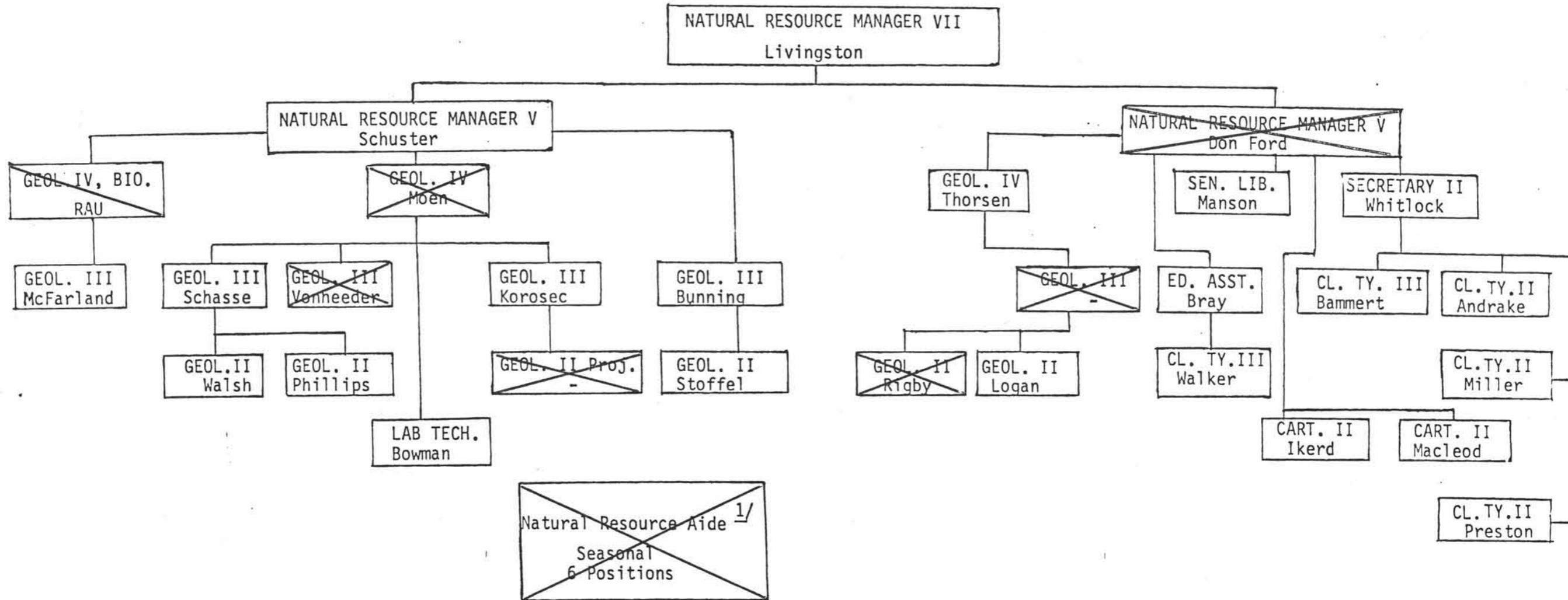
STAFF LEVELS - HISTORICAL

	<u>FY 1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>
Professional	15	15	15	17	18	17	13	11	12
Technical	3	3	3	4	4	4	4	4	4
Non-Technical	5	5	5	5	6	6	6	6	6
Division TOTAL	23	23	23	26	28	27	23	21	22
Field FTE's	?	?	5.0	5.4	7.3	7.3	5.0	5.0	6.25
Program TOTAL	?	?	28.0	31.4	35.3	34.3	28.0	26.0	28.25

DEPARTMENT OF NATURAL RESOURCES, DIVISION OF GEOLOGY AND EARTH RESOURCES

ORGANIZATION CHART

OCTOBER 1981



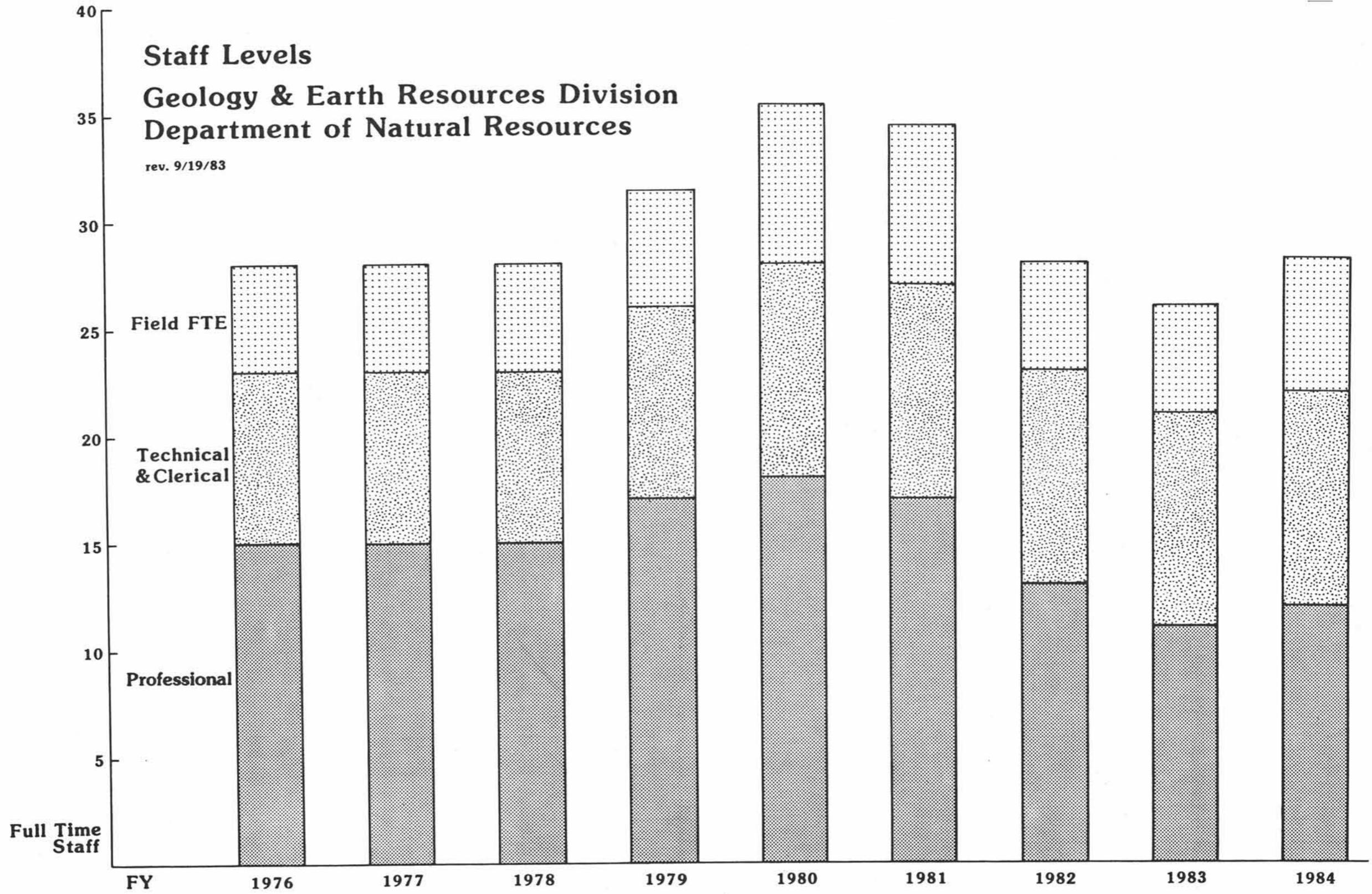
1/ Level and number of positions will vary with project and budget requirements.

Staff Levels

Geology & Earth Resources Division

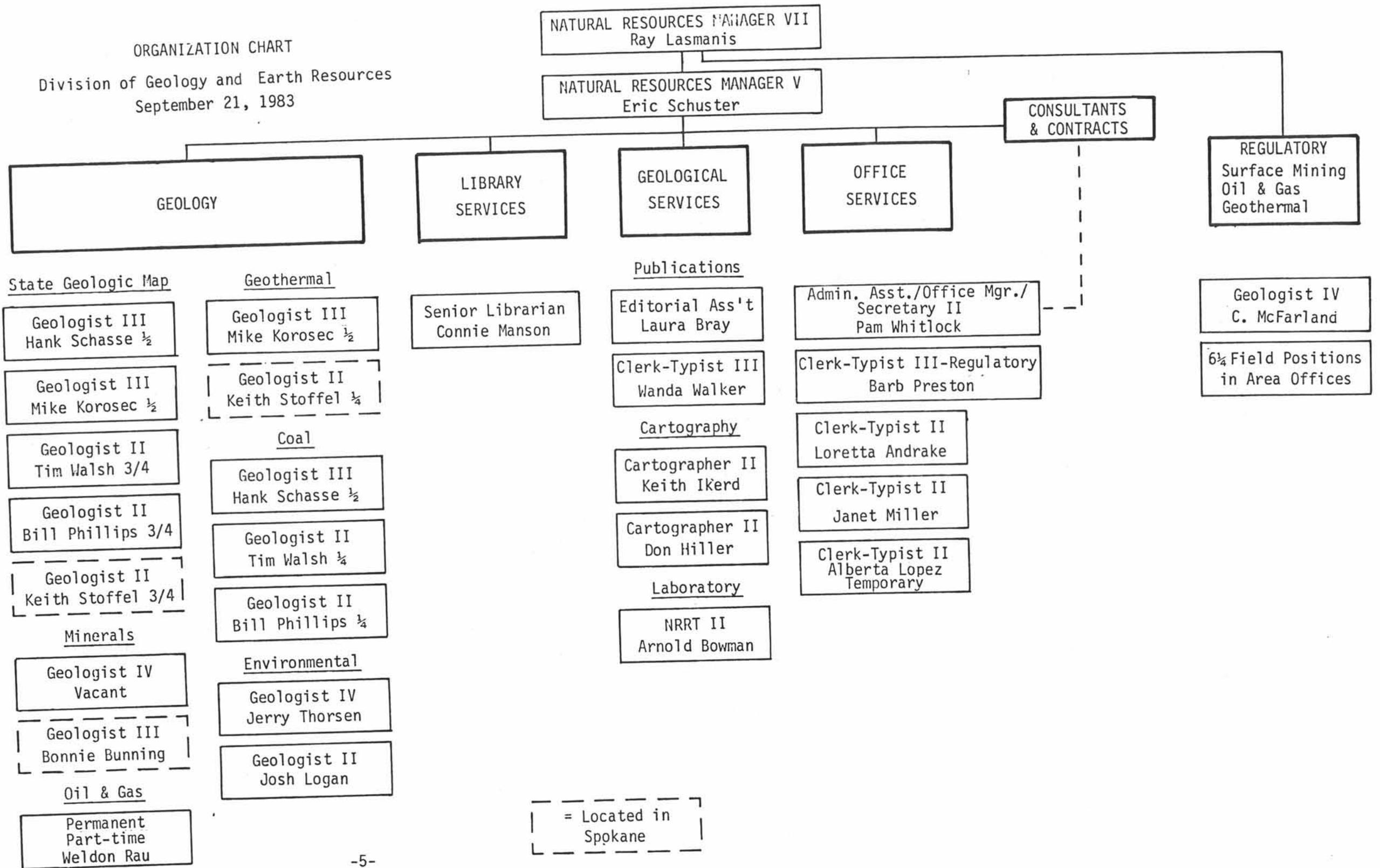
Department of Natural Resources

rev. 9/19/83



ORGANIZATION CHART

Division of Geology and Earth Resources
September 21, 1983



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 Andrade - 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

	<u>Fiscal Years</u>							Est. 1984	
	1976	1977	1978	1979	1980	1981	1982		1983
General State Funds	473,237	684,483	785,613	742,681	991,511	1,035,484	972,890	1,003,985	1,234,044
Federal Funds & Grants	146,444	105,632	103,838	110,727	374,133	352,812	221,808	71,917	76,442
Industry Funds	0	0	0	0	0	0	5,000	7,058	0
TOTAL FUNDS	619,681	790,115	889,451	853,408	1,365,644	1,388,296	1,199,698	1,082,960	1,310,486

EXPENDITURES BY FUNCTION

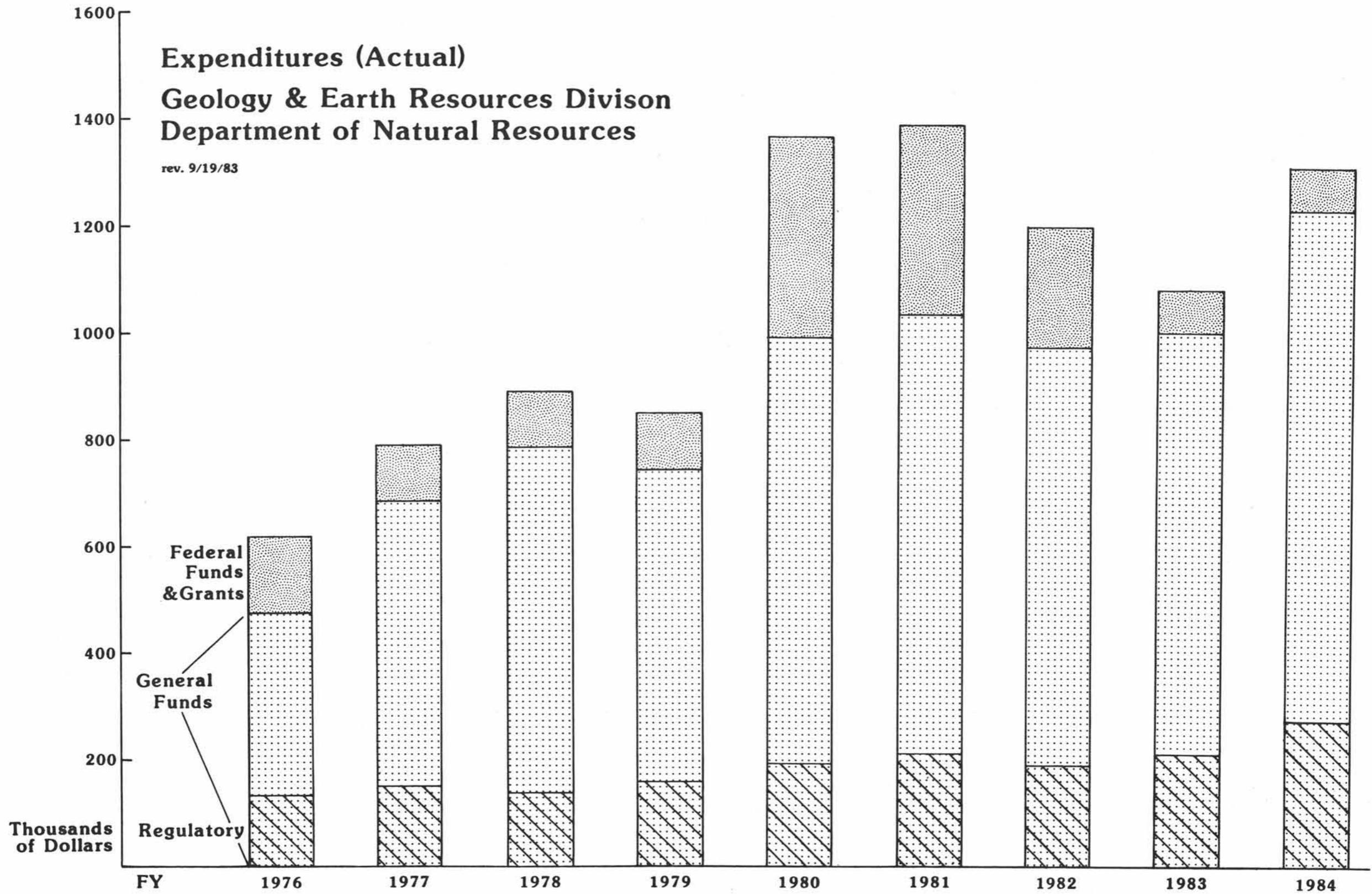
Geology/ Geothermal/etc.	482,734	639,454	750,973	694,909	1,172,355	1,174,106	1,011,146	868,822	1,034,933
Regulatory	136,947	150,661	138,478	158,499	193,289	214,190	188,552	214,138	275,553

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

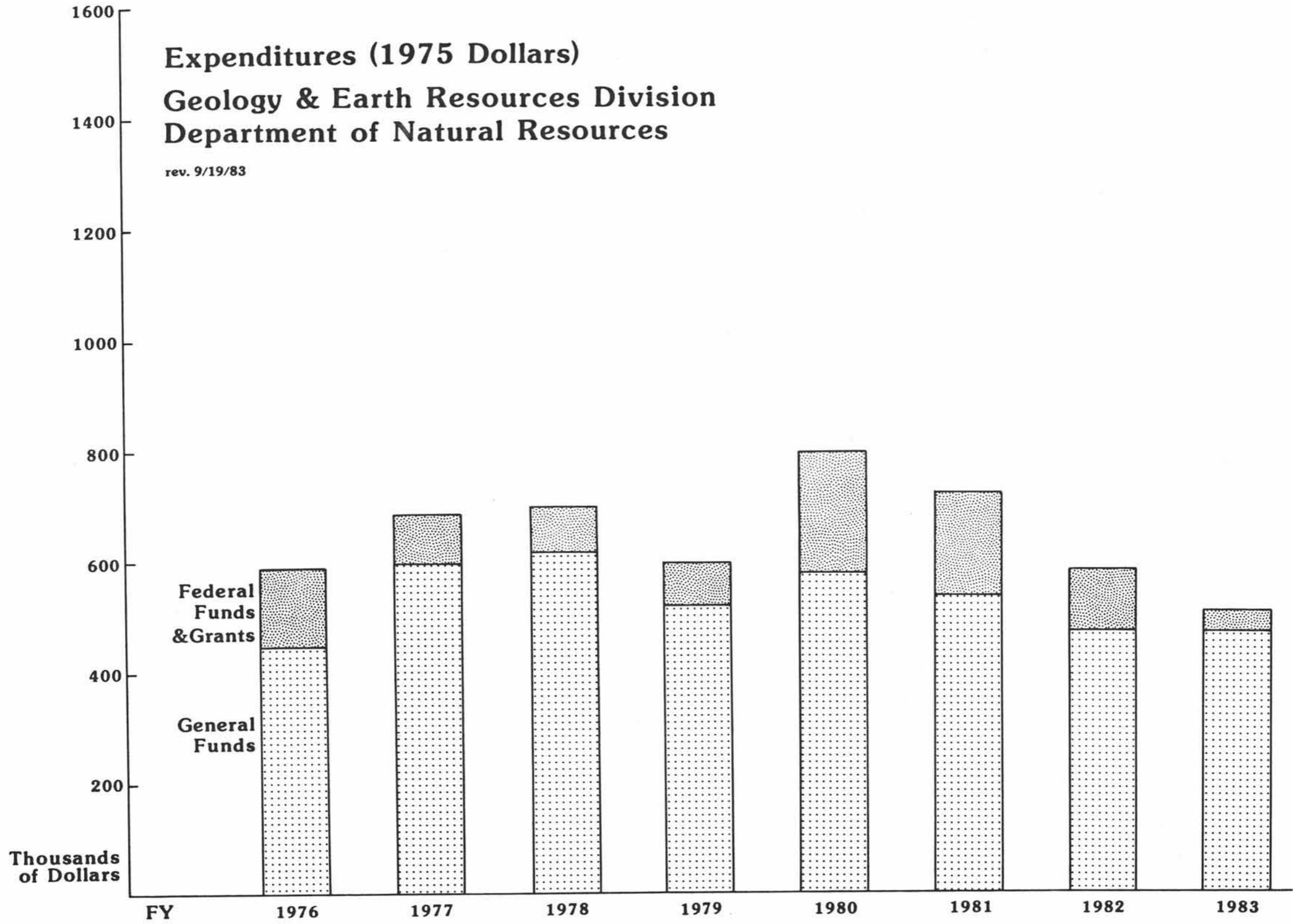
Expenditures (Actual)
Geology & Earth Resources Divison
Department of Natural Resources

rev. 9/19/83



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

rev. 9/19/83



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.

B.(2) Geothermal Exploration Program

7/81 - 7/83

- 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.
- WELLTHERM: 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.

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

- 1981 - "Pullman" Quadrangle. Published 1982. Hooper & Webster, Washington State University.
 - Ellensburg and Yakima Quadrangles. Published 1983. Bentley, Central Washington University, and Campbell, Yakima Valley College.
- 1982 - "Clarkston" Quadrangle. In preparation. Hooper & Webster.
 - "Harrah", "Toppenish", & Granger Quadrangles. Mapping finished. Bentley & Campbell.
- 1983 - "Anatone" Quadrangle. North half being mapped by Hooper & Webster. South half by Steve Reidel, Rockwell.
 - Logy Creek, Poisel Butte, & Bluelight Quadrangles. Being mapped by Bentley and Campbell.
 - Klickitat Quadrangle. Being mapped by Jim Anderson, U.S. Geological Survey.
- 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 7 1/2 minute geologic maps covering the Pasco Basin.

E. STATE GEOLOGIC MAP

September 22, 1983

I. Introduction

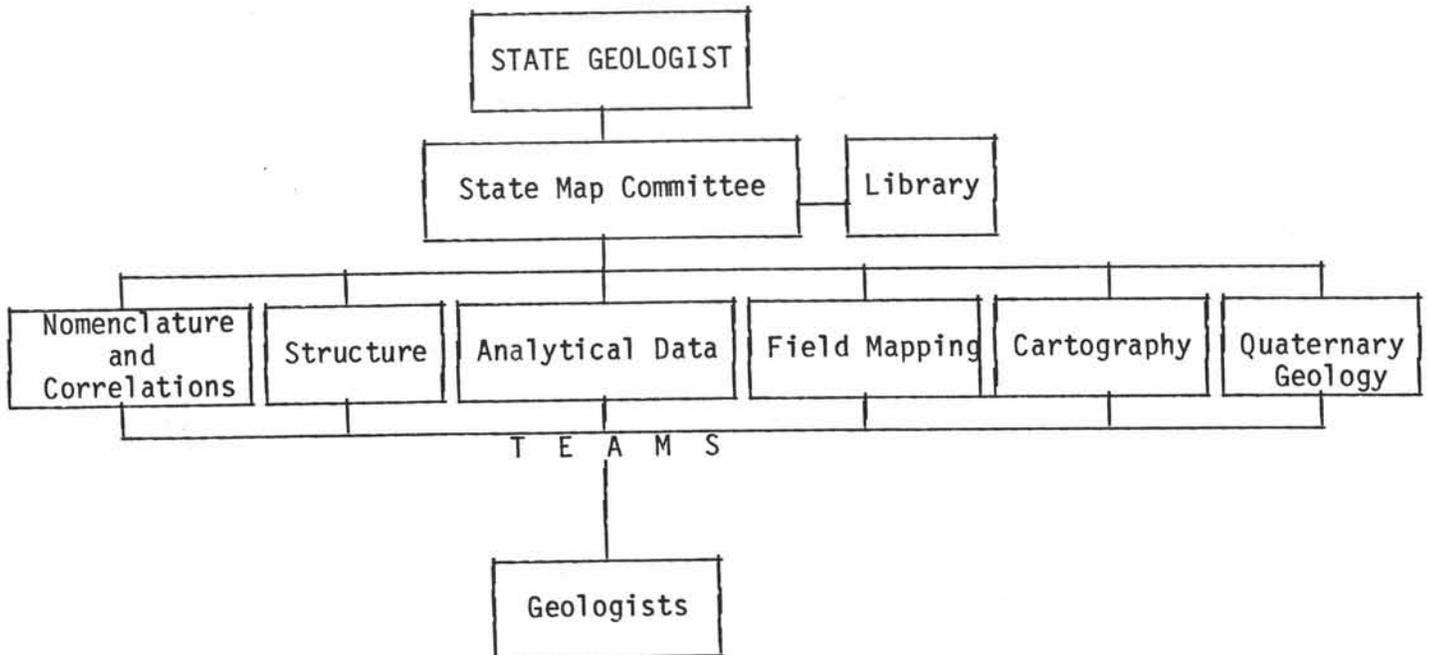
The following plan sets out the basic schedule, organization, definition of tasks, work assignments, and budget for the upcoming State Geologic Map program. Many planning details remain to be formulated. Early committee and team meetings as well as map compilation work will identify and resolve these 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 for 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	Bill
Ray, ex-officio	Mike
Bonnie	Tim
Don	Weldon
Jerry	

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

2. Nomenclature and Correlations Team:

Weldon, Leader	Mike
Tim	Bonnie
Laura	

3. Structure Team:

Tim, Leader
Bonnie
Hank

4. Analytical Data Team:

Mike, Leader
Bill

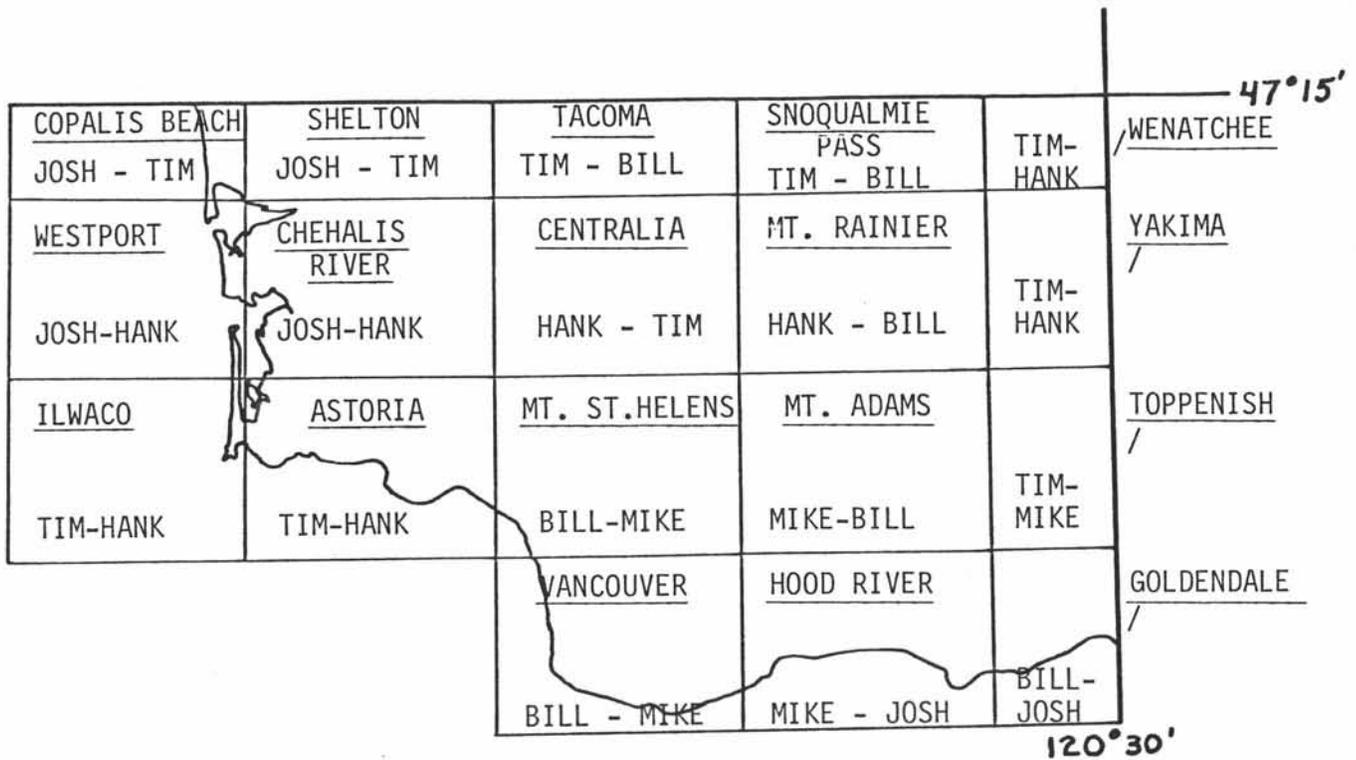
5. Field Mapping Team:

Bill, Leader	Hank
Josh	Keith S.

STATE GEOLOGIC MAP, SOUTHWEST QUADRANT

1:100,000 QUADRANGLE ASSIGNMENTS

Figure 1



<u>QUADRANGLE</u>	<u>SENIOR AUTHOR</u>	<u>JUNIOR AUTHOR</u>
Copalis Beach, S $\frac{1}{2}$ Westport	Josh Logan " "	Tim Walsh Hank Schasse
Ilwaco Shelton, S $\frac{1}{2}$	Tim Walsh Josh Logan	Hank Schasse Tim Walsh
Chehalis River Astoria	Josh Logan Tim Walsh	Hank Schasse " "
Tacoma, S $\frac{1}{2}$ Centralia	Tim Walsh Hank Schasse	Bill Phillips Tim Walsh
Mount St. Helens Vancouver	Bill Phillips " "	Mike Korosec " "
Snoqualmie Pass, S $\frac{1}{2}$ Mount Rainier	Tim Walsh Hank Schasse	Bill Phillips " "
Mount Adams Hood River	Mike Korosec " "	Bill Phillips Josh Logan
Wenatchee, SW $\frac{1}{4}$ Yakima, W $\frac{1}{2}$	Tim Walsh " "	Hank Schasse " "
Toppenish, W $\frac{1}{2}$ Goldendale, W $\frac{1}{2}$	Tim Walsh Bill Phillips	Mike Korosec Josh Logan

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):

<u>Name</u>	<u>FY84</u>	<u>FY85</u>
Laura	1	2
Bonnie	4	6
Don -----	1	3
Keith I.	1	3
Mike	4	8
Ray -----	1	1
Josh	3	3
Connie	1	1
Bill-----	6	7
Weldon	2	2
Hank	3	9
Eric-----	3	4
Keith S.	4	6
Wanda	0	1
Tim -----	6	9
Pam	<u>0.5</u>	<u>1</u>
	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

<u>Item</u>	<u>FY 84</u>	<u>FY 85</u>
Salaries:		
Full time	\$ 87,444	\$149,157
Temporary;		
Natural Resource Aides,		
2 positions @ 3 mo. each/year	7,020	7,020
Cartographer,		
6 mo. @ \$1,462/mo.	--	<u>8,772</u>
subtotal	\$ 94,464	\$164,949

VII. Budget (Cont.)

<u>Item</u>	<u>FY 84</u>	<u>FY 85</u>
Contracts:		
Graduate student mapping	\$ --	\$ 30,000
Clerical and cartographic assistance for Spokane Office	665	1,335
USGS Cooperative Mapping; Geologic	10,000	10,000
Topographic	<u>10,000</u>	<u>10,000</u>
subtotal	\$ 20,665	\$ 51,335
Goods and Services:		
Goods and services, general	\$ 25,744	\$ 42,842
Printing increase	10,000	10,000
Increase motor pool	5,000	5,000
Analyses (rock geochemistry)	2,000	5,000
Age Dating	2,000	6,000
Library materials	<u>1,000</u>	<u>1,000</u>
subtotal	\$ 45,744	\$ 69,842
Travel:		
Per Diem	\$ 4,000	\$ 4,000
Equipment:		
K & E Map Projector	\$ 8,000	\$ --
Benefits:	<u>\$ 18,187</u>	<u>\$ 30,659</u>
TOTAL	\$ 191,060	\$ 320,785

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.

VIII. Description of Products (Cont.)

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.

D. Environmental Geology

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 USDOE 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 Matheny 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.
- b) Index to Geologic and Geophysical Mapping of Washington. This was first published in early 1981, with annual updates in 1981 and 1982. The new cumulated edition is now in press, with expected release early in 1984.
- 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.

G. Regulation

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 took 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

AREA

OLYMPIA-GEOLOGY OFFICE

Application Process

- STEP 1** File application packet and \$25.00 fee with Area Office. (\$25.00 fee does not apply to D.O.T.) ^{1/}
- A. Application (SM2 RES-10-2001) 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 (SM6 RES-10-2002) (SM6 not required on D.O.T. permits) ^{2/}
 - E. Authorization from landowner if other than applicant
 - F. Copies of County or other permits if applicable
- ^{1/} D.O.T. submits an annual report and fee covering all sites used during the past year.
- ^{2/} D.O.T. has assumed lead agency status on their permits.

- STEP 2** Area reviews application packet submitted by applicant.
- A. If incomplete or inadequate, return to applicant with note of deficiencies.
 - B. Check AIMS system for any alerts.
 - C. If there are alerts, write appropriate agency for their comments.
 - D. Make an inspection of site and complete an SMB, noting any alerts found in the AIMS 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 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 an 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 SEPA process by posting the declaration and checklist with other agencies that may be involved. (No declaration will be made if another agency acted as lead agency.)
 - F. After the declaration and checklist have been posted for 15 days, and after considering comments received, Geology issues the final declaration.
 - G. Permit, with applicable conditions, is issued and copies are distributed, and the information is typed into the computer.

- 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.)

Operation Process

- STEP 6** Upon receipt of permit, operations may begin.

- STEP 9** Upon receipt of the annual report and annual fee:
- A. Inspect site
 - B. If more than 10 acres was disturbed in preceding 12 month period, obtain \$5.00 per acre for each acre over 10 in addition to the \$25.00 basic fee. This applies only in the year it was disturbed and does not carry over to the next year.
 - C. Determine if permit or plan need modification and notify operator accordingly.
 - D. If mining has been completed on any segment of permit area for 2 years or more and reclamation has not begun, notify operator and ask of his intentions for the future (in those pits large enough for progressive reclamation). If operations are suspended for more than 6 months, contact the operator in writing to determine future plans. If no plans or operation abandoned, send letter to operator advising of the need to complete reclamation within 2 years after cessation of mining.
 - E. Send annual inspection (SM7 RES-90-1501) to Olympia-Geology office.

- STEP 7** Annual billing and annual inspection (SM7 RES-90-1501) 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 (SM7 RES-90-1501) and sent to Area.

- STEP 10** Check annual inspection (SM7 RES-90-1501) and annual payment and log any changes onto computer.

Termination Process

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

- STEP 12** When notified 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 problems to Olympia-Geology.
- B. Bond cancellation notices will be acknowledged by Geology and then sent to the Area. Area will determine if change in bond amount is required and advise the operator to supply a new bond.

- C. Areas will maintain complete tickle systems.
- D. Copies of permits, correspondence and billings will be sent to Areas.

GEOLOGY & EARTH RESOURCES DIVISION

PUBLICATIONS DISTRIBUTED

	<u>FY 1976</u>	<u>1977</u>	<u>1978</u>	<u>1979*</u>	<u>1980**</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>
FREE	11,087	10,214	11,179	27,806	13,282	18,993	19,398	14,580
COMPLIMENTARY	6,244	2,746	2,890	1,224	3,334	3,902	3,207	3,346
SOLD	6,805	4,719	4,697	5,325	7,445	5,013	4,572	5,788

* Mt. St. Helens information - free pamphlets

** Mt. St. Helens slide sets - 2,505 sold

GEOLOGY & EARTH RESOURCES DIVISION
VISITORS - CONSULTATION, LIBRARY, PUBLICATIONS

FY 82 and FY 83

	<u>FY '82</u>			<u>FY '83</u>		
	Private Individuals	Corporate, Assoc. Cons. Firms	Gov't, Fed, state, local	Private Individuals	Corporate, Assoc. Cons. Firms	Gov't, Fed, state, pvt.
July	16	10	7	0	12	3
August	25	12	6	0	16	10
September	19	13	11	0	35	11
October	9	9	0	0	21	15
November	23	19	1	0	9	2
December	24	10	12	0	6	1
January	0	11	2	3	10	8
February	0	15	9	2	20	8
March	0	12	2	2	25	11
April	0	15	9	0	33	18
May	0	7	3	29	26	5
June	0	6	7	33	16	9
	<u>116</u>	<u>139</u>	<u>69</u>	<u>69</u>	<u>229</u>	<u>101</u>
					+65%	+46%
		TOTALS	<u>324</u>		TOTALS	<u>399</u>

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

GEOLOGY & EARTH RESOURCES DIVISION

PUBLICATIONS

1981 - 1983 Biennium

Bulletin 75	"Geology of the Wenatchee and Monitor quadrangles, Chelan and Douglas Counties"
Inf. Circ. 67R	"Oil and Gas Exploration in Washington, 1900-1981"
" " 74	"The Mineral Industry of Washington - Highlights of its Development 1853-1980"
" " 75	"Oil and Gas Exploration in Washington 1900-1982"
Rept. of Inv. 25	"A Cross Section of a Nevada-Style Thrust in North-east Washington"
" " " 26	"Coastal Wells of Washington"
Geol. Map 25	"Geothermal Resources of Washington"
" " 26	"Geology of the Pullman, Moscow West, Colton, and Uniontown 7½ min. Quadrangles"
" " 27	"Complete Bouguer Gravity Anomaly Map, Cascade Mountains"
" " 28	"Geologic Map of the Ellensburg Quadrangle"
" " 29	"Geologic Map of the Yakima Quadrangle"
O.F. Rept. 81-5	"Bibliographies of the Geology & Volcanic Hazards of the Cascade Range Volcanoes"
" " 81-6	"Preliminary Report on the Geology of the Grande Ronde Lignite Field, Asotin County"
" " 81-7	"Low Temperature Geothermal Resource of the Yakima Region"
" " 81-8	"Heat Flow Drilling in Washington During 1981"
" " 82-1	"Low Temperature Geothermal Resources of Eastern Washington"
" " 82-2	"Welltherm: Temperature, Depth, and Geothermal Gradient Data for Wells in Washington State"
" " 82-3	"Table of Chemical Analyses for Thermal and Mineral Spring and Well Waters Collected in 1980 and 1981"

- O.F. Rept. 82-4 "Directory of Washington Mining Operations - 1980-1981"
 " " 82-5 "Analyses and Measured Sections of Washington Coals"
 " " 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

WASHINGTON
DIVISION
OF
GEOLOGY AND EARTH RESOURCES

Raymond Lasmanis, State Geologist

GEOLOGIC PUBLICATIONS

STATE OF WASHINGTON
DEPARTMENT OF NATURAL RESOURCES
Brian J. Boyle, Commissioner of Public Lands
Russell W. Cahill, Supervisor

1982

STATE OF WASHINGTON
DEPARTMENT OF NATURAL RESOURCES
BRIAN J. BOYLE, Commissioner of Public Lands
ART STEARNS, Supervisor

DIVISION OF GEOLOGY AND EARTH RESOURCES
RAYMOND LASMANIS, State Geologist

**GEOLOGY OF THE
WENATCHEE AND MONITOR QUADRANGLES,
CHELAN AND DOUGLAS COUNTIES, WASHINGTON**

By

Randall L. Gresens

BULLETIN 75

1983

STATE OF WASHINGTON
DEPARTMENT OF NATURAL RESOURCES

BRIAN J. BOYLE, Commissioner of Public Lands
RUSSELL W. CAHILL, Supervisor

DIVISION OF GEOLOGY AND EARTH RESOURCES
VAUGHN E. LIVINGSTON JR., State Geologist

INFORMATION CIRCULAR 67R

OIL AND GAS EXPLORATION IN WASHINGTON
1900-1981

By

Carl R. McFarland



1981

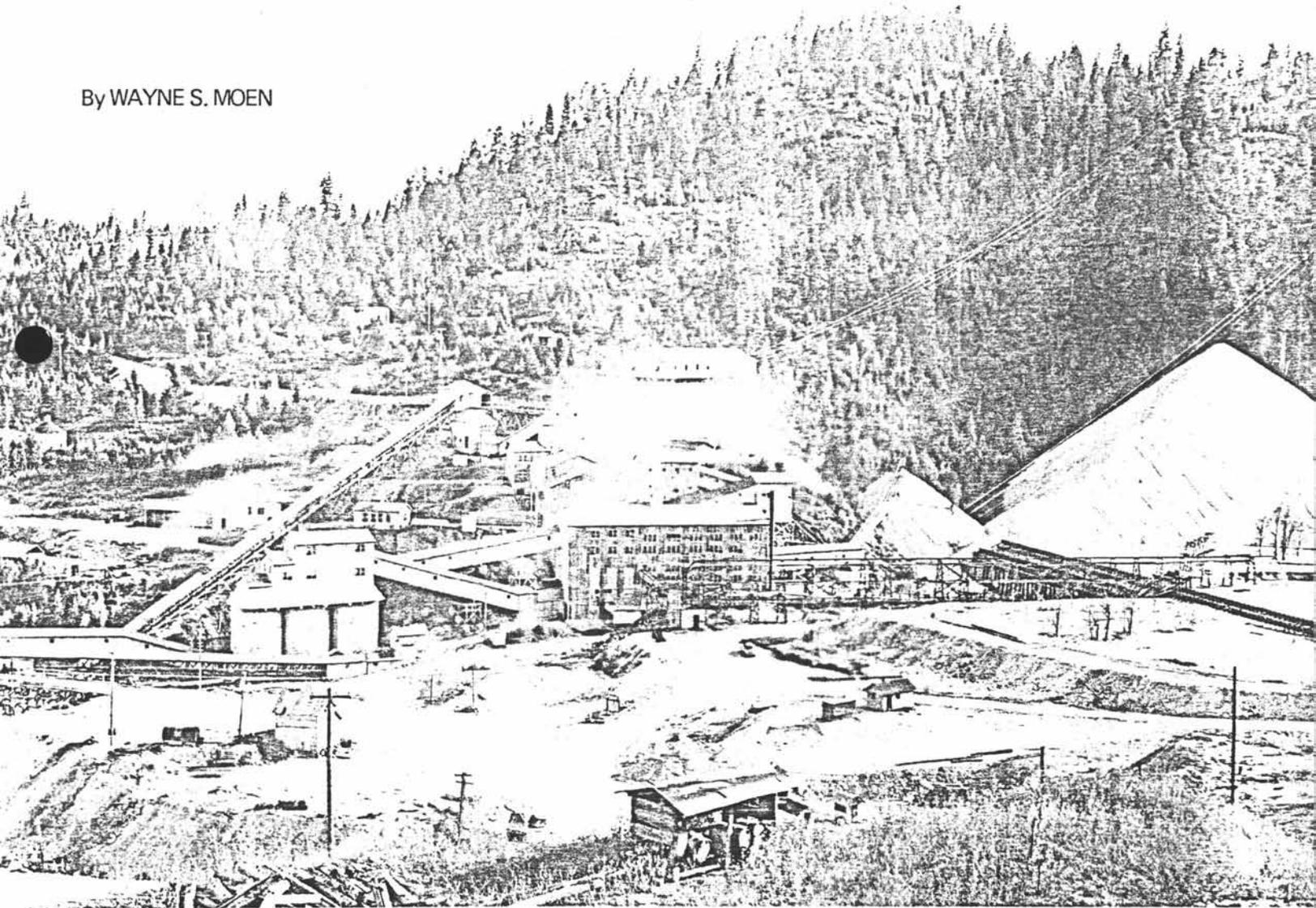
STATE OF WASHINGTON
DEPARTMENT OF NATURAL RESOURCES

BRIAN J. BOYLE, Commissioner of Public Lands
RUSSELL W. CAHILL, Supervisor

DIVISION OF GEOLOGY AND EARTH RESOURCES
RAYMOND LASMANIS, State Geologist

THE MINERAL INDUSTRY OF WASHINGTON - HIGHLIGHTS OF ITS DEVELOPMENT, 1853 - 1980

By WAYNE S. MOEN



INFORMATION CIRCULAR 74

Prepared through the cooperation of the U.S. Bureau of Mines

1982

STATE OF WASHINGTON
DEPARTMENT OF NATURAL RESOURCES

BRIAN J. BOYLE, Commissioner of Public Lands
ART STEARNS, Supervisor

DIVISION OF GEOLOGY AND EARTH RESOURCES
RAYMOND LASMANIS, State Geologist

INFORMATION CIRCULAR 75

OIL AND GAS EXPLORATION IN WASHINGTON,
1900-1982

By
Carl R. McFarland

1983

STATE OF WASHINGTON
DEPARTMENT OF NATURAL RESOURCES

BRIAN J. BOYLE, Commissioner of Public Lands

RUSSELL W. CAHILL, Supervisor

DIVISION OF GEOLOGY AND EARTH RESOURCES

VAUGHN E. LIVINGSTON JR., State Geologist

REPORT OF INVESTIGATIONS

25

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

By

J. R. SNOOK,

H. E. LUCAS,

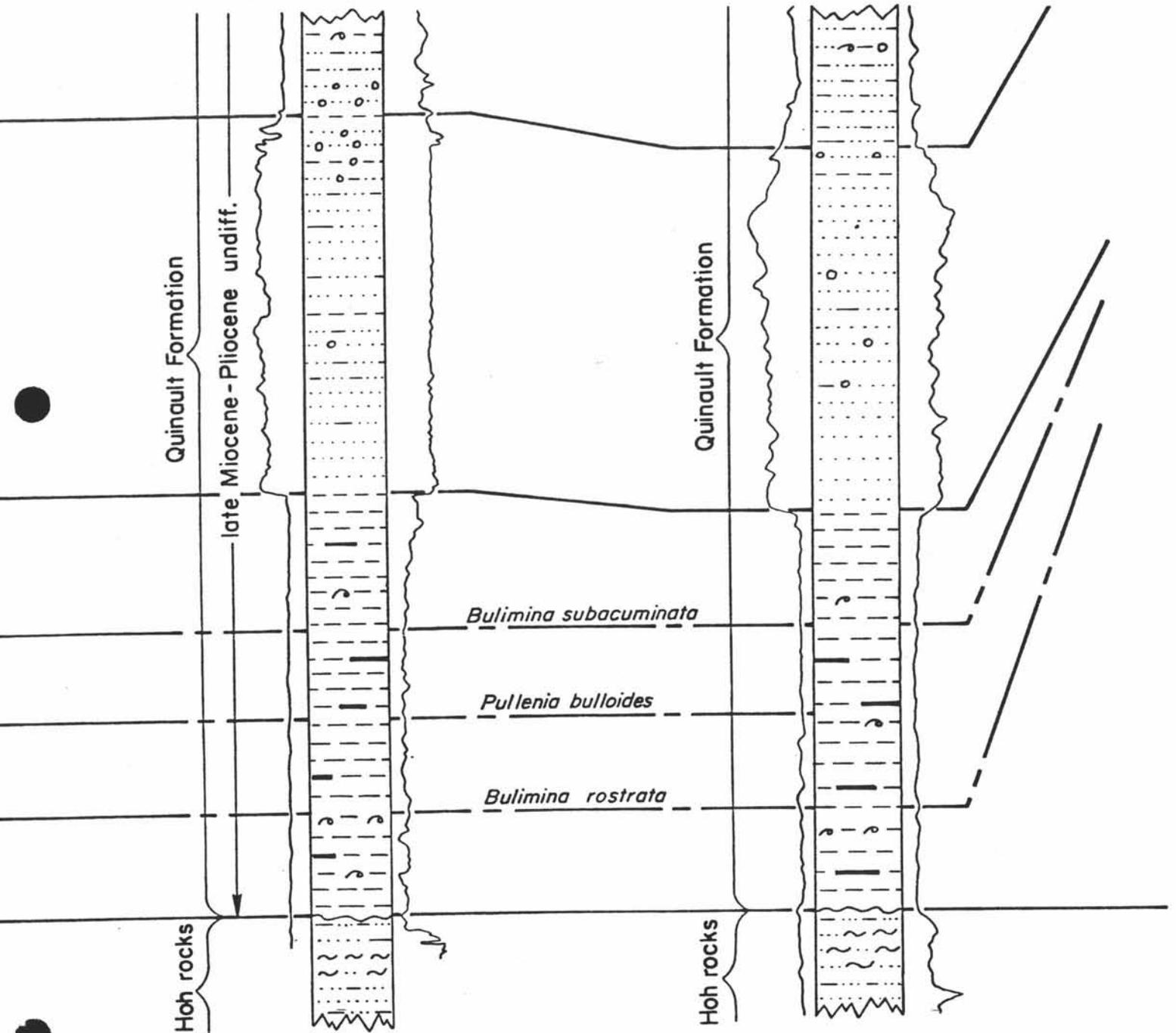
and

M. J. ABRAMS

1981

For sale by Department of Natural Resources, Olympia, Washington
Price .50¢

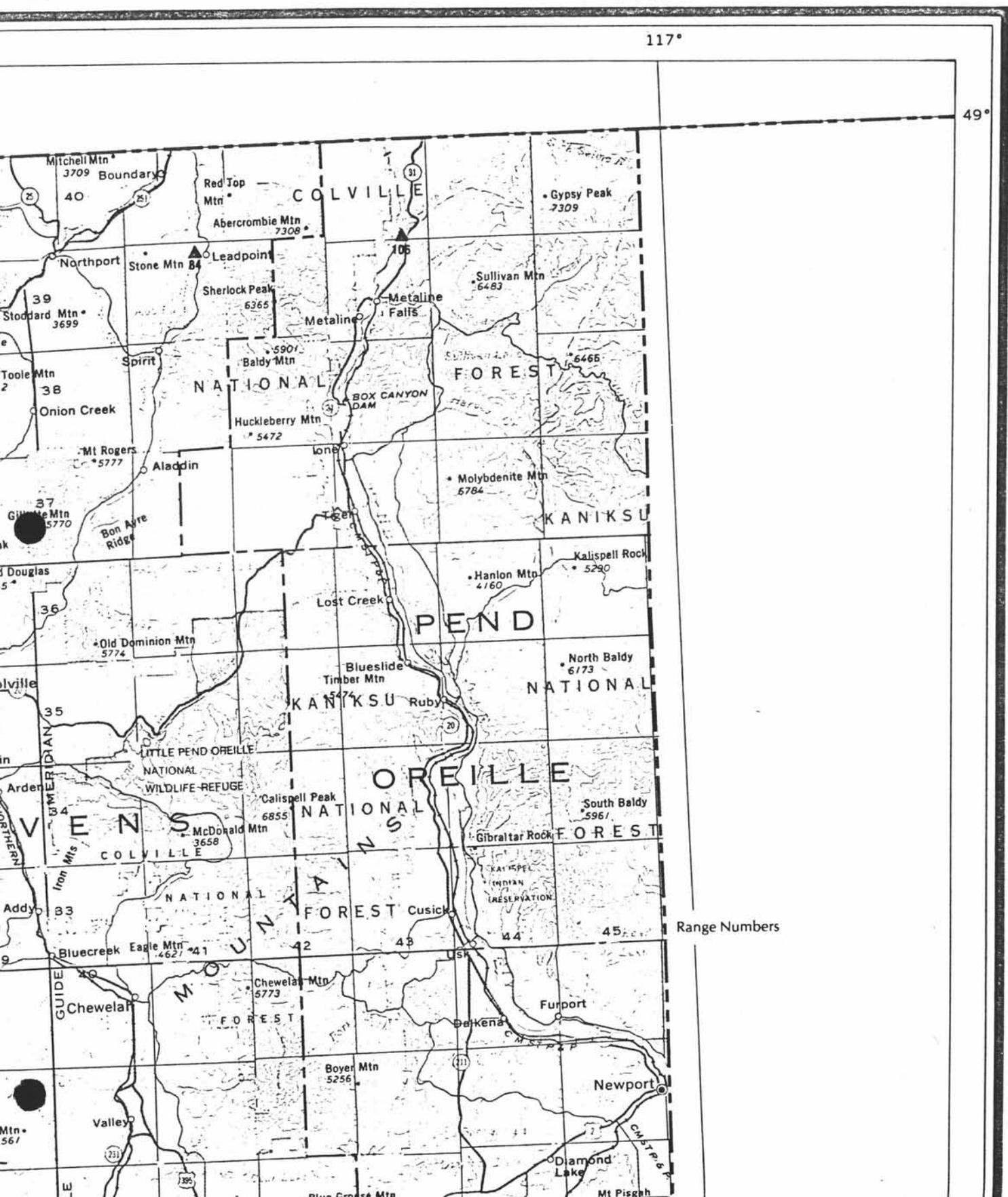
REPORT OF INVESTIGATIONS 26



COASTAL WELLS OF WASHINGTON

Geothermal Resources of Washington

1981



STATE OF WASHINGTON
DEPARTMENT OF NATURAL RESOURCES

Brian Boyle, Commissioner of Public Lands

Russell W. Cahill, Supervisor

DIVISION OF GEOLOGY AND EARTH RESOURCES

GEOLOGIC MAP GM-26

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

By

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COMPLETE BOUGUER GRAVITY ANOMALY MAP,
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Prepared under U.S. Department of Energy Contract
DE-AC07-79ET27014

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Prepared Under U.S. Department of Energy Contract

No. DE-AC07-79ET27014

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Washington State Department of Natural Resources

Under Contract No. DE-AC07-79ET27014
with the U.S. Department of Energy

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Geological Engineering Section
Washington State University
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FOR THE COMPLETE BOUGUER GRAVITY ANOMALY MAP OF THE
CASCADE MOUNTAINS, WASHINGTON

by
Z. F. Danes^v
and
William M. Phillips

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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
Earth Resources Open-File Report 81-7.

Washington Department of Natural Resources
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1983

This report was prepared under U.S. Department of Energy Contract No. DE-
AC07-79ET27014

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PREPARATION OF RESIDUAL GRAVITY MAPS FOR THE
SOUTHERN CASCADE MOUNTAINS, WASHINGTON
USING FOURIER ANALYSIS

by

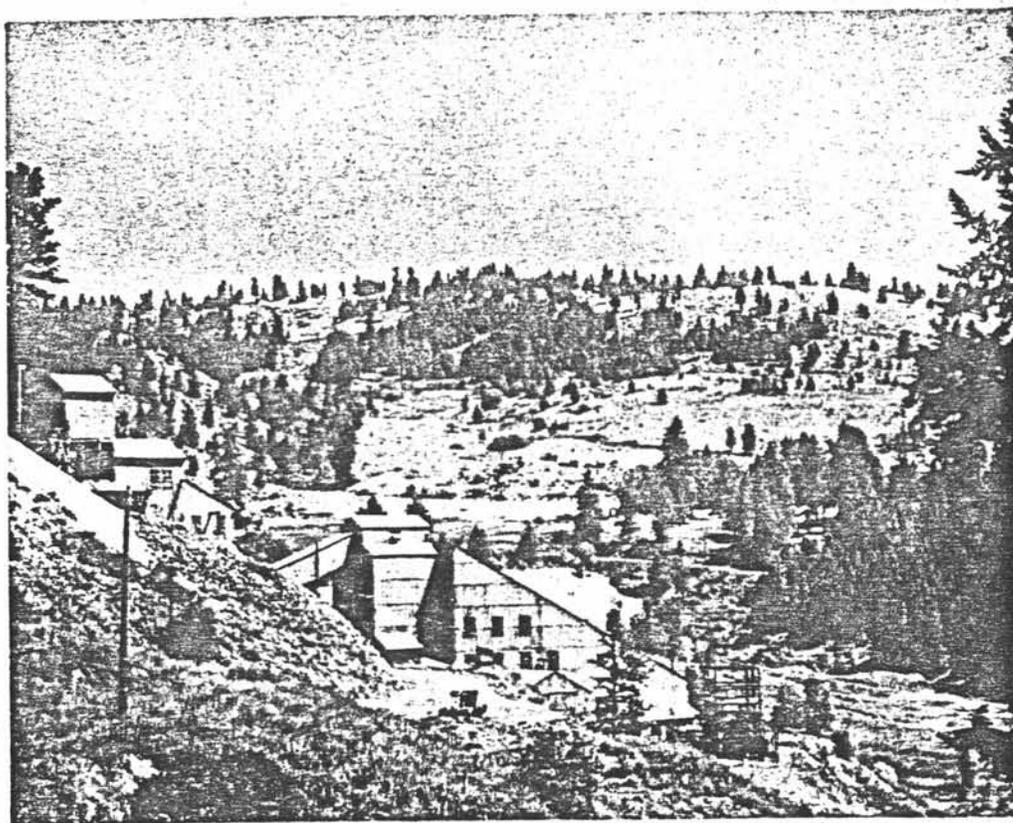
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Henry W. Schasse, Geologist

Washington Department of Natural Resources
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Olympia, Washington 98504

Presented at the 88th Annual
Northwest Mining Association Convention
Spokane, Washington
December 11, 1982

ABSTRACTS with PROGRAMS 1983



36th Annual Meeting ROCKY MOUNTAIN SECTION

79th Annual Meeting CORDILLERAN SECTION

The Geological Society of America

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

№ 18553

Coals ranging in rank from lignite to anthracite are 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, mineral-matter free) and BTU (moist, 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 systematically 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 emplacement 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 plutonism 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:
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University of Utah
Salt Lake City, Utah

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

Volume 15, Number 5, March 1983

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CORRELATION OF CENOZOIC STRATIGRAPHIC UNITS OF WESTERN OREGON AND WASHINGTON

Project Coordinators:

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