

THE GEOLOGICAL SURVEY OF WYOMING
Gary B. Glass, State Geologist

FIFTIETH ANNUAL REPORT
of the
GEOLOGICAL SURVEY OF WYOMING
for Fiscal Year 1983
July 1, 1982 to June 30, 1983

by
Gary B. Glass



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INTRODUCTION

The Office of the State Geologist was established in 1890 with the Wyoming State Constitution (Art. 9, Sec. 6) and modified by legislative enactment in 1969, 1975, 1977, 1979, and most recently Laws 1982, ch. 62, § 3 (Title 9, Ch. 2, Art. 8, 9-2-803). Gary B. Glass, the incumbent, was appointed State Geologist on June 18, 1981, to fill the unexpired term of Daniel N. Miller, Jr., and reappointed by Governor Ed Herschler for a full six year term in March 1982.

The Geological Survey of Wyoming was created by the Legislature in 1933, and has since been modified by legislative enactment in 1957, 1969, 1977, 1979, and most recently 1982 (Art. 8, 9-2-803 through 9-2-809). Under these statutes, the agency's principal functions are service-oriented and broadly grouped into four categories:

1. *Provide information, advice, and assistance for inquiries on geology and mineral resources*

- This includes requests for assistance from the Executive and Legislative branches of State Government, State and Federal agencies, industry, special interest groups, and the public.

2. *Conduct field and laboratory investigations* — These are geologic or mineral resource projects that contribute new data or information which have a practical bearing on Wyoming's communities or people.

3. *Publish maps and reports* — The agency must publish and distribute reports and maps that communicate the results of its investigations.

4. *Maintain files and libraries of the State's geology and mineral resources* — These files are part of the agency's permanent records and, with few exceptions, are available for public use.

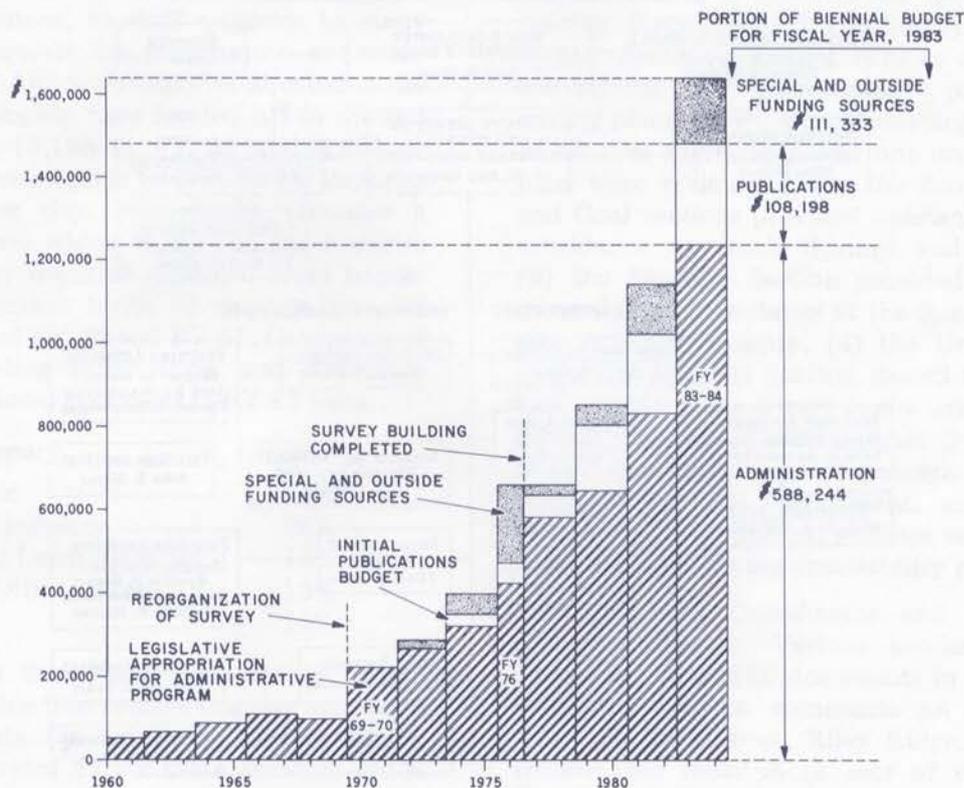


Figure 1. Biennial budgets for the Geological Survey (Expenditures for FY 83 are annotated to the right of the biennial budgets).

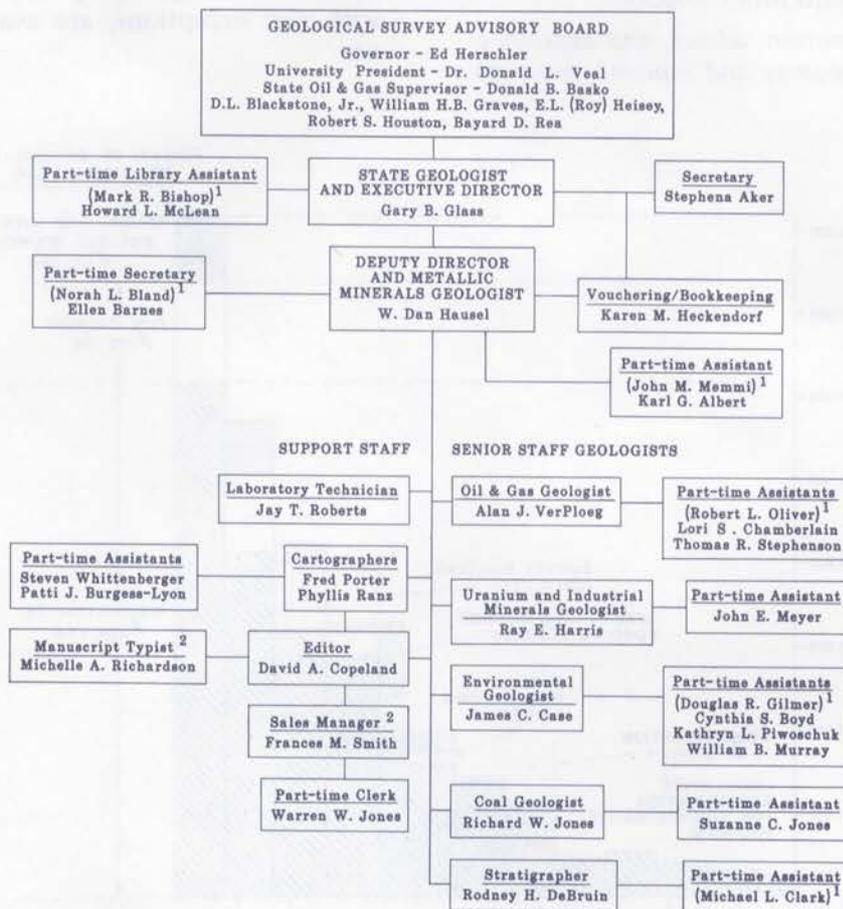
Fiscal affairs of the Survey are administered through direct appropriations from the legislature in two separate Accounts: Administration (001) and Publications (002); in addition, the Survey contracts for funding from outside sources to

conduct cooperative investigations and studies, or to assist with publication printing costs. Figure 1 illustrates the Survey's biennial budgets between 1960 and the present, and shows that portion of the biennial budget expended in FY 83.

ORGANIZATION

For operational purposes, the agency's personnel are divided into professional staff (geologists) and supporting staff (Figure 2). Because each staff geologist is an expert in his field of geology, he is expected to initiate his own investigations and projects on the basis of priority of need. About 80% of the projects are undertaken by individual staff geologists with assistance from the supporting staff. The remaining 20% are handled on a team basis that occasionally involves the entire staff as well as the State Geologist.

The geological staff (Figure 2) is divided into six one-man sections: petroleum, coal, metallic minerals, uranium and industrial minerals, environmental, and stratigraphy. Each staff geologist is the head of his respective section and enlists the part-time help of student assistants from the University of Wyoming as the need occurs and funds permit. The Laboratory Section is another one-man section that provides analytical as well as field support to the geological staff.



¹ These personnel terminated their employment before the end of FY 83.

² These positions are paid out of the Publications program.

Figure 2. Organizational chart for the Geological Survey of Wyoming in FY 83.

In addition to the secretarial and clerical support staff, the agency has a drafting section, an editorial section, and a publication sales section. The drafting section puts all illustrative materials (drawings, maps, charts, etc.) into publishable form, and makes proof copies and printer-ready negatives. The editorial section edits and puts all

manuscripts into printer-ready formats, writes printing specifications, and sees that reports are satisfactorily published. The publication sales section sells Survey publications over-the-counter and by mail, keeps an inventory of publications, and distributes exchange publications.

FUNCTIONS AND ACCOMPLISHMENTS IN FISCAL YEAR 1983

As mentioned earlier, the Geological Survey has four major functions: (1) Provide geologic advice and assistance, (2) Conduct field and laboratory investigations, (3) Publish reports and maps, and (4) Maintain records of geologic and mineral information. For each of these major functions, the activities and accomplishments of the Survey in FY 83 are described below.

1. PROVIDE INFORMATION, ADVICE, AND ASSISTANCE FOR ALL INQUIRIES ON THE STATE'S GEOLOGY AND MINERAL RESOURCES.

Because the Survey is primarily a service-oriented organization, its staff responds to many thousands of requests for information and assistance each year. Although inquiries directed to the professional geologists have leveled off in the last two fiscal years (3,156 in FY 82 and 3,408 in FY 83), these levels equate to 2.5 and 1.9 inquiries per geologist per day, respectively. (Because a sixth geologist was added in FY 83, the inquiries per man per day declined slightly). More importantly, these current levels of inquiry are still twice the levels of FY 80 and FY 81. Categories of inquirers requesting information and assistance from the professional geologists in FY 83 were:

Category	Percentage
General Public	19%
Business and Industry	38%
Wyoming and Local Agencies	15%
Federal and Other States	13%
Universities	15%

In regard to State and local entities, these services are divisible into routine ongoing assistance and spot requests for assistance. Major ongoing assistance is provided to six State agencies and is described below:

Commissioner of Public Lands — (1) The Survey's Petroleum Section provides weekly reports of oil and gas activities on or near State lands, (2) the State Geologist provides oil and gas tract evaluations to assist with selecting tracts for the lease auction, (3) the State Geologist reviews and makes recommendations on all fossil collecting permits (there were 15 applications in FY 83), and (4) spot assistance included recommendations on Kerr-McGee Coal Corporation's royalty level and Triton Coal Company's Special Use Lease, among others.

Department of Environmental Quality, Land Quality Division — (1) The Survey's Environmental Section provides reviews and recommendations on paleontology portions of mining plans. (In FY 83, paleontologic portions of 24 coal mine plans and one uranium mine plan were reviewed.), (2) the Environmental and Coal sections provided assistance on mine subsidence at Rock Springs and Glenrock, (3) the Drafting Section provided a map of mineral lease boundaries at the Sunrise mining area in Platte County, (4) the Uranium and Industrial Minerals Section described the geologic setting at the Irigary *in situ* uranium leach project, (5) The Environmental Section continued compiling maps of geologic hazards in Wyoming for the Department, and (6) The Coal and Environmental sections reviewed the Medicine Bow mining unsuitability petition.

State Planning Coordinator and Governor's Clearinghouse — Various sections of the agency reviewed 129 documents in FY 83 and submitted written comments on 31. These were the Cave Creek, Riley Ridge, and Road Hollow gas facilities (3 sets of comments); Frontier Pipeline; Onshore Oil and Gas Order

No. 1; Adobe Town, Ferris Mountains, Sand Dunes, and Honeycomb Butte Proposed Wilderness Areas; Buffalo Resource Management Plan; Green River/Hams Fork Coal Leasing (2 sets of comments); six PRLA's for coal in the Powder River Basin; Divide Resource Area Grazing Plan; Management of Stage II Roads; Snake River Proposed Wild and Scenic River Designation; Grand Teton-Corral Canyon land exchange, Teton Exploration's Teton uranium project; and Elkhorn Valley, Casper, and Yellow Creek, Evanston, housing developments.

Industrial Siting Administration — Various sections of the Survey reviewed and commented on siting applications for the MX, North Rochelle coal mine, Hampshire Energy Liquefaction Project, and the East Anschutz Ranch Project in FY 83 or early FY 84.

Legislative Service Office — Each September, the State Geologist and various sections of the Survey estimate future mineral production for the Legislative Management Council as an aid to forecasting mineral revenue.

Oil and Gas Conservation Commission — Wyoming Statute 30-5-103 makes the State Geologist one of the Commissioners for this regulatory agency. In the last two years, there has been a marked increase in the amount of time the State Geologist devotes to this important function. Monthly hearings, which routinely were no longer than one day, have gradually become 1½ to 2 days long. Special hearings in addition to the regular hearing dates are also becoming commonplace. By the end of FY 83, the State Geologist's activities related to this Commission were amounting to four or five days out of each month.

The Environmental Geology Section of the Survey also periodically provides the Oil and Gas Conservation Commission staff with assistance in their review of applications for aquifer exemptions under the Commission's Rule 407.

Spot requests for assistance from State and local entities are many and varied each year. The following list highlights the requests made of the Survey in FY 83, but is not all inclusive:

Attorney General — The Environmental Section provided technical assistance on landslides in the Little Granite Creek area of Teton County, and in collaboration with the Coal Section,

also provided assistance on a mine subsidence study at Glenrock in Converse County.

Archives, Museums, and Historical Department — The two Mineral sections assisted with design and construction of mineral exhibits in Cheyenne.

Board of Charities and Reform — The Environmental Section and State Geologist investigated an alleged decline in spring flow at Hot Springs State Park. As a result of this investigation, the Survey presented a 28-page report to the Board in mid-August, 1982. Conclusions and recommendations in that report led to a prioritized listing of recommendations and cost estimates later in August. The Priority I recommendation was for the installation of continuous monitoring devices at Big Spring so that there will be documented flow measurements in the future. Other recommendations dealt with management strategies, and the elimination of a boulder field immediately above Big Spring. The investigation also concluded that some water test wells drilled in the area had not affected the spring, and further that the lack of flow measurements over the years made it impossible to prove if the flow had declined at all.

Several other meetings were held on this matter in FY 83, and the Board hired a consulting firm to design a monitoring and metering system.

Department of Administration and Fiscal Control, Research and Statistics — The State Geologist updated maps and statistics on mineral resources for the *Wyoming Data Handbook*.

Department of Agriculture — The Survey's Drafting and Environmental sections provided drafting and technical assistance on the compilation of a *Land inventory map of Wyoming*.

Department of Economic Planning and Development — Various sections of the Survey responded to frequent requests for information on mines and mineral occurrences.

Disaster and Civil Defense Agency — The Environmental Section provided technical support and advice on plans and mock disasters.

Governor's Office — The Coal Section assessed the effect that coal mining at Gebo might have on Hot Springs State Park.

Highway Department — The State Geologist

provided advice on Interstate 90 condemnation negotiations near Sheridan. This involved several meetings.

Lincoln County — The Environmental Section provided a special report for Lincoln County's master plan (titled: *Geology and planning*).

Natrona County — The Environmental Section provided advice on a stock farm water well.

U.W. Department of Chemical Engineering — The Metallic Minerals Section looked for areas suitable for *in situ* or heap leaching experiments, and prepared a 51-page report on their findings.

U.W. Department of Civil Engineering — The Coal Section provided editorial and technical assistance in publishing results of a coal drilling project.

U.W. Economics Department — The Coal Section provided coal information for a computer program designed to forecast coal production.

U.W. Department of Geology and Geophysics — The Oil and Gas Section provided advice on the value of an oil and gas lease held by the University.

U.W. Institute for Policy Research — Various sections of the Survey provided quarterly mineral outlook articles for the *Wyoming quarterly update*.

U.W. State Archeologist's Office — The State Geologist provided technical assistance with a fossil discovery in Sheridan County.

Wyoming Legislature — The State Geologist and Coal Section prepared coal production and coal market data requested for the Legislative Session in 1983.

In addition, the Survey staff received requests for assistance or information from the Ad Valorem Tax Division, Department of Labor and Statistics, Recreation Commission, State Engineer, State Laboratory, State Inspector of Mines, Water Development Commission, and the Water Quality Division of the Department of Environmental Quality.

As an extension of this service-related function, the Survey's professional staff also presented twenty-two talks or briefings on mineral resources, geology, or geological hazards to the following groups: American Institute of Professional Geologists (Wyoming Section); American

Association of Petroleum Geologists (Rocky Mountain Section); Association of Women Geoscientists (Casper Chapter); Colorado Mining Association; Colorado School of Mines' Field Institute for Journalists and the Field Institute for Congressional and Executive Aides; Harvard, Yale, and Cornell Universities combined Geology Field Camp; Interstate Oil Compact Commission; Laramie Rockologists; National Academy of Science's Committee on Highwalls and Approximate Original Contours; Society of Mining Engineers (Bellamy Chapter); University of Wyoming Engineering and Geology Departments; Wyoming Geological Association; Wyoming Historic Preservation Society; and Wyoming Mining Association's Teacher Workshops (two).

2. CONDUCT AND REPORT ON FIELD AND LABORATORY INVESTIGATIONS THAT CONTRIBUTE NEW GEOLOGICAL KNOWLEDGE TO THE STATE CONCERNING MINERAL RESOURCES AND OTHER MATTERS THAT HAVE A PRACTICAL BEARING ON WYOMING'S COMMUNITIES AND PEOPLE.

The following investigations were completed in FY 83:

- (1) Reconnaissance study of the economic geology and Precambrian rocks of the Copper Mountain area in Fremont and Hot Springs counties.
- (2) Compilation of cross sections that illustrate characteristics of tight gas sand units of the Frontier and Almond formations in the Greater Green River Basin.
- (3) A preliminary inventory of geological hazards in Wyoming (i.e., landslides, floodplains, mine subsidence, active faults, seismic areas, and active sand dunes).
- (4) A study of sandstone uranium occurrences in the Morton Ranch area of Converse County.

Ongoing investigations include:

- (1) Field sampling and laboratory processing of diamond-bearing kimberlite from the Laramie Range and State Line District as a cooperative project with the University of Wyoming's Mining and Mineral Resource Research Institute.
- (2) A study to evaluate rapid exploration techniques for diamond-bearing kimberlite as a cooperative project with the University of Wyoming's Department of Geology and Geophysics.

(3) Reconnaissance surveys of mineral occurrences throughout the State as in-house projects in the two Mineral sections.

(4) Petrographic studies of hydrothermally altered rock from the Absaroka volcanic plateau of Park and Fremont counties and the Silver Crown Mining District of Laramie County.

(5) A characterization study of the Trapper Canyon tar sand deposit in Big Horn County will be completed in FY 84.

(6) Compilation of background radiation levels in Wyoming for publication as maps.

(7) Coding and data entry for computer programs designed to manipulate petroleum well data.

(8) Landslide research and mapping.

Projects approved or likely to start in FY 84 are:

(1) Reconnaissance survey of Wyoming's reported tar sand and heavy oil occurrences. Funding will come from the University of Wyoming's Industrial Fund.

(2) The U.S. Geological Survey is expected to fund a project to enter coal data into their National Coal Data Bank.

3. PUBLISH TIMELY AND SIGNIFICANT REPORTS AND MAPS THAT LEAD TO A BETTER UNDERSTANDING OF THE LOCAL AND REGIONAL GEOLOGY OF THE STATE AND ITS MINERAL RESOURCES.

The following 27 reports and maps were published in FY 83:

ANNUAL REPORTS

48th Annual report of the Geological Survey of Wyoming, July 1, 1980 to June 30, 1981, by G.B. Glass, (1983).

49th Annual report of the Geological Survey of Wyoming for fiscal year 1982, by G.B. Glass, (1983).

BULLETINS

Fossils of Wyoming: Bulletin 54, by M.W. Hager, (1971; reprinted in 1982).

Traveler's guide to the geology of Wyoming: Bulletin 55, by D.L. Blackstone, Jr., (1971; reprinted in 1983).

INFORMATION CIRCULARS

Diamond-bearing kimberlite pipes in Wyoming and Colorado, by W.D. Hausel, (1983).

Field Guide to some common rocks and minerals in Wyoming, by W.D. Hausel and Karl Albert, (1983).

Minerals outlook for Wyoming, February 1983, by G.B. Glass, A.J. Ver Ploeg, R.W. Jones, R.E. Harris, and W.D. Hausel, (1983).

Quarterly minerals outlook, June 1983, by G.B. Glass, A.J. Ver Ploeg, W.D. Hausel, R.E. Harris, and R.W. Jones, (1983).

MAP SERIES

Geologic map of the Dick Creek Lakes, Dunruid Peak, Francs Peak, Noon Point, and Twin Peak quadrangles, Fremont, Hot Springs, and Park counties, Wyoming: MS-10, by W.G. Wilson, (1982).

Landsat image mosaic of Wyoming: MS-11, composed by the Geological Survey of Wyoming, (1982).

OPEN-FILE REPORTS

Thermal, chemical and hydrologic data for the Thermopolis hydrothermal system, background data for WGS Preliminary Report 20: OFR 82-3, by B.S. Hinckley, H.P. Heasler, and J.K. King, (1982).

Geological reconnaissance report of metallic deposits for in situ and heap leaching extraction research possibilities: OFR 82-4, by W.D. Hausel and Suzanne Jones, (1982).

Review of reported tar sand occurrences and recent projects in Wyoming: OFR 82-5, by Michael Clark and G.B. Glass, (1982).

Geophysical logs, lithologic descriptions, and coal analyses from coal test holes drilled in 1982 in the Salt Wells and Kemmerer areas, Sweetwater and Uinta counties, Wyoming: OFR 83-1, by J.M. McClurg, J.D. Gardner, A.P. Boresi, and L.E. Borgman, (1983; superseded by Report of Investigations No. 24, 1983).

Bearing-capacity of reclaimed spoil, Rosebud Mine, Colstrip, Montana: OFR 83-2, by J.M. White and D.E. Clark, (1983).

Bedrock geologic map of the alkaline complex of the Bear Lodge Mountains, Crook County, Wyoming: OFR 83-3, by R.E. Harris, (1983).

PRELIMINARY REPORTS

The Thermopolis hydrothermal system with an analysis of Hot Springs State Park: No. 20, by B.S. Hinckley, H.P. Heasler, and J.K. King, (1982).

PUBLIC INFORMATION CIRCULARS

Geologic hazards and land use planning (extended abstracts): No. 18, edited by J.C. Case, (1983).

Genesis and exploration of metallic and non-metallic mineral and ore deposits of Wyoming and adjacent areas (extended abstracts): No. 19, edited by W.D. Hausel and R.E. Harris, (1983).

REPORT OF INVESTIGATIONS

Geology of the Elmers Rock greenstone belt, Laramie Range, Wyoming: No. 14, by P.J. Graff, J.W. Sears, G.S. Holden, and W.D. Hausel, (1982).

Geology of the headwater area of the North Fork of Owl Creek, Hot Springs County, Wyoming: No. 15, by K.A. Sundell, (1982).

Geophysical logs, lithologic descriptions, and coal analyses from coal test holes drilled in 1982 in the Salt Wells and Kemmerer areas, Sweetwater and Uinta counties, Wyoming: No. 24, by J.M. McClurg, J.D. Gardner, A.P. Boresi, and L.E. Borgman, (1983).

REPRINT SERIES

Coal deposits of Wyoming: Reprint 39, by G.B. Glass, (1981; reprinted 1982).

General geologic setting and mineralization of porphyry copper deposits, Absaroka volcanic plateau, Wyoming: Reprint 40, by W.D. Hausel, (1982).

Economic mineral deposits of Wyoming — a review: Reprint 41, by W.D. Hausel, (1981; reprinted 1982).

The Jackson Hole Coal Field: Reprint 42, by R.W. Jones, (1982).

Description of Wyoming coal fields and seam analyses; Reprint 43, by G.B. Glass, (1982; reprinted 1983).

The following 10 publications are already in preparation for publication in FY 84 or early FY 85:

BULLETIN

Bibliography of Wyoming geology, 1960-1969, by Charlotte Tancin.

MAP SERIES

Index to U.S. Geological Survey Miscellaneous Investigations Maps (I) in Wyoming: MS-9D, Compiled by R.H. DeBruin.

Index to U.S. Geological Survey Hydrologic Investigations Atlases (HA) in Wyoming: MS-9E, Compiled by R.H. DeBruin.

Index to U.S. Geological Survey Water-Supply Paper maps in Wyoming: MS-9F, Compiled by R.H. DeBruin.

Tectonic map of the Black Hills, Wyoming, Montana, and North Dakota, by A.L. Lisenbee.

MEMOIR

Precambrian uranium-bearing quartz-pebble conglomerates with a review of the Wyoming Province: No. 3, by R.S. Houston and K.E. Karlstrom.

PUBLIC INFORMATION CIRCULARS

Road log, Jackson to Dinwoody and return: No. 20, by J.D. Love and J.M. Love.

Self-guided tour to the geology of a portion of southeastern Wyoming: No. 21, by W.D. Hausel and R.W. Jones.

Index to oil shale drill holes and analyses in the Green River and Washakie basins: No. 22, by D.J. Sinks.

REPORT OF INVESTIGATIONS

Alteration and mineralization associated with sandstone uranium occurrences, Morton Ranch area, Wyoming: No. 25, by R.E. Harris.

In addition, the State Geologist and/or the staff geologists also prepared or had published the following 24 papers and reports for outside publishers:

American Association for the Advancement of Science, Symposium Volume: *Wyoming, an example of western coal development*, by G.B. Glass (In press).

American Association of Petroleum Geologists, Bulletin, Volume 66, no. 11: *Wyoming (Developments in Oil Shale in 1981)* by G.B. Glass (1982) and *Wyoming (Developments in Oil Shale in 1982)* by G.B. Glass (In press).

American Geological Institute, Earth Science Magazine: *Geology of Wyoming*, by D.L. Blackstone, Jr. and G.B. Glass (In press).

American Geological Institute, Geotimes, Volume 28, no. 2: *Coal (Research activities in the United States in 1982)* by R.A. Brant and G.B. Glass (1983).

Colorado Mining Association Yearbook: *Metallogeny of some Wyoming deposits*, by W.D. Hausel and R.E. Harris (In press).

Hot line Energy Reports: *Developments in Wyoming coal, 1982*, by R.W. Jones, (1983).

McGraw-Hill Inc., Keystone Coal Industry Manual: *Description of Wyoming coal fields and seam analyses*, by G.B. Glass, (1982 revision published; 1983 revision in press).

Rocks and Minerals Magazine: *Wyoming gold*, by W.D. Hausel, (In press); *Diamond-bearing kimberlite pipes in Wyoming and Colorado*, by W.D. Hausel (In press); and *Field guide to some common rocks and minerals of Wyoming*, by W.D. Hausel and Karl Albert (In press).

Rocky Mountain Association of Geologists Guidebook: *Road log for a portion of southeastern Wyoming*, by W.D. Hausel and R.W. Jones (In press).

Society of Mining Engineers, Mining Engineering, Volume 35, no. 5: *Wyoming (Exploration summary for 1982)*, by G.B. Glass, R.E. Harris, W.D. Hausel, and R.W. Jones, (1983).

U.S. Bureau of Mines Preprint from the 1981 Minerals Yearbook: *The mineral industry of Wyoming*, by K.E. Starch and G.B. Glass, (1983).

U.S. Department of Energy Report DOE/LC/10916-TI: *Review of reported tar sand occurrences and recent projects in Wyoming*, by Michael Clark and G.B. Glass, (1983).

University of Wyoming, Institute for Policy Research's Wyoming Quarterly Update: *Minerals outlook*, by G.B. Glass, A.J. Ver Ploeg, W.D. Hausel, R.E. Harris, and R.W. Jones, (Quarterly, 1982 and 1983).

Wyoming Geological Association Annual Field Conference Guidebook: *The Jackson Hole Coal Field*, by R.W. Jones, (1982); *General geologic setting and mineralization of the porphyry*

copper deposits, Absaroka volcanic plateau, Wyoming, by W.D. Hausel, (1982); *Reconnaissance and economic geology of the Copper Mountain metamorphic complex, Owl Creek Mountains, Wyoming*, by W.D. Hausel and P.J. Graff, (In press); *Uranium and thorium in the Bighorn Basin*, by R.E. Harris (In press).

4. GATHER AND CONTINUOUSLY UPDATE AND MAINTAIN FILES AND LIBRARIES OF ALL AVAILABLE MATERIAL, RECORDS, MAPS, AND DATA RELATING TO THE SURFACE AND SUBSURFACE GEOLOGY AND MINERAL RESOURCES OF THE STATE.

In FY 83, the Agency (1) enlarged its oil and gas well log file at least 10% by soliciting files offered by oil companies and private consultants, (2) at least doubled its inventory of mapped and identified geological hazards, particularly landslides, sand dunes, and mine subsidence, (3) examined and described in report form several hundred mineral occurrences across the State, (4) extended its aerial photographic coverage to about 80% of the State, and (5) added several thousand dollars worth of documents, reports, and maps to the University of Wyoming's Geology Library and the Survey's library through its publication exchange agreements with Federal, foreign, and other state agencies and geological surveys.

The Survey also maintains a "Confidential" file of drilling records from holes drilled on State mineral leases. As mandated in Wyoming Statute 36-6-102, all these subsurface log reports must be given to the Geological Survey within three years of drilling and become a permanent file. These drilling records remain confidential for seven years after their receipt or until expiration of the lease, whichever is the lesser.

With the exception of the "Confidential" drilling records mentioned above, files and libraries of the Survey are available to the public. A public-use area is provided on the second floor of the Wyoming Geological Survey Building. This area hosts microfiche and paper copies of many oil and gas well logs, aerial photography, unpublished geologic and mineral reports, U.S. Geological Survey and U.S. Bureau of Mines open-file reports on Wyoming, U.S. Department of Energy's uranium reports for Wyoming, Environmental Impact Statements, numerous trade journals, scientific magazines, as well as other items.

REVENUES GENERATED BY THE GEOLOGICAL SURVEY

The sale of reports and maps is an important function of the Geological Survey, and these sales provide the major source of direct revenue generated by the agency. Publication sales in FY 83 were \$73,135. With another \$70,000 projected for FY 84 sales, the total publication revenues for the 1983-1984 Biennium will approximate \$143,000. Although these revenues are approximately 22% below the record sales of \$182,603 in the 1981-1982 Biennium, they are still considerably above the \$84,970 deposited in the 1979-1980 Biennium.

Slowing sales are a function of recessionary pressures and should rebound with the economic recovery of the State and nation. As shown in Figures 3 and 4, there has been good correlation between the activities of Wyoming's mineral industry and the sale of Survey publications.

The only other direct annual revenue generated by the Geological Survey is for space rented to the U.S. Geological Survey on the second floor of the Wyoming Geological Survey Building. Rental for this space was \$6,216.21 in FY 83.

OUTSIDE FUNDING SOURCES (GRANTS)

Grants are another source of revenue. But unlike the publications sales and the rental revenues which go directly into the General Fund, grant funds are used by the Survey to fund special projects or investigations. These grants come from outside sources with the Survey generally providing services in kind. The Survey does not seek any General Fund appropriations for these types of projects as each project is normally 100% funded by the cooperating entity, be it State or Federal.

Investigations and projects of this sort provide data that the agency otherwise could not assemble or collect in as timely a manner. In all cases, the Survey only undertakes these projects when they are mandated or clearly of mutual benefit to the State of Wyoming, and each project usually results in a saleable publication. Revenue from the sale of these reports eventually repays a part of the in kind expenses. The Geological Survey is able to solicit these grants because of the reputations and calibre of its professional geologists as well as its exemplary performance on past grants. The Survey is not dependent on these funding sources, but is only augmented by them when it is in the best interest of the State. No new positions are created by these grants.

Grant income from outside sources totalled \$111,333 in FY 83. Survey personnel completed or are completing work on 5 grants: 01.16 (\$18,540 in FY 83) for a geologic hazard study funded by the Department of Environmental

Quality's Land Quality Division; 01.70 (\$8,537.34 carryover from FY 82) and 01.71 (\$8,343 in FY 83) for a study of rapid exploration techniques for diamond-bearing kimberlite exploration, funded by the University of Wyoming's Department of Geology and Geophysics; 01.40 (\$20,000 in FY 83) for a study of tight gas sands in the Greater Green River Basin, funded by the Texas Bureau of Economic Geology; 01.80 (\$23,177 in FY 83) for a characterization study of the Trapper Canyon tar sand deposit, funded by the University of Wyoming's Industrial Fund; and 01.90 (\$32,736 in FY 83) for landslide characterization and mapping, funded by the U.S. Geological Survey. The geologic hazard study and the tight gas sand study were completed in FY 83. In addition, in FY 84 the Survey will receive \$19,107 from the University of Wyoming's Industrial Fund for a grant to study tar sand and heavy oil deposits in the State and expects to receive \$33,747 from the U.S. Geological Survey to put coal data into the National Coal Resources Data System.

Although none of the above grants will extend past the 1983-1984 Biennium, the Survey anticipates that new, similar, cooperative working agreements will be developed during the 1985-1986 Biennium. There is no way of predicting what grants may develop in 1985 and 1986; and no grant can be accepted without the Governor's prior approval.

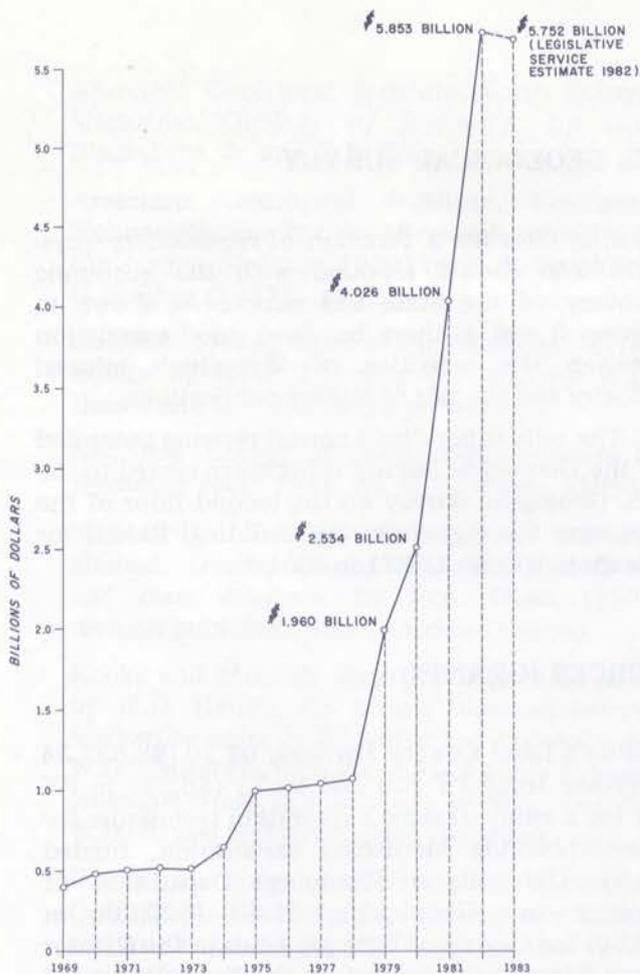


Figure 3. Assessed valuation of Wyoming's mineral production.

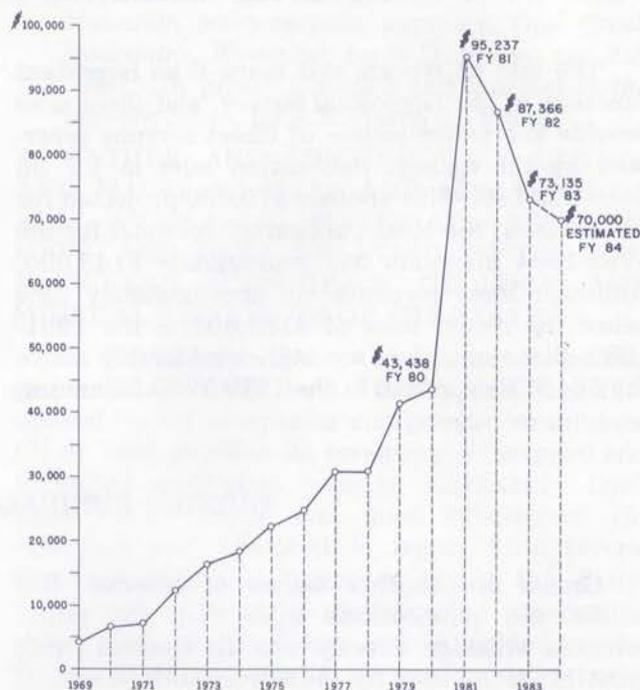


Figure 4. Annual fiscal year income from Survey publications.

MAJOR ACCOMPLISHMENTS BY PROGRAM

Administration

General Fund appropriations for the Administrative Program were \$588,244 in FY 83. This program implements the principal functions of the Geological Survey which are investigation and service as described above. The Survey acts (1) as a gathering facility and clearinghouse for all information related to the geology and mineral resources of the State and (2) as a source of technical reports and maps important to Wyoming communities, people, and industry.

During FY 83, the professional staff of the agency to include the State Geologist provided service to more than 284 telephone, letter, and visitor inquiries each month (an 8% increase over FY 82); initiated or completed more than 15 separate field investigations; collected and analyzed numerous rock samples, including 38 mineral and rock identifications for the public; and examined

and filed thousands of maps, aerial photographs, and subsurface geophysical logs. The agency also completed a special investigation and report on Hot Springs State Park, and reviewed more than 133 documents related to industrial siting, mineral development, mining, government actions, and land-use planning. Survey personnel researched, wrote, or prepared 18 in-house publications, which were published in FY 83.

Each staff geologist is in effect the State's expert on a given subject and is responsible for collecting, organizing, interpreting, and communicating all information pertinent to his field of expertise for maximum benefit to the State. Communication not only involves the writing of in-house publications, but also includes the writing and presentation of additional papers and talks at civic, social, government, and scientific meetings. Whenever practical, in an effort to expedite work,

the Survey solicits cooperative assistance from other State and Federal agencies and industry, as well as the University of Wyoming.

As time and funds permit, the staff geologists utilize special types of investigations and analyses that provide new information or verify geological interpretations that are especially relevant to Wyoming and its citizenry.

The State Geologist and professional staff are routinely called upon to act in an advisory capacity in an effort to assist the Executive and Legislative branches of State Government, city and county administrators, other State agencies, and occasionally Wyoming's Congressional delegation.

Table 1 shows a percentage breakdown of the staff geologists' activities by category.

Table 1. Percentage breakdown of staff geologists' activities.

	Range	Average
Services to the general public, State agencies, Federal agencies, and others	40-50%	45.0%
Field and laboratory projects	10-20%	15.0%
Data organization	10-25%	17.5%
Report writing and editorial reviews	10-20%	15.0%
Administration	3-5%	4.0%
Other activities	2-5%	3.5%

As evidenced above, each of the staff geologists, with the help of part-time personnel, conducted other activities in addition to their service role. General summaries and major activities of the State Geologist and the various sections are discussed below.

State Geologist (Gary B. Glass)

Besides routine administrative activities, the State Geologist principally functions in a service role as evidenced by 928 inquiries for assistance or information that were received in FY 83. In some instances, the inquirer was also directed to an appropriate staff geologist for more information.

In other service-related activities, the State Geologist attended the Governor's Resource Management Tour of Hot Springs and Washakie counties; met with the Legislative Service Office to forecast mineral production; reviewed and made recommendations on 15 applications for fossil collecting permits; provided advice to the Wyoming Highway Department on their Interstate 90 coal condemnation negotiations; reviewed documents and reports and provided technical assistance and data to other State agencies; taught a three-hour course on the geology of solid fuels (tar sand, oil shale and coal) as an Adjunct Lecturer of Geology at the University of Wyoming; and presented expert testimony for the California Attorney General's Office in a civil case where a company

allegedly misrepresented coal properties leased from the State of Wyoming.

In this service role, the following talks or briefings were also presented: talks on Wyoming's mineral industry for the Society of Mining Engineers in Laramie and the American Institute of Professional Geologists in Casper; a talk on activities of the Geological Survey for the Wyoming Geological Association in Casper; a briefing on mineral activities in Wyoming and participation in the field trip across southern Wyoming for the Colorado School of Mines' Field Institute for Congressional and Executive Aides; a briefing on coal mining and leader for a field trip to Gillette area mines for the National Academy of Science's Committee on Highwalls and Approximate Original Contours; talks on the geology of Wyoming's mineral resources for two Teacher Workshops sponsored by the Wyoming Mining Association in Casper and Cheyenne; and short briefings on tar sand and geothermal developments in Wyoming for the Interstate Oil Compact Commission in Tulsa, Oklahoma.

The State Geologist is also a member of the Governor's Water Forum, the Geothermal Resources Committee of the Interstate Oil Compact Commission (IOCC), the Association of American State Geologists (AASG), the Wyoming Geological Association (WGA), and Secretary of

the Coal Geology Division of the Geological Society of America (GSA). As such, the State Geologist attended the following meetings in FY 83: Fall (New Orleans, Louisiana) and Annual (Anchorage, Alaska) meetings of the AASG; Annual Meeting of the Coal Geology Division of the GSA (New Orleans, Louisiana); Annual Field Conference (Mammoth) and Spring Conference (Laramie) of the WGA; and the mid-year meeting of the IOCC (Tulsa, Oklahoma).

In addition to the service roles described above, the State Geologist participated in a field investigation of alleged declining spring flow at Hot Springs State Park (see earlier discussion on page 5); inspected a controversial proposed oil and gas drilling site at Little Granite Creek in Teton County; inspected damages from a major oil spill near Byron in Big Horn County; and inspected active fossil collecting quarry sites on State lands near Kemmerer in Lincoln County.

The State Geologist is also a Commissioner on the Wyoming Oil and Gas Conservation Commission (see earlier discussion on page 4). This is the only regulatory activity of the State Geologist or the Survey, and in this regard, the State Geologist serves on the Commission in his capacity as State Geologist rather than as the chief administrative officer of the Geological Survey.

The State Geologist authored or coauthored seven Survey publications published in FY 83: the 48th and 49th *Annual report of the Geological Survey of Wyoming*; mineral overviews in the February and June issues of *Minerals outlook for Wyoming*; Open-file report 82-5 on tar sand occurrences in Wyoming; and Reprint 39 and Reprint 43 on Wyoming coal deposits. Outside publications included a Wyoming coal article for the American Association for the Advancement of Science; another coal article for McGraw-Hill's *Keystone Coal Industry Manual*; articles on Wyoming geology and on coal research activities in the United States for the American Geological Institute; a Wyoming minerals summary for the U.S. Bureau of Mines' *Minerals yearbook preprint*; an article on Wyoming's tar sand deposits for the U.S. Department of Energy; mineral overviews for four issues of the University of Wyoming's *Wyoming quarterly update*; an article on Wyoming's oil shale for the American Association of Petroleum Geologists; and an article on 1982 mineral exploration activities in Wyoming for the Society of Mining Engineers.

Coal Section (Richard W. Jones)

The Coal Section serves as a major source of information on Wyoming's coal deposits and coal mining activity. Office, field, and laboratory investigations are designed to better define and characterize the State's coal resources through: collection and compilation of data, maintenance of a library and file of coal related data, and publication of maps and reports resulting from the investigations.

The Section has now operated for a full fiscal year with a staff coal geologist. Section personnel visited most of the active coal mines in the State and established a photographic file for each mine; participated in two University of Wyoming coal projects; published several reports; and presented several talks.

The Coal Section provided technical support for a coal drilling and analyses project in southwestern Wyoming undertaken by the Engineering and Geology Departments of the University of Wyoming under a grant from the U.S. Departments of Energy and Interior. Open-file Report 83-1, which was prepared by the Section during early FY 83, was later published by the Geological Survey of Wyoming as Report of Investigations No. 24 entitled, *Geophysical logs, lithologic descriptions, and coal analyses from coal test holes drilled in 1982 in the Salt Wells and Kemmerer areas, Sweetwater and Lincoln counties, Wyoming*. The Section also provided assistance to a coal economics and marketing project (undertaken by the Economics Department, University of Wyoming) by providing information on coal prices, taxes, contracts, production, quality, and coal deliveries for entry into a computer program. The project was designed to forecast the State's coal production based on market analysis, contract demand, and trends in coal utilization.

Papers published in FY 83 included: *The Jackson Hole Coal Field*, published first in the Wyoming Geological Association's Annual Field Conference Guidebook, and then reprinted by the Geological Survey as Reprint 42; *Developments in Wyoming Coal, 1982*, published by the Association of Women Geoscientists and Hotline Energy Reports; summer, spring, fall, and winter coal activity updates published in the University of Wyoming's *Wyoming quarterly update*; and slightly revised coal activity updates were also published in the Survey's February and June issues of *Minerals outlook for Wyoming*.

The Staff Coal Geologist presented a talk on the Jackson Hole Coal Field at the 1982 Wyoming Geological Association Field Conference; gave a talk on 1982 coal developments in Wyoming to the Association of Women Geoscientists; led a field trip through the Hanna Basin for the combined geology summer field camps of Harvard, Yale, and Cornell universities; in conjunction with the State Geologist, briefed the Committee on Highwalls and Approximate Original Contours of the National Academy of Sciences on coal geology and mining in the Powder River Basin, and organized and led the Committee on a field tour of southern Powder River Basin coal mines; and briefed the Colorado School of Mines' Field Institute for Journalists on mineral activities in southern Wyoming.

The Section collaborated with the Metallic Minerals Section in preparing a road log/field guide for the 1983 Rocky Mountain Association of Geologists (RMAG) Field Conference on stratigraphy, structure, and oil and gas in the Laramie/Hanna/Shirley Basin area. This road log will be published in FY 84 by the RMAG and as a separate Geological Survey of Wyoming report. The Section also provided coal expertise to the Environmental Section in regard to underground coal mine locations and subsidence features in the State.

Environmental Geology Section (James C. Case)

As part of its service role, the Environmental Section both reviewed and generated information for various environmental impact statements and plant siting applications. Numerous reports on land development suitability were submitted to the U.S. Department of Housing and Urban Development for their use in developing environmental impact statements for proposed subdivisions. Paleontologic portions of 24 coal mine plans and one uranium mine plan were reviewed under a Memorandum of Understanding with the Land Quality Division of the Wyoming Department of Environmental Quality.

The Section is assisting various county agencies with their county development plans. Areas geologically unsuitable for development are being defined. As part of this program, the Section hosted a one-day conference on geological hazards and land use planning in April, 1983. Section personnel edited nine extended abstracts of papers presented at the conference in Laramie. The Survey published the abstracts as Public Information Circular No. 19. In addition, preliminary maps depicting landslides, windblown deposits, mined-out areas and subsidence, and earthquake epicenters

in Wyoming were distributed. Shortly after the conference, a special report on geology and planning was prepared for inclusion in Lincoln County's master plan. A general report on geological hazards in Wyoming is also in progress.

Other major functions of the Environmental Section are to compile, create, and make available pertinent information on environmental and engineering geology matters in Wyoming. In this regard, field investigations are as much a function of the Section as its service responsibilities.

In FY 83, the Section was very active in researching and mapping geological hazards in Wyoming. Much of this research was funded by a grant from the Land Quality Division of the Wyoming Department of Environmental Quality. All mined-out areas (coal) were examined on aerial photographs for evidence of subsidence. Most potential subsidence areas were field checked and mapped. Also, all available literature was collected on windblown deposits and a search using aerial photography, was begun to locate unmapped deposits. So far, a fairly large area of dunes has been located in the vicinity of Fontenelle Reservoir. Landslide research and mapping has been another major activity of the Section. The mapping is partially supported by a contract with the U.S. Geological Survey. There are three mapping projects currently in progress — Flaming Gorge Reservoir area, Little Granite Creek, and Highway 14-A in the Bighorn Mountains.

The Section was involved with various special projects. Together with the State Geologist, a report of investigations on Hot Springs State Park was prepared in response to suspected declining flows at the park. A series of overburden thickness maps and short report were prepared for the Sun-up Ridge Addition at Glenrock in Converse County. The addition is located over abandoned coal mines.

More aerial photography was acquired, giving the Section approximately 80% coverage of the State. A copy camera and color enlarger were purchased and have expanded in-house processing capabilities.

Laboratory Section (Jay T. Roberts)

The Laboratory Section provides sample preparation and analytical services to the various other sections. These services have included mineral separations, qualitative and semiquantitative chemical analyses, and X-ray powder diffraction analysis. The Section also routinely provides

sample preparation services such as cutting, crushing, grinding, sieving, staining, etc., of geological samples. Although the quantitative capabilities of the Survey's laboratories remain relatively limited, a current file of laboratories offering such services is maintained.

The Section's capabilities were significantly enhanced in March with the installation of a Scintag Pad II automated X-ray powder diffractometer (APD). Selection of the instrument was based largely on precision and versatility, and it is felt that the Survey obtained an excellent value in both regards. In addition, the APD system computer and software package greatly simplifies the data collection and interpretation process, reducing the time necessary to perform an analysis. The APD has proven to be a valuable tool in the identification of unknown mineral specimens. A computer file of diffraction data for frequently encountered phases has been generated which often allows for automatic identification of unknowns, and the Section is expanding this file. Other APD capabilities being investigated are studies of mineral solid solution, in particular the ilmenite-geikielite series, the semiquantitative analysis of mineral mixtures, and the characterization of various grades of nephrite jade.

The Section also put an old arc emission spectrograph into operation for elemental analysis. The instrument is most useful for qualitative analysis of elements present in concentrations of one percent or more. Minimum detection limits are typically on the order of 500 ppm. The instrument is also useful in some cases for semiquantitative analysis of minor and trace elements.

The Laboratory Section continued work on the ongoing projects of the Metallic Minerals Section related to exploration for diamond-bearing kimberlites. A Wilfley table, mineral jig, and magnetic separator are routinely used to obtain heavy mineral concentrates from field samples. Diamond extraction from kimberlite samples is accomplished through the use of a grease table and water floatation apparatus. The feasibilities of using electrostatic and dielectric techniques for diamond extraction as well as other mineral separation are being investigated.

Metallic Minerals Section (W. Dan Hausel)

The Metallic Minerals Section functions as a principal source of information on Wyoming's base, precious, ferrous and ferroalloy metals, and precious and semiprecious stones, and related geology. The Section also supervises and conducts

independent and cooperative investigations on the characteristics and distribution of various mineral deposits throughout the State and adjacent areas. Mining firms, geological consultants, citizens, and prospectors obtain information and assistance on prospects and on rock and mineral identifications from this Section.

Section personnel continued their investigations of diamond-bearing kimberlite in the Laramie Range. One ongoing project involved stream sediment sampling of drainages near Sybille Canyon and in the vicinity of Happy Jack in Albany County. Sampling during FY 83 was designed to isolate the source of anomalous stream sediment samples that were collected in FY's 81 and 82. Additionally, several kimberlite diatremes have been sampled and processed for diamond occurrences. Diamonds have been extracted from the Sloan 1 kimberlite and the Evelyn kimberlite pipe, both located in the Colorado-Wyoming State Line District. This project was funded (\$19,220) by a University of Wyoming Mining and Mineral Resource Research Institute (MMRRI) grant with funding to continue through FY 84.

A second ongoing kimberlite research project is a National Aeronautics and Space Administration (NASA)-sponsored joint project between the Metallic Minerals Section and the University of Wyoming's Remote Sensing Section of the Geology Department. This project is designed to investigate rapid exploration techniques for diamond-bearing kimberlites. Potential kimberlite targets are located by remote sensing, followed by field investigations (geophysical surveys, geological mapping, and stream sediment sampling). This project is funded by a grant from the University's Geology and Geophysics Department (approximately \$14,400).

At the beginning of the field season in FY 83 (late May), the Section initiated an investigation of the economic geology and Precambrian rocks of the Copper Mountain metamorphic complex in Fremont and Hot Springs counties. The project consists of preparing a reconnaissance geological map of the Precambrian rocks of the range, and detailed geological maps (both surface and underground) of the three major historic metal mining areas — the Gold Nugget, McGraw, and DePass areas.

Over the past several years, the Section has been conducting reconnaissance surveys of mineral resources throughout the State. These data will be compiled for publication during FY 84 or FY 85. An offshoot of this study will be a revision of MS-5, the *Wyoming mines and minerals map*.

The Absaroka volcanic plateau in northwestern Wyoming contains numerous porphyritic intrusives that are accompanied by copper, lead, zinc, gold, and silver mineralization and associated hydrothermal alteration. The alteration haloes around these deposits are generally quite extensive and are useful in the exploration of these mineralized stocks. In FY 83, the Metallic Minerals Section published, *General geologic setting and mineralization of the porphyry copper deposits, Absaroka volcanic plateau, Wyoming* in the Wyoming Geological Association's 33rd Annual Field Conference Guidebook. This was reprinted as Geological Survey of Wyoming Reprint 40. As a follow-up to this reconnaissance report, the Section is conducting petrographic studies of hydrothermally altered rock collected during FY 82. A similar alteration study has been undertaken on the Copper King Mine in the Silver Crown District of Laramie County (Geological Survey of Wyoming Open-file Report 82-4) and petrographic studies on the Copper King porphyry are continuing.

The Metallic Minerals Section of the Survey was co-sponsor to the 1982 International Archean Geochemistry Field Conference held in Wyoming in early FY 83 and was co-sponsor of the Wyoming Geological Association, Geological Survey of Wyoming, and University of Wyoming Joint Spring Conference. Public Information Circular No. 19, *Genesis and exploration of metallic and non-metallic mineral and ore deposits of Wyoming and adjacent areas* was published as a proceedings for the Joint Spring Conference.

In collaboration with the Coal Section, a road log on the geology of a portion of southeastern Wyoming was prepared for an upcoming Rocky Mountain Association of Geologists (RMAG) conference which will be held in early FY 84. The road log will be published as a part of the proceedings of that conference.

Papers prepared by the Section and published in FY 83 included: *General geologic setting and mineralization of the porphyry copper deposits, Absaroka volcanic plateau, Wyoming*, (previously discussed); Public Information Circular 19 (previously discussed); *Geological reconnaissance report of metallic deposits for in situ and heap leaching extraction research possibilities*, Geological Survey of Wyoming Open-file Report 82-4; *Geology of Elmers Rock greenstone belt, Laramie Range, Wyoming*, Report of Investigations No. 14; *Geology, exploration, and diamond extraction of kimberlite in Colorado and Wyoming* (abstract), Wyoming Geological Association, April Newsletter;

quarterly minerals updates for the University of Wyoming's *Wyoming quarterly update*; slightly revised mineral updates for the Survey's February and June issues of *Minerals outlook for Wyoming*; and two free information circulars entitled, *Field guide to some common rocks and minerals of Wyoming*, and *Diamond-bearing kimberlite pipes in Wyoming and Colorado*.

Several papers prepared in FY 83 are scheduled for publication in FY 84 or early FY 85: (1) *Reconnaissance and economic geology of the Copper Mountain metamorphic complex, Owl Creek Mountains, Wyoming* (abstract only) in the American Association of Petroleum Geologists Abstracts and (2) the same paper in full in Wyoming Geological Association's 34th Annual Field Conference Guidebook; (3) *Road log for a portion of southeastern Wyoming, (stratigraphy, tectonics, and economic geology)*, 1983 RMAG Guidebook; (4) *Self-guided tour to the geology of a portion of southeastern Wyoming*, Geological Survey of Wyoming Public Information Circular No. 21; (5) *Metallogeny of some Wyoming deposits*, Colorado Mining Association 1983 Yearbook; (6) *Wyoming gold*; (7) *Diamond-bearing kimberlite pipes in Wyoming and Colorado*; (8) and *Field guide to some common rocks and minerals of Wyoming*, all in Rocks and Minerals Magazine; and (9) *Radioactive occurrences and uranium mines of Wyoming*, Geological Survey of Wyoming Bulletin 64.

The Section presented talks to the Wyoming Geological Association's 33rd Annual Field Conference, in 1982; the Wyoming Geological Association's weekly luncheon; the 86th National Mining Convention; the Laramie Rockologists; the Wyoming Historic Preservation Society; the University of Wyoming Engineering Department; the University of Wyoming Geology Department, and the Casper Chapter of the Association of Women Geoscientists.

The Section also prepared a poster session on kimberlite exploration activities for the University of Wyoming's engineering fair, and responded to requests by the Wyoming State Museum to aid in the design and construction of mineral exhibits. The State Museum also appointed W. Dan Hausel as the Associate Curator of Mineralogy to aid in the collection and descriptions of Wyoming rocks and minerals.

Oil and Gas Section (Alan J. Ver Ploeg)

The Oil and Gas Section functions as a principal source of geologic information on Wyoming's

oil, natural gas, and oil shale deposits. As such, the section provides technical assistance and advice to other State agencies on oil and gas matters. In this regard, the Section prepared a forecast of future oil and gas production and value per unit for the Legislative Services Office. All new oil and gas discoveries were routinely evaluated with regard to State mineral ownership and discoveries on or near State lands were reported to the Commissioner of Public Lands on a weekly basis.

In addition, the Section also maintains a library of petroleum related data and conducts independent investigations on hydrocarbon-bearing deposits in the State. Throughout FY 83, the Section received and filed substantial amounts of new subsurface information provided by the petroleum industry and directed to the Survey through the Wyoming Oil and Gas Conservation Commission. In addition, numerous electric logs were donated to the Survey by oil companies and private consultants. These logs were incorporated into the well log library, filling gaps in the collection.

Field investigations of the Trapper Canyon tar sand deposit southeast of Shell in Big Horn County continued in FY 83. Although this project is sponsored by the U.S. Department of Energy's Laramie Energy Technology Center, funding is through the University of Wyoming's Industrial Fund (\$23,177 in FY 83). The project included sampling and describing the deposit as well as mapping the geology of the Bush Butte Quadrangle while looking for additional deposits. Work on the project will be completed in early FY 84.

In addition, the Section completed a tight gas sand study on subcontract (\$20,000) with the Texas Bureau of Economic Geology. The project involved looking at the depositional environments of the Upper Cretaceous Frontier Formation and Mesaverde Almond Formation in the Greater Green River Basin. Cross sections were constructed illustrating the stratigraphic characteristics of each unit. Also, the engineering characteristics of the two sands were examined using electrical well logs, specifically various porosity logs. A map showing the location of oil and gas fields, producing formations, and tight gas sand application areas was constructed. The results were combined with additional work done on tight gas sands by the Texas Bureau of Economic Geology, and a report was submitted to the Gas Research Institute (source of funding for the project).

Work was initiated in late FY 83 on a new updated oil and gas map of Wyoming. The new

map (scale = 1:500,000) will be completed in FY 84. The Section also provided petroleum outlook articles for the University of Wyoming's *Wyoming quarterly update* publication, published in the spring, summer, fall and winter. Slightly revised versions of these outlook articles were published in the Geological Survey's *Minerals outlook for Wyoming* (February and June issues).

Stratigraphy Section (Rodney H. DeBruin)

The Stratigraphy Section functions as a principal source of information on the stratigraphy and general geology of Wyoming both to the other sections of the Survey as well as to outside inquirers. The Section maintains a library and file of stratigraphic data and conducts stratigraphic as well as other geologic investigations.

In FY 83, this Section collaborated with the Oil and Gas Section on a tight gas sands study subcontracted from the Texas Bureau of Economic Geology (\$20,000 grant). This work was incorporated into a report to the Gas Research Institute. Also in conjunction with the Oil and Gas Section, work continued on a characterization study of the Trapper Canyon tar sand deposit in the Bighorn Basin.

Work is continuing on a series of index maps which depict geologic mapping in the State. Three more were completed in FY 83 and will be published as Map Series MS-9D, MS-9E, and MS-9F in early FY 84. Most of the pictures have been taken and much of the research has been done for a *Stratigraphic atlas of the Bighorn Basin*. Work was also started on a *Stratigraphic atlas of the Laramie Basin*. Additional stratigraphic atlases will follow the completion of these two.

Five completed geological quadrangle maps in the Bighorn Basin were solicited from the Iowa State University's Geology Department. Once the maps are submitted to the Geological Survey, they will be edited and prepared for publication. In anticipation of siting the MX missile in Wyoming, a comprehensive reference list for the geology of southeastern Wyoming was prepared.

Other ongoing projects include (1) the overseeing of coding and data entry for the Survey's computer programs for petroleum data, and (2) the acquisition of all pertinent publications on Wyoming geology.

Uranium and Industrial Minerals Section (Ray E. Harris)

The Uranium and Industrial Minerals Section is

a major source of information and research on uranium and thorium, trona, bentonite, phosphate, limestone, gypsum, zeolites, sand and gravel, other industrial minerals, and rare earth elements. Because this Section is new in FY 83, some of the Section's activities were directed toward establishing a base of information and prioritizing long- and short-term research projects in these commodities. Numerous requests for information were answered during FY 83 from citizens, universities, industry, and State and Federal governments. Research projects were initiated in uranium, thorium, rare earth elements, bentonite, talc, and zeolite geology and mineralogy.

During FY 83, the Land Quality Division of the Wyoming Department of Environmental Quality (DEQ) requested an investigation of Wyoming Mineral Corporation's Irigary uranium *in situ* leach project. Some detailed cross sections were constructed to determine the continuity of shale units that confine the leach solutions to the ore zone. This information, completed in August, was used by the DEQ to determine environmental constraints on the project.

The Section continued preparation of a new bulletin on radioactive minerals in Wyoming, begun by the Metallic Minerals Section in FY 82. New occurrences were added to the bulletin and the introductory technical chapters were written this year.

A study of unconformity-related uranium occurrences in Wyoming was begun in FY 83. This type of uranium occurrence hosts the world's largest producing deposits (in Canada and Australia), and several uranium occurrences in Wyoming are of this type. Some results of this ongoing study were described in a talk at the Wyoming Geological Association's Annual Spring Conference. An extended abstract of this talk was published in Geological Survey of Wyoming Public Information Circular 19. Individual occurrences of this type will be described in the new bulletin mentioned above. This bulletin should be released in FY 84 or early FY 85.

A report on the uranium deposits of the Morton Ranch Area, Converse County, was completed during FY 83. In addition, the compilation of a map of background radiation levels in Wyoming was begun. This map will provide information on naturally occurring radiation levels from rocks, soils, and cosmic radiation, and will eventually be published at a scale of 1:500,000. The Section also compiled a map of the Bear Lodge Mountains alkaline complex (Crook County). The alkaline complex, north of Sundance,

contains large thorium and rare earth element resources, and some uranium resources.

Other studies begun in FY 83 included (1) mineral identification and semiquantitative analyses of rare earth element occurrences in the northern Bighorn Mountains; (2) descriptions of the geology, mineralogy, and industrial potential of zeolite minerals in Wyoming; (3) geographic and geologic variations in bentonite properties throughout Wyoming; and (4) descriptions of talc occurrences in Wyoming. This latter project is being assisted by the University of Wyoming Department of Anthropology. Information from these studies will be used for a future bulletin on industrial mineral occurrences, production, and geology in Wyoming, and to revise the 1979 *Mines and minerals map of Wyoming*.

This Section, together with the Metallic Minerals Sections, chaired the Ore Genesis Session of the Wyoming Geological Association's Annual Spring Conference, and edited the abstracts of the talks which were published as Public Information Circular 19. The session was very successful, with about 300 participants in attendance.

The Uranium and Industrial Minerals Geologist authored or coauthored several in-house publications or articles in FY 83: *Bedrock geologic map of the alkaline complex of the Bear Lodge Mountains, Crook County, Wyoming*, published as Open-file Report 83-3; edited *Genesis and exploration of metallic and nonmetallic mineral and ore deposits of Wyoming and adjacent areas*, published as Public Information Circular No. 19; *The genesis of Canadian and northern Australian unconformity uranium deposits — Wyoming exploration significance*, (extended abstract) in Public Information Circular No. 19; and uranium and industrial minerals outlooks in the February and June issues of *Wyoming minerals outlook*.

Outside articles published in FY 83 included a summary of uranium exploration activities for Wyoming for the Society of Mining Engineers' *Mining engineering magazine* and uranium and industrial minerals outlooks in fall, winter, summer, and spring issues of the University of Wyoming's *Wyoming quarterly update*.

In addition, the following publications were written in FY 83 for publication in FY 84: *Metallogeny of some Wyoming deposits*, for the Colorado Mining Association's 1983 Yearbook; *Uranium and thorium in the Bighorn Basin, Wyoming*, for the Wyoming Geological Association's 34th Annual Field Conference Guidebook; and *Alteration and mineralization associated with*

sandstone uranium occurrences, Morton Ranch area, Wyoming, for publication as a Geological Survey of Wyoming Report of Investigations.

Publications

The Publications Program of the Survey is simply a means of communicating some of the geological information collected and interpreted by the professional staff to the public at large. Publications, however, should be viewed as an integral part of the Survey's overall service function as stipulated by law (9-2-805, part a, subsections iv and v).

Through the years, the Publications Budget has changed. Originally, it was designed to provide funds to pay for just the printing and distribution of the agency's publications and maps for resale. As the scope and volume of investigations and the style of reports and maps changed, changes were also made in the budgeting procedure. New line items were added for other kinds of supplies and services that were more closely related to publications than to the Administration Program. In FY 79, the salaries of two clerical employees were shifted over from administration to publications. The Publications Budget in FY 83 was \$108,198.

All publication contracts and other expenditures are geared to the funds available for any given biennium. There is always a backlog of material that cannot be published in any given year because of publication cost, which in turn is dependent upon the characteristics of the material (size, color, black and white, etc.), and the volume to be printed, type of binding, and whether it requires typesetting or can be photocopied.

The priorities as to what material will be published and what will not are established by the State Geologist after consultation with the editor and the professional staff.

A separate part of publications sales is budgeted as "Purchases for Resale". This is simply a separate mechanism to make available special publications and maps published by the U.S. Geological Survey or similar organizations that have an appeal to Wyoming citizens or tourists. It is in effect another type of geological service.

In the last two fiscal years, the publications sales staff responded to 7,995 (FY 82) and 6,482 (FY 83) requests for publications. This is a decline from the record 11,119 inquiries in FY 81, but is similar to requests in FY 80 (7,500), and reflects a leveling off due to recessionary pressures. A percentage breakdown of publication customers in FY 83 is:

Category	Percent of Customers	Percent of Sales Revenue
General Public	72%	45%
Business and Industry	22%	39%
Wyoming and Local Agencies	1%	6%
Federal and other States	1%	2%
Universities	4%	8%

Revenues generated from the sale of publications are deposited in the General Fund. Weekly tallies are reported to the State Geologist, and quarterly tally reports are submitted to the Advisory Board showing monthly income totals and the number of each type of report or map sold. Prices for individual items are based on fifteen years of experience and the nature of the item. Some publications are highly scientific or technical and have a limited market, others, are specifically written for the general public.

In every instance, biennial budget requests for printing funds have been geared to revenue collected from the sale of publications during the two previous years. In other words, the funds requested of the legislature for commercial printing costs are already on deposit in the General Fund. As a general rule, sales income had been increasing at the rate of \$6,500/year until FY 81. Sales income in FY 81, however, increased a phenomenal \$51,799 over FY 80. With the recession, sales have declined substantially, but are now in line with the traditional \$6,500/year historical increase. It is possible that slumping sales will turn around by the end of FY 84 and increase to \$76,500 in FY 85 and \$83,000 by FY 86.

All publications of the Geological Survey are distributed free of charge to the libraries and archives throughout the State. Limited numbers of each publication are also provided to other State agencies and branches of government and to elected officials and school teachers on request. In addition, the Survey participates in publication exchange programs with all other state geological surveys, numerous foreign geological surveys, the U.S. Geological Survey, and the U.S. Bureau of Mines.

Although many publications are sold over-the-counter, the bulk of the sales are phone or mail orders. In addition, some of the mailed items require specialty rates because of size, weight, or shape of the item.

In addition to editing and laying-out reports and maps prepared by the Survey's professional staff, the editorial, drafting, and publications staff write and prepare some in-house reports on their

own. In particular, bibliographies, publication lists, reprints, and some information circulars are done solely by the publications staff. Editing and manuscript preparation of reports and maps submitted for publication by outside authors routinely require above average efforts by this staff. In FY 83, for example, eight outside manuscripts were revised to ensure they conform to Survey

standards before they were published by the agency.

The two graphs in Figure 5 summarize the general subject matter of in-house Survey publications and the number of new publications completed each decade.

A complete listing of reports and maps published in FY 83 is provided on pages 8 to 10.

GENERAL CONTENT OF SURVEY PUBLICATIONS FROM 1911 THROUGH 1982

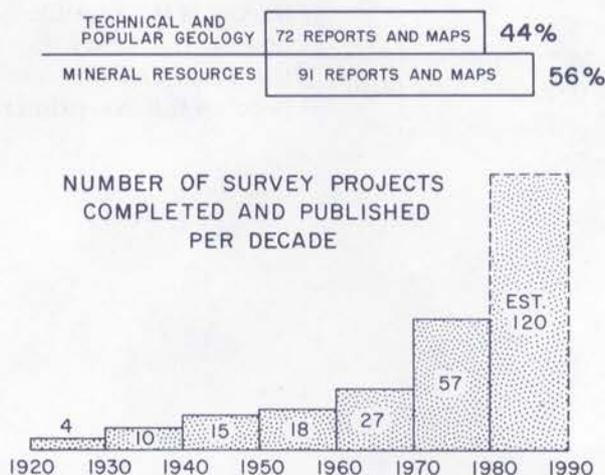


Figure 5. General content of publications and number of publications per decade.

PROBLEM AREAS AND RECOMMENDATIONS

1. There is still a need for a State Minerals Supervisor. In essence, this Minerals Supervisor would be comparable to Wyoming's Oil and Gas Supervisor with responsibility for verifying production reports, preventing waste, and promoting conservation of the State's mineral resources, exclusive of oil and gas. In particular, there is no State agency currently assessing mining and exploration activities on State-owned lands.

It is recommended that the responsibility and authority for such a position be assigned to the Board of Land Commissioners. Alternatively, it appears that the Board of Land Commissioners may already have the authority to direct the State Geologist to make such appraisals at least on State or school lands through Wyoming Statutes § 9-2-803, Paragraph (c), part (i). This alternative would require at least one additional full-time position in the Geological Survey.

2. With revenues from Wyoming's mineral industry leveling off or at least growing more slowly, forecasting of future tax revenues has become more important and more difficult. These forecasts, particularly on the short term, would be much more accurate and timely if the State were receiving monthly mineral production reports. Quarterly reports are less desirable, but certainly better than no reports at all. Although the Oil and Gas Conservation Commission already receives monthly reports for oil and gas production, there is apparently no similar requirement for any other minerals produced in Wyoming.

As an alternative to changing State reporting procedures, which may be the preferable action, Federal agencies have numerous reporting forms that could be supplied to the State as well. In particular, the Energy Information Administration of the U.S. Department of Energy collects monthly

data on oil, natural gas, coal, and uranium and the U.S. Bureau of Mines collects similar monthly data on nonfuel mineral production. Although much of this data is "confidential", the State could honor that confidentiality requirement as fully as the Federal agencies. Implementing this alternative would undoubtedly require the support of both the Governor and Wyoming's Congressional Delegation. It would also avoid duplication of effort.

3. In response to declining State revenues, all agency budgets were cut in FY 84 and biennial budgets for FY 85-86 were allowed little or no growth.

The point is that there are some agencies whose importance to the recovery and long term

stability of the State's economy is magnified by "bad times". The Geological Survey is such an agency since its services, investigations, and publications keep the State's mineral resources in view where industry might be enticed into beginning or renewing exploration and eventual production. While cutting or freezing the budgets for such agencies may realize some small savings, long term losses resulting from scaled down Survey activities may far overshadow these short term gains.

Unfortunately, it is hard to quantify the effect of the Survey's "no growth" Biennial Budget for FY 85-86. The biggest concern to the Geological Survey is the possible loss of experienced personnel due to the salary freeze. It is hoped that across-the-board budget cuts and freezes in salary might become the exception rather than the rule.