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

FIFTY-FIRST ANNUAL REPORT

of the

GEOLOGICAL SURVEY OF WYOMING

for Fiscal Year 1984
July 1, 1983 to June 30, 1984

by

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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 encumbent, 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

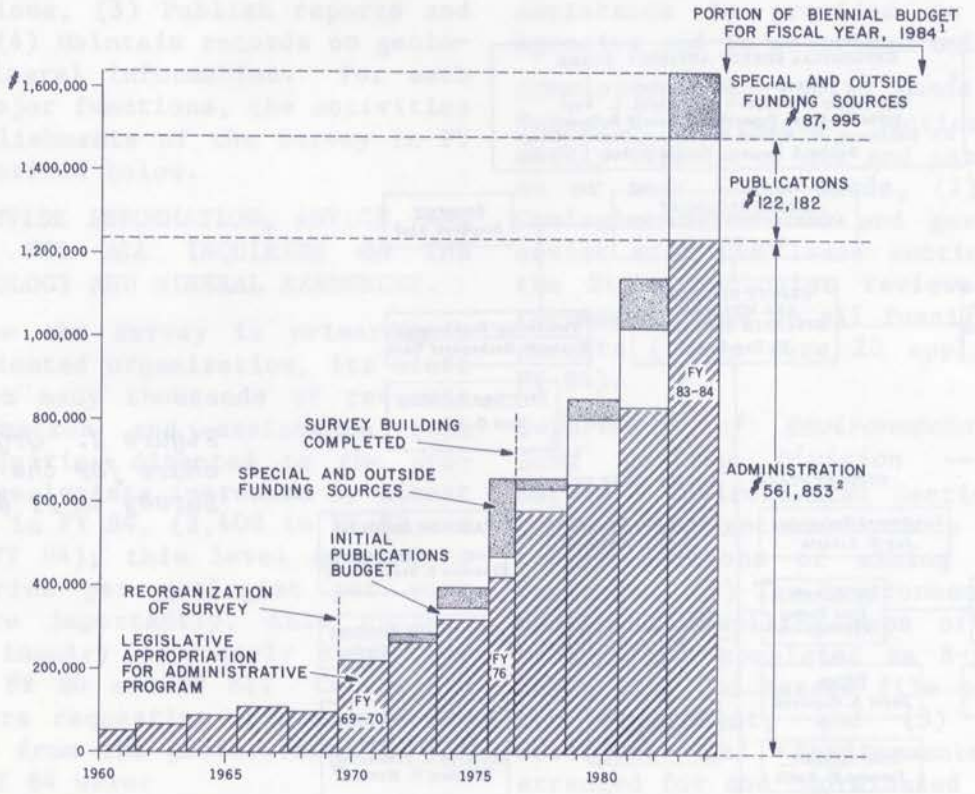


Figure 1. Biennial budgets for the Geological Survey (Expenditures for FY 84 are annotated to the right of the biennial budgets; [1]$27,099 or 4% of the combined Administrative and Publications budgets were reverted back to the General Fund in FY 84; [2]This includes a $10,000 appropriation for capital improvements to install a fume hood in the Geological Survey of Wyoming Building.

agency publishes and distributes reports and maps that communicate the results of its investigations.

4. *Maintain files and libraries on 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.

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 84.

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.

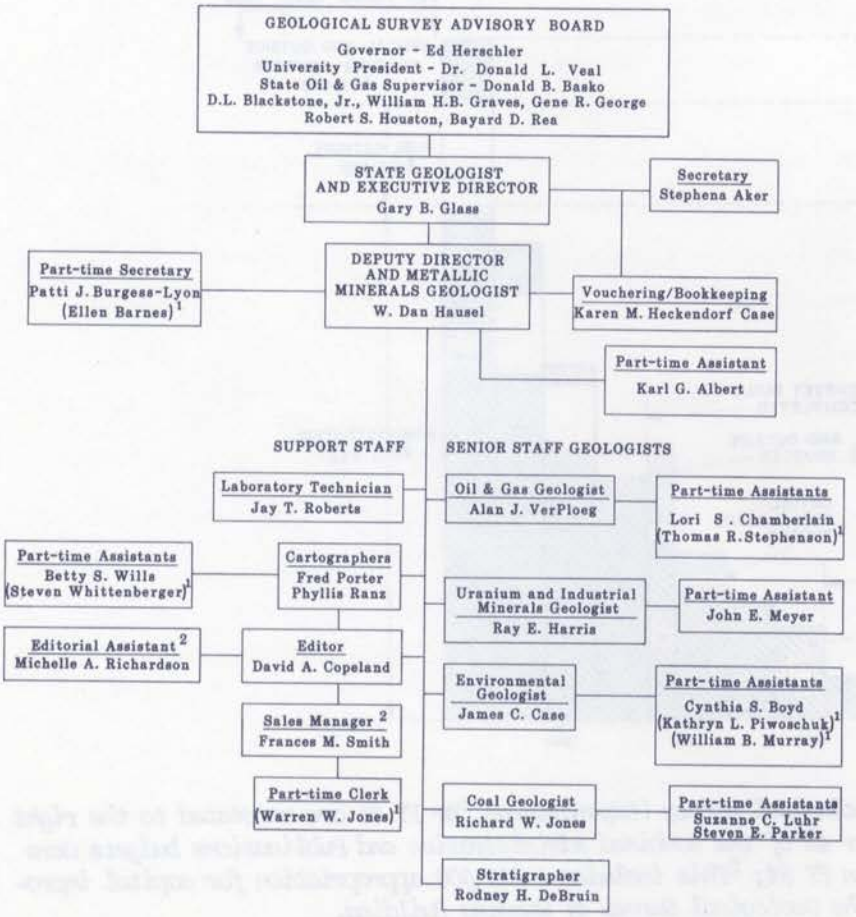


Figure 2. Organization chart for the Geological Survey in FY 84.

[1] These personnel terminated their employment before the end of FY 84.
[2] These positions are paid out of the Publications Program.

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 chief 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.

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 material (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 1984

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 on geologic and mineral information. For each of these major functions, the activities and accomplishments of the Survey in FY 84 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. Inquiries directed to the professional geologists increased by almost 13 percent in FY 84, (3,408 in FY 83 and 3,846 in FY 84); this level equates to 2.1 inquiries per geologist per work day. More importantly, this current level of inquiry is nearly twice the levels of FY 80 and FY 81. Categories of inquirers requesting information and assistance from the professional geologists in FY 84 were:

Category	Percentage
General Public	21%
Business and Industry	34%
Wyoming and Local Agencies	15%
Federal and Other States	13%
Universities	17%

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 ranks oil and gas tracts to assist with the lease auction, and (3) the State Geologist reviews and makes recommendations on all fossil collecting permits (there were 20 applications in FY 84).

Department of Environmental Quality, Land Quality Division -- (1) The Survey's Environmental Section provides reviews and recommendations on paleontology portions of mining plans when requested, (2) The Environmental Section continued compiling maps of geological hazards and completed an 8-page report describing the hazard file prepared for the Department, and (3) the State Geologist and Environmental Section arranged for and coordinated the removal of dinosaur bones found in an active coal mine in southwestern Wyoming so that mining could continue.

State Planning Coordinator and Governor's Clearinghouse -- Various sec-

tions of the agency reviewed 93 documents in FY 84 and submitted written comments on 17. These were the Upper Platte River study; Washakie Resource Management Plan - Issues and Criteria; Platte River Area Resource Management Plan; Powder River Basin Coal Leasing - Round 2; Road Hollow Gas Plant; Riley Ridge Natural Gas Project (3 sets of comments); Gulf's Granite Ridge exploration well in Sheridan County; Bureau of Land Management's proposed FY 84 sale acreage; Green River Hams Fork Coal Leasing - Round 2; Union Pass/Green River Connecting Road; Management of Stage II Roads; Resource Management Plan for Bighorn Canyon National Recreation Area; Colorado River Water Quality Improvement Program - Big Sandy; Thermopolis-Alcova-Casper Transmission Line; and Salt Wells-Pilot Butte Grazing Study.

Industrial Siting Administration -- Various sections of the Survey reviewed and commented on siting applications for Exxon's LaBarge Project and Amoco's East Anschutz Ranch Project.

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 few 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 1 1/2 to 2 days long. Special hearings in addition to the regular hearing dates are also becoming commonplace. By the end of FY 84, 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 84, but is not all inclusive:

Board of Charities and Reform -- In FY 84, a consulting firm hired by the Board installed a monitoring and metering system at Hot Springs State Park. The State Geologist attended several meetings and visited the Park in response to complaints that the meters were not functioning properly and that water delivered to the users was dirty. It was noted that a new 8-inch user pipe had been installed west of the access road and much further from Big Spring than anticipated. Later it was also learned that the installed meters were unsuitable for measuring high temperature waters. The State Geologist offered to examine the situation, but the Board voted to restore the 12-inch user pipe at the mouth of the spring. By summer, the metering devices on both the canals had been removed. Responsibility for the Park reverts to the Recreation Commission in FY 85.

Department of Administration and Fiscal Control, Research and Statistics Division -- The State Geologist provided historical production and price information on coal, oil, natural gas, trona, and uranium for use by the Division.

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 by compiling information and maps on landslide-prone areas and earthquake-prone areas in Wyoming.

Highway Department -- The Coal Section

provided an overview discussion of Wyoming coal deposits and mine-specific data for inclusion in the Department's publication *Coal mining in Wyoming*.

Lincoln County -- The Environmental Section briefed the County's Planning Office on geological hazards in the southern half of Lincoln County.

Uinta County -- The Environmental Section provided a preliminary report on geological hazards for the County's Master plan and briefed the Planning Office on geological hazards in Uinta County.

U.W. Department of Geology and Geophysics -- The Oil and Gas Section provided an evaluation of an oil and gas tract donated to the University of Wyoming.

U.W. Institute of Policy Research -- Various sections of the Survey provided quarterly mineral update articles for the *Wyoming Quarterly Update*.

In addition, the Survey staff received requests for assistance or information from the Ad Valorem Tax Division, Archives, Museums, and Historical Department, Attorney General, Employment Security Commission, Game and Fish Department, Governor's Office, Inspector of Mines, Occupational Health and Safety, Public Service Commission, Recreation Commission, State Archaeologist, State Auditor, State Engineer, State Forester, Water Development Commission, and Water Quality Division, Department of Environmental Quality.

As an extension of this service-related function, the Survey's professional staff also presented twenty-one talks or briefings on mineral resources, geology, or geological hazards to the following groups: American Association of Petroleum Geologists (Rocky Mountain Section) (two); American Mining Congress; Colorado School of Mines' Field Institute for Journalists and the Field Institute for Congressional and Executive Aides; Natrona County Gem and Rock Show; National Convention of Extension Homemakers; Rocky Mountain Association of Geologists; Stoney Brook University Geology Field Camp; United Wyoming Residents of Albany County; University of Texas at El Paso's Geology Department; Wyoming Geological Association (two); Wyoming Historical Preservation Society; and the Wyoming Mining Association's Teacher Workshops (three).

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 84:

(1) A reconnaissance study of landslides in the Little Granite Creek area of Teton County.

(2) A characterization study of the Trapper Canyon tar sand deposit in the Bighorn Basin.

(3) A detailed study of the geology and mineral occurrences of the Copper Mountain area of Fremont and Hot Springs Counties.

(4) The *Oil and Gas Map of Wyoming* was revised and is in press.

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 and the Coal Section.

(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) Reconnaissance survey of Wyoming's reported tar sand and heavy oil occurrences.

(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) Compilation and coding of coal data from the Bighorn and Wind River Basins for entry into the U.S. Geological Survey's National Coal Resources Data System.

(9) Landslide research and mapping in the Little Mountain area of Sweetwater County and the Blacks Fork River area of Uinta County.

(10) Reconnaissance study of the South Pass supracrustal belt, Fremont County.

(11) Field study of nonconformity-related uranium occurrences in Wyoming.

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 37 reports and maps were published in FY 84:

ANNUAL REPORTS

50th Annual report of the Geological Survey of Wyoming for Fiscal Year 1983, by G.B. Glass, (1983).

BULLETINS

Bibliography of Wyoming geology, 1960-1969: Bulletin 64, by Charlotte Tancin, (1984).

INFORMATION CIRCULARS

Geology of Wyoming, by G.B. Glass and D.L. Blackstone, Jr., (1984).

Hints for rock hunting and prospecting in Wyoming, by W.D. Hausel (revised, 1984).

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

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

Wyoming jade, by F.K. Root, (reprinted 1983).

MAP SERIES

Index to U.S. Geological Survey coal resource occurrence and coal development potential open-file reports in Wyoming: MS-9A, Compiled by G.B. Glass, (revised 1984).

Index to U.S. Geological Survey Geologic Quadrangle Maps (GQ) in Wyoming: MS-9B, Compiled by R.H. DeBruin (revised 1984).

Index to U.S. Geological Survey Miscellaneous Field Studies Maps (MF) in Wyoming: MS-9C, Compiled by R.H. DeBruin (revised 1984).

Index to U.S. Geological Survey Miscellaneous Investigations Maps (I) in Wyoming: MS-9D, Compiled by R.H. DeBruin (1983).

Index to U.S. Geological Survey Hydrologic Investigations Atlases (HA) in Wyoming: MS-9E, Compiled by R.H. DeBruin (1983; revised 1984).

Index to U.S. Geological Survey Water Supply Paper maps in Wyoming: MS-9F, Compiled by R.H. DeBruin (1983).

Index to selected U.S. Geological Survey Bulletins that contain geologic maps for Wyoming: MS-9G, Compiled by R.H. DeBruin, (1984).

Index to selected U.S. Geological Survey Professional Papers that contain geologic maps for Wyoming: MS-9H, Compiled by R.H. DeBruin, (1984).

OPEN FILE REPORTS

Subsurface temperatures in northeastern Wyoming measured by bottom

hole temperature records: OFR 83-4, by K.T. Kilty, (1983).

Almond and Frontier tight gas sand cross sections, Greater Green River Basin, Wyoming: OFR 83-5, by A.J. VerPloeg, R.H. DeBruin, R.L. Oliver, and Michael Clark, (1983).

Preliminary map of landslides and windblown sand deposits on the Wyoming half of the Ogden 1°x2° topographic map: OFR 84-1, by J.C. Case, C.S. Boyd, W.B. Murray, and K.L. Piwoschuk, (1984).

Preliminary map of landslides and windblown sand deposits on the Wyoming half of the Preston 1°x2° topographic map: OFR 84-2, by J.C. Case, C.S. Boyd, W.B. Murray, and K.L. Piwoschuk, (1984).

Preliminary map of landslides on the Driggs 1°x2° topographic map: OFR 84-3, by J.C. Case and K.L. Piwoschuk, (1984).

Preliminary map of landslides and windblown sand deposits on the Rock Springs 1°x2° topographic map: OFR 84-4, by J.C. Case, C.S. Boyd, W.B. Murray, and K.L. Piwoschuk, (1984).

Preliminary map of landslides and windblown sand deposits on the Lander 1°x2° topographic map: OFR 84-5, by J.C. Case, C.S. Boyd, W.B. Murray, and K.L. Piwoschuk, (1984).

Preliminary map of landslides on the Thermopolis 1°x2° topographic map: OFR 84-6, by J.C. Case, K.L. Piwoschuk, and W.B. Murray, (1984).

Preliminary map of landslides on the Cody 1°x2° topographic map: OFR 84-7, by J.C. Case, K.L. Piwoschuk, and W.B. Murray, (1984).

Preliminary map of landslides and windblown sand deposits on the Rawlins 1°x2° topographic map: OFR 84-8, by J.C. Case, C.S. Boyd, and W.B. Murray, (1984).

Preliminary map of landslides and windblown sand deposits on the Casper 1°x2° topographic map: OFR 84-9, by J.C. Case and C.S. Boyd, (1984).

Preliminary map of landslides on the Sheridan 1°x2° topographic map: OFR 84-10, by J.C. Case, K.L. Piwoschuk, and W.B. Murray, (1984).

Preliminary map of landslides and windblown sand deposits on the Gillette 1°x2° topographic map: OFR 84-12, by J.C. Case and K.L. Piwoschuk, (1984).

PUBLIC INFORMATION CIRCULARS

Road log, Jackson to Dinwoody and return: PIC No. 20, by J.D. Love, and J.M. Love, (1983).

Self-guided tour of the geology of a portion of southeastern Wyoming: PIC No. 21, by W.D. Hausel and R.W. Jones, (1984).

Oil shale sample locations and analyses, southwest Wyoming and northwest Colorado: PIC No. 22, by D.J. Sinks, L.G. Trudell, and G.F. Dana, (1983).

Tour guide to the geology and mining history of the South Pass gold mining district, Fremont County, Wyoming: PIC No. 23, by W.D. Hausel, (1984).

REPORT OF INVESTIGATIONS

Alteration and mineralization associated with sandstone uranium occurrences, Morton Ranch area, Wyoming: RI No. 25, by R.E. Harris, (1984).

Geothermal resources of the Laramie, Hanna, and Shirley Basins, Wyoming: RI No. 26, by B.S. Hinckley and H.P. Heasler, (1984).

REPRINT SERIES

Metallogeny of some Wyoming deposits: Reprint 44, by W.D. Hausel and R.E. Harris, (1983).

WYOMING GEO-NOTES

No. 2: by G.B. Glass, A.J. VerPloeg, W.D. Hausel, R.E. Harris, and R.W. Jones, (March, 1984).

No. 3: by G.B. Glass, A.J. VerPloeg, R.E. Harris, R.W. Jones, and W.D. Hausel, (June, 1984).

The following eight publications are

already in preparation for publication in FY 85 or early FY 86:

BULLETINS

Paleontology of the Green River Formation, with a review of the fish fauna: Bulletin No. 63, by Lance Grande (revised 1984).

MAP SERIES

Oil and gas map of Wyoming: MS-12, by T.R. Stephenson, A.J. VerPloeg, and L.S Chamberlain.

Tectonic map of the Black Hills, Wyoming, Montana, and South Dakota: MS-13, by A.L. Lisenbee.

Mines and minerals map of Wyoming: by R.E. Harris and W.D. Hausel.

MEMOIRS

Precambrian uranium-bearing quartz-pebble conglomerates: by R.S. Houston and K.E. Karlstrom.

REPORT OF INVESTIGATIONS

Analyses and measured sections of 25 coal samples from the Hanna Coal Field of southcentral Wyoming: RI No. 27, by G.B. Glass and J.T. Roberts.

Economic geology of the Copper Mountain supracrustal belt, Fremont County, Wyoming: by W.D. Hausel, P.J. Graff, and K.G. Albert.

REPRINT SERIES

A field guide to the Casper Mountain area: Reprint No. 45, Edited by P. Knittel, (1978).

In addition, the State Geologist and/or the staff geologists also prepared or had published the following 15 papers and reports for outside publishers:

American Association of Petroleum Geologists, Abstracts for AAPG-EMD Rocky Mountain Section Meeting, September 18-21, 1983, Billings, Montana: *Reconnaissance and economic geology of the Copper Mountain metamorphic complex, Owl Creek Mountains, Wyoming*, by W.D. Hausel and P.J. Graff, (1983); *Update on coal in Bighorn Basin, Montana and Wyoming*, by R.W. Jones, (1983).

American Association of Petroleum, Geologists, Bulletin v. 67, no. 10: *Developments in coal in 1982*, by S.A. Friedman, R.W. Jones, and M.L.W. Jackson, (1983).

American Institute of Mining and Metallurgical Engineers, Black Hills Section Meeting, September, 1984: *Economic geology of the Colorado-Wyoming kimberlite province*, by W.D. Hausel, and J.T. Roberts, (in press); *Overview of Wyoming coal developments*, by R.W. Jones, (in press).

American Mining Congress, Abstracts for 1983 Annual Meeting, San Francisco, California: *A review of the geology, exploration methods, and diamond extraction techniques of Colorado-Wyoming kimberlites*, by W.D. Hausel and K.G. Albert, (1983).

International Symposium on Remote Sensing of the Environment, Third Thematic Conference, Remote Sensing for Exploration Geology, April 16-19, 1984, Colorado Springs, Colorado: *Detection of diamond-bearing kimberlites in the Colorado-Wyoming province*, by R.W. Marrs, J.E. Marks, W.D. Hausel, and K.G. Albert, (1984).

Rocky Mountain Association of Geologists, 1983 Field Conference Guidebook, Rocky Mountain Foreland Basins and Uplifts: *[Geologic road log] Colorado-Wyoming line to Laramie, Rawlins, and Steamboat Springs*, by W.D. Hausel and R.W. Jones, (1983).

Society of Mining Engineers, Mining Engineering, v. 36, no. 5: *Wyoming [Exploration in 1983]*, by R.W. Jones, W.D. Hausel, and R.E. Harris, (1984).

U.S. Bureau of Mines Preprint from the 1982 Minerals Yearbook: *The mineral industry of Wyoming*, by K.R. Starch and G.B. Glass, (1984).

University of Wyoming, Institute for Policy Research's Wyoming Quarterly Update: Minerals outlook, by G.B. Glass, A.J. VerPloeg, W.D. Hausel,

R.E. Harris, and R.W. Jones (four quarterly summaries, two in 1983 and two in 1984).

Wyoming Geological Association, 1984 Annual Field Conference Guidebook: *Minerals in Permo-Pennsylvanian rocks in Wyoming*, by R.E. Harris, and W.D. Hausel, (in press).

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

In FY 84, the Agency (1) enlarged its oil and gas well log file by soliciting files offered by oil companies and private consultants, (2) enlarged its inventory of mapped and identified geologic hazards, particularly landslides, sand dunes, and mine subsidence, (3) examined and described in report from several hundred mineral occurrences across the State and (4) 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 84 were $48,878. With the $73,134 collected in FY 83, the total publication revenues for the 1983-1984 Biennium were $122,012. Although these revenues are approximately 33% 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, sales of Survey publications have correlated well with the activities of Wyoming's mineral industry.

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 $6,527.92 in FY 84.

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 service 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 form 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 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 totaled $87,995 in FY 84. Survey personnel completed or are completing work on 5 grants: 01.71 ($5,673.84 carryover from 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; 01.80 ($6,216.67 carryover from FY 83) for a characterization study of the Trapper Canyon tar sand deposit, funded by the University of Wyoming's Industrial Fund; 01.90 ($23,250.79 carryover from FY 83) for landslide characterization and mapping, funded by the U.S. Geological Survey; 01.81 ($19,107 in FY 84) for studying tar sand and heavy oil occurrences in Wyoming, funded by the University of Wyoming's Industrial Fund; and 01.50 ($33,747 in FY 84) to put coal data from the Bighorn and Wind River Basins into the National Coal Resources Data System, funded by the U.S. Geological Survey.

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.

MAJOR ACCOMPLISHMENTS BY PROGRAM

Administrative Program

General Fund appropriations for the Administrative Program were $551,853 in FY 84. 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 84, the professional staff of the agency to include the State Geologist provided service to more than 320 telephone, letter, and visitor inquiries each month (a 13% increase over FY 83); initiated or completed more than 14 separate field investigations; collected and analyzed numerous rock samples, including 163 mineral and rock identifications or analyses; and examined and filed hundreds of maps,

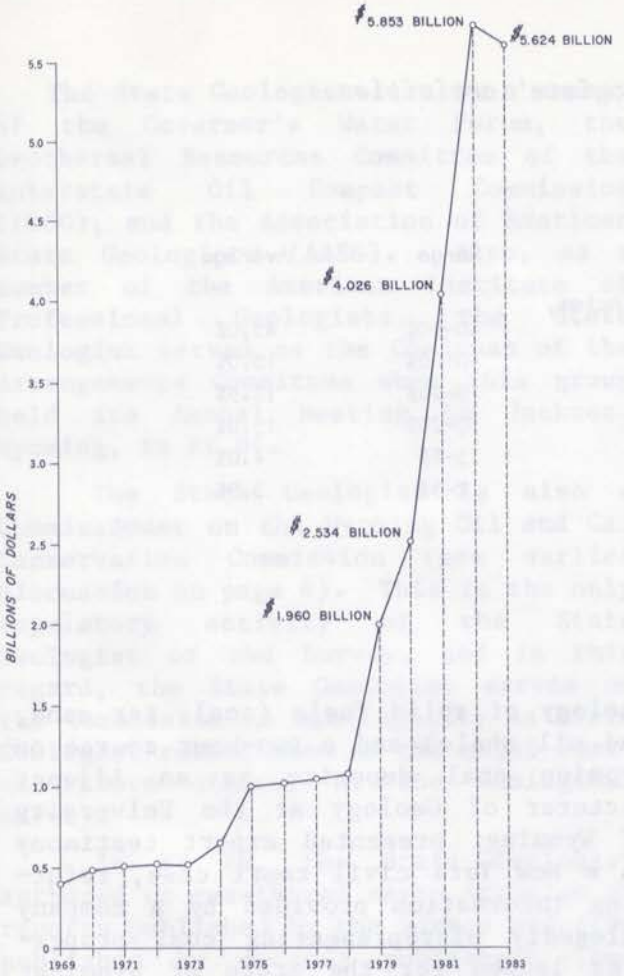


Figure 3. Assessed valuation of Wyoming's mineral production.

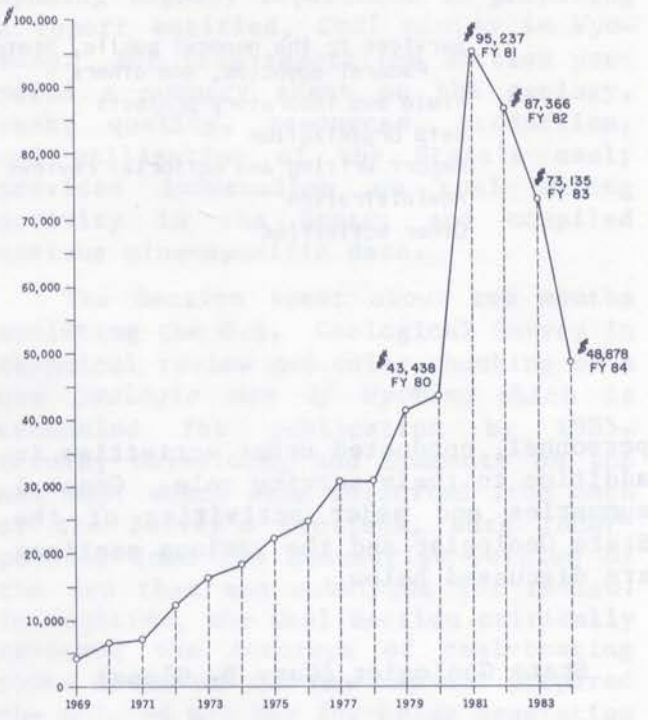


Figure 4. Annual fiscal year income from Survey publications.

aerial photographs, and subsurface geophysical logs. The agency also reviewed more than 94 documents related to industrial siting, mineral development, mining, government actions, and land-use planning. Survey personnel researched, edited, wrote, or prepared 37 publications, which were published by the Survey.

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.

As evidenced above, each of the staff geologists, with the help of part-time

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%

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 931 inquiries for assistance or information that were received in FY 84. 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 Johnson and Sheridan Counties; met with the Legislative Service Office to forecast mineral production and valuation; met with the Consensus Revenue Estimating Group to select revenue projects acceptable to both the Executive and Legislative branches of government; reviewed and made recommendations on 20 applications for fossil collecting permits and inspected six active and three proposed fossil collecting quarries near Kemmerer or Kaycee; 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 (coal, tar sand, and oil shale) and a two-hour course on Wyoming coal deposits as an Adjunct Lecturer of Geology at the University of Wyoming; presented expert testimony in a New York civil court case, refuting information provided by a company allegedly misrepresenting coal properties leased for the State of Wyoming; also provided information to the California Attorney General's Office, the Internal Revenue Service, and the Federal Bureau of Investigation in similar cases of alleged fraudulent activities involving State coal leases; and assisted in the review and criticism of 13 documents, which the U.S. Bureau of Land Management had prepared and which purportedly described the geology and mineral resources of some Wilderness Study areas, in Wyoming.

In this service-role, the following talks or briefings were also presented: talks on Wyoming's mineral industries and geology for the Colorado School of Mine's Field Institute for Congressional and Executive Aids at Laramie and Rocks Springs, for the Wyoming Mining Association's Teacher Workshop in Casper, and for a minerals seminar sponsored by the Department of Geology and Geophsyics in Laramie; and a talk on the natural gas situation in Wyoming for a citizen's group in Laramie.

The State Geologist is also a member of the Governor's Water Forum, the Geothermal Resources Committee of the Interstate Oil Compact Commission (IOCC), and the Association of American State Geologists (AASG). Also, as a member of the American Institute of Professional Geologists, the State Geologist served as the Chairman of the Arrangements Committee when this group held its Annual Meeting in Jackson, Wyoming, in FY 84.

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.

In FY 84, the State Geologist authored or coauthored seven articles or reports published by the Survey and five published by outside publishers (see pages 6 to 9). Another coal article for publication by the Survey was in press at the end of the fiscal year, and work was continuing on a bibliography of Survey publications and history of the Survey.

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 Chief in collaboration with the Metallic Minerals Section, participated in the Rocky Mountain Association of Geologists (RMAG) Field Conference in October, 1983. The two Sections led the Wyoming portion of the conference through the Laramie, Shirley, and Hanna Basins as the participants examined the stratigraphy, structure, and mineral resources of these areas. The Section also collaborated with the Wyoming Highway Department in preparing a report entitled, *Coal mining in Wyoming*. For this report the Section prepared a summary sheet on the geology, rank, quality, resources, production, and utilization of the State's coal; provided information on coal mining activity in the State; and compiled various mine-specific data.

The Section spent about two months assisting the U.S. Geological Survey in technical review and color checking of a new *Geologic map of Wyoming* which is scheduled for publication by 1985. Errors, omissions, and comments on the new map, which were solicited from each of the Survey's Sections, were incorporated into the manuscript version of the map that was submitted for review. In addition, the Coal Section critically reviewed the outcrops of coal-bearing rocks shown on the new map and prepared the colored map key for color separation of the coal-bearing rocks. The Section will use the new *Geologic map of Wyoming* as the geologic base for a new *Coal resources map of Wyoming*. Compilation of this new map, which will replace an outdated 1951 version, is in progress.

In November, 1983, the Section began work on a cooperative project with the U.S. Geological Survey to enter coal resource data from the Bighorn and Wind River Basins into their National Coal Resources Data System (NCRDS). This project is partially funded through a grant of $33,747 from the U.S. Geological Survey. The Section will enter all available stratigraphic and coal data, coal analyses, and coal resource information (including coal mine production) into NCRDS for these two basins. Eventually, the project will expand to other coal areas in the State. As part of this cooperative agreement, the grant is providing some field support to a graduate student's work on the Felix coal interval in the Power River Basin.

The Section continues to provide

expertise to the Environmental Section, other State agencies, industry, and the general public in regard to underground coal mine locations and subsidence features in the State. The Section retains and maintains an extensive file of underground coal mine maps, coal mine descriptions, historical data, and production figures for both active and abandoned coal mines in the State. The Section continues to investigate historical coal mining areas to document and map the locations of mines and to obtain photographs of these mining areas before all evidence of them disappears.

In addition, the Section Chief presented mineral and geologic briefings to the Colorado School of Mines Field Institute for Journalists, which toured southern Wyoming in FY 84, and authored or coauthored five articles or reports published by the Survey as well as another nine articles published by outside publishers (see pages 6 to 9).

Environmental Geology Section
(James C. Case)

The thrust of the Environmental Section's activities in FY 84 centered around mapping and analysis of geological hazards, with special emphasis on earthquake locations and occurrences, landslide genesis and locations, and windblown deposits. Areas with mine subsidence were further defined, and work was begun on locating previously unmapped active faults.

Overviews of geological hazards in the southern half of Lincoln County and all of Uinta County were prepared and presented to the planning agencies in those two counties. The Planning Offices in both counties were visited to more completely present and explain the material they received. A 20-page preliminary report on geological hazards in Unita County was given to the Uinta County Planning Office at that time.

Landslide mapping and delineation of unstable slopes is ongoing in Uinta County with a draft report on landslides and slope stability in the Blacks Fork River area scheduled for completion in FY 85. In addition, the Section is preparing a report on landslides in the Little Mountain area of Sweetwater County. That report will include an explanation of landslide mapping procedures and classification systems used by the Environmental Section. The Section is also working on a chart that depicts a Landslide Classification System for Wyoming; and the Section completed a map of landslides in the Little Granite Creek area of Teton County. This preliminary map is available for public inspection. Landslide mapping is partially supported by a grant from the U.S. Geological Survey.

Eleven preliminary maps at a scale of 1:250,000 (1°x2° sheets) which show landslides and windblown sand deposits for much of the State were made available as Open File Reports. These maps include previously unpublished information from Uinta, Sweetwater, Sublette, Lincoln, Teton, and Park Counties. Work was begun on a statewide 1:500,000 scale overview map of geological hazards.

An eight-page report on geological hazards was prepared for the Land Quality Division of the Department of Environmental Quality. This report described the types of information on geological hazards that are available from the Environmental Section and included an index map showing topographic maps in Wyoming on which at least some geological hazards have been identified and mapped.

Geologic hazard work was coordinated with Wyoming's Disaster and Civil Defense Agency. Specifically, information was compiled and generated on landslide-prone and earthquake-prone areas for various parts of the State as an aid to that agency in estimating the damage that could occur from disasters related to these geologic hazards. Similar information was also supplied to counties when requested.

In summary, hazards mapping in the field and from interpretation of aerial photography is an ongoing project.

Landslide mapping, slope stability analysis, and the compilation of maps that depict seismic risk and potential earthquake damage will remain high priorities for a number of years.

Laboratory Section (Jay T. Roberts)

The primary function of the Laboratory Section is to provide analytical services to the staff geologists. In addition, the Section provides assistance in field investigations and maintains much of the laboratory and other equipment in use at the Survey.

Tools and techniques routinely used by the Section include X-ray diffraction, emission spectroscopy, mineral separation apparatus, and laboratory facilities for a variety of chemical and petrographic procedures. The Section also has limited access to an X-ray spectrometer in the University of Wyoming's Department of Chemistry and makes occasional use of this instrument for quantitative elemental analyses.

The Laboratory Section expanded its capabilities to include the fire assay technique for the analysis of gold, silver, and some platinum group metals. The method, as currently performed by the Section, gives quantitative results for ores with values as low as 0.02 ounce/ton gold and platinum and 0.1 ounce/ton silver. In combination with emission spectroscopy, detection limits are as low as 0.001 ounce/ton, but these results are only semiquantitative at best. A typical analysis was generally completed in one working day.

The installation of a fume hood in the Section's laboratory was completed in early 1984 at a cost of $8,730. Its installation was made possible by a special appropriation of the Legislature, and the donation of a hood by the University of Wyoming's Department of Geology and Geophysics. The availability of a fume hood now allows a wide variety of chemical, mineral separation, and petrographic procedures which the Section could not safely use in the past.

The Laboratory Section continued to perform mineral separations in support of the Metallic Minerals Section's diamond exploration projects and coauthored an outside paper on the Colorado-Wyoming kimberlite province with the Metallic Minerals Section. The Section also prepared a suite of cut and stained rock samples from the Copper King deposit for use in alteration studies by the Metallic Minerals Section.

In addition to the above projects, the Survey staff and the general public submitted a total of 95 samples for analysis or identification. Quantitative analyses were performed on 23 of these samples using fire assay, X-ray fluorescence, and X-ray diffraction techniques. The remaining samples were analyzed by qualitative or semiquantitative methods using X-ray diffraction, emission spectroscopy, mineral separation, and wet chemical methods.

Metallic Minerals Section
(W. Dan Hausel)

The Metallic Minerals Section functions as the principal source of information on Wyoming's base, precious, ferrous, and ferroalloy metals, and precious and semi precious stones and related geology. The Section supervises and conducts independent and cooperative investigations on the characteristics and distribution of various mineral deposits throughout the State and adjacent areas. Mining companies, geological consultants, universities, prospectors, and the general public obtain information and assistance on various mineralized areas and on rock and mineral identifications from this Section. Additionally, the Section Chief is the Deputy Director of the Geological Survey, a member of several graduate thesis committees at the University of Wyoming, and the Associate Curator of Mineralogy for the Wyoming State Museum.

The Section continued its investiga-

tions on diamondiferous kimberlite within the Laramie Range of southeastern Wyoming. Two major kimberlite-related projects were carried out during FY 84. One project, partially funded by the University of Wyoming's Mining and Mineral Resource Research Institute (MMRRI), is designed to sample all major drainages in the Wyoming kimberlite province. Concentrates of stream sediment samples which are collected by panning in the field, are further concentrated on a Wilfley table in the Survey's diamond laboratory. The final concentrates are microscopically examined and suspected kimberlitic minerals (pyrope garnet, chromian diopside, magnesian ilmenite, etc.) are tested for positive identification. Newly discovered kimberlites are sampled and tested for diamonds, using a grease table and a skin flotation separator.

To date, the project has been very successful, and has resulted in the discovery of seven kimberlite intrusives as well as the identification of two diamond-bearing pipes. The overall project also attracted several exploration and mining firms to the Colorado-Wyoming kimberlite province. One company's preliminary testing of the Wyoming portion of the State Line District, south of Laramie, outlined low-grade diamond resources that average 0.005 to 0.01 carat per ton. Although preliminary testing indicated low-grade resources, the testing produced gemstone to industrial diamond ratios similar to many South African diamond mines. Diamonds up to one carat in weight were recovered.

Two areas of interest outlined by the project, are the Sheep Rock area near Sybille Canyon, and the Happy Jack-Pole Mountain region located east of Laramie. A single kimberlite intrusive was identified in the Sheep Rock area although stream sediment sampling produced numerous anomalous samples approximately four miles both upstream and downstream from the known kimberlite, which indicates there may be other kimberlites present.

In the Happy Jack-Pole Mountain area, fourteen anomalous stream sediment samples led to the discovery of several possible kimberlite intrusives. These suspected kimberlite occurrences will be examined using electromagnetic and electrical resistivity surveys in FY 85 as the areas were too wet for such testing in the latter part of FY 84. Several of the occurrences were covered with shallow free-standing water.

A second kimberlite-related project was partially funded by The National Aeronautics and Space Administration (NASA), and was a joint venture between the Geological Survey of Wyoming's Metallic Minerals Section and the University of Wyoming's Remote Sensing Laboratory. The two-year project, which ended in FY 84, was designed to locate kimberlite intrusives using remote sensing methods. Although no new intrusives were discovered by the project, information derived from known kimberlite occurrences suggests that kimberlite produces somewhat unique color and infrared reflectance bands that may be useful as exploration tools.

In regard to these projects, the Section Chief coauthored two outside papers on kimberlite research in FY 84 (see page 8); presented a seminar on kimberlite to the geology faculty and students at the University of Texas at El Paso; and solicited six papers on diamondiferous kimberlites for a technical session he will chair at the American Institute of Mining and Metallurgical Engineers' meeting scheduled for Denver in October, 1984.

The Metallic Minerals Section also completed a study of the mineral deposits and complex Archean geology of Copper Mountain located south of Thermopolis and north of Shoshoni. A 1:24,000 scale map of the entire complex was produced by compiling unpublished thesis maps and by mapping about one-third of the complex. Maps of the major precious and base metal mining regions (Gold Nugget, McGraw, and DePass) were completed at a scale of 1:8,000, and geologic maps of four underground mines were also produced (1:120 scale). Based on this investigation, the region appears to be a high-grade supracrustal

belt similar to many Archean (>2.5 billion years old) belts in Greenland. The area has also undergone several periods of mineralization. In addition to petroleum and uranium mineralization produced during the Phanerozoic (<600 million years old), at least three Precambrian mineralizing events are probable. Stratiform syngenetic deposits of iron, copper, and possibly gold and tungsten were produced during deposition of the supracrustal rocks in the Archean. Some mineralized late Archean granites and pegmatites suggest a second mineralizing event. A third Early Proterozoic event (2-2.5 billion years old) is evident in the DePass region. Copper Mountain is presently under investigation by mining companies searching for low-grade stratiform gold deposits.

The Survey will publish the results of this investigation in FY 85. The Section Chief presented a talk on Copper Mountain at the Rocky Mountain Section Meeting of the American Association of Petroleum Geologists in Billings, and had a paper published by the Wyoming Geological Association.

The Section began reconnaissance mapping and investigations of the South Pass supracrustal belt. Historically, about 90 million tons of iron ore and 325,000 ounces of gold have been mined from the South Pass area, and there is still the possibility of again mining and producing large tonnages of gold, tungsten, and iron ore. The project objectives which are expected to take as many as three to four field seasons, are to make or revise geologic maps of seven 7 1/2-minute quadrangles, as well as portions of several adjoining quadrangles containing Archean supracrustal rocks, and to map all accessible underground mines. If funds allow, this project may include detailed geochemical studies of major and trace element enrichment of veins, enrichment or depletion of major and trace elements in the adjacent wall rocks, wall rock alteration, and the mode of occurrence of gold.

The South Pass belt, near Lander, is an area of considerable interest to numerous mining firms and prospectors, and each year, an undisclosed amount of gold is produced by prospectors and small companies. Because this area is also attractive to tourists, the Section prepared a tour guide to the geology and mining history of the South Pass area, which was published by the Survey.

The Section continued revising the 1979 edition of the *Mines and minerals map of Wyoming* in cooperation with the Uranium and Industrial Minerals Section. The new map will provide information on the genesis and age of mineral deposits, as well as the location of many deposits not identified on the 1979 map. The Section began a summary report of Wyoming's strategic metals and minerals deposits; continued editing a collection of papers on the economic geology of Wyoming; and prepared a preliminary listing of unpublished reports by the Survey.

In its service role, the Section examined and identified more than 68 rock and mineral specimens for the general public, industry, or the Wyoming State Museum; answered more than 800 inquiries; conducted a field trip of the geology of southeastern Wyoming for the Rocky Mountain Association of Geologists in conjunction with the Coal Section and Dr. D.L. Blackstone, Jr. of the University of Wyoming's Department of Geology and Geophysics; provided tours of (1) the South Pass mining district for an exploration company, (2) the Wind River Canyon for the Wyoming Historic Preservation Society, (3) the State Line diamond district for the University of Wyoming's Geography and Geology Departments as well as geologists from Stony Brook University, and (4) the Sierra Madre copper deposits for a Teacher Workshop sponsored by the Wyoming Mining Association; and prepared poster sessions on Wyoming's mineral resources for the College of Engineering's Open House and the Natrona County Gem and Rock Show. The Section Chief also authored or coauthored eight

reports published by the Survey in FY 84, and eleven articles published outside the Survey (see pages 6 to 9).

Oil and Gas Section (Alan J. VerPloeg)

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 Service 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. 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 will be incorporated into the well log library, filling gaps in the collection.

The characterization study of the Trapper Canyon tar sand deposit in the eastern Bighorn Basin was completed. The project included sampling and describing the deposit as well as mapping the geology of the Bush Butte 7 1/2-minute quadrangle while looking for additional deposits. The results of the study were presented at the Rocky Mountain Section Meeting of the American Association of Petroleum Geologists in Billings, Montana in September of 1983. A technical report of the results of the study has been submitted to the Department of Energy and should be released by them in early FY 85. The Survey will also publish an expanded version of the report.

Work was completed on a 1984 edition of the *Oil and gas map of Wyoming*. The 1:500,000 scale map will be available as Map Series No. 12 (MS-12) in early FY 85. Like the earlier 1980 edition of this map, it shows all of Wyoming's oil and gas fields. Pipelines, refineries, and gas plants are also shown on the map along with major oil shale occurrences.

Late in FY 84, the Oil and Gas Section initiated a field reconnaissance of known tar sand and heavy oil occurrences in Wyoming. The objectives of this study are (1) to visit and sample the occurrences of tar sands and heavy oils listed in Geological Survey of Wyoming Open File Report 82-5 in order to provide a more accurate characterization of each surface occurrence, and (2) to identify deposits which would be suited to a more detailed characterization study similar to the Trapper Canyon project. This project is partially funded by the U.S. Department of Energy, through the University of Wyoming's Industrial Fund.

In addition, work was initiated on an oil and gas profile of the Bighorn Basin. This report will highlight the history of oil and gas exploration in the basin, as well as profiling current production and future exploration trends. It will include structural contour maps, geologic maps, and cross sections (regional and detailed). Completion is anticipated in late FY 85 or early FY 86. In the future, similar reports will be done on the other major basins in the State.

The Section Chief authored or coauthored five reports published by the Survey in FY 84 and four published outside the Survey (see pages 6 to 9).

Stratigraphy Section (Rod H. DeBruin)

The Stratigraphy Section functions as a principal source of information on the stratigraphy and general geology of Wyoming 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. Consequently, 291 requests for information from industry, the general public, universities, and State and Federal government agencies were answered in FY 84. Also, several projects were undertaken in cooperation with other sections of the Survey.

The Stratigraphy Section collaborated with the Oil and Gas Section on a characterization study of the Trapper Canyon tar sand deposit in the Bighorn Basin. The Bush Butte 7 1/2-minute quadrangle was mapped in connection with this project. This study, partially funded by the Department of Energy through the University of Wyoming's Industrial Fund, has been submitted to them for publication. The Wyoming Geological Association will also publish a version in their 1984 guidebook on *The Permian and Pennsylvanian geology of Wyoming*. Partial funding has been received from the Department of Energy to visit and characterize reported tar sand deposits throughout the State. The field work was started in FY 84 and will continue into FY 85. This is also a cooperative project with the Oil and Gas Section.

A detailed description of the Absaroka Volcanic Supergroup was written for inclusion in a future publication by the Metallic Minerals Section on mineralization of the porphyry copper deposits of the Absaroka volcanic plateau. Geologic mapping of the Gravel Spring 7 1/2-minute quadrangle began in late FY 84 and will continue in FY 85. This project is also being done in support of the Metallic Minerals Section.

The Section is reviewing five geologic maps in the Bighorn Basin that have been received from Iowa State University's Geology Department. They have been field-checked and will be published by the Survey.

Uranium and Industrial Minerals Section (Ray E. Harris)

The Uranium and Industrial Minerals Section is a major source of information on radioactive minerals (uranium- and thorium-bearing) and the industrial minerals bentonite, gypsum, limestone and dolomite, phosphate, trona, zeolites, and construction material (sand, gravel, clinker, etc.) in Wyoming. Other minerals of sedimentary origin and assorted industrial minerals and rocks such as talc and anorthosite are also the responsibility of this Section. In FY 84, 450 requests for information regarding these commodities were answered for private citizens, State and Federal government agencies, and private industry. Although interest in radioactive minerals remained at a low level, there were more inquiries in FY 84 than in FY 83, the first full year for the Section.

Field work, calculations, and preliminary mapping of gamma-radiation levels in Wyoming continued. The preliminary maps are being compiled at a scale of 1:250,000. When all 16 sheets are completed at this scale, they will be combined into a statewide map at 1:500,000 scale. To date, data has been collected for all or portions of the Torrington, Cheyenne, and Ashton sheets.

Other ongoing projects included the preparation of a bulletin on radioactive minerals in Wyoming; field and laboratory studies of (1) tantalum and rare earth elements in the northern Bighorn Mountains; (2) zeolites in Wyoming with emphasis on sampling and mapping of occurrences in the Beaver Rim area of Fremont County, (3) bentonites in southern Wyoming with a detailed investigation of occurrences in the Steele Shale near Medicine Bow in Carbon County, and (4) talc occurrences as a joint project with the University of Wyoming's Anthropology Department; revision of the 1979 edition of the *Mines and minerals map*; editing and prepara-

tion of a collection of papers on the economic geology of Wyoming; preparation of a report on industrial mineral occurrences in the State; and compilation of a 1:500,000 scale map of construction materials in Wyoming.

In regard to the bentonite project, IMC of Colony, Wyoming, generously provided samples and laboratory analyses of their bentonite deposits in the Black Hills of northeastern Wyoming. The bentonite study will compare Black Hills bentonites with bentonites in southern Wyoming.

The Section Chief authored or coauthored six reports published by the Survey and another six published outside the Survey (see pages 6 to 9).

Publications Program

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 Administrative Program. In FY 79, the salaries of two employees were shifted over from administration to publications. The Publications Budget in FY 84 was $122,182.

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, illustrations, 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 part of the Publications Program 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 6,482 (FY 83) and 4,321 (FY 84) requests for publications. This is a decline from the record 11,119 inquiries in FY 81, and reflects a decline due to recessionary pressures. A percentage breakdown of publication customers in FY 84 is:

Category	Percent of Customers	Percent of Sales Revenue
General Public	78%	53%
Business and Industry	12%	27%
Wyoming and Local Agencies	2%	5%
Federal and Other States	2%	3%
Universities	6%	12%

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 of 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 others 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. While FY 83 sales were $73,134, sales in FY 84 dropped to $48,878. In 1984, the Legislature requested that the Survey try to increase its publication's revenues to 75% of the overall budget for the Publications Program (this equates to $82,000 per year). Consequently, changes will be made in the Publications and Administrative Programs to meet this goal. Already a new CPT Word Processor was purchased to facilitate the preparation of manuscripts.

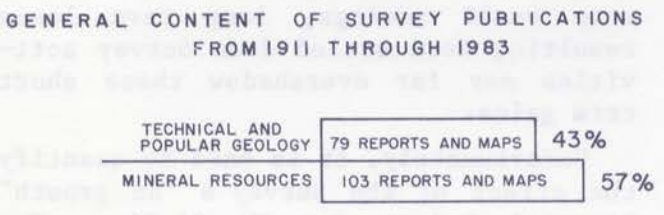
Publications of the Geological Survey are distributed free of charge to the libraries and archives throughout the State. Limited numbers of each publication are also provided to other State agencies and branches of government and to elected officials and school teachers on request. In addition, the Survey 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 84, for example, four 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 Survey publications and the number of new publications completed each decade.

A complete listing of reports and maps published in FY 84 is provided on pages 6 and 7).



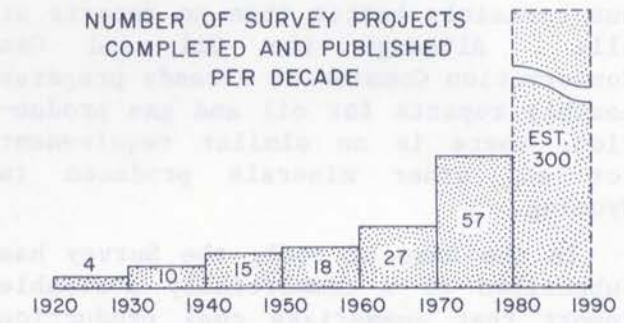


Figure 5. General content of publications and number of publications per decade.

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 responsiblity 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 Department of Public Lands. 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 prepares monthly reports for oil and gas production, there is no similar requirement for any other minerals produced in Wyoming.

In the case of coal, the Survey has subscribed to a commercially available report that summarizes coal production reported to the Federal Energy Regulatory Commission (derived from Form 423). Similar monthly data for uranium and trona are not available from Federal agencies because they are "confidential". Although acquisition of this "confidential" data would undoubtedly require the support of both the Governor and Wyoming's Congressional Delegation, it would avoid duplication of effort.

In a similar vein, anyone needing production statistics for Wyoming's mineral industries realizes there is little agreement between the production reported by the Ad Valorem Tax Division, the Oil and Gas Conservation Commission, and the State Inspector of Mines. There is even less agreement with similar production statistics for Wyoming published by the U.S. Department of Energy and the U.S. Bureau of Mines. This is because reporting requirements vary with the individual agencies. This problem will persist until the gathering of production data is relegated to one entity.

3. In response to declining State revenues, all agency budgets were cut by four percent 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 service, 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 loses 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.

4. Bad times are also affecting

Wyoming's mineral industries particularly uranium, iron ore, and a segment of the coal industry (southern Wyoming). While the need for reclamation is not denied, it does appear that some reclamation is conflicting with the future development and conservation of the State's mineral resources. For example, reclamation will bury more than 10 million tons of iron ore at Atlantic City, a large but unestimated tonnage of uranium ore at various locations across the State, and about 46 million tons of coal in the Hanna Basin. If this reclamation could be deferred or at least limited to the elimination of safety and pollution problems, resumption of mining and its economic benefits might be hastened in these areas.

A similar situation exists in the reclamation plans for old metal mines across the State. These sites provide the incentive for future exploration and serve as valuable exposures for exploration geologists. In this regard, the Geological Survey is working with the Land Quality Division of the Department of Environmental Quality to structure reclamation that will eliminate hazards to health and safety, yet preserve access to mines and geologic exposures with scientific as well as potential economic value.