WYOMING STATE GEOLOGICAL SURVEY
Gary B. Glass, State Geologist

SIXTY-FIRST ANNUAL REPORT

of the

WYOMING STATE GEOLOGICAL SURVEY

For Fiscal Year 1994
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by

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CONTENTS

INTRODUCTION

STATUTORY AUTHORITY

The history of the Geological Survey begins in Territorial times with the Office of the Territorial Assayer in 1878. This short-lived office was followed by the Office of the Territorial Geologist and Mining Engineer (1881-1890). At Statehood, the Constitution defined a State Geologist (1890), and later an Office of the State Geologist (1897-1932) was created. These beginnings evolved into the Geological Survey as it is today.

The Wyoming State Geological Survey was created by the Legislature in 1933. Its statutes have since been modified by legislative enactment in 1957, 1969, 1977, 1979, 1982, 1987, and most recently, 1991 (Chapter 122 and 203 of the Session Laws). The current statutes for the State Geologist and Geological Survey are W.S. 9-2-801 through 9-2-810 in Title 9, Ch. 2, Art. 8. In addition, the Constitutional position of State Geologist, which was established in 1890 (Art. 9, Sec. 6), was repealed by an amendment to the Wyoming State Constitution in 1990. Also, W.S. 30-5-103, 33-41-107, and 36-6-102 pertain to duties and responsibilities of the State Geologist.

AGENCY PURPOSES

The purposes of the Geological Survey are (1) to study, examine, and seek an understanding of the geology, mineral and energy resources, and physical features of the State, (2) to prepare, publish, and distribute relevant reports and maps on the geology and mineral resources of the State, and (3) to provide information, advice, and assistance related to the State's geologic, mineral, and energy resources.

AGENCY GOALS

The following eight goals of the Geological Survey link the Survey's purposes, activities, and programs to the needs of the State:

1. Dissemination of Information — PROVIDE TIMELY, ACCURATE, AND ACCESSIBLE INFORMATION ABOUT THE STATE'S GEOLOGY, MINERAL AND ENERGY RESOURCES, AND PHYSICAL FEATURES THAT HAS A PRACTICAL BEARING ON WYOMING'S CITIZENRY AND ECONOMY.

This goal is achieved by providing geologic and topographic maps and general interest, scientific, and technical reports on geologic, mineral, and energy resources; by making technical files and databases available to the public; and by operating a public information service that provides answers to inquiries or enables inquirers to readily identify and obtain existing information.

2. Geologic Framework — INCREASE KNOWLEDGE OF THE GEOLOGIC STRUCTURE AND GEOLOGIC FORMATIONS IN THE STATE TO PROVIDE THE SCIENTIFIC FRAMEWORK FOR INVESTIGATIONS OF MINERAL AND ENERGY RESOURCES AND GEOLOGIC HAZARDS AND TO MEET ANTICIPATED FUTURE RESPONSIBILITIES.

This goal is achieved through geologic mapping; through structural, stratigraphic, and paleontologic field studies; through the testing of conceptual models; and through laboratory investigations of the petrographic, chemical, and physical properties of rocks and minerals.

3. Assessments of Mineral and Energy Resources — INCREASE KNOWLEDGE OF THE DISTRIBUTION, RESERVES, AND QUALITY (PETROGRAPHIC, CHEMICAL, AND PHYSICAL CHARACTERISTICS) OF THE STATE'S MINERAL AND ENERGY RESOURCES TO PROMOTE THEIR DEVELOPMENT AS WELL AS TO PROVIDE FACTUAL INFORMATION FOR POLICY DECISIONS AFFECTING THE AVAILABILITY AND USE OF THE STATE'S LAND, MINERAL, AND ENERGY RESOURCES.

This goal is achieved by using techniques of resource evaluation including geologic mapping, reconnaissance exploration, and field and laboratory studies of rocks and minerals, as well as the entry of this information into interactive databases.

4. Origins of Mineral and Energy Resources — ENHANCE THE ABILITY TO DISCOVER HIDDEN OR AS YET UNRECOGNIZED MINERAL AND ENERGY RESOURCES BY DEVELOPING INFORMATION ON THE NATURAL PROCESSES BY WHICH MATERIALS IN THE EARTH ARE FORMED, TRANSPORTED, AND CONCENTRATED.

This goal is achieved through field investigations, laboratory analysis, and the formulation and testing of conceptual models.

5. Identification and Mitigation of Potential Geologic Hazards — IDENTIFY POTENTIAL GEOLOGIC HAZARDS AND IMPROVE THE SURVEY'S ABILITY TO PREDICT THE LOCATION, TIME, AND SEVERITY OF NATURAL AND MAN-MADE HAZARDS SO THAT LOSS OF LIFE AND PROPERTY IS MINIMIZED IF NOT ELIMINATED.

This goal is achieved through geologic mapping, field investigations, aerial photographic interpretation, and the application of geologic principles related to dynamic Earth processes.

6. Timely Reporting of Events and Conditions — PROVIDE FORECASTS OF MINERAL PRODUCTION AND PRICES AS WELL AS TIMELY REPORTS ON IMPORTANT HYDROLOGIC AND GEOLOGIC EVENTS AND CONDITIONS OF IMMEDIATE CONCERN TO THE PUBLIC AND TO STATE AND LOCAL GOVERNMENTAL ENTITIES.

This goal is accomplished by ongoing analysis of mineral- and energy-related activities, including man-related projects and the geologic conditions surrounding those projects, and the timely dissemination of relevant information to include warnings. Similarly, natural events are also monitored, particularly in regard to how they might affect the State's citizenry.

7. Coordination — IMPROVE THE COORDINATION OF EARTH-SCIENCE DATA COLLECTION, RESEARCH, AND MAPPING TO MINIMIZE DUPLICATION OF EFFORT, INCREASE DATA ACCESSIBILITY, AND REDUCE COSTS.

Coordination is carried out by sharing and(or) exchanging plans, technologies, and databases with appropriate entities and by striving to standardize information formats.

8. Mission Support — IMPROVE THE GEOLOGICAL SURVEY'S ABILITY TO EFFECTIVELY CARRY OUT ITS MISSION.

This is accomplished by providing new training or continuing education opportunities for employees; by replacing and upgrading obsolete field, laboratory, and publication-related equipment; by acquiring computer software and(or) hardware to enhance the operations and management of the Geological Survey; and by implementing innovative ideas that increase output from available resources.

AGENCY ACCOMPLISHMENTS

In FY94, the Geological Survey's staff:

- Provided data, advice, and assistance to both in-state and out-of-state inquirers, responding to more than 15,840 inquiries. Of these, 8,570 were related to geology and mineral and energy resources; 649 to the effective use of earth-science techniques, products, and information; and 6,621 to requests for Survey publications and(or) information on publications.

- Prepared 22 new reports or maps that communicate information on the State's geologic, mineral, and energy resources, and published 21 of those reports for dissemination through the Publications Sales Unit.

- Prepared 34 additional articles on Wyoming geology and(or) mineral resources for publication by professional and scientific organizations.

- Gave 42 talks, field trips, or briefings on the State's geologic, mineral, and(or) energy resources.

- Maintained and expanded public files and databases on the State's geologic, mineral, and energy resources.

- Identified and evaluated geologic hazards associated with earthquakes, landslides, aquifer vulnerability, and naturally-occurring toxic elements.

- Assessed mineral and energy resources, documented their occurrences, and determined their origins and manners of occurrence through more than 16 field, office, and(or) laboratory investigations, four of which were completed in FY94.

- Increased knowledge of the State's geology or potential geologic hazards through seven ongoing investigations in FY94.

ORGANIZATION

To accomplish its purposes and achieve its goals, the Geological Survey operates under eight functional programs, called Sections: Coal, Geologic Hazards, Geologic Mapping, Industrial Minerals and Uranium, Metals and Precious Stones, Oil and Gas, Publications, and Supportive Services (Figure 1). All these functional programs except the Publications Program are considered Administration programs.

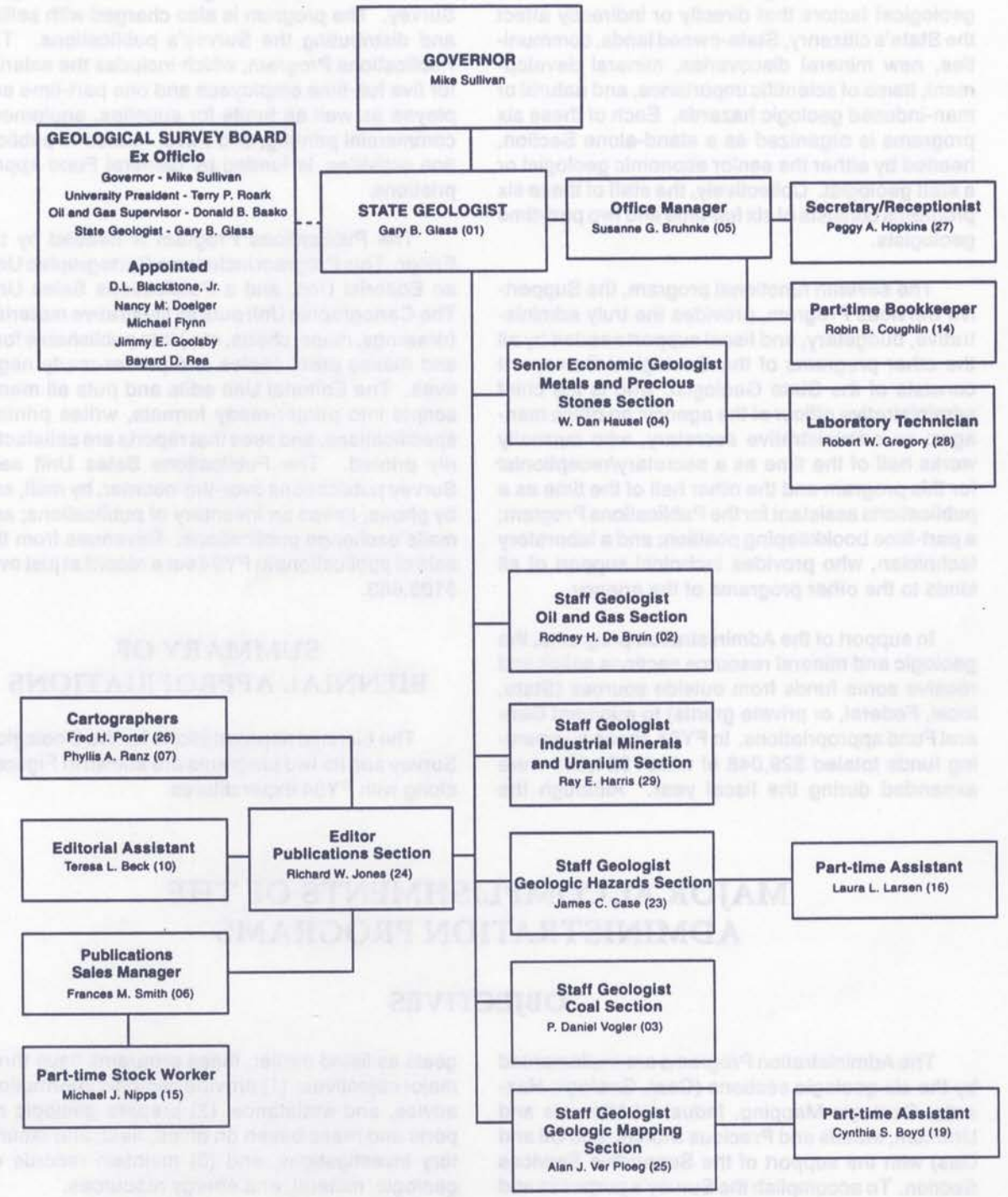

Figure 1. Organization chart for the Geological Survey in FY94.

ADMINISTRATION PROGRAMS (001)

Since 1969, when the Geological Survey was last reorganized and expanded, efforts by the Coal, Geologic Hazards, Geologic Mapping, Industrial Minerals and Uranium, Metals and Precious Stones, and Oil and Gas Programs have been directed at geological factors that directly or indirectly affect the State's citizenry, State-owned lands, communities, new mineral discoveries, mineral development, items of scientific importance, and natural or man-induced geologic hazards. Each of these six programs is organized as a stand-alone Section, headed by either the senior economic geologist or a staff geologist. Collectively, the staff of these six programs consists of six full-time and two part-time geologists.

The seventh functional program, the Supportive Services Program, provides the truly administrative, budgetary, and fiscal support needed by all the other programs of the Geological Survey. It consists of the State Geologist, who is the chief administrative officer of the agency; an office manager; an administrative secretary, who currently works half of the time as a secretary/receptionist for this program and the other half of the time as a publications assistant for the Publications Program; a part-time bookkeeping position; and a laboratory technician, who provides technical support of all kinds to the other programs of the agency.

In support of the Administration programs, the geologic and mineral resource sections solicit and receive some funds from outside sources (State, local, Federal, or private grants) to augment General Fund appropriations. In FY94, these augmenting funds totaled $29,048 of which $21,881 were expended during the fiscal year. Although the projects funded by these grants become part of the Administration Program, the continuation of these projects into future years is speculative as they are only funded on an annual basis.

PUBLICATIONS PROGRAM (002)

This is the publishing arm of the Geological Survey. The program is also charged with selling and distributing the Survey's publications. The Publications Program, which includes the salaries for five full-time employees and one part-time employee as well as funds for supplies, equipment, commercial printing, and travel related to publication activities, is funded by General Fund appropriations.

The Publications Program is headed by the Editor. This Program includes a Cartographic Unit, an Editorial Unit, and a Publications Sales Unit. The Cartographic Unit puts all illustrative materials (drawings, maps, charts, etc.) into publishable form and makes proof copies and printer-ready negatives. The Editorial Unit edits and puts all manuscripts into printer-ready formats, writes printing specifications, and sees that reports are satisfactorily printed. The Publications Sales Unit sells Survey publications over-the-counter, by mail, and by phone; keeps an inventory of publications; and mails exchange publications. Revenues from the sale of publications in FY94 set a record at just over $103,683.

SUMMARY OF BIENNIAL APPROPRIATIONS

The biennial appropriations for the Geological Survey and its two programs are shown in Figure 2 along with FY94 expenditures.

MAJOR ACCOMPLISHMENTS OF THE ADMINISTRATION PROGRAMS

OBJECTIVES

The Administration Programs are implemented by the six geologic sections (Coal, Geologic Hazards, Geologic Mapping, Industrial Minerals and Uranium, Metals and Precious Stones, and Oil and Gas) with the support of the Supportive Services Section. To accomplish the Survey's purposes and goals as listed earlier, these programs have three major objectives: (1) provide geologic information, advice, and assistance, (2) prepare geologic reports and maps based on office, field, and laboratory investigations, and (3) maintain records on geologic, mineral, and energy resources.

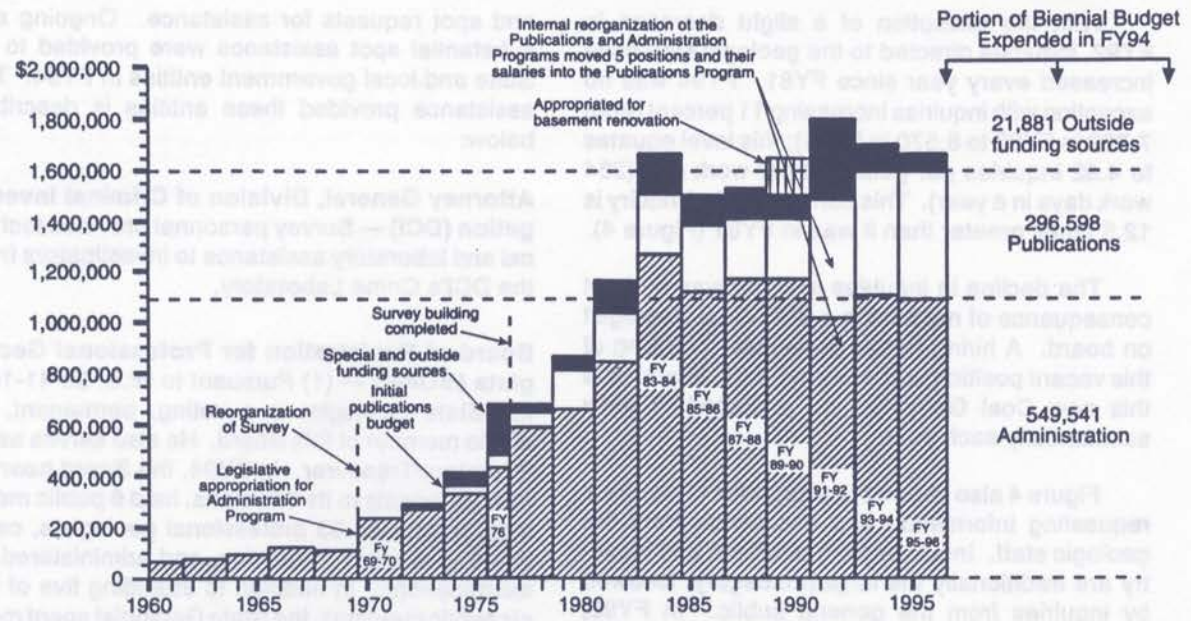

Figure 2. Biennial appropriations for the Geological Survey (expenditures for FY94 are annotated to the right of the biennial appropriations).

ACCOMPLISHMENTS

For each of these three major objectives, the activities and accomplishments of the Administration Programs in FY94 are described below:

SERVICES: Provide information, advice, and assistance for all inquiries on the State's geologic, mineral, and energy resources.

General

Because the Geological Survey is primarily a service-oriented organization, its geologic staff responds to many thousands of requests for information and assistance each year. Figure 3 illustrates the percentages of these inquiries received by the different Geologic Sections of the Survey over the last three fiscal years. The Geologic Hazards Section again had the most inquiries in FY94. The rather significant number of inquiries directed to this Section in the last two years were in great measure related to the Section Head's chairmanship of the Western States Seismic Policy Council coupled with the Section's coordination efforts following the 1994 earthquakes that occurred in the northwestern part of the State. There was also a significant increase in inquiries to the Metals and Precious Stones Section.

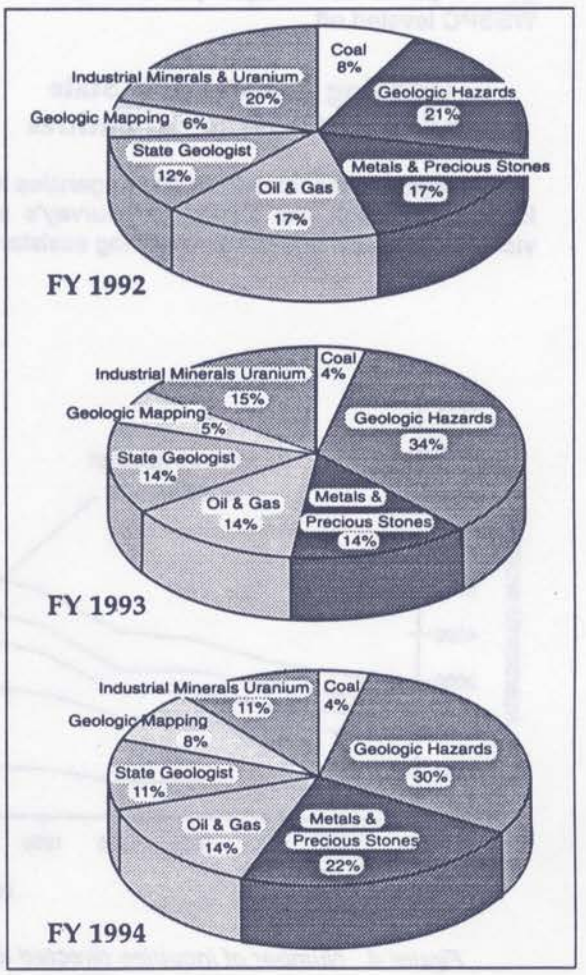

Figure 3. Percentage of inquiries directed to each of the Geologic Sections (FY92 through FY94).

With the exception of a slight decrease in FY92, inquiries directed to the geologic staff have increased every year since FY81. FY94 was no exception with inquiries increasing 11 percent (from 7,709 in FY93 to 8,570 in FY94); this level equates to 4.82 inquiries per geologist per work day (254 work days in a year). This current level of inquiry is 12.5 times greater than it was in FY81 (Figure 4).

The decline in inquiries in FY92 was a direct consequence of not having a Staff Coal Geologist on board. A hiring freeze prevented the filling of this vacant position until early in FY93. Inquiries to this new Coal Geologist are expected to grow substantially each year.

Figure 4 also shows the categories of inquirers requesting information and assistance from the geologic staff. Inquiries from business and industry are traditionally the largest category, followed by inquiries from the general public. In FY93, however, inquiries from Federal agencies and other states were the largest category, reflecting the Geological Survey's significant involvement with the Western States Seismic Policy Council (WSSPC). In FY94, the two greatest inquiry categories were again business and industry and the general public as the agency's involvement with WSSPC leveled off.

Ongoing Assistance to State and Local Government Entities

In regard to inquiries from State agencies and local jurisdictions, the Geological Survey's services are divisible into routine ongoing assistance and spot requests for assistance. Ongoing and substantial spot assistance were provided to 23 State and local government entities in FY94. The assistance provided these entities is described below:

Attorney General, Division of Criminal Investigation (DCI) — Survey personnel provided technical and laboratory assistance to investigators from the DCI's Crime Laboratory.

Board of Registration for Professional Geologists (BOPG) — (1) Pursuant to W.S. 33-41-107, the State Geologist is a voting, permanent, ex officio member of this Board. He also serves as its Secretary/Treasurer. In FY94, the Board heard 4 formal appeals to its decisions, held 6 public meetings, registered 33 professional geologists, certified 6 geologists-in-training, and administered 19 examinations. In addition to attending five of the six public meetings, the State Geologist spent more than two days each month on Board-related matters, which included responses to 57 telephone and two visitor inquiries as well as writing 125 letters; and (2) in this third year of operation, the office manager and the bookkeeper of the Geological Survey continued to provide bookkeeping, accounting, and personnel-related support to the BOPG.

Consensus Revenue Estimating Group (CREG) — The State Geologist is a member of CREG, a group that makes revenue estimates for use by the Governor and the Legislature, prior to each Legislative Session. With advice and information provided by the Heads of the Coal, Industrial Minerals and Uranium, and Oil and Gas Sections, the State

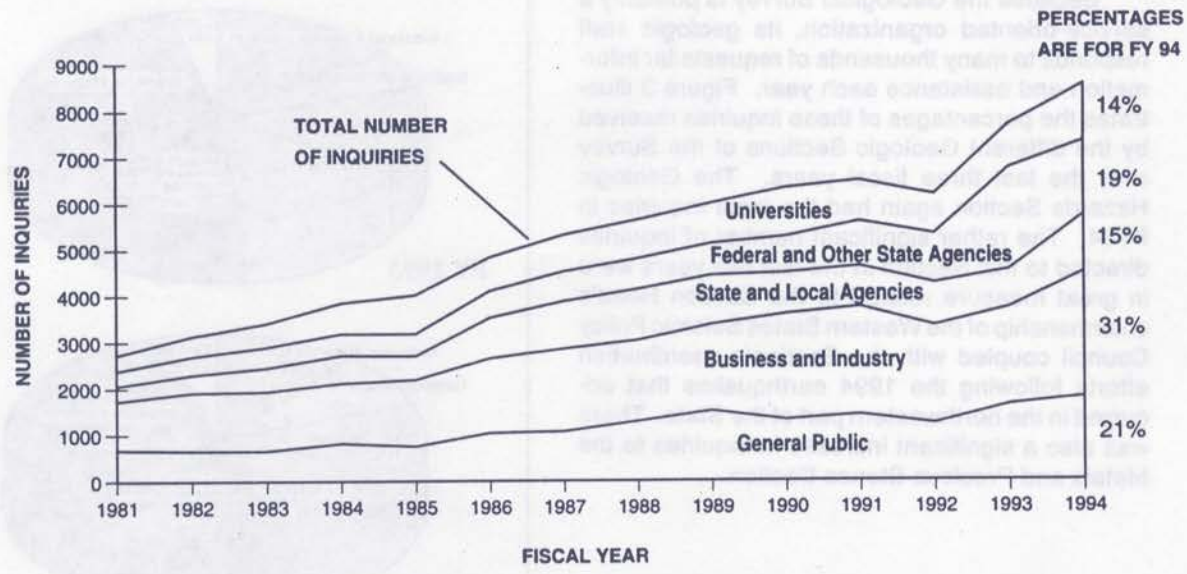

Figure 4. Number of inquiries directed to the Geologic Sections by category and fiscal year.

Geologist provided forecasts and continually apprised CREG of the minerals situation throughout FY94. This group met three times in FY94, once on mineral forecasts and twice as a whole.

Department of Administration and Information, Computer Technology Division — The Head of the Geologic Mapping Section is a member of the multi-agency Wyoming Geographic Information Advisory Council (WGIAC).

Department of Administration and Information, Economic Analysis Division — The State Geologist and Heads of the Coal, Industrial Minerals and Uranium, and Oil and Gas Sections provided information on prices and production of oil, natural gas, coal, uranium, and industrial minerals throughout the year for use in economic forecasting. In addition, information was provided for updating the annual *Wyoming data handbook*.

Department of Commerce, Division of Economic and Community Development (DECD) — (1) The Head of the Industrial Minerals and Uranium Section worked with the DECD staff in reviewing the development potential of several industrial minerals.

Department of Environmental Quality, Abandoned Mine Land Program (DEQ-AML) — The Head of the Geologic Hazards Section remained a member of the Technical Review Committee (TRC) for the Abandoned Mined Land Research Program, reviewing 17 research proposals; was a member of the Reclamation Proposal Selection Committee for Project 17E - Mine shafts, subsidence holes, and bentonite pits; participated in a meeting on selenium research; and participated in the Fifth Semiannual Project Review Seminar in Laramie, Wyoming.

Department of Environmental Quality, Industrial Siting Division — The Heads of the geologic sections and the State Geologist review siting applications when they are submitted.

Department of Environmental Quality, Land Quality Division (DEQ-LQD) — (1) the Head of the Industrial Minerals and Uranium Section provided locations of some abandoned mines; and (2) under a Memorandum of Understanding with the DEQ-LQD, the Head of the Geologic Hazards Section and(or) the State Geologist review paleontologic surveys included in mining applications.

Department of Environmental Quality, Water Quality Division (DEQ-WQD) — In a Federal-State cooperative effort with the DEQ-WQD, the State Engineer, the Wyoming Water Resources Center, and the Department of Geology and Geophysics at the University of Wyoming, the Geologic Hazards Section continued its participation in a statewide study of aquifer vulnerability to contamination. The Section completed a preliminary, 1:500,000-scale, statewide map of surficial materials and continued its preparation of more detailed, larger-scale, surficial geology maps.

Governor's Clearing House — The State Geologist and Heads of the six geologic sections reviewed 121 documents for the Governor's Clearing House in FY94 and submitted written comments on 34.

Governor's Office — (1) The State Geologist served as a member of the Governor's Coalbed Methane Task Force, and he represented the Governor's Office on the U.S. Bureau of Land Management's Coal Lease Sale Review Group; and (2) the Head of the Geologic Hazards Section served as a member of the Governor's Multihazard Mitigation Task Force.

Laramie County — The Geologic Hazards Section provided the county with Preliminary Landslide Maps.

Legislative Service Office — Throughout the year, the State Geologist and the Heads of the Coal, Industrial Minerals and Uranium, and Oil and Gas Sections provided information on production and prices for minerals produced in the State.

Lincoln County — The Geologic Hazards Section briefed county officials on earthquakes and related geologic hazards.

Northwest College — The Geologic Hazards Section assisted Northwest College and the University of Wyoming in the establishment of a short-term research project for the Young Scholars Program. Coordination with the U.S. Geological Survey and the National Park Service permitted four students to monitor soil-gas radon in Yellowstone National Park in FY94.

Oil and Gas Conservation Commission (OGCC) — (1) Wyoming Statute 30-5-103 makes the State Geologist one of the Commissioners of this regulatory agency. Monthly hearings were routinely 1.0-2.0 days long in FY94; and (2) the Geologic Mapping Section provided lithologic and stratigraphic information on 39 wells to assist the Commission's staff and field personnel in evaluating applications for injection or water disposal wells.

Park County — The Geologic Hazards Section provided the county with Preliminary Landslide Maps.

State Engineer — The State Geologist or the Head of the Geologic Hazards Section routinely attend the Water Forum, which is chaired by the State Engineer.

State Land and Farm Loan Office — (1) The Oil and Gas Section reviewed the locations of 3,012 drilled or permitted well sites and provided the State Land Office with weekly reports, which showed that 349 of the locations were on or near State lands; (2) the State Geologist reviewed and made recommendations on 11 commercial or scientific fossil-collecting permits; and (3) the Geologic Mapping Section (a) conducted field inspections of nine commercial and two scientific fossil quarries on State lands, and (b) evaluated the paleontological values of 191 state land parcels nominated for public auction, and then recommended that certain parcels should have their paleontologic resources reserved to the State upon their sale.

Teton County — The Geologic Hazards Section coordinated a demonstration of rapid visual screening for building resistances to earthquake damages.

University of Wyoming — (1) The Geologic Hazards Section continued its participation in a Federal/State/University of Wyoming/Wyoming Water Resources Center's study group investigating the vulnerability of aquifers to contamination, to include the preparation of both a 1:500,000-scale statewide map and 1:250,000-scale maps of surficial materials and features for Wyoming; (2) the Geologic Mapping Section continued its cooperative program with the University's Geology Library whereby customized bibliographies can be prepared for inquirers; (3) The Publications Section published a treatise on the geology of Wyoming that was jointly prepared by the Department of Geology and Geophysics and the State Geological Survey; (4) The Coal Section continued its participation in a Federal/State/University of Wyoming group assessing cumulative hydrologic impacts on the Powder River Basin; (5) The Metals and Precious Stones Section provided mineral and rock identifications to the Geology Museum; and (6) ongoing assistance, classroom lectures, and information were provided to faculty and students from many departments of the University.

Wyoming Emergency Management Agency (WEMA) — The Head of the Geologic Hazards Section is the Survey's liaison to WEMA; he is also one of the State's representatives to the Western States Seismic Policy Council (WSSPC); and he planned, organized, and chaired the 1993 Annual Meeting of WSSPC, which was held in September 1993 at Jackson, Wyoming.

Spot Assistance to State and Local Government Entities

In addition, spot requests for information or other assistance were received from 76 other State and local government entities in FY94 as well as inquiries from 116 Federal, foreign, or government entities and universities in other states.

Talks and Briefings

As an extension of this service-related function, the State Geologist and Section Heads collectively presented 42 talks, field trips, or briefings on mineral resources, geology, or geologic hazards to the following 26 different groups:

A & E Resources, South Pass (field trip)
Albany and Carbon County 4-H Camp, Centennial
American Association of Petroleum Geologists (AAPG), Rocky Mountain Section, Salt Lake City, Utah (two poster sessions)
American Institute of Mining Engineers, (1 talk in Casper and 1 talk in Rock Springs)
BHP Exploration, South Pass (field trip)
Compass Minerals, Sierra Madre (field trip)
Desk & Derrick, Casper
Echo Bay Exploration, South Pass (field trip)
Gideon Stone Company, Medicine Bow and Sierra Madre mountains (field trip)
Kiwanis Club, Laramie (2 talks)
Kryznar Stone Company, Denver (briefing)
KTWO-TV show, Cheyenne
KUWR radio talk shows, (4)
Native American Energy and Minerals Institute, (1 talk in Cheyenne and 1 field trip at Guernsey State Park)
Prospectors of Wyoming, Cody
Royal Gold Exploration, Seminoe Mountains (field trip)
Shriners, Laramie
State Gem and Mineral Show, Casper
Sunrise Stone, Laramie (briefing)
U.S. Bureau of Land Management, (1 talk in Rock Springs and 1 briefing at Buffalo)
University of Wyoming, Department of Geography, Laramie
University of Wyoming, Law School, Laramie
UWTV show, Laramie
Western States Seismic Policy Council, Jackson
Wheatland Area Development Council, Wheatland
Wyoming Geological Association (9 talks)

INVESTIGATIONS: Conduct office, field, and laboratory investigations and prepare geologic reports and maps that (a) increase understanding of the geologic, mineral, and energy resources of the State and (b) have a practical bearing on Wyoming's communities and people.

Arranged by Geologic Section, the following 23 investigations, projects, or studies were ongoing or completed in FY94:

Coal Section

• **National Coal Resources Data System** (ongoing; this project is partially funded by a grant from the U.S. Geological Survey's Branch of Coal Resources; the Section developed a computer-based, data-handling program for quick retrieval and submission of statewide coal data; and compiled coal data for inclusion in a computerized national database).

• **Characterization of Wyoming coals** (ongoing; statewide data on the chemical composition and physical properties of coals were compiled and entered into a computerized database).

• **Coalbed methane resources and activities in Wyoming** (ongoing; summary articles on the development of coalbed methane in Wyoming were prepared for *Wyoming Geo-notes* in FY94).

Geologic Hazards Section

• **Landslide mapping and classification** (ongoing; the Section began mapping thirty-five 1:24,000-scale quadrangles where additional landslide mapping is needed.

• **Earthquakes and seismicity** (ongoing; the head of the Section served as chairman of the Western States Seismic Policy Council (WSSPC) for the council's annual meeting, which was held in Jackson on September 20-23, 1993; this involved organizing and moderating the annual meeting as well as moderating the WSSPC business meetings before the annual meeting; in addition, the Section's earthquake awareness and response activities increased substantially during and following a series of earthquakes in northwestern Wyoming; and an earthquake display was prepared for the U.S. Bureau of Land Management in Worland.

• **Mapping of surficial materials and features** (ongoing; this project was originally begun as a joint effort with the U.S. Geological Survey and the University of Wyoming's Department of Geology and Geophysics. It has evolved into a project that will provide one 1:500,000-scale and fifty-six 1:100,000-scale surficial geology maps for use by Wyoming's Aquifer Vulnerability to Agricultural Contamination Program. The maps are given to the Wyoming Water Resources Center and the Water Quality Division of the Wyoming Department of Environmental Quality as they are completed. The Wyoming Water Resources Center is digitizing them and incorporating them into a Geographic Information System for use by the project.

• **Earth Science Information Center** (ongoing; in cooperation with the U.S. Geological Survey, the Section continued to operate the publicly accessible Earth Science Information Center (ESIC) in Wyoming; this center provides information on cartographic, hydrologic, geologic, and remote sensing data to include microfiche indices for all Federal aerial and space imagery; and it also acquired some indices of aerial photography available through State and private entities).

Geologic Mapping Section

• **Bibliographies of Wyoming geology** (ongoing; completed compilation of an updated bibliography of the theses and dissertations (1989-1994) completed for the University of Wyoming's Department of Geology and Geophysics).

• **1:100,000-scale geologic maps** (ongoing; nearly completed the first draft of the Cheyenne Quadrangle).

• **Atlas of major Rocky Mountain gas reservoirs** (completed; a major joint effort with the Oil and Gas Section; see Oil and Gas Section for details).

• **Southern Bighorn Mountains** (ongoing; completed field work on the 1:24,000-scale Hole-in-the-Wall and Poker Butte geologic quadrangle maps; and revised and submitted the Monument Hill and Beartrap Meadows geologic quadrangle maps for publication as color maps).

Industrial Minerals and Uranium Section

• **Industrial minerals and construction materials map of Wyoming** (completed and submitted for editing and publication).

• **Geology, industrial minerals, and construction materials of the Guernsey 7 1/2-minute Quadrangle** (ongoing; mapped the geology, industrial minerals, and construction materials in a two-square mile area in the southwestern portion of the quadrangle).

• **Characterization of limestones in Wyoming** (ongoing; this project involves sampling and describing minable limestones throughout Wyoming and determining the variability and location of chemical-grade material).

• **Radioactive mineral occurrences and uranium mines in Wyoming** (ongoing; reports on radioactive mineral occurrences and uranium mines

in Lincoln, Hot Springs, Sheridan, and Weston Counties were published in FY94; and a report on Sweetwater County was submitted for editing and publication).

• **Decorative stone deposits in the Medicine Bow National Forest** (completed; this study was funded by a grant from the U.S. Forest Service; and the report has been submitted for publication).

Metals and Precious Stones Section

• **Strategic minerals** (ongoing; library and field research continued; library research was focused on aluminum, beryllium, and iron deposits; field investigations included manganese, molybdenum, copper, gold, silver, iron, lead, and zinc occurrences and deposits to include an ongoing evaluation of the gold, silver, and iron in banded iron formations).

• **Kimberlite and lamproite diamond investigations** (ongoing; this is a continuing project building on earlier work completed over the last 12 years).

• **Economic geology of the Rattlesnake Hills mining district** (ongoing; continued field investigations and geologic mapping at 1:24,000-scale).

• **Economic geology of the Cooper Hill mining district** (completed and published).

• **Precious metals and diamond investigations in southern Wyoming** (ongoing; this project has been partially funded by three grants from Union Pacific Resources; results from the first year were published as an open file report in FY93; results from the second year were made available as an unpublished mineral report in FY94 and submitted for publication as another open file; the final phase of this project is the testing for diamond in a lamproite sample from the Leucite Hills).

Oil and Gas Section

• **Characterization of oil and gas reservoirs, including oil and gas composition and properties** (ongoing; the Section's computerized databases now contain reservoir data for the majority of the reservoirs in northeastern Wyoming, the Thrust Belt, and the Greater Green River Basin, available oil and gas analyses from northeastern Wyoming, and 1,699 water analyses from oil and gas fields across the State).

• **Atlas of major Rocky Mountain gas reservoirs** (completed; this project was partially funded by the Gas Research Institute; the Oil and Gas and Geologic Mapping Sections in cooperation with Barlow & Haun, Inc. finished an atlas of major Wyoming gas reservoirs as part of a larger atlas of major gas reservoirs in the Rocky Mountain region; this multistate cooperative effort between the Wyoming, New Mexico, Colorado, and Utah geological surveys was coordinated by the New Mexico Bureau of Mines and Mineral Resources; and the final report was published in FY94).

• **Estimations of oil and gas resources and reserves** (ongoing; preparing a report on the resources and reserves of helium in Wyoming).

Miscellaneous

• **Rock and mineral identifications and analyses** (ongoing; more than 96 rock and mineral specimens were identified for the general public, mining companies, or the University of Wyoming Geology Museum; and the Laboratory Unit conducted 587 analyses, tests, or procedures on 151 samples in support of in-house geologic investigations.

• **Articles written for publication by outside publishers** (ongoing; in FY94, the Section Heads and the State Geologist collectively prepared 34 papers or articles for outside publication).

PUBLIC FILES: Gather and continuously update and maintain files and libraries on all available reports, records, maps, and other data relating to the surface and subsurface geologic, mineral, and energy resources of the State.

In FY94, the Geological Survey (1) enlarged its geologic hazards files; (2) expanded its computerized databases of oil and gas reservoir characteristics and oil and gas composition; (3) acquired additional downhole logs from uranium drilling in the Red Desert and other areas of the State; and (4) began entering coal analyses into a new database; The Survey also maintains a "Confidential" file of drilling records from holes drilled on State mineral leases, pursuant to Wyoming Statute 36-6-102.

With the exception of the "Confidential" drilling records mentioned above, files and libraries of the Survey are for the most part available to the public. A public-use area is provided on the second floor of the Wyoming Geological Survey Building. This area hosts microfiche, microfilm, and paper copies of many oil and gas well logs; aerial photographs; unpublished geologic and mineral reports; open file

reports of the U.S. Geological Survey and the U.S. Bureau of Mines; the U.S. Department of Energy's uranium reports for Wyoming, and the Earth Science Information Center (ESIC). The Survey's extensive collection of Environmental Impact Statements, Industrial Siting Applications, and numerous other government documents are now kept in the Survey's reference library.

In a concerted effort, the Coal, Industrial Minerals and Uranium, and Oil and Gas Sections continued to enter mineral resource data into the Survey's personal computers for easier management and manipulation of data. While the initial goals of these computerization efforts were the input of mineral production, market, and price information, other resource data are now being added.

MAJOR ACCOMPLISHMENTS OF THE PUBLICATIONS PROGRAM

OBJECTIVES

Publications are an essential part of the Survey's overall service function as mandated by law (W.S. 9-2-805, part a, subsections iv and v). The Publications Program, which is synonymous with the Publications Section, is both the publishing and sales arm of the Survey and performs an essential role in the sale and distribution of information to the public. This program contains the funds for preparing and printing geological information collected and interpreted by Survey personnel or outside authors. There are now five full-time positions and one part-time position in this program.

The major objectives of the Publications Program are three-fold: (1) to make information about Wyoming's geologic, mineral, and energy resources available in various publication formats, (2) to sell and distribute Survey publications, and (3) to provide technical support to the Section Heads, the State Geologist, other Survey staff, and occasionally to outside entities.

ACCOMPLISHMENTS

For each of these major objectives, the activities and accomplishments of the Publications Program in FY94 are described below:

PUBLISHING: Make information about Wyoming's geologic, mineral, and energy resources available in various publication formats.

The Editor and the State Geologist establish publishing priorities. The two graphs in Figure 5 summarize the general subject matter of Survey publications and the number of new publications completed each decade. In FY94, the Editorial Unit prepared bid specifications for 12 printing jobs. The Editor also attended the press runs for 7 of those jobs to assure the printed quality of those publications met Survey standards.

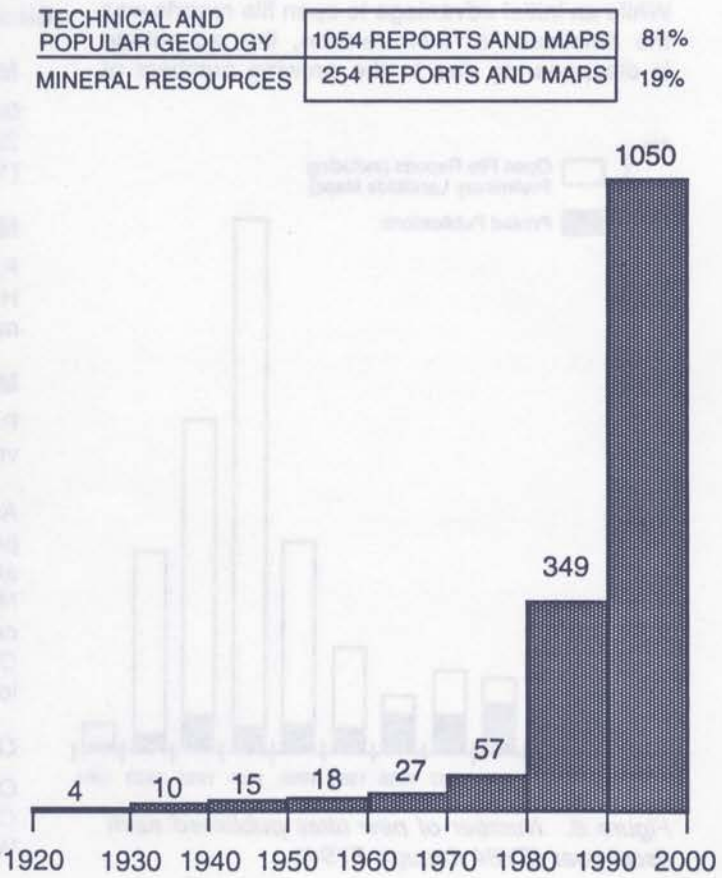

Figure 5. General content of Survey publications since FY20 (excludes publications lists and posters) and number of new titles by decade.

The Geological Survey published 18 new titles and reprinted 3 existing titles in FY94 (Figure 6). Because of the significantly greater work required in the preparation of the *Atlas of major Rocky Mountain gas reservoirs* and the two-volume memoir titled *Geology of Wyoming*, fewer publications were completed in FY94 than in previous years.

In recent years, the Section has upgraded its photographic and computer equipment. It currently has an excellent desktop publishing system, including voice-activated software to assist a handicapped employee, and it acquired a computerized drafting system late in FY93.

However, because of the volume of manuscripts submitted by the geologic sections, there is always a backlog of unpublished manuscripts each year. For this reason, an increasing number of publications are prepared as open file or in-house reports or as preliminary maps rather than preparing them for commercial printing. An open file or in-house report or preliminary map is one that is prepared in a reproducible a format and is reproduced only as requested. The disadvantages with these types of publications are the often inferior reproduction; the inability to adequately illustrate the reports with photographs, color, and other special methods; and the sometimes high cost of reproduction on an individual basis, particularly if there are a number of large illustrations. While an initial advantage to open file reports was the timeliness of their release, this advantage is disappearing due to the growing numbers of submitted open file manuscripts and the lack of adequate editing resources.

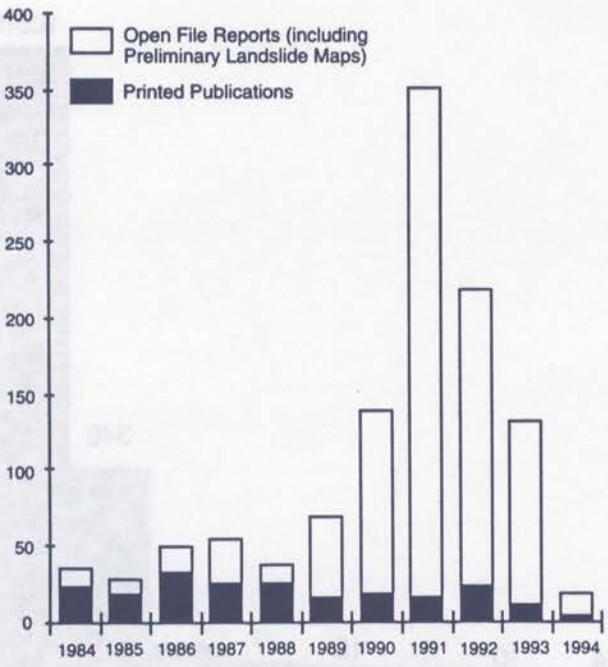

Figure 6. Number of new titles published each fiscal year (FY84 through FY94).

The 22 publications listed below represent the combined efforts of the Publications Section and the geologic sections toward meeting the primary objective of the Publications Program:

ANNUAL REPORT

Sixtieth annual report of the Geological Survey of Wyoming for Fiscal Year 1993, July 1, 1992, to June 30, 1993, by G.B. Glass and S.G. Bruhnke (1993).

BULLETIN

Traveler's guide to the geology of Wyoming (second edition, second printing): B-67, by D.L. Blackstone, Jr. (1993).

EDUCATIONAL SERIES

Wyoming geomaps (second printing): ES-1, by Sheila Roberts (1994).

INFORMATION PAMPHLET

Geology of Wyoming (fifth printing): IP-2, by G.B. Glass and D.L. Blackstone, Jr., (1994).

MAP SERIES

Precambrian basement map of Wyoming: outcrop and structural configuration: MS-43, by D.L. Blackstone, Jr., (1993).

MEMOIR

Geology of Wyoming: M-5, edited by A.W. Snoke, J.R. Steidtmann, and S.M. Roberts (1993).

MINERAL REPORT (IN-HOUSE REPORT)

Preliminary geologic map of the Rattlesnake Hills supracrustal belt, Natrona County, Wyoming: MR94-1, by W.D. Hausel (1994).

MISCELLANEOUS

Publications available from the Geological Survey of Wyoming: (April, 1994).

Atlas of major Rocky Mountain gas reservoirs: publication of the New Mexico Bureau of Mines and Mineral Resources, prepared by the New Mexico Bureau of Mines and Mineral Resources, the Wyoming State Geological Survey, the Colorado Geological Survey, and the Utah Geological Survey.

OPEN FILE REPORTS

Occurrences of radioactive elements in Lincoln County, Wyoming: OFR 93-2, by R.E. Harris, W.D. Hausel, and J.K. King (1993).

Occurrences of radioactive elements in Hot Springs County, Wyoming: OFR 93-3, by R.E. Harris, W.D. Hausel, and J.K. King (1993).

Occurrences of radioactive elements in Sheridan County, Wyoming: OFR 93-4, by R.E. Harris, W.D. Hausel, and J.K. King (1993).

Earthquake epicenters and suspected active faults with surficial expression in Wyoming: OFR-94-1, by J.C. Case, L.L. Larsen, C.S. Boyd, and J.C. Cannia (1994).

PUBLIC INFORMATION CIRCULARS

Guide to the geology, mining districts, and ghost towns of the Medicine Bow Mountains and Snowy Range scenic byway: PIC-32, by W.D. Hausel (1993).

REPORT OF INVESTIGATIONS

Overview of the Hanna, Carbon, and Cooper Lake Basins, southeastern Wyoming: RI-48, by D.L. Blackstone, Jr. (1993).

Geology and mineralization of the Cooper Hill mining district, Medicine Bow Mountains, southeastern Wyoming: RI-49, by W.D. Hausel (1994).

REPRINTS

Changing ideologies in Wyoming coal petrography: R-55, by J.C. Shearer (1994).

Mining history and geology of some of Wyoming's metal and gemstone districts and deposits: R-56, by W.D. Hausel (1994).

WYOMING GEO-NOTES

No. 39: by G.B. Glass, R.H. De Bruin, T.A. Moore, R.E., Harris, W.D. Hausel, A.J. Ver Ploeg, and J.C. Case (1993).

No. 40: by G.B. Glass, R.H. De Bruin, T.A. Moore, R.E. Harris, W.D. Hausel, A.J. Ver Ploeg, and J.C. Case (1993).

No. 41: by G.B. Glass, R.H. De Bruin, T.A. Moore, R.E. Harris, W.D. Hausel, A.J. Ver Ploeg, and J.C. Case (1994).

No. 42: by G.B. Glass, R.H. De Bruin, P.D. Vogler, R.E. Harris, W.D. Hausel, A.J. Ver Ploeg, J.C. Case, and J.C. Shearer (1994).

SALES AND DISTRIBUTION: Sell and distribute Survey publications.

In FY94, the Editor, Publications Sales Manager, and Editorial Assistant responded to 2,049 written inquiries about publications, answered an average of 18 telephone inquiries and inquiries from visitors to the sales desk per work day, and receipted 3,899 sales transactions for a record $103,683.11 in sales.

Figure 7 shows a percentage breakdown of revenues derived from the sale of publications over the last three fiscal years, arranged by customer category. The revenues from sales to the

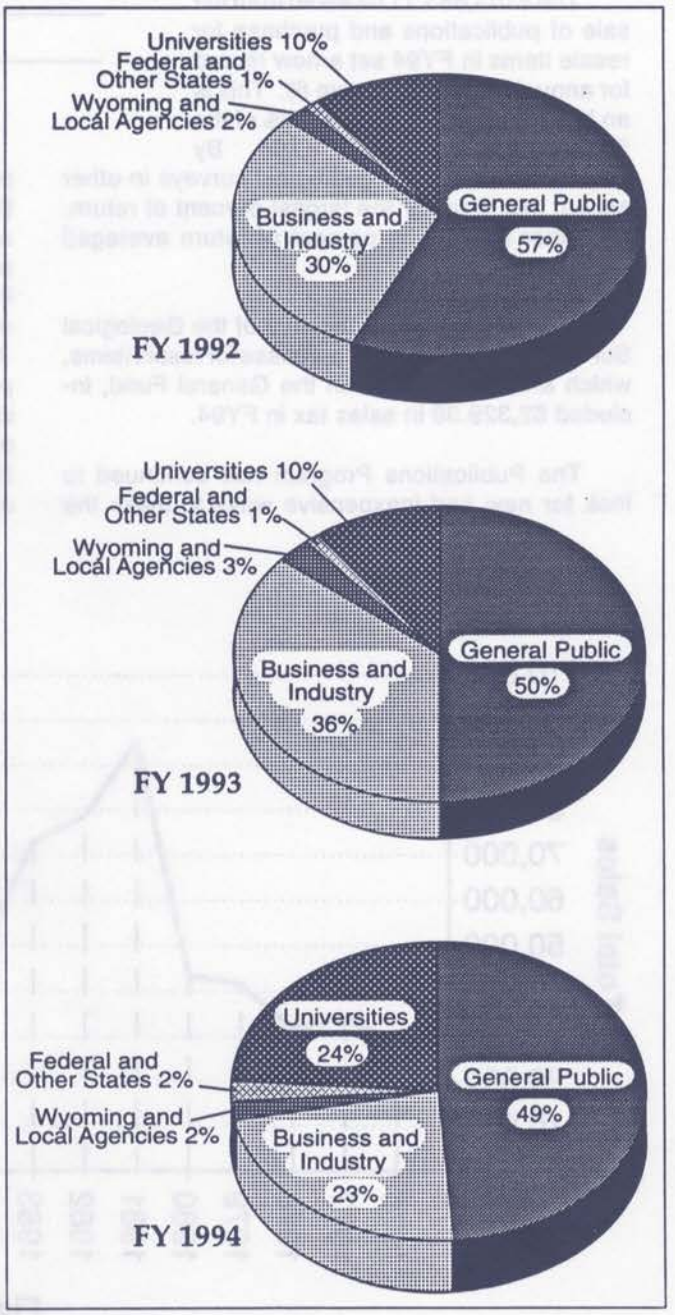

Figure 7. Percentage of publication revenue arranged by customer category (FY92 through FY94).

general public have exceeded 49 percent of the total since FY85.

The volume of receipted sales in each customer category and the revenues derived from that customer category are shown in Table 1. The revenue derived from the "universities" category was unusually large in FY94. This reflected widespread interest in the new memoir on the geology of Wyoming.

Table 1. Breakdown of publication sales by customer category and by sales revenue for FY94.

Category	Percent of Customers	Sales Revenue	Percent of Revenue
General public and(or) unidentified	57%	$51,195	49%
Business and industry	32%	23,436	23%
Universities	7%	24,870	24%
Wyoming and local agencies	3%	2,480	2%
Federal, other states and foreign	1%	1,702	1%
	100%	$103,683	100%

The $103,683.11 received from the sale of publications and purchase for resale items in FY94 set a new record for annual revenues (Figure 8). This is an amount equal to about 12.3% of the Survey's expenditures in FY94. By way of comparison to geological surveys in other states, this is by far the largest percent of return. For other states, the percent of return averaged only 3.2%.

The revenues from the sale of the Geological Survey's publications and purchase for resale items, which are all deposited in the General Fund, included $2,329.39 in sales tax in FY94.

The Publications Program has continued to look for new and inexpensive ways to make the public aware of valuable earth-science publications available from the Geological Survey. In addition to the preparation of press releases describing new titles, new Survey publications are listed in each issue of the Survey's quarterly newsletter, *Wyoming Geo-notes*. Subscriptions to *Wyoming Geo-notes* have been increased through promotional mailings. Topographic map sales have continued to rise since FY90 because of increased public awareness of that service and because the Survey is selling maps by mail and phone orders as well as over-the-counter.

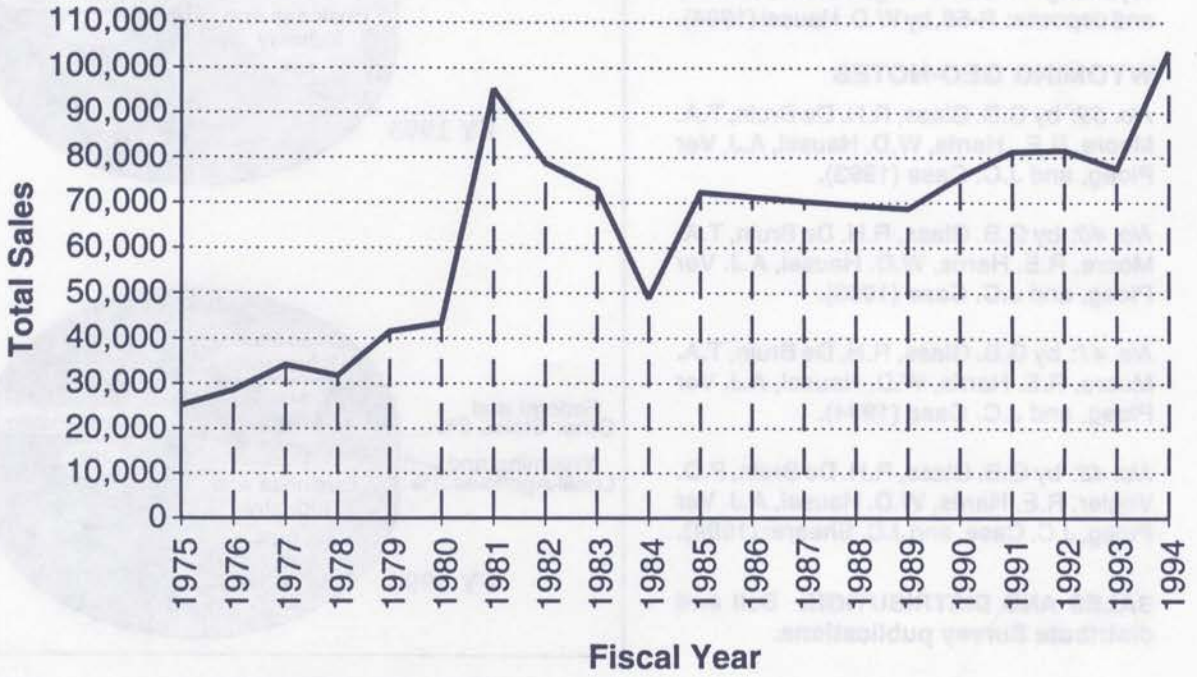

Figure 8. Fiscal year income to the General Fund from the sale of publications.

Publications of the Geological Survey are distributed free-of-charge to 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 on request. In addition, the Survey participates in publication exchange programs with many other state geological surveys, numerous foreign geological surveys, the U.S. Geological Survey, the U.S. Department of Energy, the U.S. Bureau of Mines, and other entities. While the copies sent out on exchange agreements do not add directly to sales revenue, they provide an important service to the State by allowing acquisition of publications from out-of-state agencies without direct charge. The publications acquired through the Survey's exchange agreements are subsequently donated to the University of Wyoming's Geology Library. In FY94, more than 1,534 publications were received in exchange for Survey publications.

TECHNICAL SUPPORT: Provide technical advice and support to the State Geologist, Section Heads, other Survey staff, and occasionally to outside entities.

The Publications Section provides editing and drafting for maps and reports published by the Survey, creates illustrations for talks and displays, and generally assists in publication-related activities. The Editor also answers requests for information about Survey editing techniques, policies, and procedures from agencies, organizations, and consultants.

The cartographers frequently advise University of Wyoming faculty, staff, and students on drafting techniques. They also occasionally provide advice to consultants and members of the general public as well as other State and Federal agencies.

SUMMARY OF PERMANENTLY ASSIGNED VEHICLES

The following list of motor vehicles is provided in accordance with Section 9-2-1014 revised:

License Number	Assigned To	Reason For Assignments
S-528	Ray E. Harris	1990 pick-up for off-road field work. [odometer: 77,047]
S-656	W. Dan Hausel	1987 pick-up for off-road field work. [odometer: 66,982]
S-799	James C. Case	1981 station wagon for light field work. [odometer: 97,242]
S-1330	Richard W. Jones	1988 station wagon for press runs. [odometer: 81,002]