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

SIXTIETH ANNUAL REPORT

of the

GEOLOGICAL SURVEY OF WYOMING

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by

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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 Geological Survey of Wyoming 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 204 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 In addition, the Constitutional position of State Geologist, which was established in 1890 (Art. 9, Sec. 6), was repealed by an amendment to the Wyoming State Constitution in 1990.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, and (3) to provide information, advice, and services related to the State's geology, mineral and energy resources, and physical features.

AGENCY GOALS

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

Information Dissemination — 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 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.

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 petrologic, physical, and chemical properties of rocks and minerals.

Mineral and Energy Resource Assessment — 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.

Mineral and Energy Resource Processes — 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.

Hazards Identification and Prediction — 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.

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 BODIES.

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.

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 data bases with appropriate entities and by striving to standardize information formats.

Program Support — IMPROVE THE SURVEY'S ABILITY TO EFFECTIVELY CARRY OUT ITS PURPOSES.

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 Survey; and by implementing innovative ideas that increase output from available resources.

AGENCY ACCOMPLISHMENTS

In FY93 , the Geological Survey:

— provided data, advice, and assistance to both in-state and out-of-state inquirers, responding to more than 14,334 inquiries. Of these, 7,709 were related to geology and mineral and energy resources; 277 to the effective use of earth-science techniques, products, and information; and 6,348 to requests for Survey publications and(or) information on publications.

— prepared 135 new reports or maps that communicate information on the State's geologic, mineral, and energy resources, and published those reports for dissemination through the Publications Sales Unit.

— maintained and expanded public files and data bases on the State's geologic, mineral, and energy resources.

— identified and evaluated geologic hazards associated with earthquakes, landslides, active faults, 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 20 field, office, and(or) laboratory investigations, five of which were completed in FY93.

— increased knowledge of the State's geology or potential geologic hazards through seven investigations, four of which were completed in FY93.

ORGANIZATION

To accomplish its purposes and achieve its goals, the Geological Survey operates under two programs (Figure 1):

ADMINISTRATION PROGRAM (001) - Since 1969, when the Geological Survey was last reorganized and expanded, efforts of the Administration

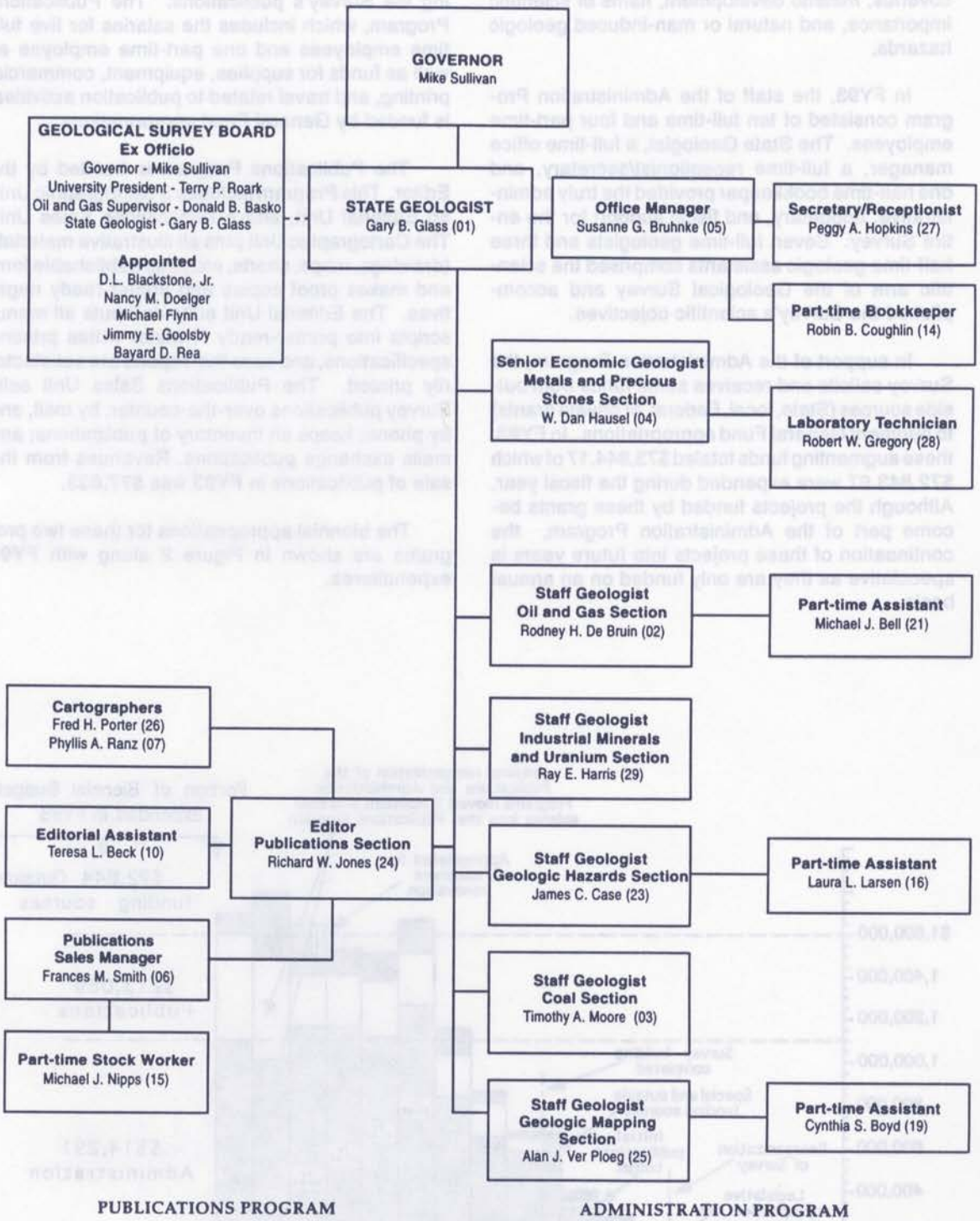

Figure 1. Organization chart for the Geological Survey in FY93.

Program 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.

In FY93, the staff of the Administration Program consisted of ten full-time and four part-time employees. The State Geologist, a full-time office manager, a full-time receptionist/secretary, and one half-time bookkeeper provided the truly administrative, budgetary, and fiscal support for the entire Survey. Seven full-time geologists and three half-time geologic assistants comprised the scientific arm of the Geological Survey and accomplished the Survey's scientific objectives.

In support of the Administration Program, the Survey solicits and receives some funds from outside sources (State, local, Federal, or private grants) to augment General Fund appropriations. In FY93, these augmenting funds totaled $73,844.17 of which $72,843.67 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 FY93 was $77,633.

The biennial appropriations for these two programs are shown in Figure 2 along with FY93 expenditures.

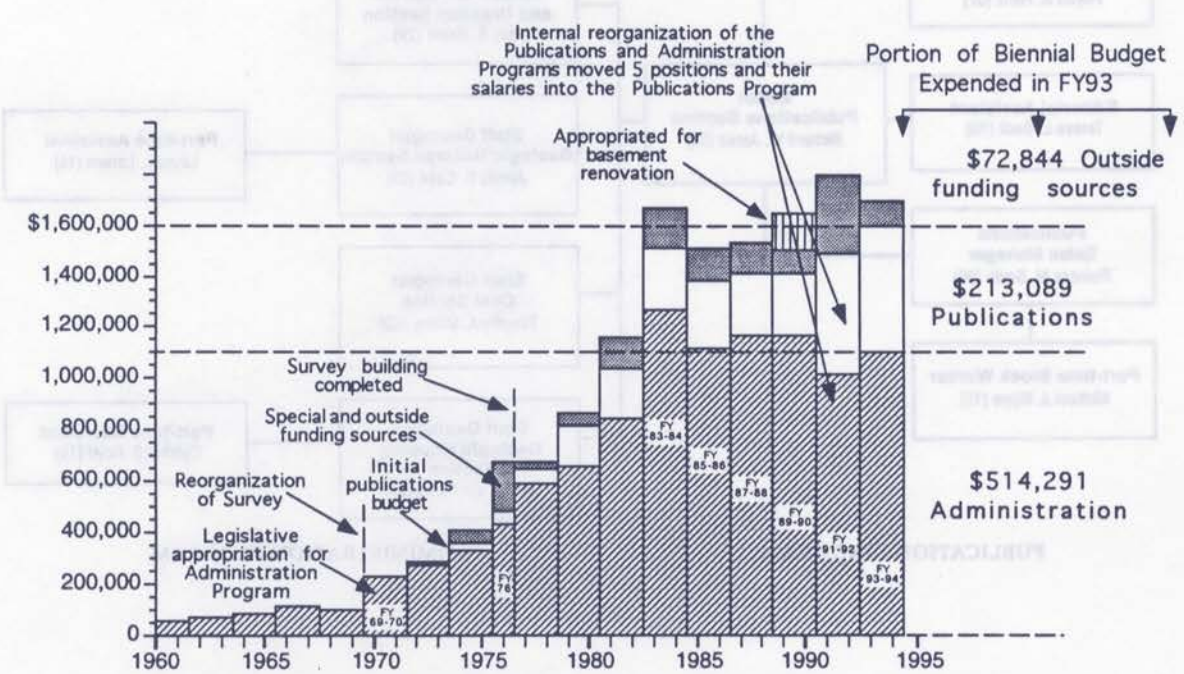

Figure 2. Biennial appropriations for the Geological Survey (expenditures for FY93 are annotated to the right of the biennial appropriations).

MAJOR ACCOMPLISHMENTS OF THE ADMINISTRATION PROGRAM

OBJECTIVES

The Administration Program is implemented by the State Geologist, six geologic sections (Coal, Geologic Hazards, Geologic Mapping, Industrial Minerals and Uranium, Metals and Precious Stones, and Oil and Gas) and the Laboratory unit. To accomplish the Survey's purposes and goals as listed earlier, this program has 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.

ACCOMPLISHMENTS

For each of these three major objectives, the activities and accomplishments of the Administration Program in FY93 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 had the most inquiries in FY93. This rather significant increase over last year was in great measure related to the Section Head's chairmanship of the Western States Seismic Policy Council. Similarly, the increase in inquiries to the State Geologist was related to his new duties as a Member and Secretary/Treasurer of the Wyoming Board of Registration for Professional Geologists.

With the exception of a slight decrease in FY92, inquiries directed to the geologic staff have increased every year since FY81. FY93 was no exception with inquiries increasing about 24.5 percent (from 6,194 in FY92 to 7,709 in FY93); this level equates to 4.3 inquiries per geologist per work day (254 work days in a year). This current level of inquiry is 283 percent greater than it was in FY81 (Figure 4).

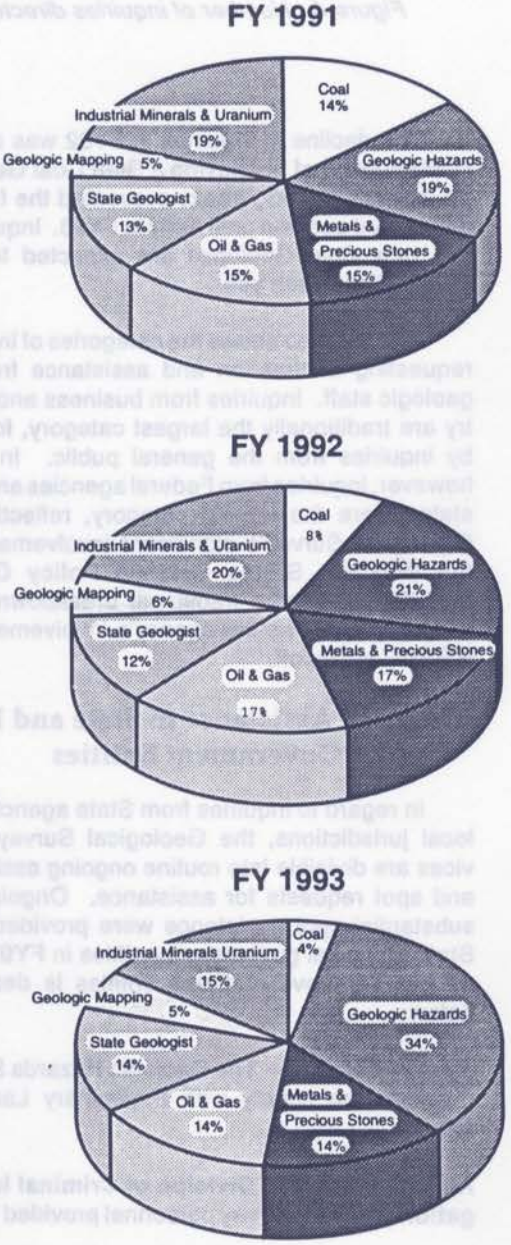

Figure 3. Percentage of inquiries directed to each of the Geologic Sections (FY91 through FY93).

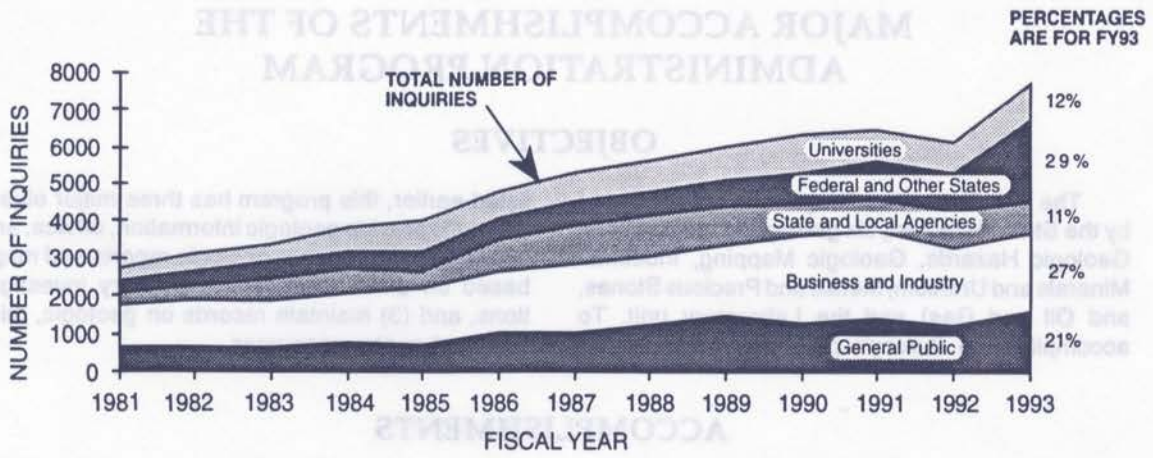

Figure 4. Number of inquiries directed to the Geologic Sections by category and fiscal year.

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). A more traditional breakdown is expected in FY94 as the agency's involvement with WSSPC levels 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 30 State and local government entities in FY93. The assistance provided these entities is described below:

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

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

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.

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

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 recently created Board. He also serves as its Secretary/Treasurer as well as a member of its Committee on Examinations . The BOPG held 8 public meetings, registered or renewed the registrations of 2,449 professional geologists as well as 152 certified geologists-in-training, and administered eight examinations. In addition to attending the eight public meetings, the State Geologist spent more than 2.5 days each month on BOPG-related matters, which included responses to 97 phone and 5 visitor inquiries as well as writing 342 letters; and (2) in this second year of operation, the office manager and bookkeeper of the Geological Survey continued to provide bookkeeping, accounting, and personnel-related support to the BOPG.

City of Casper — The Geologic Hazards Section provided the city with Preliminary Landslide Maps.

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 preparing and manning a booth at the international StonExpo 93 in Orlando, Florida; (2) he also prepared and manned a booth in cooperation with the DECD staff for the 1993 Industrial Minerals Forum in Long Beach, California; and (3) he invited and convinced the Industrial Minerals Forum to meet at Laramie, Wyoming in 1996.

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 Geologist provided forecasts and continually apprised CREG of the minerals situation throughout FY93. This group met four times in FY93, twice on mineral forecasts and twice as a whole.

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

Department of Environmental Quality, Abandoned Mine Land Program (DEQ-AML) — (1) The Heads of the Coal, Industrial Minerals and Uranium, and Metals and Precious Stones Sections periodically provide the locations of abandoned mines and sometimes review and make recommendations on Abandoned Mined Land Reclamation Projects; and (2) the Head of the Geologic Hazards Section, as a member of the Technical Review Committee (TRC) for the Abandoned Mined Lands Research Program, provided input into the program's research efforts on selenium, and he participated in the Fourth Semiannual Project Review Seminar in Kemmerer, 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 advice on the development potential of certain industrial minerals; and (2) under a Memorandum of Understanding with the DEQ-LQD, the Head of the Geologic Hazards Section and(or) the State Geologist reviewed paleontologic surveys included in new mining applications.

Department of Environmental Quality, Water Quality Division (DEQ-WQD) — (1) In a 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 study of aquifer vulnerability and contamination in Goshen County; and (2) the Geologic Hazards Section is also preparing preliminary 1:250,000-scale maps of surficial materials, which will be used in a statewide study of aquifer vulnerability.

Department of Health (DOH) — The Geologic Hazards Section finished work on grants (a) to determine the reliability in measurements of soil-gas radon, and (b) to see if there are predictable relationships between measurements of radon and background gamma-radiation. These grants were partially funded by the U.S. Environmental Protection Agency through the DOH.

Governor's Clearing House — The State Geologist and Heads of the six geologic sections reviewed 165 documents for the Governor's Clearing House in FY93 and submitted written comments on 31.

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 Multi-hazard Mitigation Task Force.

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.

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

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 will permit 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 1.0-1.5 days long in FY93; and (2) the Geologic Mapping Section provided lithologic and stratigraphic

information on 45 wells to assist the Commission's staff and field personnel in evaluating applications for underground water disposal or injection wells.

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

Secretary of State's Office — The Head of the Metals and Precious Stones Section and the Laboratory Unit assisted the Secretary of State's Office in the investigations of some mineral-related fraud cases in cooperation with the U.S. Postal Inspection Service, the U.S. Attorney General, the Federal Bureau of Investigation, and the U.S. Securities and Exchange Commission.

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

State Land and Farm Loan Office — (1) The Oil and Gas Section (a) reviewed the locations of 2,987 drilled or permitted well sites and provided the State Land Office with weekly reports, which showed that 344 of the locations were on or near State lands, (b) assigned a development potential to 388 State oil and gas lease tracts to assist the State Land Office in selecting tracts for the State's lease auctions, and (c) continually updated its computerized listing of oil and gas potential and sale results on State lease tracts; (2) the State Geologist reviewed and made recommendations on 11 commercial or scientific fossil-collecting permits; (3) the Geologic Mapping Section (a) conducted field inspections of seven fossil quarries on State lands, and (b) evaluated the paleontological values of 55 state land parcels nominated for public auction, and then recommended that certain parcels should have their paleontologic resources reserved to the State upon sale; and (4) the Head of the Industrial Minerals and Uranium Section provided information on trona resources involved in a proposed land exchange involving State lands.

State Engineer — The State Geologist or the Head of the Geologic Hazards Section routinely attend the Water Forum and the State Geologist is a member of the State Mapping Advisory Council, which is chaired by the State Engineer.

State Planning Coordinator (SPC) — The Head of the Geologic Hazards Section continued to participate in the SPC's Selenium Work Group. More than 800 articles on selenium were loaned to the Natrona County Cooperative Extension Service to assist in their analysis of selenium at the Kendrick/ Casper-Alcova Irrigation District.

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

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

University of Wyoming — (1) A study of diamond-bearing kimberlite deposits in Wyoming by the Metals and Precious Stones Section ended in FY93 when Congress eliminated funding for the University's Mining and Mineral Resources Research Institute, which had partially funded the project for the last 12 years; (2) the Head of the Geologic Hazards Section participated in the Wyoming Water Research Center's study group investigating the vulnerability of aquifers to contamination, and he also reviewed research proposals for the Center as well as for the University of Wyoming's Office of Research, (3) In a cooperative effort with the Department of Geology and Geophysics, the Geologic Hazards Section is preparing 1:250,000-scale maps of surficial materials and features for incorporation into the U.S. Geological Survey's surfical geology map of the U.S.; (4) the Geologic Mapping Section continued its cooperative program with the University's Geology Library whereby customized bibliographies can be prepared for inquirers; (5) The Publications Section provided editorial and word processing assistance for a treatise on the geology of Wyoming that is being jointly prepared by the Department of Geology and Geophysics and the Geological Survey. Some members of the Geological Survey's professional staff wrote articles for the treatise and the Survey will bid and publish the volume when it is completed; (6) The Head of the Coal Section developed and co-taught a course on the botanical aspects of coal bed formation for the Department of Botany; (7) The Coal Section provided background and materials to the Geology Museum for use in a new exhibit on Wyoming's coal deposits; (8) In conjunction with the School of Extended Studies, the Head of the Coal Section developed a short course aimed at explaining the unique benefits and problems of Wyoming's coal deposits: and (9) ongoing assistance and information was provided to faculty and students from many departments of the University.

Wyoming Emergency Management Agency (WEMA) — (1) The Head of the Geologic Hazards Section is the Survey's liaison to WEMA. He is also the State's representative to the Western States Seismic Policy Council (WSSPC) where he served as chairman of the Executive Board in FY93 as well as chairman of the Building Codes Committee. In

the latter case, he organized a workshop on the Uniform Building Code and seismic zone changes, which was held in September 1992 at Reno, Nevada. As Chairman of WSSPC, he planned and organized 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 47 other State and local government entities in FY93 as well as inquiries from 167 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 29 talks, field trips, or briefings on mineral resources, geology, or geologic hazards to the following 24 different groups:

American Institute of Professional Geologists, Casper
American Association of Petroleum Geologists (AAPG), Rocky Mountain Section, Casper (three talks)
American Association of Petroleum Geologists, Energy Minerals Division, Casper (see AAPG above)
Australian Institute of Mining & Metallurgy, Christchurch, New Zealand
Cheyenne Rotary Club, Cheyenne
Colorado Mining Association, Denver
FMCA Rock Hounds, Laramie
Girl Scout Troup 453, Laramie
Industrial Minerals Forum, Long Beach, California
International StonExpo '93, Orlando, Florida
Laramie Chamber of Commerce, Laramie
Lions Club, Lingle
Riverton Gem & Mineral Club, Lander
Society of Economic Paleontologists & Mineralogists, Casper (see AAPG above)
Society of Organic Petrology, College Station, Pennsylvania (3 talks)
U. S. Geological Survey, Reston, Virginia and South Pass, (1 talk; 1 field trip)
University of Canterbury, Department of Geology, Christchurch, New Zealand
University of Wyoming, Department of Botany, Laramie
University of Wyoming, Department of Education, Laramie (2 talks)
University of Wyoming, Department of Geography, Laramie
Western States Seismic Policy Council, Reno and Incline Village, Nevada (3 talks)
Wyoming Emergency Management Agency, Cheyenne
Wyoming Geological Association (5 talks)
Wyoming Mining Association, South Pass

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 29 investigations, projects, or studies were ongoing or completed in FY93:

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; compiled coal data for inclusion in a computerized national data base).

- **Characterization of Wyoming coals** (ongoing; statewide data on the chemical composition and physical properties of strippable coals were tabulated and entered into a computerized data base; a coal petrographic microscope was obtained so that the composition of Wyoming coals could be more completely assessed).

- **Coalbed methane resources and activities in Wyoming** (ongoing; includes a cooperative study of subsurface coal geology at the Metfuels Coalbed Methane Project in the Hanna Coal Field; summary articles on the development of coalbed methane in Wyoming were prepared for *Wyoming Geo-notes* in the last three quarters of FY93).

- **Demonstrated reserve base (DRB) of coal in Wyoming** (completed; this project was partially funded by the U.S. Department of Energy's Energy Information Administration (EIA); this one-year, statewide project identified eight billion more tons of compliant coal than had previously been reported in the demonstrated reserve base for Wyoming; an open file report was published by the Geological Survey in FY93).

Geologic Hazards Section

- **Gamma radiation and radon relationships** (completed; this project was partially funded by the U. S. Environmental Protection Agency through the Wyoming Department of Health; aerial and ground-based background gamma-radiation data were compared with radon data from home sampling at four test sites: central Goshen County, Afton, Sheridan, and Laramie; in addition, ground-based background gamma-radiation was compared with soil-gas radon data collected in the Laramie Basin; reasonably positive correlations were found between ground-based background gamma-radiation and the home radon data as well as the soil-gas radon data in the Laramie area; an unpublished summary report was prepared in FY93).

- **Landslide mapping and classification** (completed; the Section prepared and published the final 117 Preliminary Landslide Maps of the State (1:24,000-scale); copies of pertinent maps were provided to nine counties as well as the Shoshone and Bridger-Teton National Forests; in the future, these maps will be revised as warranted).

- **Earthquakes and seismicity** (ongoing; the Head of the Section represented Wyoming on the Western States Seismic Policy Council (WSSPC) and was chairman of the Executive Board and chairman of the Building Codes Committee of WSSPC; the Head of the Section moderated a workshop on the Uniform Building Code and seismic zone changes in the western U.S. held at Reno, Nevada in FY93 [unpublished workshop proceedings were prepared]; with the assistance of the Wyoming Emergency Management Agency, arrangements were made for the 1993 Annual Meeting of WSSPC at Jackson in FY94; as chairman of WSSPC, a Statement of Work for FY93-FY94 was prepared, input on the scope of the annual meeting and future directions for WSSPC was solicited from member states, coordination with the Central U.S. and Northeast States Earthquake Consortiums was initiated, and a WSSPC newsletter was started).

- **Mapping of surficial materials and features** (ongoing; this is a joint effort with the University of Wyoming's Department of Geology and Geophysics and the U.S. Geological Survey; in FY93, the Section prepared 1:250,000-scale maps of the Cheyenne, Torrington, Newcastle, Gillette, and Sheridan Quadrangles for use in compiling a surficial materials map for the entire U.S.; these maps will also be used in a statewide aquifer vulnerability study, which is a cooperative effort with the Wyoming Water Research Center, the Wyoming Department of Environmental Quality, and the University of Wyoming).

- **Soil-gas radon variability** (completed; this project was partially funded by the U. S. Environmental Protection Agency through the Wyoming Department of Health and was also a cooperative effort with the U.S. Geological Survey and U.S. Bureau of Mines; twelve sample sites in the Laramie Basin were monitored weekly for 35 weeks; at a given sample site, the study found significant variability in soil-gas radon measurements from one week to the next, and in some cases there were hour to hour variations; an unpublished summary report was prepared in FY93).

- **Earth Science Information Center** (ongoing; in cooperation with the U.S. Geological Survey, the Section continued to operate the publically 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; it also began to acquire indices of aerial photography available through State and private entities).

Geologic Mapping Section

- **Index maps depicting geologic mapping in Wyoming** (ongoing; completed compilation of an unpublished index map showing 88 thesis and dissertation maps of Wyoming done by students at out-of-state universities).

- **1:100,000-scale geologic maps** (ongoing; compilation work began on the Cheyenne Quadrangle).

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

- **Stratigraphic Nomenclature Chart** (completed; this was a joint statewide project with the U.S. Geological Survey; the final colored version of this chart was published in FY93).

Industrial Minerals and Uranium Section

- **Industrial minerals and construction materials report and map for Wyoming** (ongoing; information for most commodities has been gathered; files on silica, gypsum, bentonite, limestone, and decorative rock were expanded).

- **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 northwesternmost portion of the quadrangle).

- **Characterization of limestones in Wyoming** (ongoing; about 75 percent of the limestone-bearing areas of the State were examined and sampled in FY93).

- **Radioactive mineral occurrences and uranium mines in Wyoming** (ongoing; an open file report on radioactive mineral occurrences and uranium mines in Goshen County was published in FY93; similar reports on Lincoln, Sweetwater, Hot Springs, Sheridan, and Weston Counties were in preparation; a carbonatite-hosted uranium anomaly was investigated in the Bear Lodge Mountains of northeastern Wyoming).

- **Decorative stone deposits in the Medicine Bow National Forest** (ongoing; this study is funded by a grant from the U.S. Forest Service; field work began in late June).

Metals and Precious Stones Section

- **Economic geology of the Seminoe Mountains mining district** (completed; a preliminary report was submitted for publication outside the Geological Survey while a final report was submitted for publication by the Survey; the project identified several gold anomalies, some copper, lead, and zinc, lapidary materials, and a heavy mineral anomaly possibly related to an undiscovered kimberlite).

- **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** (completed; this 12-year project had been partially funded through a cooperative agreement with the University of Wyoming's Mining and Mineral Resources Research Institute; as a result, a few hundred heavy mineral anomalies, indicative of potentially diamond-bearing kimberlite or lamproite, were identified in the Laramie, Medicine Bow, and Seminoe Mountains and in the Green River Basin; the results were published as a 1993 revision of Open File Report 88-11).

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

- **Economic geology of the Itmay mine, Sierra Madre** (completed; assisted the U.S. Forest Service in a field study of the mineral potential of the massive sulfide mineralization at this mine).

- **Precious metals and diamond in southern Wyoming** (ongoing; this project has been partially funded by two grants from Union Pacific Resources; continued field investigations for precious metal anomalies and diamond; 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; numerous gold and some silver, rare earth element, and arsenic anomalies were identified; the potential for diamond-bearing rocks in the Green River Basin was investigated).

Oil and Gas Section

- **Characterization of oil and gas reservoirs, including oil and gas composition and properties** (ongoing; the Section's computerized data base now contains reservoir data for 300 of the largest gas reservoirs in the State, 305 oil and gas analyses, and 1,699 water analyses from oil and gas fields across the State).

- **Tight gas sands in the Frontier Formation of Wyoming** (ongoing; this project was partially funded by a grant from the Texas Bureau of Economic Geology (TBEG); the Survey provided geologic and engineering parameters for several hundred Frontier Formation wells in the Greater Green River Basin in support of a cooperative project with TBEG; continued editing a manuscript on the geologic controls on reservoir properties of low-permeability sandstones in the Frontier Formation, prior to submittal for publication by the Survey).

- **Regional oil and gas fields maps of Wyoming** (completed; oil and gas field maps of the Bighorn Basin and southeastern Wyoming were published in FY93; these were the last two of five 1:316,800-scale maps, which collectively depict the entire hydrocarbon-productive area of the State).

- **Atlas of major Rocky Mountain gas reservoirs** (ongoing; this project is partially funded by the Gas Research Institute; the Oil and Gas and Geologic Mapping Sections in cooperation with Barlow and Haun, Inc. continued preparation of 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 is coordinated by the New Mexico Bureau of Mines and Mineral Resources).

- **Estimations of oil and gas resources and reserves** (ongoing; preparing a report on the resources and reserves of helium in Wyoming; a report on carbon dioxide was completed in FY92).

Miscellaneous

- **Rock and mineral identifications and analyses** (ongoing; more than 120 rock and mineral specimens were identified for the general public, mining companies, or the University of Wyoming Geology Museum; and the Laboratory Unit conducted 582 analyses, tests, or procedures on 259 samples in support of in-house geologic investigations.

- **Articles written for publication by outside publishers** (ongoing; in FY93, the State Ge-

ologist and Section Heads prepared 29 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 FY93, the Geological Survey (1) enlarged its geologic hazards files, particularly in regard to radon, uranium, radium, lead, zinc, and arsenic; (2) expanded its computerized data base of oil and gas reservoir characteristics and oil and gas composition; (3) acquired downhole logs from uranium drilling in the Bison Basin and other areas of the State; and (4) purchased computerized coal delivery and price data; 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 first floor 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, the Sections are now entering data on coal, oil, and gas composition.

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 State Geologist, Section Heads, other Survey staff, and occasionally to outside entities.

ACCOMPLISHMENTS

For each of these major objectives, the activities and accomplishments of the Publications Program in FY93 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 FY93, the Editorial Unit prepared bid specifications for 8 printing jobs. The Editor also attended the press runs for 5 of these jobs to assure the printed quality of these publications met Survey standards.

The Geological Survey published 135 new titles in FY93 (Figure 6). The larger numbers of publications completed each year since FY82 are the result of a concerted effort to increase the number of new publications each year.

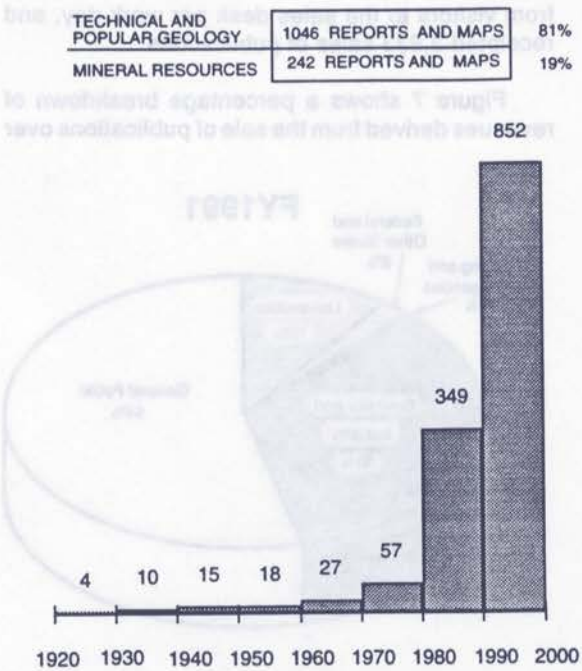

Figure 5. General content of Survey publications since FY20 (excludes publications lists and posters) and number of new titles by decade.

Relatively level funding, inflation, and position losses have necessitated some changes in how the Section accomplishes its mission. In recent years, the Section has upgraded its photographic and computer equipment. It currently has an excellent desk top publishing system, and it acquired a computerized drafting system late in FY93.

However, because of the larger 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 reports or preliminary maps rather than preparing them for commercial printing. An open file report or preliminary map is one that is prepared in a reproducible 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.

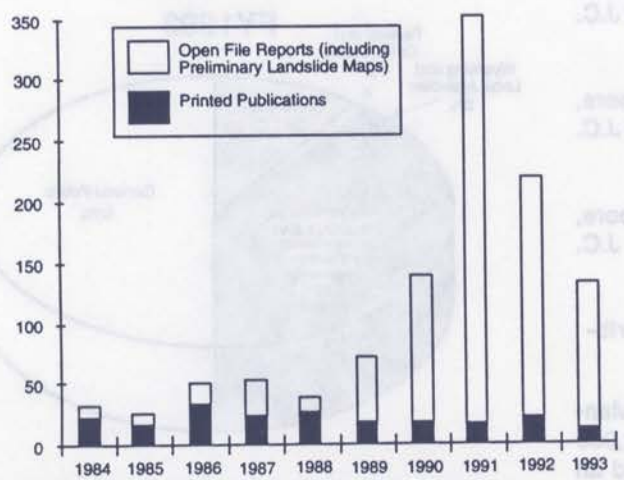

Figure 6. Number of new titles published each fiscal year (FY80 through FY93).

The 135 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

Fifty-ninth annual report of the Geological Survey of Wyoming for Fiscal Year 1992, July 1, 1991 to June 30, 1992, by G.B. Glass and S.G. Bruhnke (1992).

INFORMATION PAMPHLET

Geology of Wyoming (fourth printing): IP-2, by G.B. Glass and D.L. Blackstone, Jr., (1993).

MAP SERIES

Oil and gas fields map of the Bighorn Basin: MS-40, by R.H. De Bruin and S.D. Hostetler (1993).

Stratigraphic chart showing Phanerozoic nomenclature for the State of Wyoming: MS-41, by J.D. Love, A.C. Christiansen, and A.J. Ver Ploeg (1993).

Oil and gas fields map of southeastern Wyoming basins: MS-42, by R.H. De Bruin and S.D. Hostetler (1993).

MISCELLANEOUS

Publications available from the Geological Survey of Wyoming: (March, 1993).

OPEN FILE REPORTS

Second draft of a stratigraphic chart showing Phanerozoic nomenclature for the State of Wyoming: OFR 92-2, by J.D. Love, A.C. Christiansen, and A.J. Ver Ploeg (1992)

The John Blue Canyon silica sand deposit, Big Horn County, Wyoming: OFR 92-3, by R.E. Harris (1992).

Demonstrated reserve base of Wyoming coal as of January 1, 1991: OFR 92-4, R.W. Jones and G.B. Glass (1992).

Preliminary study of precious metals and stones along the Union Pacific right-of-way, southern Wyoming: OFR 92-5, by W.D. Hausel, G.G. Marlatt, E.L. Nielsen, and R.W. Gregory (1992).

Mineral pigments in Wyoming: OFR 92-6, by R.E. Harris (1992).

Occurrences of radioactive elements in Goshen County, Wyoming: OFR 93-1, by R.E. Harris and J.K. King (1993).

PRELIMINARY LANDSLIDE MAPS

117 quadrangles were completed in FY93, by J.C. Case and others (1992 and 1993).

REPRINTS

Subsurface geology of Upper Cretaceous and lower Tertiary coal-bearing rocks, Wind River Basin, Wyoming: R-53, by D.G. Hogle and R.W. Jones (1992)

Precious metal, base metal, and gemstone deposits of Wyoming: R-54, by W.D. Hausel (1993).

WYOMING GEO-NOTES

No. 35: by G.B. Glass, R.H. DeBruin, R.W. Jones, R.E., Harris, W.D. Hausel, D.B. Basko, A.J. VerPloeg, and J.C. Case (1992).

No. 36: by G.B. Glass, R.H. DeBruin, T.A. Moore, R.E. Harris, W.D. Hausel, A.J. VerPloeg, and J.C. Case (1992).

No. 37: by G.B. Glass, R.H. DeBruin, T.A. Moore, R.E. Harris, W.D. Hausel, A.J. VerPloeg, and J.C. Case (1993).

No. 38: by G.B. Glass, R.H. DeBruin, T.A. Moore, R.E. Harris, W.D. Hausel, A.J. VerPloeg, J.C. Case, and J.C. Shearer (1993).

SALES AND DISTRIBUTION: Sell and distribute Survey publications.

In FY93, the Editor, Publications Sales Manager, and Editorial Assistant responded to 2,060 written inquiries about publications, answered an average of 18 telephone inquiries and inquiries from visitors to the sales desk per work day, and receipted 3,833 sales of publications.

Figure 7 shows a percentage breakdown of revenues derived from the sale of publications over

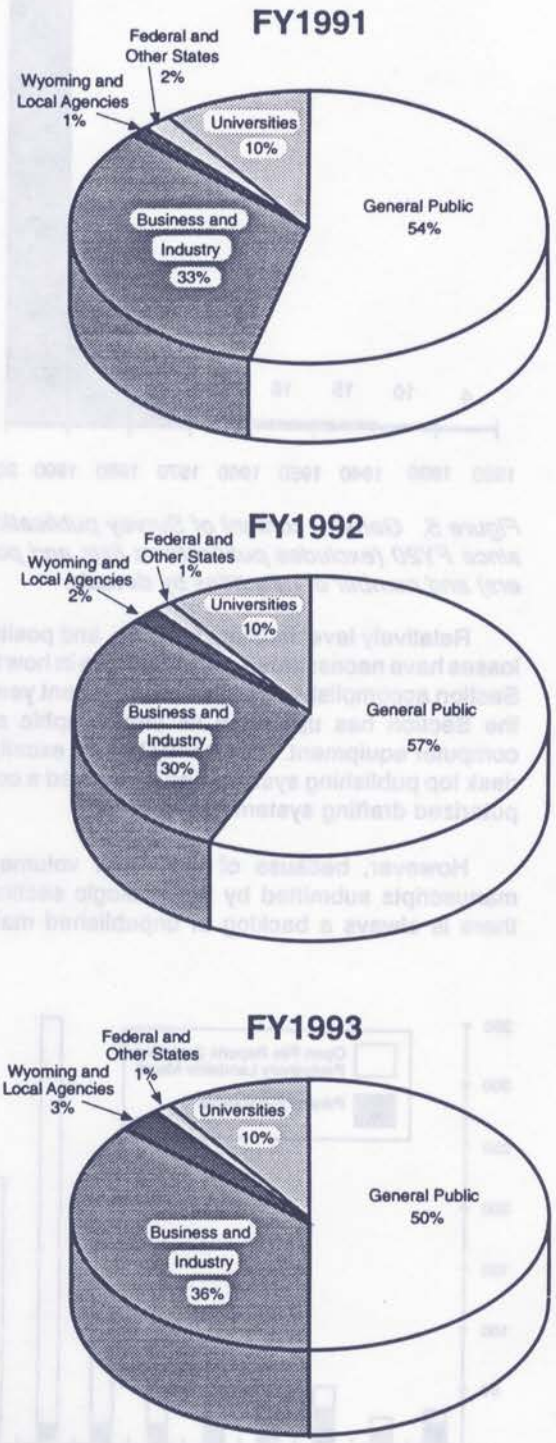

Figure 7. Percentage of publication revenue arranged by customer category (FY91 through FY93).

the last three fiscal years, arranged by customer category. The revenues from sales to the general public have exceeded 50 percent of the total since FY86.

Table 1 shows the volume of receipted sales in each customer category and the revenues derived from that customer category.

Table 1. Breakdown of publication sales by customer category and by sales revenue for FY93.

Category	Percent of Customers	Sales Revenue	Percent of Revenue
General Public and(or) unidentified	50%	$39,052	50%
Business and Industry	40%	28,255	36%
Universities	7%	7,289	10%
Wyoming and Local Agencies	2%	2,040	3%
Federal, Other States and Foreign	1%	997	1%
	100%	$77,633	100%

Revenues generated from the sale of publications are deposited in the General Fund. Table 2 summarizes the breakdown of revenue from publication sales by publication type for FY93.

Table 2. Breakdown of revenue from publication sales by publication type for FY93

36.17%	Topographic maps (all scales)	$28,078.00
21.37%	Bulletins	16,592.00
14.40%	Map Series	11,179.50
3.90%	Open File Reports	3,024.50
3.27%	Public Information Circulars	2,536.00
3.13%	Reports of Investigations	2,431.00
3.01%	Educational Series	2,336.00
2.60%	Geologic Map of Wyoming	2,020.00
2.47%	Geologic Highway Map	1,918.00
2.03%	Reprints	1,576.00
1.93%	Wyoming Geo-notes	1,498.00
0.85%	Memoirs	657.00
0.83%	Unpublished Mineral Reports	644.95
0.65%	Preliminary Reports	507.00
0.45%	Postcards	351.25
0.21%	County Resource Series	162.00
97.27%	Subtotal	$75,511.20
6.01%	Miscellaneous publications	4,665.65
(5.69)%	Postage & accounts receivable	(4,419.28)
2.42%	Sales Tax collections	1,875.14
100.0%*	Grand Total	$77,632.71

* Total may not equal 100% because of independent rounding.

As a general rule, sales income had been increasing until the peak year of FY81 (Figure 8). With the subsequent recession, sales declined substantially, dropping to $48,878 in FY84. Although slumping sales jumped back up in FY85, they resumed a steady one percent a year decline until FY90. That year, sales took a dramatic 10 percent increase, to $75,709, followed by a 7.5 percent increase to $81,359 in FY91, and a slight increase to $81,749 in FY92. The decrease in sales revenue in FY93 is mostly a result of not being able to bank the receipts from the last week in the year until FY94. The last week's sales receipts were over $2,850.

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 mailings of press releases describing new items, 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.

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 FY93, more than 1,227 publications were received in exchange for Survey publications.

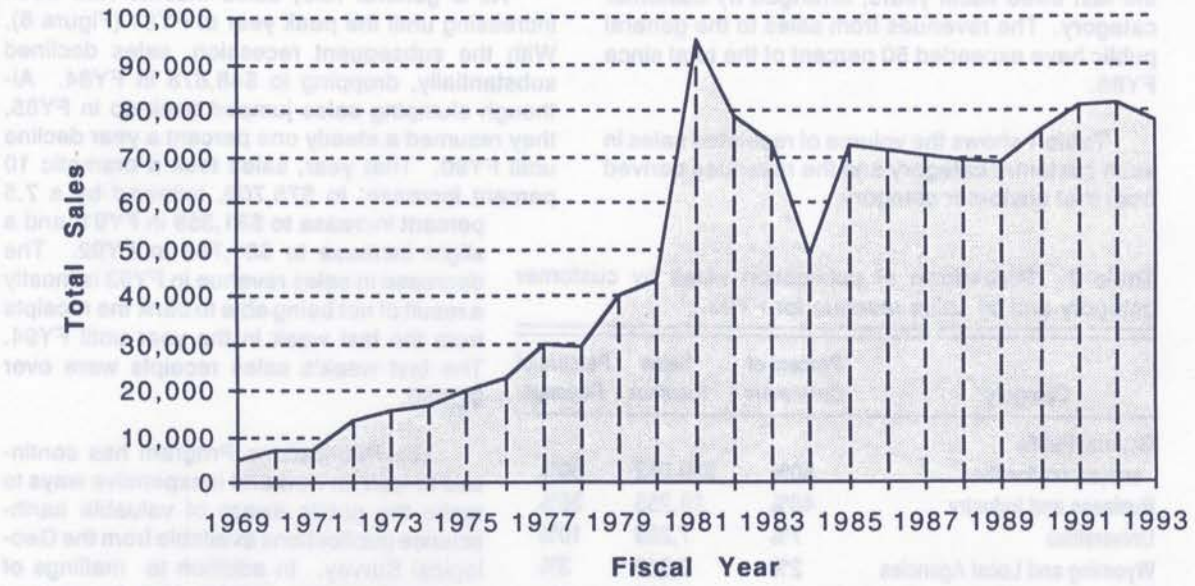

Figure 8. Fiscal year income to the General Fund from the sale of publications.

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.
S-656	W. Dan Hausel	1987 pick-up for off-road field work.
S-799	James C. Case	1981 station wagon for light field work.
S-1330	Richard W. Jones	1988 station wagon for press runs.