

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

FIFTY-EIGHTH ANNUAL REPORT
of the
GEOLOGICAL SURVEY OF WYOMING

For Fiscal Year 1991
July 1, 1990 to June 30, 1991

by

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Laramie, Wyoming
October, 1991

*Geological Survey
of Wyoming*

THE GEOLOGICAL SURVEY OF WYOMING

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INTRODUCTION

STATUTORY AUTHORITY

The office of State Geologist, which was established in 1890 with the Wyoming State Constitution (Art. 9, Sec. 6), was repealed by an amendment in 1990.

The Geological Survey was created by the Legislature in 1933. It has since been modified by legislative enactment in 1957, 1969, 1977, 1979, 1982, and most recently, 1991 (Chapter 122 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.

AGENCY MISSION

The mission of the Geological Survey is to study and interpret the geologic, mineral, and energy resources of the State.

AGENCY GOALS

The Geological Survey of Wyoming's goals, which are listed below, link the Survey's activities and programs to the State's needs:

INFORMATION DISSEMINATION — PROVIDE TIMELY, ACCURATE, AND ACCESSIBLE INFORMATION ABOUT THE STATE'S GEOLOGIC, MINERAL, AND ENERGY RESOURCES THAT HAVE A PRACTICAL BEARING ON WYOMING'S CITIZENRY AND ECONOMY.

This goal is achieved by publishing geologic 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 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 the techniques of resource evaluation including geologic mapping, recon-

naissance 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 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 VALUES AS WELL AS TIMELY REPORTS ON IMPORTANT HYDROLOGIC AND GEOLOGIC EVENT AND CONDITIONS OF IMMEDIATE CONCERN TO THE PUBLIC AND TO 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.

MISSION SUPPORT — IMPROVE THE SURVEY'S ABILITY TO EFFECTIVELY CARRY OUT ITS MISSION.

AGENCY ACCOMPLISHMENTS

In FY91, the Geological Survey of Wyoming:

— provided data, advice, and assistance to both in-state and out-of-state inquiries, responding to more than 19,907 inquiries. Of these, 6,509 were related to geology and mineral and energy resources; 348 to the effective use of earth-science techniques, products, and information; and 13,050 to requests for Survey publications and/or information on publications.

— prepared 354 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 Section.

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

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

— identified and evaluated geologic hazards in Wyoming associated with earthquakes, landslides, active faults, and naturally-occurring toxic elements (selenium and radon).

— assessed mineral and energy resources, documented their occurrences, and determined their origins and manners of occurrence through more than 26 field and laboratory investigations.

— increased knowledge of the State's stratigraphic framework through 10 geologic mapping and/or geologic investigations.

ORGANIZATION

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

ADMINISTRATION PROGRAM (001) - Since 1969, when the Agency was reorganized and expanded, efforts of the Administration 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.

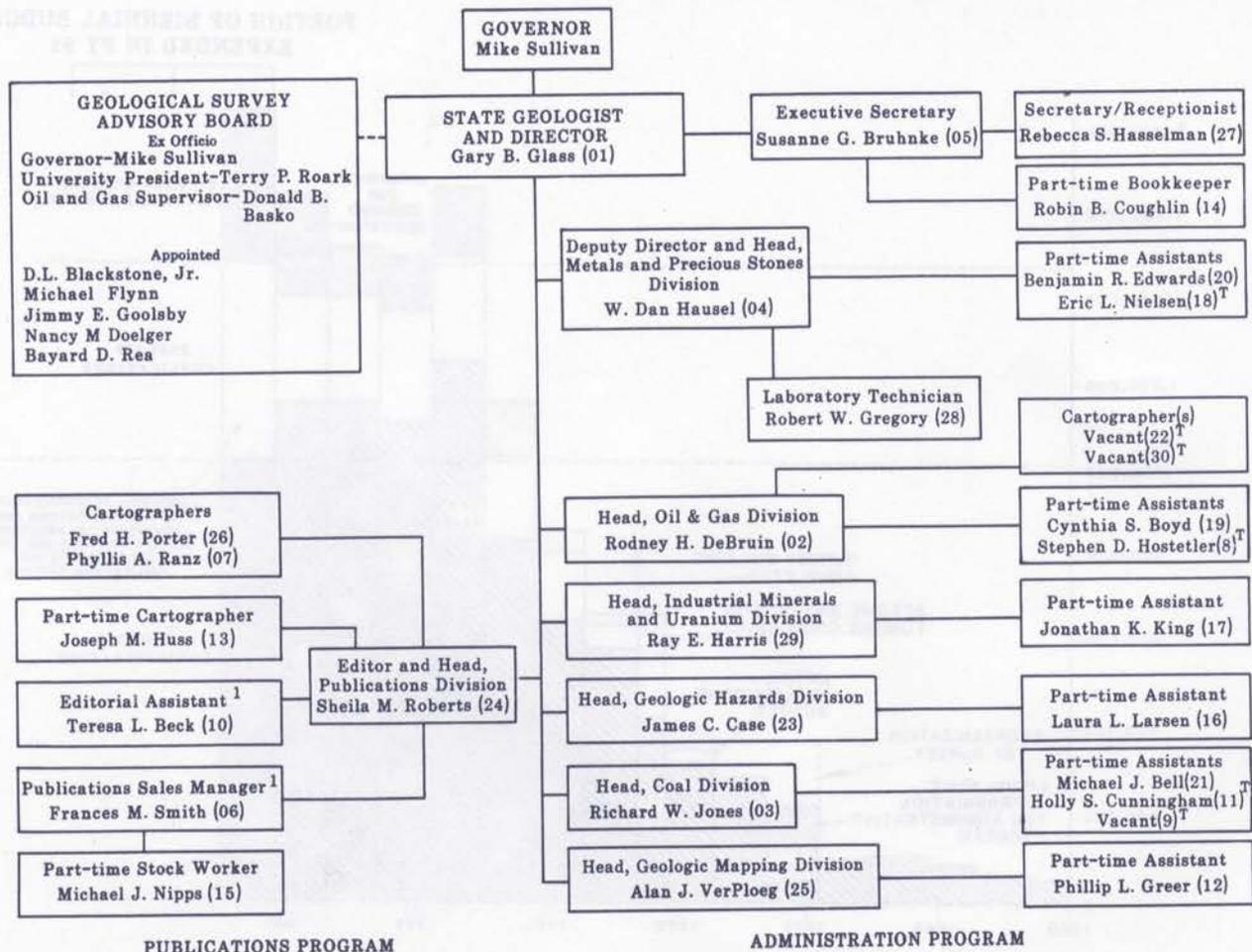
In FY91, the staff of the Administration Program consisted of 10 full-time and 7 part-time employees. The State Geologist, two full-time secretaries, and one half-time bookkeeper provide the truly administrative, budgetary, and fiscal support for the entire Agency. Seven full-time geologists and 6 part-time geologic assistants form the scientific arm of the Agency and accomplish the Agency's major objectives.

In support of the Administration Program, the Agency solicits and receives some funds from outside sources (State, local, or Federal grants) to augment General Fund appropriations. In FY91, these augmenting funds totaled \$353,890.93 of which \$114,348.28 were expended during the fiscal year. A special \$20,000 appropriation by the

Legislature partially accounts for the large increase in augmenting funds in FY91-92. That \$20,000 was used as matching dollars in three grants that totalled 8.84 times more than the cash match. Although the projects funded by these grants become part of the Administration Program, their continuation into future years is speculative as they are only funded on an annual basis.

PUBLICATIONS PROGRAM (002) - This is the publishing arm of the Agency. The program is also charged with selling and distributing the Agency's publications. The Publications Program, which includes the salaries for five full-time employees and two part-time employees as well as funds for supplies, equipment, commercial printing, and travel related to publication activities, is funded by General Fund appropriations.

The Publications Program consists of a Publications Division, which is headed by the Editor. This Division includes a Cartographic Section, an Editorial Section, and a Publications Sales Section. The Cartographic Section puts all illustrative materials (drawings, maps, charts, etc.) into publishable form and makes proof copies and printer-ready negatives. The Editorial Section edits and puts all manuscripts into printer-ready formats, writes printing specifications, and sees that reports are satisfactorily printed. The Publications Sales Section sells Survey publications



^T These are the only temporary positions currently paid out of augmenting grant funds

Figure 1. Organization chart for the Geological Survey in FY91.

over-the-counter, by mail, and by phone, keeps an inventory of publications, and mails exchange publications. Revenues from the sale of publications in FY91 was \$81,359, a 7.5 percent increase from the previous year.

The biennial appropriations for these two programs are shown in Figure 2 along with FY91 expenditures.

MAJOR ACCOMPLISHMENTS OF THE ADMINISTRATION PROGRAM

OBJECTIVES

The Administration Program is implemented by the State Geologist, six geologic divisions (Coal, Geologic Hazards, Geologic Mapping, Industrial Minerals and Uranium, Metals and Precious Stones, and Oil and Gas) and the Laboratory Section. To accomplish the Agency's mission 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.

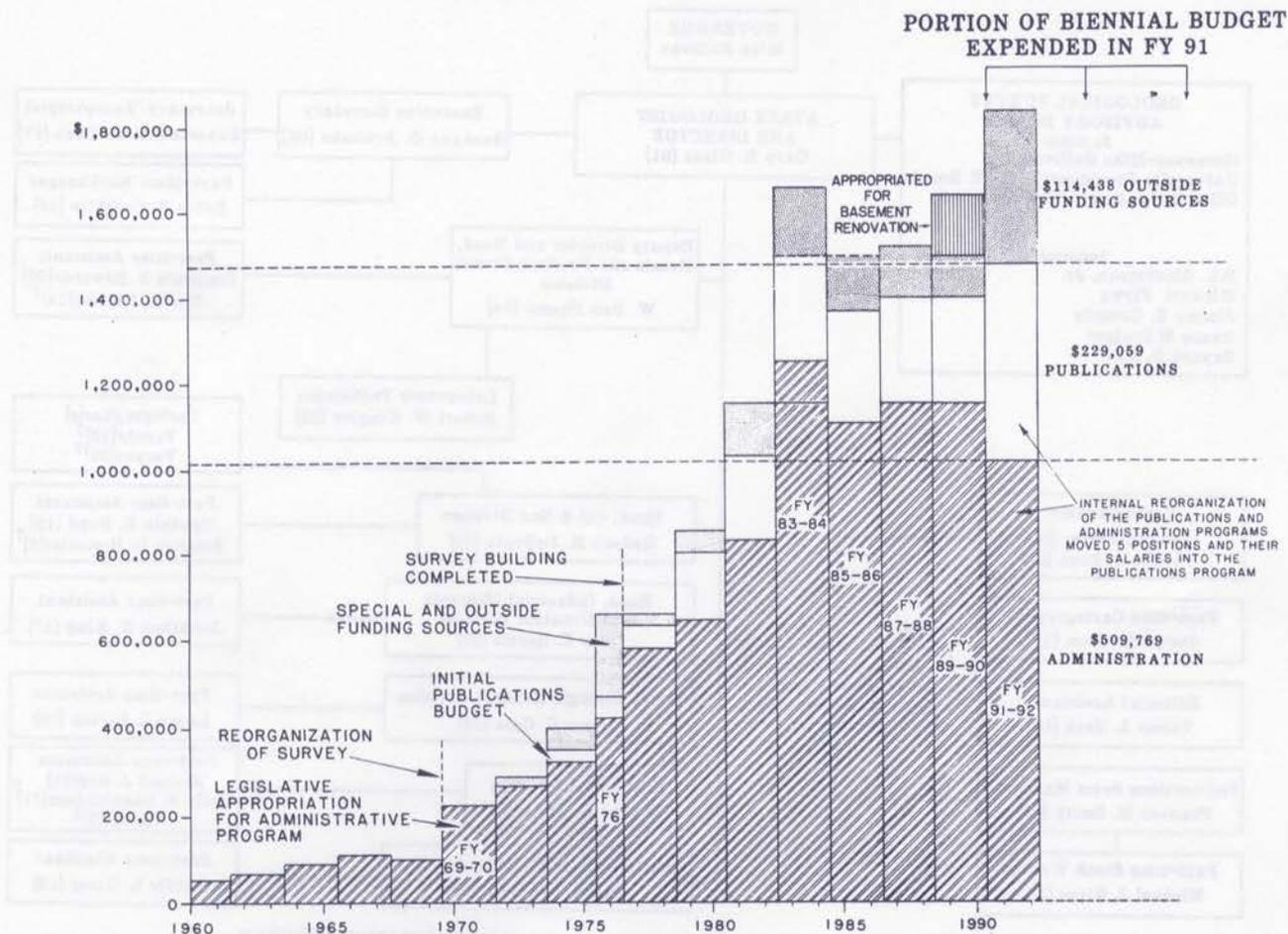


Figure 2. Biennial appropriations for the Geological Survey (expenditures for FY91 are annotated to the right of the biennial appropriations).

ACCOMPLISHMENTS

For each of these three major objectives, the activities and accomplishments of the Administration Program in FY91 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 Divisions of the Survey over the last three fiscal years. Most significantly, the Geologic Hazards and Industrial Minerals and Uranium Divisions had the most inquiries in FY91. This has been the case for the last three years.

Since at least FY81, inquiries directed to the geologic staff have increased every year. In FY91, inquiries in-

creased about 3 percent (from 6,349 in FY90 to 6,509 in FY91); this level equates to 3.2 inquiries per geologist per work day (254 work days in a year). More importantly, this current level of inquiry is 239 percent greater than it was in FY81 (Figure 4). Figure 4 also shows the categories of inquirers requesting information and assistance from the geologic staff. Inquiries from business and industry continue to be the largest category, followed closely by inquiries from the general public.

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 25 State and local government entities in FY91. The assistance provided these entities is described below:

Department of Administration and Information, Division of Research and Statistics — (1) The State Geolo-

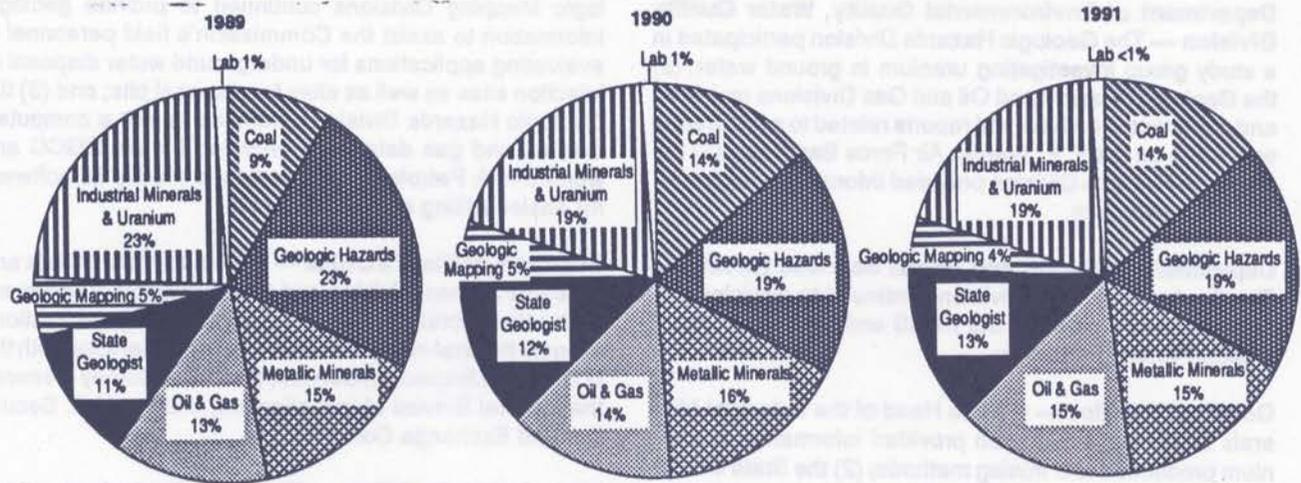


Figure 3. Percentage of inquiries directed to each of the Geologic Divisions, Fiscal Years 1989-1991.

gist and Heads of the Coal, Industrial Minerals and Uranium, and Oil and Gas Divisions provided information on the prices of oil, coal, uranium, and industrial minerals; maps; production statistics; and forecasts related to mineral and energy resources throughout the year for use in economic forecasting; and (2) the State Geologist reviewed and commented on annual revisions of the Wharton Economic Forecasting Model for Wyoming.

Department of Commerce, Division of Economic and Community Development (DECD) — (1) The State Geologist and Heads of the Coal, Industrial Minerals and Uranium, and Metals and Precious Stones Divisions provided information on mines, mineral-related projects, production trends, and markets for mineral and energy resources to the staff of the DECD; (2) the Head of the Industrial Minerals and Uranium Division assisted the DECD staff in their evaluations of several projects regarding decorative stone, granite, ballast sources, sulfur, and zeolites; and (3) the Head of the Geologic Hazards Division assisted in preparing a siting proposal for a \$200 million Laser Interferometer Gravity-wave Observatory (LIGO), which was submitted to the California Institute of Technology.

Department of Commerce, Parks and Cultural Resources Division — The Head of the Geologic Mapping Division assisted in the compilation of a sign describing the geology of the Wind River Canyon.

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 Divisions, the State

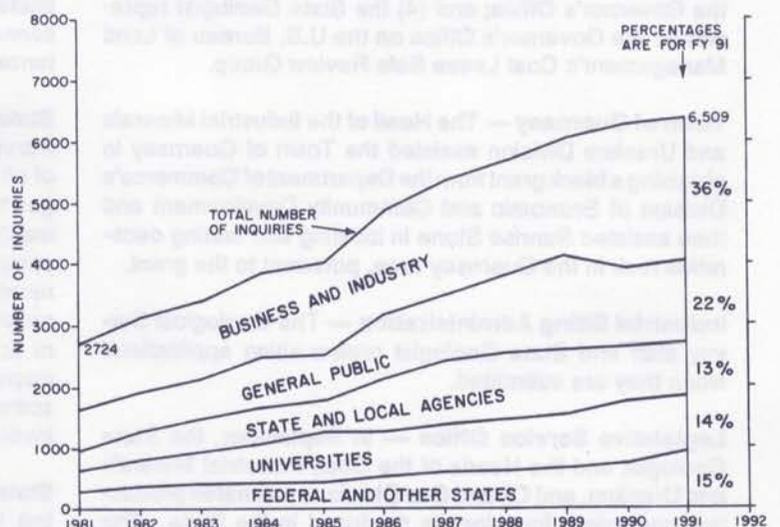


Figure 4. Number of inquiries directed to the Geologic Divisions by category and fiscal year.

Geologist provided forecasts and continually apprised CREG of the minerals situation throughout FY91. The State Geologist met with CREG four times in FY91.

Department of Environmental Quality, Land Quality Division (DEQ-LQD) — (1) The Heads of the Coal, Industrial Minerals and Uranium, and Metals and Precious Stones Divisions continued to review and make recommendations on Abandoned Mined Land Reclamation Projects (AML); (2) the Head of the Industrial Minerals and Uranium Division participated as a member of the DEQ-LQD's Selection Committee for Procurement in the AML Program; (3) under a Memorandum of Understanding with the DEQ-LQD, the Head of the Geologic Hazards Division reviews paleontologic surveys included in new mining applications; and (4) the Head of the Metals and Precious Stones Division assisted in a study of asbestos.

Department of Environmental Quality, Water Quality Division — The Geologic Hazards Division participated in a study group investigating uranium in ground water; (2) the Geologic Hazards and Oil and Gas Divisions reviewed and commented on data and reports related to a hazardous waste site on the F. E. Warren Air Force Base; and (3) the Geologic Hazards Division provided information and references on selenium.

Department of Health and Social Services (DHSS) — The Geologic Hazards Division continued to participate in radon-related projects of the DHSS and the U.S. Environmental Protection Agency.

Governor's Office — (1) The Head of the Industrial Minerals and Uranium Division provided information on uranium production and mining methods; (2) the State Geologist served as a member of the Governor's Coalbed Methane Task Force; (3) the State Geologist attended a meeting of economic forecasters in Denver for the Governor's staff and commented on several documents provided by the Governor's Office; and (4) the State Geologist represented the Governor's Office on the U.S. Bureau of Land Management's Coal Lease Sale Review Group.

Town of Guernsey — The Head of the Industrial Minerals and Uranium Division assisted the Town of Guernsey in obtaining a block grant from the Department of Commerce's Division of Economic and Community Development and then assisted Sunrise Stone in locating and testing decorative rock in the Guernsey area, pursuant to the grant.

Industrial Siting Administration — The Geological Survey staff and State Geologist review siting applications when they are submitted.

Legislative Service Office — In September, the State Geologist and the Heads of the Coal, Industrial Minerals and Uranium, and Oil and Gas Divisions estimated production and prices for minerals produced in the State. The Survey's estimates and those of several other State agencies were used to reach a consensus on future mineral production and prices. Later these consensus estimates were used by the Consensus Revenue Estimating Group to provide a forecast of mineral revenue for use by both the Governor and the Legislature.

Town of Lovell — The Head of the Industrial Minerals and Uranium Division completed a draft report on a silica sand deposit for the Town of Lovell. This project had been funded in part by a grant from the Division of Economic and Community Development of the Department of Commerce.

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 0.5-1.5 days long in FY91 and involved more than 400 dockets. The State Geologist also served as the Acting Chairman of the Commission when the Governor was not present. Matters related to the OGCC, in addition to the hearings, routinely require another two or more days of effort by the State Geologist each month; (2) the Geologic Hazards, Oil and Gas, and Geo-

logic Mapping Divisions continued to provide geologic information to assist the Commission's field personnel in evaluating applications for underground water disposal or injection sites as well as sites for disposal pits; and (3) the Geologic Hazards Division continued to edit a computerized oil and gas data base provided by the OGCC and worked with Petroleum Information to modify its software for easier editing of the data base.

Secretary of State's Office — The Head of the Metals and Precious Stones Division and the Laboratory Section 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.

State Auditor's Office — The State Geologist provided comments on the new computerized WIN accounting system as a member of the User's Advisory Group.

State Crime Laboratory — When requested, Survey personnel continued to provide technical and laboratory assistance to investigators from the State Crime Lab.

State Land and Farm Loan Office — (1) The Geological Survey's Oil and Gas Division provided (a) weekly reports of oil and gas activities on or near State lands, (b) oil and gas tract evaluations to assist with selecting tracts for the lease auction every other month, and (c) an updated computerized listing of oil and gas potential and sale results on State lease tracts; and (2) the State Geologist (a) reviewed and made recommendations on nine commercial or scientific fossil-collecting permits, (b) conducted field inspections of several fossil quarries, and (c) provided some information regarding proposed land exchanges involving State lands.

State Planning Coordinator (SPC) and Governor's Clearing House — (1) The Head of the Geologic Hazards Division continued to participate in the SPC's Selenium Work Group; and (2) the State Geologist and Heads of the six geologic divisions reviewed 178 documents for the Governor's Clearing House in FY91 and submitted written comments on 43.

Sublette and Sweetwater County Emergency Management Offices — The Head of the Geologic Hazards Division provided each of these offices with a report on the seismic history and future earthquake potential in Wyoming, with a series of landslide maps, and with educational materials on earthquakes.

Teton County Planning Office — The Head of the Geologic Hazards Division provided Teton County with copies of the preliminary landslide maps that the Division generated for that county.

University of Wyoming — (1) The State Geologist and several of the Survey's Division Heads continued to provide quarterly minerals outlook articles for publication in the Survey Research Center's *Wyoming quarterly update*; (2) the State Geologist and Head of the Metals and

Precious Stones Division remained members of the American Heritage Center's Advisory Board for the Anaconda Collection; (3) the State Geologist served on the College of Agriculture's Advisory Council; (4) the Metals and Precious Stones Division continued field and laboratory research into diamond-bearing kimberlite deposits in Wyoming, partially funded by a cooperative agreement with the University's Mining and Mineral Resources Research Institute; (5) the Head of the Geologic Hazards Division participated in a study group investigating the vulnerability of aquifers to contaminations, sponsored by the Wyoming Water Research Center and also reviewed research proposals for the Center as well as for the University of Wyoming's Office of Research, (6) the Head of the Geologic Hazards Division provided information to the Department of Soil, Plant, and Insect Sciences in regard to selenium in Wyoming; (7) the Heads of the Metals and Precious Stones, Geologic Hazards, and Publications Divisions assisted the Department of Geology and Geophysics in planning and implementing the Wyoming Geological Association's Annual Meeting and field trips to be held in Laramie in September 1991; and (8) ongoing assistance and information was provided to faculty and students from many departments of the University.

Wyoming Emergency Management Agency (WEMA) —

The Head of the Geologic Hazards Division is the Survey's liaison to WEMA. He is also a member of the Governor's Multi-hazard Task Force and the Governor's representative to the Western States' Seismic Policy Council (WSSPC) where he is a member of the Executive Board. As the Governor's representative to the WSSPC, he attended the annual meeting, which was held in Alaska. In addition, the Head of the Geologic Hazards Division provided a one-day workshop on earthquakes and prepared a report on seismic hazards and risk in Wyoming so that the State would be eligible for funding through the National Earthquake Hazards Reduction Program.

Wyoming Highway Department (WHD) — The Head of the Industrial Minerals and Uranium Division provided assistance in locating sources of gravel for highway construction; and (2) the Head of the Geologic Mapping Division assisted in placing signs that identify rock formations along U.S. 14 west of Sheridan in cooperation with Sheridan College and the Wyoming Geological Association.

Spot Assistance to State and Local Government Entities

In addition, spot requests for information or other assistance were received from 57 other State and local government entities in FY91 as well as inquiries from 120 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 Division Heads collectively presented 40 talks, field trips, or briefings on mineral resources, geology, or geologic hazards to the following 32 different groups:

American Association of Petroleum Geologists, Denver
 American Institute of Professional Geologists, Casper (3 talks)
 Association of American State Geologists, Saratoga Springs, New York
 Association of Earth Science Editors, Tulsa, Oklahoma
 Bald Mountain Mining Company, South Pass
 Cheyenne Gem and Mineral Society, Cheyenne
 Colorado Mining Association, Denver
 First United Methodist Church, Laramie (2 talks)
 Geological Society of America, Dallas, Texas
 Geological Survey of Wyoming, Laramie
 Kiwanis Club, Laramie
 KUWR radio talk show, Laramie (2 talks)
 Laramie County Community College, Cheyenne
 Lions Club, Laramie
 Northwest Mining Association, Spokane, Washington
 Oregon Trail Grange, Casper
 Rock River Elementary School, Rock River
 Rotary Club, Casper
 Society of Mining Engineers, Casper and Denver (2 talks)
 Thayer Elementary School, Laramie
 U.S. Department of Energy, Dallas, Texas
 U.S. Forest Service, Albany, Wyoming
 Union Pacific Resources, southern Wyoming and Medicine Bow Mountains (2 field trips)
 University of Wyoming, Department of Plant, Soil, and Insect Sciences, Hartville area
 Warf Resources, South Pass
 Western States Seismic Policy Council, Anchorage, Alaska
 Wyoming Children's Museum and Nature Center, Laramie
 Wyoming Emergency Management Agency, Laramie
 Wyoming Geological Association (2 talks)
 Wyoming Mining Association, South Pass and Casper (1 talk and 1 field trip)
 Wyoming Public Employees Association, Laramie
 Wyoming Society of Professional Engineers, Cheyenne

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 Division, the following investigations, projects, or studies were ongoing or completed in FY91:

Coal Division

- **Coalbed methane potential in Wyoming** (ongoing as a joint effort with the Oil and Gas Division; a report on coalbed methane in Wyoming was published; and numerous inquiries on coal quality, occurrences, and resources related to coalbed methane were answered).

- **National Coal Resources Data System** (ongoing; compiled coal data for inclusion in a computerized national data base; as an outgrowth of this project, a paper on the stratigraphic framework of coal-bearing rocks in the Wind River Basin was published by the Rocky Mountain Association of Geologists; partially funded by a grant from the U.S. Geological Survey's Branch of Coal Resources).

- **Characterization of Wyoming coals** (ongoing; assembled and entered data on the chemical composition and physical properties of the Wyodak coal in the Powder River Coal Field into a computerized data base).

- **Federal coal drilling in Wyoming to include coal analyses** (completed; published reports on some drilling records in both the Bighorn and Wind River Coal Fields; partially funded by the U.S. Bureau of Land Management).

- **Demonstrated reserve base (DRB) of coal in Wyoming** (ongoing; a one-year project for revising the existing coal quality categories assigned to the current DRB for Wyoming; the project is slated for completion in late 1991; partially funded by the U.S. Department of Energy's Energy Information Administration).

- **Coal resources map of Wyoming** (completed and published by the Survey).

Geologic Hazards Division

- **Selenium** (ongoing; the Head of the Division continued as a member of the State Planning Coordinator's Selenium Work Group; data and reports on selenium were provided to the U.S. Geological Survey, the Wyoming Department of Environmental Quality, the State Planning Coordinator's Office, and the Department of Soil, Plant, and Insect Sciences at the University of Wyoming).

- **Landslide mapping and classification** (ongoing; completed landslide maps of 100 (1:24,000-scale) quadrangles; published 313 Preliminary Landslide Maps (1:24,000-scale); published sixteen 1:250,000-scale regional maps of landslides; published a 1:100,000-scale landslide map of Wyoming; gave three talks on landslides; provided preliminary landslide maps to the U.S. Geological Survey, the Bureau of Land Management, and the Teton, Shoshone, and Medicine Bow National Forests; conducted a site inspection and analysis of a landslide that nearly dammed the Greys River in Lincoln County; and assisted the U.S. Forest Service in ongoing landslide research).

- **Earthquakes and seismicity** (ongoing; the Head of the Division represented Wyoming on the Western States Seismic Policy Council and is a member of the Executive Board; gave seven public presentations; initiated and organized a train-the-trainer workshop for elementary teachers and curriculum coordinators; prepared a detailed report which established Wyoming's eligibility for the National Earthquake Hazards Reduction Program (NEHRP); assisted in the organization of the 2nd Biennial Earthquake Program Exchange Workshop for the Federal Emergency Management Agency (FEMA); assisted FEMA in developing a five-year program for states that become eligible for the NEHRP; prepared a bibliography on earthquake information and updated a map of earthquakes and active faults in Wyoming; prepared a manuscript on earthquakes and active faults in Wyoming; and administered a contract for work on the Teton fault, which is partially funded by the National Park Service).

- **Underground disposal or injection of produced water** (ongoing; in conjunction with the Oil and Gas and Geologic Mapping Divisions, the Geological Hazards Division provided subsurface geologic information on sites for

underground disposal or injection of water and for pit sites to the staff of the Oil and Gas Conservation Commission; continued editing Petroleum Information's oil and gas data base for Wyoming; prepared an operations manual for Petroleum Information's data base and finished modifying existing manipulative software; was partially funded by a grant from the Wyoming Oil and Gas Conservation Commission).

- **Earth Science Information Center** (ongoing; assumed responsibility for the operation of Wyoming's Earth Science Information Center (ESIC) from the State Engineer's Office; collected, maintained, and disseminated cartographic, hydrologic, geologic, and remote sensing data to include microfiche indices for all Federal aerial and space imagery).

Geologic Mapping Division

- **Geologic mapping in the southern Bighorn Mountains** (ongoing; two more 1:24,000-scale geologic maps were field checked and published as open files; three other photogeologic maps were completed and await field checking).

- **Index maps depicting geologic mapping in Wyoming** (ongoing; one 1:1,000,000-scale index map was published and a 1:500,000-scale map differentiating between adequately mapped and inadequately mapped areas was revised).

- **Bibliographies of Wyoming geology** (ongoing; initiated a cooperative project with the University of Wyoming's Geology Library for use of bibliographic data stored on compact disk; this provides an accessible, on-line bibliography and index to Wyoming geology as well as the ability to make customized bibliographies upon request).

- **1:100,000-scale geologic maps** (ongoing; completed a final draft of the Nowater Creek Quadrangle for publication and began work on the Kaycee Quadrangle).

- **Stratigraphy of the Frontier and Lower Cretaceous formations in the Bighorn Basin** (ongoing; assembled subsurface logs and picked the tops of pertinent formations; began constructing cross sections).

- **Stratigraphic nomenclature chart for Wyoming** (ongoing; joint project with the U.S. Geological Survey).

Industrial Minerals and Uranium Division

- **Industrial minerals and construction materials bulletin and map** (ongoing; information for most commodities have been gathered; files on silica sources, zeolites, and decorative rock were expanded and additional work was done on decorative stone and railroad ballast sources).

- **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 of the quadrangle).

- **Silica sands** (ongoing; assisted the Town of Lovell in an evaluation of a silica sand deposit; and preparing a report on the results of that investigation for publication by the Survey).

- **Radioactive mineral occurrences in Wyoming** (ongoing; preparing a bulletin on uranium mines and uranium occurrences in Wyoming for publication by the Survey; examined unconformity-related uranium anomalies in the Sierra Madre, Richeau Hills, and Hartville uplift; and began a literature search on phosphorite-related occurrences of uranium).

- **Surficial background gamma radiation maps of Wyoming** (ongoing; continued to prepare the Casper and Cheyenne 1° X 2° Quadrangles for publication and took readings in areas on the Ashton and Gillette Quadrangles).

Metals and Precious Stones Division

- **Gold, silver, and iron resources in banded iron formations** (ongoing; continued to evaluate the potential for these three metals in the State's banded iron formations).

- **Guide to the geology, mining districts, and ghost towns of the Medicine Bow Mountains including the Snowy Range scenic highway** (ongoing; a report is in preparation).

- **Economic geology of the South Pass-Atlantic City mining district** (ongoing; published a final report and a 1:48,000-scale map of the South Pass granite-greenstone belt; began conversion of an open file map of the Miners Delight Quadrangle into a full color map series publication by the Survey; led four field trips through the district for scientific societies and companies; initially partially funded by a grant from the U.S. Geological Survey's COGEMAP Program).

- **Economic geology of the Seminoe Mountains mining district** (ongoing; a 1:24,000-scale map of the western portion of the district was published as an open file report; mapping of the eastern portion was also nearly completed; petrographic and geochemical studies of basaltic and peridotitic metakomatiites of the area were begun).

- **Strategic and rare metals and minerals** (ongoing; conducted field and/or literature research on aluminum, beryllium, iron, manganese, molybdenum, copper, gold, silver, lead, and zinc occurrences in Wyoming).

- **Kimberlite and lamprolite investigations** (ongoing; continued exploring for potentially diamond-bearing kimberlite pipes through the collection and examination of stream-sediment samples in the Laramie and Medicine Bow Mountains; partially funded through a cooperative agreement with the University of Wyoming's Mining and

Mineral Resources Research Institute; began investigations of lamproites in the Leucite Hills for diamonds and gem-quality peridot; partially funded by a grant from Union Pacific Resources).

- **Economic geology of the Cooper Hill District** (ongoing; began field investigations and geologic mapping at 1:12,000-scale).

- **Precious metal occurrences in southern Wyoming** (ongoing; began field investigations for gold and silver anomalies in coal, clinker, titaniferous sandstone, veins, skarns, sand and gravel, and a broad zone of alunite-silica alteration; partially funded by a grant from Union Pacific Resources).

Oil and Gas Division

- **Heterogeneity classification of Wyoming oil reservoirs** (completed; 160 Wyoming oil reservoirs in the Department of Energy's TORIS Data Base were classified; another 95 oil reservoirs in Colorado, Utah, and Montana were also classified; the Head of the Oil and Gas Division coordinated this multi-state effort, which included the state geological surveys of Colorado, Utah, and Montana; a summary of the results was presented in Dallas; partially funded by a grant from the Geoscience Institute for Oil and Gas Recovery Research, The University of Texas at Austin).

- **Characterization of oil and gas composition and properties** (ongoing; published data for the Powder River Basin as well as some data for the Greater Green River Basin were entered into a computerized data base).

- **Coalbed methane resources and activities in Wyoming** (ongoing; a joint effort with the Coal Division; a report on coalbed methane was published; summary articles on the development of coalbed methane in Wyoming were prepared for Wyoming Geo-notes each of the last two quarters of FY91).

- **Tight gas sands in the Frontier Formation of Wyoming** (ongoing; provided geologic and engineering parameters for several hundred Frontier Formation wells in the Greater Green River Basin in support of a cooperative project with the Texas Bureau of Economic Geology (TBEG); published an oil and gas fields map of the Greater Green River Basin; partially funded by a grant from TBEG).

- **Regional oil and gas fields maps of Wyoming** (ongoing; a map of oil and gas fields of the Wind River Basin was submitted for publication by the Survey and a similar map of the Bighorn Basin was started).

- **Oil and gas map of Wyoming** (completed and published by the Survey).

- **Atlas of major Rocky Mountain gas reservoirs** (ongoing; the Oil and Gas Division in cooperation with Barlow and Haun, Inc. began preparing an atlas of major Wyoming gas reservoirs as part of a larger atlas of major gas reservoirs in the Rocky Mountain region; the project is

partially funded by the Gas Research Institute; 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; submitted a report on the resources and reserves of carbon dioxide in Wyoming for publication by the Survey).

Miscellaneous

- **Rock and mineral identifications and analyses** (ongoing; the Metals and Precious Stones Division and the Laboratory Section provided rock and mineral identifications for at least 50 persons; and the Laboratory Section conducted 556 analyses and tests on 163 samples in support of the Geologic Divisions).

- **Special publication efforts in FY91** (ongoing; the Editor finished revising a separate booklet of activities for the classroom, which augments the *Wyoming geomaps* publication; the Editor also prepared and jointly edited the Wyoming Geological Association's annual field conference guidebook; the Editor also began editing a large volume on the geology of Wyoming, which will be jointly published by the Geological Survey and the Department of Geology and Geophysics).

- **Articles written for publication by outside publishers** (ongoing; in FY91, the State Geologist and Division Heads prepared 44 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 FY91, the Agency (1) enlarged its geologic hazards files, particularly in regard to landslides, earthquakes, and seismicity; (2) expanded its geologic, mineral, and energy resource files; (3) added several thousand entries to its computerized data bases; and (4) assumed responsibility for the operation of Wyoming's Earth Science Information Center (ESIC). 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 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 and Oil and Gas Divisions 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 Divisions 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 Division, 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. In FY91, five positions in the Administration Program were transferred to the Publications Program. These positions (the editor, two full-time cartographers, a part-time cartogra-

pher, and a part-time stock worker) were transferred to the Publications Program because they traditionally worked in that program. There are now five full-time and two part-time positions 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 standard publication format, (2) to sell and distribute Survey publications, and (3) to provide technical support to the State Geologist, Division 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 FY91 are described below:

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

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 FY91, the Editorial Section prepared bid specifications for 10 printing jobs. The Editor also attended the press runs for these jobs to assure the printed quality of these publications met Survey standards.

TECHNICAL AND POPULAR GEOLOGY	722 REPORTS AND MAPS	77%
MINERAL RESOURCES	217 REPORTS AND MAPS	23%

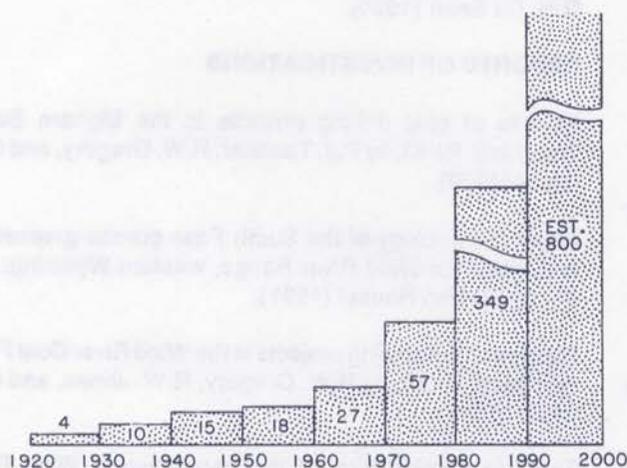


Figure 5. General content of Survey publications since FY20 (excludes publications lists and posters) and number of new titles by decade.

The 354 new titles published by the Survey in FY91 set a new record for publications completed in one year (Figure 6). This dramatic increase and other increases since FY82 are the result of a concerted effort to increase the number of new publications each year.

Level funding and small cuts in the appropriations for the Publications Program over the last five years, however, have necessitated some adjustments. The Division has been forced to pay for necessary equipment repairs and

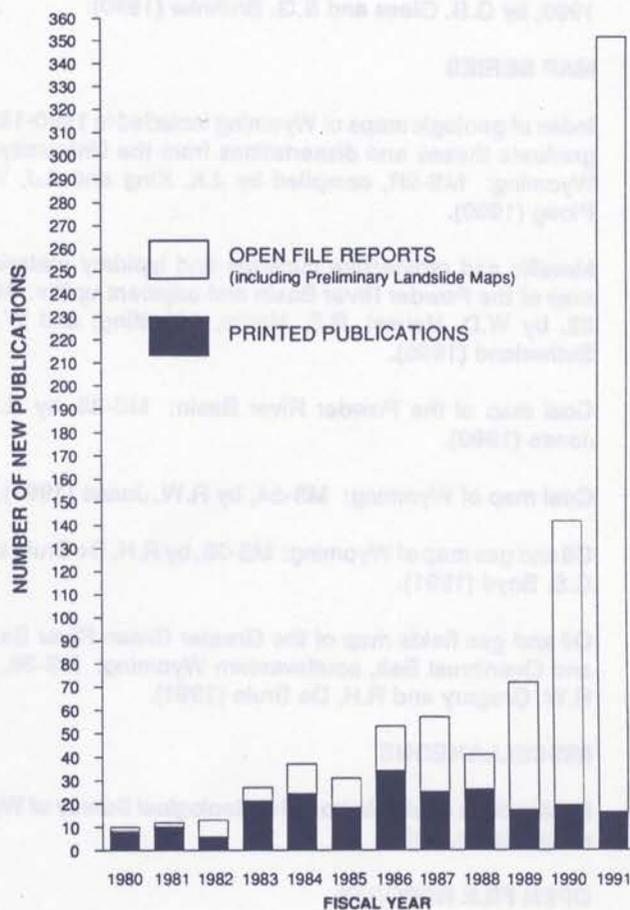


Figure 6. Number of new titles published each fiscal year (1980 through 1991).

replacements out of money that could otherwise have been spent on printing. Each year, several prepared manuscripts are deferred from publication until the following year and an increasing number of publications are prepared as open file reports or preliminary maps rather than sent out 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 advantage to this procedure is the timeliness of release (it does not have to wait for available printing monies). The disadvantages 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.

The 354 publications listed below represent the combined efforts of the Publications Division and the Geologic Divisions toward meeting the primary objective of the Publications Program:

ANNUAL REPORT

Fifty-seventh annual report of the Geological Survey of Wyoming for Fiscal Year 1990, July 1, 1989 to June 30, 1990, by G.B. Glass and S.G. Bruhnke (1990).

MAP SERIES

Index of geologic maps of Wyoming included in 1980-1989 graduate theses and dissertations from the University of Wyoming: MS-9R, compiled by J.K. King and A.J. Ver Ploeg (1990).

Metallic and radioactive minerals and lapidary materials map of the Powder River Basin and adjacent uplifts: MS-32, by W.D. Hausel, R.E. Harris, J.K. King, and W.M. Sutherland (1990).

Coal map of the Powder River Basin: MS-33, by R.W. Jones (1990).

Coal map of Wyoming: MS-34, by R.W. Jones (1991).

Oil and gas map of Wyoming: MS-35, by R.H. De Bruin and C.S. Boyd (1991).

Oil and gas fields map of the Greater Green River Basin and Overthrust Belt, southwestern Wyoming: MS-36, by R.W. Gregory and R.H. De Bruin (1991).

MISCELLANEOUS

Publications available from the Geological Survey of Wyoming, March, 1991.

OPEN FILE REPORTS

Strategic mineral resources in Wyoming - titanium: OFR 90-7, by W.D. Hausel.

Geology of the Cheyenne belt, Wyoming: OFR 90-8, by E.L. Duebendorfer.

Gemstones, lapidary materials, and geologic collectibles in Wyoming: OFR 90-9, by W.M. Sutherland.

Earthquake epicenters and suspected active faults with surficial expression in Wyoming: OFR 90-10, by J.C. Case, L.L. Larsen, C.S. Boyd, and J.C. Cannia.

Landslide map of Wyoming: OFR 91-1, by J.C. Case, L.L. Larsen, L.A. Coombs, D.R. Gilmer, T.C. Nissen, J.A. Ford, J.C. Cannia, and W.B. Murray.

1° x 2° quadrangle landslide maps of Wyoming: by J.C. Case and others

OFR 91-2A	Ashton
OFR 91-2B	Cody
OFR 91-2C	Sheridan
OFR 91-2D	Gillette
OFR 91-2E	Driggs
OFR 91-2F	Thermopolis
OFR 91-2G	Armintio

OFR 91-2H	Newcastle
OFR 91-2I	Preston
OFR 91-2J	Lander
OFR 91-2K	Casper
OFR 91-2L	Torrington
OFR 91-2M	Ogden
OFR 91-2N	Rock Springs
OFR 91-2O	Rawlins
OFR 91-2P	Cheyenne

Precambrian geology of the Seminoe Mountains (iron-gold) mining district, Bradley Peak Quadrangle, Carbon County, Wyoming: OFR 91-3, by W.D. Hausel.

Preliminary geologic map of the Beartrap Meadows Quadrangle, Johnson County, Wyoming: OFR 91-4, by A.J. Ver Ploeg and P.L. Greer.

Preliminary geologic map of the Monument Hill Quadrangle, Washakie and Johnson counties, Wyoming: OFR 91-5, by A.J. Ver Ploeg and P.L. Greer.

PRELIMINARY LANDSLIDE MAPS

313 quadrangles were completed in FY91, by J.C. Case and others (1990-1991).

PUBLIC INFORMATION CIRCULAR

Coalbed methane in Wyoming: PIC 30, by R.W. Jones and R.H. De Bruin (1990).

REPORTS OF INVESTIGATIONS

Results of coal drilling projects in the Bighorn Basin, Wyoming: RI-43, by P.J. Taucher, R.W. Gregory, and G.B. Glass (1990).

Economic geology of the South Pass granite-greenstone belt, southern Wind River Range, western Wyoming: RI-44, by W. Dan Hausel (1991).

Results of coal drilling projects in the Wind River Coal Field, Wyoming: RI-46, by R.W. Gregory, R.W. Jones, and G.B. Glass (1991).

Tectonic relationships of the southeastern Wind River Range, southwestern Sweetwater uplift, and Rawlins uplift, Wyoming: RI-47, by D.L. Blackstone, Jr. (1991).

WYOMING GEO-NOTES

No. 27: by G.B. Glass, R.H. De Bruin, R.W. Jones, R.E. Harris, J.C. Case, and A.J. Ver Ploeg, (1990).

No. 28: by G.B. Glass, R.H. De Bruin, R.W. Jones, W.D. Hausel, R.E. Harris, and A.J. Ver Ploeg, (1990).

No. 29: by G.B. Glass, R.H. De Bruin, R.W. Jones, W.D. Hausel, R.E. Harris, A.J. Ver Ploeg, and J.C. Case, (1991).

No. 30: by G.B. Glass, R.H. De Bruin, R.W. Jones, R.E. Harris, W.D. Hausel, A.J. Ver Ploeg, and J.C. Case, (1991).

SALES AND DISTRIBUTION: Sell and distribute survey publications.

In FY91, the Publications Sales Manager and Editorial Assistant responded to 573 written inquiries about publications, answered an average of 30 telephone inquiries and inquiries from visitors to the sales desk per work day, and received 4,857 sales of publications.

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 general public have exceeded 50 percent of the total since FY86. In FY91, the largest increase in sales was in the Map Series, but there was also a continued increase in topographic map sales.

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

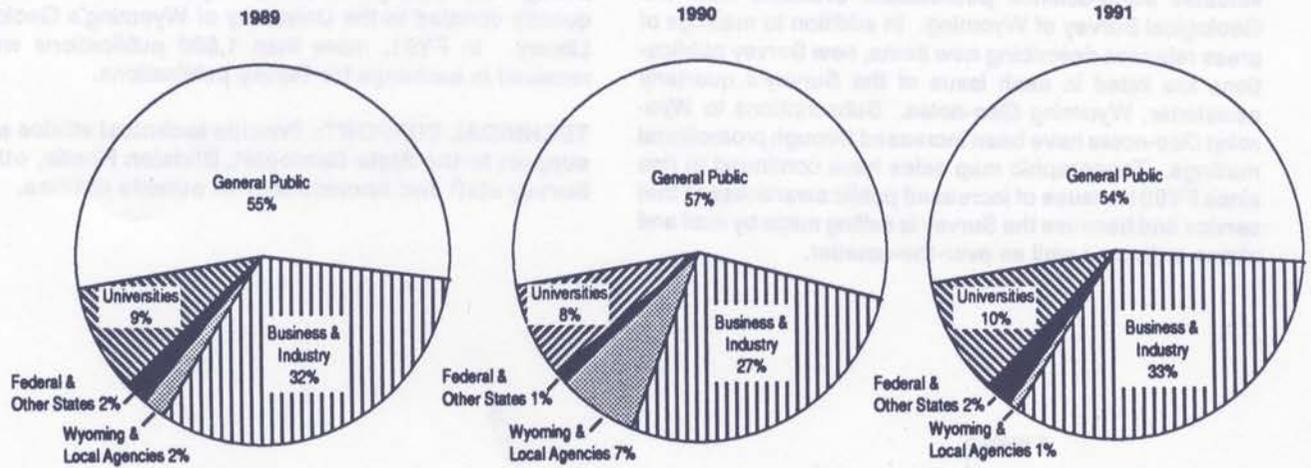


Figure 7. Percentage of publication revenue arranged by customer category (FY89 through FY91).

Table 1. Breakdown of FY91 publication sales by customer category and by sales revenue.

Category	Percent of Customers	Sales Revenue	Percent of Revenue
General Public and(or) unidentified	77%	\$44,242	54%
Business and Industry	12%	26,787	33%
Universities	8%	8,079	10%
Wyoming and Local Agencies	2%	966	1%
Federal, Other States and Foreign	1%	1,285	2%
	100%	\$81,359	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 FY91.

Table 2. Breakdown of revenue from publication sales by publication type for FY91.

29.13%	Topographic maps (all scales)	\$23,696.50
19.72%	Bulletins	16,041.00
17.53%	Map Series	14,260.50
7.31%	Reports of Investigations	5,950.00
5.96%	Open File Reports	4,849.00
5.58%	Public Information Circulars	4,538.00
2.44%	Memoirs	1,983.00
2.11%	Educational Series	1,715.00
1.92%	Geologic Map of Wyoming	1,562.20
1.87%	Geologic Highway Map	1,518.00
1.76%	Reprints	1,428.00
1.44%	Wyoming Geo-notes	1,173.50
0.87%	Preliminary Reports	709.00
0.41%	Postcards	330.00
0.30%	County Resource Series	245.00
98.33%	Subtotal	\$79,998.70
1.67%	Miscellaneous publications and price difference for mailed publications	1,359.77
100.0%	Grand Total	\$81,358.47

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. Much of the increase in FY91 is attributable to new Map Series releases as well as sales of topographic maps of all scales.

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 of Wyoming. 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 nearly all 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. These distributions do not add directly to sales revenue, but they provide an important service to the State and allow 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 FY91, more than 1,500 publications were received in exchange for Survey publications.

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

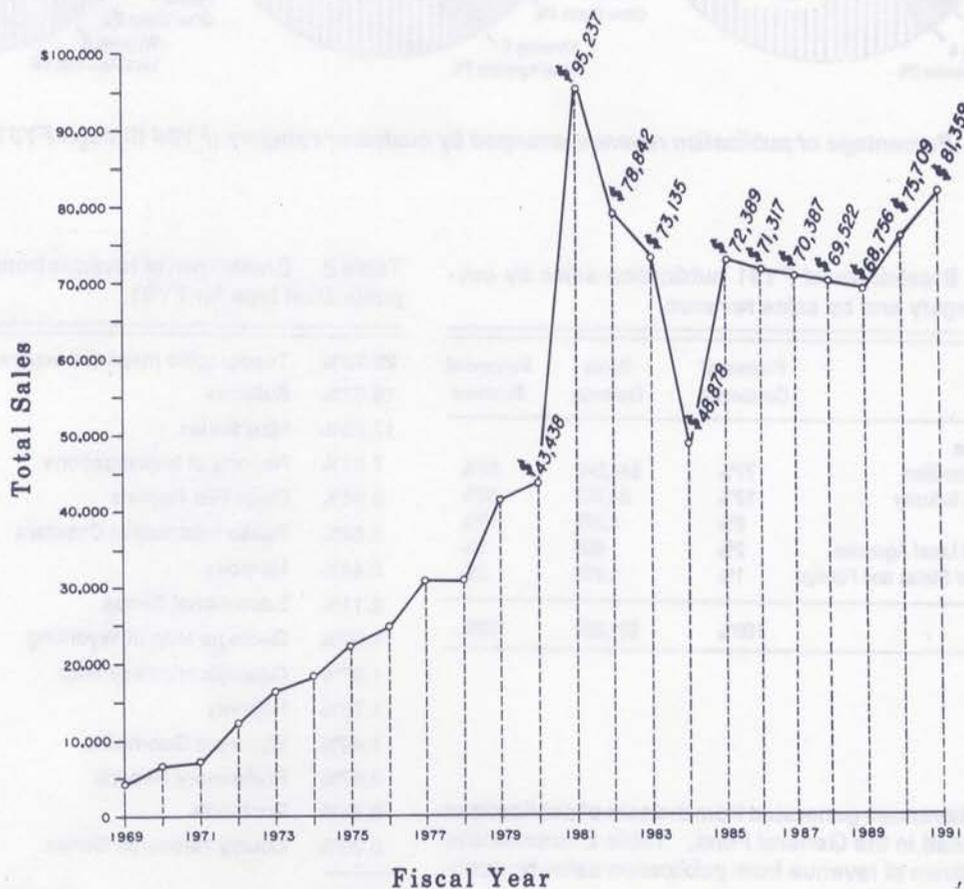


Figure 8. Fiscal year income to the General Fund from the sale of publications.

The Publications Division 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 advise 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 truck for off-road field work.
S-656	W. Dan Hausel	1987 truck for off-road field work.
S-799	James C. Case	1981 station wagon for light field work.
S-1330	Sheila Roberts	1988 station wagon for travel to press runs.