

1996 Annual Report

**Idaho
Geological
Survey**

Annual Report of the Idaho Geological Survey

Fiscal Year 1996

**Idaho Geological Survey
University of Idaho
Moscow, Idaho**

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INTRODUCTION

Overall, FY-96 was another productive and busy year for the Idaho Geological Survey. The staff produced seventy-nine publications, abstracts, reports, and presentations on the state's geology and mineral resources. The Survey responds to over sixty public inquiries of all kinds every day and has sold thousands of publications and maps to Idaho's citizens this year. The Survey fulfills its mandate as the lead state agency for the collection, interpretation, and dissemination of geologic and mineral data for Idaho with a staff of ten people in the main office at the University of Idaho in Moscow and one-person offices on the campuses of Boise State University in Boise and Idaho State University in Pocatello. The details and accomplishments of this mission are described in the *Research* and *Service* sections of this Annual Report.

Late in the fiscal year, the University began a major remodeling of Morrill Hall. The work is to include seismically retrofitting the building, installing an elevator and stairway, and constructing restrooms on each floor. When the dust and dirt finally settle, getting to the Survey's offices on the third floor will be much easier and accessible to the handicapped. The Survey and its clientele should very much appreciate these amenities, and especially the new restrooms since prior to the remodeling the only facilities in the building were on the first floor and in the basement. The staff no doubt will miss their daily exercise up and down the stairway. When the construction is completed, the Survey will occupy most of the third floor.

A two percent across-the-board cut for all state agencies was ordered by Governor

Philip Batt when state revenues dipped early in FY-95. By the end of the fiscal year the holdback had also been declared permanent for FY-96. As a small state agency, the Survey had to take this reduction entirely from its operating expense account, decreasing that from \$54,200 to \$41,900. This is the amount of state money available to operate the agency for the year. Luckily, not all work had to come to a standstill. Through acquired outside funding of almost \$530,000, the Survey was able to cover field expenses on specific research projects. Nevertheless, general operating money for the agency remains very low now, amounting to only seven percent of its total state funding.

In March 1996, the United States Congress pronounced the death sentence on the U.S. Bureau of Mines. Hundreds of federal employees were terminated, and research labs were closed nationwide, including the Western Field Operations Center in Spokane, Washington. The business of collecting mineral data by the Bureau was transferred to the U.S. Geological Survey. Nonetheless, the Bureau's closure will have regional impact. It leaves the Idaho Geological Survey as the only agency collecting this detailed information for Idaho from which to review the state's mineral industry. The timing of the Bureau's demise also proved somewhat locally ironic in that the mineral industry in Idaho set an all-time record for nonfuel mineral production in 1995 of over \$1 billion and more than doubled the state's previous high for gold production. In addition, two new mines were dedicated in the state. This high level of activity was hardly a sign of demise in the domestic mining industry.

The Digital Mapping and Information Laboratory is swamped with requests for digital data in Geographic Information System (GIS) applications. The addition of a half-time state-funded position helped to answer the mushrooming workload, but the lab's computers are still running twelve-plus hours a day. The Survey also began a large project to compile the digital geology of the Nez Perce and Clearwater National Forests. The result will be nine 1:100,000-scale maps to be completed next year.

The Survey's several contract employees were busy with inventorying abandoned mine lands (AML) in Idaho and preparing mine histories to back up field examinations. The staff completed a major AML contract for Region IV of the U.S. Forest Service (central and southern Idaho) and started work on another contract for Region I (northern Idaho). In addition, a 309-page report was prepared for the federal Bureau of Land Management on the history of mines in Pine Creek on the west end of the Coeur d'Alene Mining District. This report provides the most complete record of these

mines ever compiled.

Field work supported under the STATEMAP portion of the National Geologic Mapping Act continued in the Pocatello and Coeur d'Alene areas. In addition, work began on the Pocatello 1:100,000-scale digital compilation. The Survey's program in earth science education again conducted a successful summer workshop. Cooperative programs are well-established with the state Bureau of Disaster Services. The Survey's hydrogeologist in Pocatello began research on the ground-water flow beneath the Idaho National Engineering Laboratory and continued his close support of ground-water studies in the Pocatello area. The branch office at Boise was busy answering numerous questions about the geology and mineral resources of the state and acting as the agency's general liaison with state and federal agencies in the capitol city.

These are the highlights of the Survey's FY-96 activities. Details about these and other projects are contained in the following pages.

RESEARCH

Boise Basin

A new color geologic map of the historic Boise Basin should be available by early 1997. The mapping by Thor Kiilsgaard, recently retired from the U.S. Geological Survey, is a masterpiece of the geologic mappers' art. Though the map is in a GIS/digital format, the Survey decided to print it in color in honor of Thor, the acknowledged living dean of Idaho geologists. Much of the area is private land owned by Boise Cascade Corporation. The Survey agreed to provide the company with the digital geologic data in return for some funding to print the final product. Boise Cascade needs the data for ecosystem evaluation of watersheds on its land. The Boise Basin, Idaho's largest gold mining area, has produced over 3 million ounces of the precious metal.

Digital Mapping and Information Lab

The Digital Mapping and Information Lab (DMI) had another busy year as the geologic spatial data center for the Survey. Among its many tasks, the lab collects new geology for publication and compiles new and existing geologic maps to produce geologic map data sets. The lab completed four 7.5-minute geologic maps, and another six 7.5-minute quadrangles were digitized and are waiting further processing. The Pocatello mapping project is an exciting example of the new digital products under construction in the lab. When complete, the Pocatello area will have new surficial and bedrock geologic maps along with several

layers of geophysical data. This data will be released as several maps in both paper and digital form.

The DMI lab now has a working metadata design. Metadata are the layers of information about the data set—a digital legend of sorts. Having extensive metadata included with a data set greatly improves the quality of information available to GIS users and minimizes the misuse of highly interpretive data sets like geologic mapping. For example, in ArcView 2.1, metadata allow one to simply click on a geologic unit and obtain complete unit descriptions, information about the map authors, and how the information was entered into the computer. The Survey's metadata model is based on the Federal Geographic Data Committee standard of 1994. All new digital map releases or publications will have complete metadata available.

The DMI lab continued its outreach efforts to the University of Idaho campus. In addition to the daily tasks of digitizing and mapmaking, full-time and part-time student workers undertook a face lift for the Survey's home page on the Internet's World Wide Web, wrote computer code to improve data quality, and helped organize the first northern Idaho meeting of the Urban and Regional Information Systems Association (URISA), Northern Rockies Chapter. This inaugural meeting was called primarily to expand the network of GIS users in the state. DMI lab workers presented exhibits on how geologic thematic mapping data are collected at the Survey. Having created these new geologic data, the

Survey finds in meetings like this an important forum to educate GIS users about geospatial information and define for them what a geologic map is, and what it is not.

Earthquake Studies

New methods for assessing the hazard from earthquake shaking were used in completing a study funded by the Idaho Bureau of Disaster Services (IBDS) for the Pocatello area. Structural design factors were determined for a large regional event and a smaller local source. Shaking values show that substantial damage could be expected particularly with unreinforced masonry structures. In other research also funded by the IBDS, the Survey is preparing a "user friendly" analysis of the earthquake study for local planners and officials.

The Survey is close to completing the first statewide inventory of potentially active faults. Data on the fractures are entered into a format compatible with that used by other state surveys and the U.S. Geological Survey. A check on data quality is nearly finished. A final digital version of the map and all the metadata for the faults should be released within a year.

Work continues on a cooperative project with the Montana Bureau of Mines and Geology to establish a seismic network to monitor the Lewis and Clark Line and associated faults in northern Idaho. Research is underway to assess the evidence of paleoseismicity in the Quaternary geologic record. Reconnaissance mapping of deposits that may have recorded earthquake events is being completed along the Clark Fork River from Idaho to Missoula, Montana. To date, field studies have shown at least two

sites where evidence of liquefaction features exist in the sediments of Glacial Lake Missoula. Geologists will obtain paleomagnetic samples at each of the sections for correlation with known flood stratigraphy. Other evidence for recent fault activity is mainly geomorphic and is being addressed through an analysis of aerial photographs.

Grangeville Mapping

Geologic maps have been completed for the Hungary Ridge, Goodwin Meadows, Sawyer Ridge, and Dairy Mountain 7.5-minute quadrangles located just south of Grangeville. The area straddles the contact between the old continent and the accreted terrain of western Idaho. The complex geology of the Hungary Ridge and Sawyer Ridge quadrangles was digitized and integrated into the geologic compilation of the Elk City quadrangle (scale 1:100,000) to provide a digital geologic map of the Nez Perce National Forest. The other 7.5-minute quadrangles will be added to the Grangeville 1:100,000-scale compilation.

Ground Water in the Subalpine Environment

The Survey continues to study the distribution and timing of ground-water recharge in southeastern Idaho's subalpine watershed and the quantification of the mechanisms of ground-water transport by means of light stable isotopes. Because recharge in southern Idaho is dependant on winter snowpack and because water losses due to evaporation and sublimation can be significant in such a dry climate, the amount of effective recharge available from a given year's snowpack may vary substan-

tially depending on climatic, meteorologic, and hydrologic conditions prevailing in particular watersheds. One of the long-term goals of the research is to develop methods for refining forecasts of snowpack recharge in this part of the state. The research is funded by the National Science Foundation's EPSCoR program. Ground-water flow and transport processes are being investigated within a small, instrumented field laboratory developed in the Mink Creek watershed. The work is being conducted cooperatively with the U.S. Forest Service and the U.S. Natural Resources Conservation Service, with whom the Survey is sharing hydrologic data and equipment.

Inactive and Abandoned Mine Lands

Work was completed on the final report for the inactive and abandoned mine lands project conducted in cooperation with the U.S. Forest Service (Region IV). The project examined mines that had significant historic production for hazardous materials and physical hazards. The project identified about two dozen mines that had serious problems; most of them were already being studied for cleanup. In addition to this work, detailed histories were prepared for seven mines in the area.

The Survey received an extension for additional work in five mining areas of the Sawtooth National Forest. Field inspections and hazard inventories were completed during the fall in different areas: on mines in the Soldier Mining District north of Fairfield, on several complex properties in the Boulder Creek District in the Sawtooth National Recreation Area, and on mines in the Stokes Mining District south of Burley in

the Albion Mountains. Local USFS personnel assisted with the logistics of contacting several claim owners. Of the nine properties inspected, two were ranked high for hazardous materials or physical hazards, four were rated medium, and the rest were rated low.

Late in June, the Survey signed a challenge grant with the USFS to inventory inactive and abandoned mines in Region I forests north of the Salmon River. The initial work will concentrate on over a hundred mines and prospects in the Prichard and Eagle Creek area of the Panhandle National Forest in Shoshone County. Field parties will describe, video, and sample these sites at various levels of intensity. This program should continue for several years as there are several thousand known mines in northern Idaho.

Also underway is the inventory of inactive or abandoned mines in the Nez Perce National Forest. Geologists visited about seventy properties. This program was done at the same time that geologic maps of four 7.5-minute quadrangles were being completed. Many of the mines had been visited several years ago during research under the Idaho Initiative mapping program.

The federal Bureau of Land Management contracted with the Survey to prepare a history on the mines in the Pine Creek area in the western part of the Coeur d'Alene Mining District. Included in the report are the Sidney, Highland Surprise, Constitution, Nabob, Little Pittsburg, Amy-Matchless, and Hilarity mines. The report details the overall development of the properties and includes extensive sections on the geology, ownership, and past production. The document is believed to be the

most comprehensive summary ever done on the Pine Creek mines. With this report, the Survey will have completed thorough production histories on about fifty mines.

Mammoths at Tolo Lake

Survey geologists again took part in the geologic characterization of two mammoth sites: one at Tolo Lake near Grangeville and the other at Kamiah. A new radiocarbon date of 14,500 years ago for the Kamiah mammoth is a bit surprising because it precedes the latest Glacial Lake Missoula floods. The Kamiah mammoth was apparently buried by a landslide-debris flow. Today's recreational interest in Tolo Lake will soon destine the site to be submerged in a bass pond. This likelihood makes the current geologic studies of the lake basin and the materials collected so far even more important. Survey geologists conducted research during the 1995 summer field season on the paleomagnetism of the basalts surrounding the lake and on the sediments above, within, and below the stratigraphic level of the fossil bones. Results should help to better understand the age of the lake and sediments. The scientists are also hoping to establish a correlation tool between individual mammoth research sites. Researchers from the Survey and the University of Idaho are still examining the cores and paleomagnetic samples for additional clues to the lake's age and origin.

National Geologic Mapping Program

The Survey has been participating in the National Geologic Mapping Act (NGMA) for the past four years. Under the act hun-

dreds of quadrangles have been mapped nationwide. In Idaho, new geologic maps have been completed or are underway in the Boise, Twin Falls, and Pocatello metropolitan areas, and work is just beginning on a 1:100,000-scale digital compilation of the entire state. The focus of the NGMA (STATEMAP component) has been urban environmental geologic mapping. The program, administered by the U.S. Geological Survey, operates through state surveys on competitive federal contracts that are matched dollar for dollar with state funds. This past year, Senator Larry Craig introduced the act's four-year reauthorization in the Senate, and Congressman Ken Calvert of California did the same in the House. The Survey's associate director/state geologist, who is also president-elect of the Association of American State Geologists, testified in favor of the reauthorization before the House's energy and natural resources subcommittee. The Survey looks forward to many more years under this successful program.

Nez Perce and Clearwater National Forests

Most efforts in the Survey's Digital Mapping and Information Lab over the past year have been directed at compiling digital geologic map coverages for the Clearwater and Nez Perce National Forests. These digital maps are packaged in 30 x 60 minute maps, called tiles, at the original map scales (up to 1:24,000).

The nine tiles covering this area will be distributed in GIS (Arc/Info) format and contain metadata detailing the source of the original information used in the compilations. Over thirty sources are included in

the maps. As for the geology, over a hundred geologic units are represented along with the usual symbols and other information contained in geologic maps. A new set of computer macros was written to further simplify the conversion of these AutoCAD-generated geologic compilations into full Arc/Info coverages. These will be the first all digital 1:100,000-scale geologic maps done by the Survey in Idaho and are some of the very first maps anywhere in the country which contain metadata.

Quaternary Mapping

Surficial geologic mapping in the Clark Fork area led to new interpretations of the Pleistocene Clark Fork Ice Dam and Glacial Lake Missoula. A Survey geologist presented the research to National Aeronautics and Space Administration scientists and earth science teachers involved with the Pathfinder mission to planet Mars. The Missoula Floods may provide keys to how the Martian canals formed. The new map of Clark Fork valley was also used by the University of Idaho geology field camp as the basis for a Quaternary mapping exercise at the Clark Fork field campus.

The Survey has constructed a digital model of the Pend Oreille lake basin. Cooperative work with the Juneau Icefield Research Program and the University of Idaho shows that the seismic profiles of modern glaciated valleys on the Juneau Icefield can be used to interpret the origin and structure of the Pend Oreille lake basin. This research shows sediment filling a deep trough that extends a thousand feet below lake level. Results have important applications to the character and origin of the Rathdrum aquifer, the sole water source for

the Coeur d'Alene-Spokane urban corridor.

Snake River Plain Aquifer and INEL

The Survey is involved in research that is part of a larger, multi-university effort funded by the federal Department of Energy (DOE). Scientists are working to further their understanding of the subsurface geology and hydrogeology in the eastern Snake River Plain aquifer beneath the Idaho National Engineering Laboratory (INEL). The Survey's Pocatello office is taking the lead in developing correlation models for lithology and permeability to describe flow characteristics of the aquifer below INEL. To evaluate the utility of the approach in this complex geologic environment, the research will use advanced statistical modeling and simulation techniques as well as stochastic ground-water modeling methods. If the methodology proves applicable, the study will significantly advance DOE's ability to predict contaminant fate and transport in the subsurface at the INEL.

STATEMAP in Idaho

The Survey completed the surficial geologic map of the Pocatello South quadrangle in July for STATEMAP 1994. The map shows interpretations of the late Tertiary graben fill, Pleistocene pediment and piedmont gravel deposits, loess distribution and thickness, Bonneville Flood scour features and bar deposits, and Holocene alluvium and alluvial-fan deposits. Mapping of the late Tertiary and younger units revealed an asymmetry across the valley that may represent Quaternary fault movement along the eastern margin of the graben. The

STATEMAP work in 1995 in the Pocatello area included mapping of bedrock geology and structure by an Idaho State University geologist. This map should help clarify the area's tectonic setting.

Other Survey projects in the Pocatello South quadrangle have been completed and dovetail with the surficial geologic map to provide broader planning tools. The Survey's seismic hazards study for the quadrangle was recently finished. It interprets shaking accelerations for the central valley fill on which downtown Pocatello rests. The Survey now has substantial basic geologic data for the southern half of this urban area. Plans next year call for expanding the program to the north.

Geologic mapping is essential to model the hydrogeology of both the valley bottom and the marginal valley sediments. It also provides the basic data for interpreting slope stability, on-site sewage drainage, solid waste sites, and seismic shaking hazards. The Survey's urban geologic mapping in the Pocatello area has already added greatly to understanding the surficial geology and has assisted in developing a conceptual framework for characterizing the ground-water system. Along with concurrent studies of gravity, slope stability, and

seismic shaking, the surficial geologic mapping is broadening the geologic information needed for critical urban planning issues. One example is a suburb now known to have been built on a large landslide complex adjacent to the valley floor. All units in this housing development rely on septic drain fields for sewage treatment. Elevated nitrate levels appearing in nearby city wells may have as their source the effluent from this suburb. Explaining the failures of these septic drain fields has been helped by recent geologic interpretations of the unusual topography and drainage created by the landslide-disrupted alluvial fan sediments in this housing area.

Quaternary mapping in the Coeur d'Alene area under STATEMAP is in its second year. Geologists have completed the first product, the Post Falls quadrangle. New mapping has shown at least four separate units of gravel deposition in the Rathdrum Prairie flood deposits. No stratigraphy in the aquifer unit was previously identified or applied in the hydrologic models of this important sole source aquifer. Mapping has also discovered adjacent upland gravels of possible Tertiary age that reveal the existence of previous erosional cycles and drainages in the area.

SERVICE

Branch Offices

The Boise and Pocatello branch offices had a busy year responding to numerous inquiries from individual citizens, companies, and agencies. Earthquakes, surficial geology, gold prospecting, mining, and environmental issues were the most common topics of concern in the Boise area while water issues dominated in the Pocatello area. Information requested ranged from highly technical issues to those oriented to the general public. For example, in Boise the Survey's geologist explained earthquakes and the state's geology to a group of Ada County teachers attending a summer workshop. And to another group of teachers this geologist directed a tour of a mining operation. The Boise office serves as a liaison with other state and federal agencies located in Boise. Our geologist provided geologic expertise to the Department of Water Resources's ad hoc technical committee created to formulate a hydrologic modeling proposal for the Treasure Valley. As a specialist in economic geology, the Boise geologist taught part of a spring semester course on ore deposits at Boise State University and gave numerous talks on the state's mining and mineral industry this past year. Similarly, our hydrogeologist in the Pocatello office at Idaho State University taught several courses and supervised a number of graduate students in addition to his own technical work and research.

Earth Science Education

The Survey held its fifteenth and six-

teenth workshops for secondary school teachers in the summer. In early July, the Survey conducted its third Environmental Geology and Hydrology Workshop at South Fremont High School in St. Anthony. The workshop was held in cooperation with Fremont County School District. Teachers studied the area's basic landforms, rock types, and soils on field trips to features such as Menan Buttes, St. Anthony sand dunes, basalt lava tubes, and the Huckleberry Ridge tuff at the former Teton Dam site. They were also given an overview of the Snake River Aquifer from a visiting hydrologist with the U.S. Geological Survey. The teachers learned first-hand the process for collecting water samples from local streams to determine quality levels. From this experience, the teachers were encouraged to get their own students involved in properly collecting water-quality results for a statewide database maintained by Students Investigating Today's Environment, or SITE.

In late July the Survey co-sponsored the Idaho Earthquake Education field workshop at Challis with the Idaho Bureau of Disaster Services (IBDS) and the Idaho Earth Science Teachers Association (IESTA). The theme for the meeting was the state's geology and earthquakes. The IBDS provided funds to develop and distribute a packet of teaching materials on earthquakes and to help defray the lodging and instructional costs of the participants. This field program has become increasingly popular with the state's teachers. Under another IBDS grant to the Survey, preparations are underway for a fourth workshop to be held next July

in the Teton Valley. In April, Survey geologists presented details of our earthquake education workshops at a special session of the National Geology Teachers Association convened at the annual meeting of the Geological Society of America Cordilleran Section in Portland, Oregon.

The Survey continues to cooperate with IESTA to develop programs that enhance earth science education in the state. A Survey geologist serves on IESTA's board. Staff helped organize information booths and a geology field trip at the annual science teachers conference in Boise.

The Survey is preparing displays on local geology for the University of Idaho field campus at Clark Fork and the Farragut State Park. These displays will feature the agency's mapping projects. Digital models of prehistoric geologic scenery are being developed in the Survey's Digital Mapping and Information lab. Both of these popular tourist sites will allow the Survey to showcase its state-of-the-art work.

Geologic Hazards

The Survey's third annual Idaho Earthquake Education field workshop, discussed also under *Earth Science Education*, broke previous attendance records. Among those attending were representatives from Region 10 of the Federal Emergency Management Agency (FEMA) and the earthquake coordinator from the Idaho Bureau of Disaster Services. FEMA was so enthusiastic about this educational program that it wants to use the Idaho workshop as an example to other states. Another main partner in the workshop is the Idaho Earth Science Teachers Association (IESTA). The Survey show-

cased the workshop at the Western States Seismic Policy Council annual meeting in Flagstaff, Arizona, and also at the annual Cordilleran Section meeting of the Geological Society of America in Portland, Oregon.

The Survey and the Idaho Bureau of Disaster Services continued to cooperate in answering requests on earthquake response, siting information, and other geologic hazards. The catalog of Idaho's earthquakes was updated and released on computer disc. The IBDS has completed its move to new headquarters at Gowen Field in Boise. The governor has issued an executive order for disaster response in the state that expands the active roles of many agencies including the Survey. Both state and federal governments have been overwhelmed by the increasingly high costs of disaster response. The new government policies will emphasize disaster mitigation and preparedness.

The Survey responded to events and activities that included several landslides, an explosives plant fire, and earthquake planning scenarios. The most noteworthy events were the floods in northern Idaho. Heavy rains on late winter snowpack caused extreme flooding. Numerous landslides and slope failures also impacted the area. Damage was estimated at \$20 million. Staff geologists volunteered to work with damage assessment teams and helped write and develop a flood mitigation plan. The disaster emphasized the need to delineate and manage the floodplains in rural small towns.

The Survey served on a transition committee that assisted in the reorganization of the Western States Seismic Policy Council. The agency, now housed with the West-

ern Council of Governments in San Francisco, has a board of directors composed of state emergency management directors and state geologists elected from the seventeen member states. Its next annual meeting will be in Montana.

Meteorite Impact?

A "big bang in Idaho?" A possibility, although remote. In July, the Survey invited the U.S. Geological Survey to examine some strange looking drill core from an even more improbable source. Years ago, Shama Minerals drilled a 4,000-foot exploratory hole that penetrated the entire Cambrian and Ordovician stratigraphic sections of the Bayhorse anticline near Challis. Remarkably, Shama had relied on "divine guidance" to direct its exploration program; otherwise the hole would probably never have been drilled and this unusual rock sample would not have been recovered. The lower 100 feet of the core contains a breccia that might be the result of an impact from a large meteorite. The possibility for this impact event follows from other evidence found in the Beaverhead Range near the Idaho-Montana border. Although initial opinions of the breccia's origin were mixed, the USGS took samples of the core to Denver for lead-uranium dating and other analyses.

Mine Property Files and Records

In 1996, Congress closed the U.S. Bureau of Mines. The federal agency's Western Field Operations Center in Spokane, Washington, had housed a large collection of mining property files on the western

states. In early February, during the coldest days of winter and sub-zero record lows, Survey personnel went to Spokane to retrieve the Idaho part of this information treasure trove. During the short time available, the Survey copied all or parts of nearly 300 property files, many from northern Idaho where the Survey's records were incomplete. The files are a welcome addition to the state property file collection, which contains historic data on 8,300 mines and prospects.

Mining Industry Review

With the closing of the U.S. Bureau of Mines, the Survey, through its annual review of the state's mining industry, took on more intense responsibility for collecting this important economic data. Field tours of sixteen active properties were conducted during the year. Survey personnel attended the dedication of two new gold mines in the state: Hecla's Grouse Creek mine west of Challis and FMC's Beartrack mine near Salmon. A third new precious metal operation opened in Owyhee County. Over thirty other advanced projects were scattered around the state. A notable highlight for 1995 was a new production record for Idaho of 300,023 ounces of gold, more than double the old record of 149,000 ounces set in 1941. This represents remarkable output for an industry that is supposed to be stagnant or in decline. Adding to the gold miners' success was the phosphate industry that in 1995 produced almost \$569 million in elemental phosphorous and phosphoric acid, thereby retaining its long-term position as the backbone of the state's mining sector. Sand and gravel production continued strong as residential and commercial development expanded

throughout the state. Idaho is also the nation's primary source of garnet and vanadium. All this mining activity, based on preliminary estimates, set the stage for a new all-time nonfuel mineral production record of over \$1 billion. A review of Idaho's metallic and nonmetallic mining industry is presented each December at the Northwest Mining Association's annual meeting in Spokane, Washington. Six more invited presentations at local and regional meetings gave Idaho's mining sector widespread publicity. Another address, given at the national Geology of Industrial Minerals forum held in Wyoming in 1996, focused on the state's industrial minerals.

National Park Service

Work began on a cooperative project with the Association of American State Geologists and the National Park Service (NPS) to compile bibliographies of maps and other materials published by state surveys nationwide for the lands in their states administered by the NPS. The Survey will bring this information being gathered by the other state surveys together into a comprehensive digital database.

Portneuf Ground Water Forum and Ground Water Guardian Program

The Survey's branch office in Pocatello has taken on the task of organizing and redirecting the Pocatello area ground-water technical task force and leading the monthly meetings of the new Portneuf

Ground Water Forum. The new duties are in response to requests from the cities of Pocatello and Chubbuck, the Idaho Division of Environmental Quality, and regional city and county planners. Members include water professionals from city, county, and state agencies, private consulting companies, the Fort Hall tribes, and local and state representatives of federal agencies. The forum meets regularly to discuss technical issues related to the area's ground-water problems. It acts as a technical advisor to city, county, and tribal governments on ground-water quality and water supply and meets with local government staff and representatives on a regular and as-needed basis to disseminate technical information and to advise on water problems. The forum will be primarily focused on development-related ground-water issues for the coming year and will prepare written recommendations on technical topics for use by local governments and planners.

A closely related set of duties involves the Pocatello office in a newly created local chapter of the national Ground Water Guardian Program. This project, initiated by members of the Portneuf Ground Water Forum, aims to deliver educational materials, speakers, and public awareness of ground-water resources to the greater Pocatello-Chubbuck area. The Survey's hydrogeologist is a member of this group and is providing technical materials, advice, and graphics for a set of information brochures being designed by the group for public distribution.

PUBLICATIONS

In FY-96, the Survey released the following publications and reports:

GeoNote 34. *Idaho's Active Mining Operations in Metals and Phosphate, 1994-1995*, by Earl H. Bennett, 1 p.

GeoNote 35. *Idaho's Active Mining Operations in Industrial Minerals (Excluding Phosphate), 1994-1995*, by Earl H. Bennett, 2 p.

GeoNote 36. *Nonfuel Mineral Production in Idaho—1994*, by Earl H. Bennett and Virginia S. Gillerman, 2 p.

GeoNote 37. *Idaho, the Gem State*, by Earl H. Bennett, 1 p.

Information Circular 56. *Catalog of Idaho Earthquakes, 1872-1995*, compiled by Andrew P. Hilt, Roy M. Breckenridge, and Kenneth F. Sprenke, one 3½-inch diskette.

Staff Report 96-1. *Field Guide to the Quaternary Geology of the Boise Valley*, by Kurt L. Othberg, Jim E. O'Connor, and Paul A. McDaniel, 48 p.

Technical Report 95-4. *Annual Report of the Idaho Geological Survey, Fiscal Year 1995*, 28 p.

Technical Report 95-5. *Geologic Map of the Troy Quadrangle, Latah County, Idaho*, by John H. Bush and Kurt L. Priebe, 1 plate.

List of Publications—1996, 54 p.

STAFF PUBLICATIONS & ACTIVITIES

PUBLICATIONS

Exploration in Idaho—1995, by V.S. Gillerman and E.H. Bennett: Mining Engineering, 1996, v. 48, no. 5, p. 54-56.

Field Guide to the Quaternary Geology of the Boise Valley and Adjacent Snake River Valley, by Kurt L. Othberg, Jim E. O'Connor, and Paul A. McDaniel: Idaho Geological Survey Staff Report 96-1, 1996, 48 p.

Glacial Lake Missoula/Clark Fork Ice Dam—A Digital Model, by R.M. Breckenridge and Loudon Stanford, in M.P. Golombek, K.S. Edgett, and J.W. Rice, eds., Mars Pathfinder Landing Site Workshop II: Characteristics of the Ares Vallis Region and Field Trips to the Channeled Scabland: Lunar and Planetary Institute Technical Report 95-01, Part 2, 1995, 47 p.

Hazard Mitigation Report With Early Implementation Strategy, Northern Idaho Flooding of 1996, by Team (others and R.M. Breckenridge): Federal Emergency Management Agency FEMA-1102-DR-IDAHO, March, 1996, 62 p.

Idaho 1994 Annual Estimate, by A. Tanner and Virginia S. Gillerman: Mineral Industry Surveys, U.S. Bureau of Mines, 3 p.

Idaho Earthquake Catalog 1872-1995, by A. Hilt, R.M. Breckenridge and K.F. Sprenke: Idaho Geological Survey Information Circular 56, 1996, one 3½-inch diskette.

The Idaho Geological Survey's STATEMAP Project, by K.L. Othberg, R.M. Breckenridge, and Bill Bonnichsen (authorship unlisted): Idaho Cities, 1995.

Idaho's Active Mining Operations in Industrial Minerals (excluding phosphate), 1994-1995, by Earl H. Bennett: Idaho Geological Survey GeoNote 35, 1995, 2 p.

Idaho's Active Mining Operations in Metals and Phosphate, 1994-1995, by Earl H. Bennett: Idaho Geological Survey GeoNote 34, 1995, 1 p.

Idaho the Gem State, by Earl H. Bennett: Idaho Geological Survey GeoNote 37, 1995, 1 p.

The Mineral Industry of Idaho, by U.S. Bureau of

Mines, Idaho Geological Survey, and U.S. Department of Interior: Minerals Yearbook, v. II, Area Reports: Domestic 1993-94, p. 75-78.

Nonfuel Mineral Production in Idaho—1994, by Earl H. Bennett and Virginia S. Gillerman: Idaho Geological Survey GeoNote 36, 1995, 1 P.

Report of the Panel on In Situ Mining Research, by E.H. Bennett: Committee on Research Programs of the U.S. Bureau of Mines, National Research Council, 1995, Research Programs of the U.S. Bureau of Mines, 1995 Assessment; National Research Council Report, National Academy Press, Washington, D.C., 1995, p. 63-75.

Seismic Potential of the Lewis and Clark Zone, National Hazards Earthquake Reduction Program, by R.M. Breckenridge, K.F. Sprenke, and M.C. Stickney: U.S. Geological Survey Open-File Report 95-210, 1995, v. 1, p. 286-288.

Seismic Reflection Survey of Icy Basin, Juneau Icefield, Alaska, by C.M. Haagen, K.F. Sprenke, R.M. Breckenridge, and M.M. Miller: Juneau Icefield Research Program Foundation for Glacier and Environmental Research, Seattle, 1996, Open-File Report, 12 p.

ABSTRACTS

Characterization of Ground-Water Recharge and Transport With Light Stable Isotope Tracers, by J. Welhan, G. Gerber and S. Van Hoff: American Geophysical Union, spring meeting, Baltimore, Maryland, May.

Earthquake Education Workshops in Idaho, by Kurt L. Othberg, Roy M. Breckenridge, and Stephen W. Weiser: Geological Society of America Abstracts with Programs, v. 28, no. 5, 1996, p. 97-98.

Geology of the Tolo Lake Mammoth Site, by S.L. Letsinger, W.C. Rember, K.F. Sprenke, R.L. Sappington, R.M. Breckenridge, K.L. Othberg, and L.R. Stanford: 49th Annual Northwest Anthropological Conference Abstracts, Moscow, March, 1996, p. 21-22.

Hazards Associated With Inactive and Abandoned Mines (IAMs) in Idaho, by E.H. Bennett, V.S. Gillerman, F.J. Moye, and V.E. Mitchell: Geological Society of America Abstracts with Programs, 1995, v. 27, no. 6, p. A-193.

Overdeepened Glaciated Basins, Southeastern Alaska and Northern Idaho, by R.M. Breckenridge, K.F. Sprenke and M.M. Miller: Geological Society of America Abstracts with Programs, v. 28, no. 5, 1996, p. 51.

Partnerships for the Enhancement of Earth Science Education in Idaho, by F. Jon Bair, Jo A. Dodds, Terry G. Kuroda, Kurt L. Othberg, H. Randy Powell, and Judy A. Walling: Geological Society of America Abstracts with Programs, v. 28, no. 5, 1996, p. 45.

Results of Preliminary Geological and Archeological Investigations at Tolo Lake, Near Grangeville, Idaho, by R.L. Sappington, W.C. Rember, K.F. Sprenke, R.M. Breckenridge, and K.L. Othberg: 49th Annual Northwest Anthropological Conference Abstracts, Moscow, March, 1996, p. 31.

REPORTS & PRESENTATIONS

A Brief History of the Western States Seismic Policy Council, by R.M. Breckenridge, David Love, and Doug Bausch: Internet WSSPC World Wide Web site, 1995, Northern Arizona University.

Cartographic Layout and GIS Misconceptions, by Loudon R. Stanford: Ecosystem analysis class, University of Idaho, February.

Characterization of Ground-Water Recharge and Transport With Light Stable Isotope Tracers, by John A. Welhan: American Geophysical Union spring meeting, Baltimore, Maryland, May.

The Clarkia Flora—An Idaho Forest 20 Million Years Ago (A tribute to Jack Smiley 1924 -1996), by K.F. Sprenke and R.M. Breckenridge: Poster display McClure Hall, University of Idaho, January-June.

Comment on the Interim USGS National Seismic Hazard Maps for Idaho, by R.M. Breckenridge and K.F. Sprenke: Idaho Geological Survey unpublished report, 1996, 14 p.

Earthquake Education Workshops in Idaho, by Kurt L. Othberg and Roy M. Breckenridge: Geological Society of America Cordilleran section meeting, Portland, Oregon, April.

Earthquake Hazards in Idaho, by R.M. Breckenridge: Geologic hazards class, University of Idaho, April.

Earthquakes and Geology, by Virginia S. Gillerman: Ada County Seismic Workshop, Boise, July.

Earthquakes in Idaho—Interactive Display, by K.F. Sprenke and R.M. Breckenridge: Seismic Observatory, McClure Hall, University of Idaho, September-present.

Environmental Geology of Puget Sound, Case Studies, by Kurt L. Othberg: Geologic hazards class, University of Idaho, April.

Field Trip Guide to Hells Canyon and the Snake River From Clarkston to Pittsburg Landing, Idaho, Washington, and Oregon, by E.H. Bennett with contributions from R.M. Breckenridge: Idaho Geological Survey unpublished report for Walla Walla Community College, 1996, 33 p.

Geologic Setting of the Borah Peak Earthquake, 1983, by R.M. Breckenridge: Third annual Earthquake Education Field Workshop, Challis, July.

Geology and Ground-Water Conditions in the Johnny Creek Subdivision and Possible Impacts of Septic Systems on Ground-Water Quality, by John A. Welhan: Pocatello City Council and Johnny Creek Citizens' Committee, Pocatello, August.

Geology and Hydrology of the Lower Portneuf Valley Aquifer System, by John A. Welhan: Idaho Association of Geoscientists meeting, Pocatello, January.

Geology, Hydrology and Vulnerability of the Pocatello Municipal Aquifer, by John A. Welhan: Engineering Water Control Systems, College of Engineering, Idaho State University, October.

Geostatistical Characterization of Hydraulic Conductivity Variability in the Eastern Snake River Plain Aquifer, by John A. Welhan: Geology Department, Utah State University, Logan, Utah, February.

Glacial Lake Missoula and the Clark Fork Dam Breakout, by R.M. Breckenridge: Mars Pathfinder Landing Site Workshop II, Lunar and Planetary Institute, Farragut State Park, September.

- Ground Failure Hazards of Southeastern Idaho, Case Studies*, by Kurt L. Othberg. Geologic hazards class, University of Idaho, April.
- Ground Motion Shaking in the Lower Portneuf Valley, Idaho*, by Brian Petersen and R.M. Breckenridge. Western States Seismic Policy Council annual meeting, poster session, Flagstaff, September.
- Ground-Water Availability and Well Yields on the Gibson Jack Bench*, by John A. Welhan. Bannock County planning commission, Pocatello, February.
- History of Selected Mines in the Pine Creek Area, Shoshone County, Idaho*, by Victoria E. Mitchell. Idaho Geological Survey unpublished report, 1996, 309 p.
- History of the Goldstone Mine, Lemhi County, Idaho*, by Victoria E. Mitchell. Idaho Geological Survey unpublished report, 1995, 13 p.
- History of the Harmony Mine, Lemhi County, Idaho*, by Victoria E. Mitchell. Idaho Geological Survey unpublished report, 1995, 16 p.
- History of the Queen of the Hills Mine, Lemhi County, Idaho*, by Victoria E. Mitchell. Idaho Geological Survey unpublished report, 1995, 8 p.
- History of the Silver Star Mine, Lemhi County, Idaho*, by Victoria E. Mitchell. Idaho Geological Survey unpublished report, 1995, 6 p.
- History of the Viola Mine, Lemhi County, Idaho*, by Victoria E. Mitchell. Idaho Geological Survey unpublished report, 1995, 25 p.
- History of the Yellowjacket Mine, Lemhi County, Idaho*, by Victoria E. Mitchell. Idaho Geological Survey unpublished report, 1995, 28 p.
- Idaho Earthquake Education Field Workshops*, by R.M. Breckenridge and Stephen Weiser. Western States Seismic Policy Council annual meeting, poster session, Flagstaff, September.
- Idaho's Elephants*, by K.F. Sprenke and R.M. Breckenridge. Poster display, McClure Hall, University of Idaho, July-December.
- Idaho Geology and Mining Update*, by Virginia S. Gillerman. Pacific Northwest Metals and Minerals Conference, Portland, Oregon, April.
- Industrial Minerals of Idaho*, by Virginia S. Gillerman. 32nd Forum on the Geology of Industrial Minerals, Laramie, Wyoming, May.
- The May 2, 1996, Kingdome Earthquake, Duvall, Washington*, by K.F. Sprenke and R.M. Breckenridge. Poster display, McClure Hall, University of Idaho, May.
- Mining and Minerals in Idaho and You*, by E.H. Bennett. St. Maries Middle School, St. Maries, May.
- Mining and the Environment, Idaho, 1995*, by Virginia S. Gillerman. Idaho Department of Lands 1996 Minerals Workshop, Boise, February.
- Mining, Exploration, and the Environment, Idaho, 1995*, by Virginia S. Gillerman. Northwest Mining Association Convention, Spokane, Washington, December; U.S. Forest Service Region 1 Minerals and Lands Workshop, Coeur d'Alene, March.
- Mining, Minerals and the Environment in Idaho, 1994*, by Earl H. Bennett and Virginia S. Gillerman. Idaho Geological Survey unpublished report, October, 73 p.
- Minutes of the 1995 Annual Meeting*, by E.H. Bennett. American Association of State Geologists, annual meeting, Reno, Nevada, unpublished report, 1996, 37 p.
- National Science Foundation EPSCoR Research Progress Report*, by John A. Welhan. Poster presentation, annual program review, Moscow, October.
- Overview of Idaho Gold*, by Virginia S. Gillerman. Idaho Gold Prospectors Association, Boise, March.
- Overview of Mining Activity in Idaho, 1995*, by Virginia S. Gillerman. Society for Mining, Metallurgy and Exploration, Inc. (SME), Boise Chapter, February.
- Overview of the Portneuf Ground Water Forum*, by John A. Welhan. Monthly city-county meeting of Pocatello, Chubbuck, and Bannock County officials, Pocatello, April.
- Overview of the Survey's Digital Mapping and Information Lab*, by Loudon R. Stanford. Mapping graphics 180 class, University of Idaho, October; Ground-water techniques (GEOL-410) class, University of Idaho, December.
- Paleoseismicity of the Lewis Clark Zone Interpreted From Quaternary Deposits, Idaho and Montana, A Project Update*, by R.M. Breckenridge. Western States Seismic Policy Council

- annual meeting, poster session, Flagstaff, September.
- Partnerships for the Enhancement of Earth Science Education in Idaho*, by F. Jon Bair, Jo A. Dodds, Terry G. Kuroda, Kurt L. Othberg, H. Randy Powell, and Judy A. Walling: Geological Society of America Cordilleran section meeting, April.
- Preliminary Surficial Geologic Map of the Pocatello South Quadrangle, Bannock and Power Counties, Idaho*, by Terrence A. Osier and Kurt L. Othberg: Idaho Geological Survey unpublished report, 1995, scale 1:24,000.
- A Preview of the Geostatistical Approach to Lithologic Modeling on the INEL*, by John A. Welhan: U.S. Geological Survey, Idaho National Engineering Laboratory, April.
- Quaternary History of the Pend Oreille River*, by R.M. Breckenridge: Pend Oreille Anthropological Society, Newport-Oldtown, February.
- Rapid Visual Analysis of Earthquake Hazards to Buildings in Challis, Idaho*, by R.M. Breckenridge and S. Weiser: Third annual Earthquake Education Field Workshop, Challis, July.
- Rapid Visual Analysis of Earthquake Response of Buildings, Using Applied Technology* Council Document 21, by R.M. Breckenridge: Geologic hazards class, University of Idaho, April.
- Report of the AASG Federal Liaison Committee*, by E.H. Bennett: Association of American State Geologists, fall meeting, Washington, D.C., unpublished report, 16 p.
- Report of the AASG Federal Liaison Committee*, by E.H. Bennett: Association of American State Geologists, spring meeting, Washington, D.C., unpublished report, 18 p.
- Role of the Idaho Geological Survey in Geologic Hazards Mapping*, by R.M. Breckenridge: Federal Emergency Management Agency Interagency Hazard Mitigation Team workshop, Coeur d'Alene, February.
- Seismic Zones and Building Codes: An exercise in Rapid Visual Screening of Buildings in the Area of the Borah Peak Earthquake*, by R.M. Breckenridge and Stephen Weiser: Idaho Geological Survey unpublished report for the Third Annual Idaho Earthquake Education Field Workshop, 1995, 13 p.
- Site Inspection Report for the Abandoned and Inactive Mines in Idaho on U.S. Forest Lands (Region 4)*, edited by Victoria E. Mitchell and Earl H. Bennett: Idaho Geological Survey project report, nine chapters, variously paginated.
- Surficial Geologic Map of the Clark Fork Area, Idaho and Montana*, by R.M. Breckenridge: Idaho Geological Survey unpublished report: 1995, 1 colored sheet.
- Surficial Geology Mapping of the Clark Fork Area*, by R.M. Breckenridge: Geology field course, University of Idaho, Clark Fork field campus, June.
- Why Study Ice Age Floods in 1996?—The IGS STATEMAP Project in Northern Idaho*, by R.M. Breckenridge: Kiwanis Club of Moscow, January.

PROFESSIONAL ACTIVITIES

- 11th Thematic Conference on geologic remote sensing, February, Las Vegas, Nevada (J.A. Welhan).
- 32nd Forum on the Geology of Industrial Minerals, Laramie, Wyoming, May (V.S. Gillerman).
- Admissions secretary, Society of Economic Geologists (V.S. Gillerman).
- Advisory board meeting, Idaho Geological Survey, Boise, December (E.H. Bennett).
- Advisory board meetings, College of Mines and Earth Resources, September and April (E.H. Bennett).
- Advisory board meeting, National Geologic Mapping Act, Washington, D.C., April (E.H. Bennett).
- Annual meeting, Association of American State Geologists, Charlottesville, Virginia, June (E.H. Bennett).
- Beartrack gold mine dedication, August (E.H. Bennett).
- Chair, Boise GEM section, American Institute of Mining, Metallurgical and Petroleum Engineers (V.S. Gillerman).
- Chair, Portneuf Ground Water Forum, Pocatello (J.A. Welhan).
- Co-chair, environmental geology session, Geological Society of America national meeting, New Orleans, Louisiana (E.H. Bennett).
- Co-leaders, field trip to the Superfund and Coeur d'Alene Basin restoration in the Silver Valley for

- a delegation from Senator Larry Craig's office, April (E.H. Bennett, W.C. Rember).
- Co-leaders, geology field trip of Hells Canyon and the Snake River, Walla Walla Community College, continuing education program, May (E.H. Bennett, R.M. Breckenridge).
- Co-leaders, geology field trip to Guffey Butte, Idaho State Science Teachers Association, October (B. Bonnicksen, M.M. Godchaux, and K.L. Othberg).
- Congressional dinner, Idaho Mining Association, Washington, D.C., May (E.H. Bennett).
- Contributor and reviewer, Seismic Risk Analysis of the Western United States, National Transportation Board, by Doug Bausch, Western States Seismic Policy Council (R.M. Breckenridge).
- Director and co-instructor, Environmental Geology and Hydrology Workshop (Geology 504 Sections 80, University of Idaho), St. Anthony, July (K.L. Othberg).
- Director and co-leader, Third Annual Idaho Earthquake Education Workshop, Challis, Idaho Geological Survey, July (K.L. Othberg).
- Director, paleomagnetism laboratory, Idaho Geological Survey/College of Mines and Earth Resources (K.L. Othberg).
- Disaster coordinator, Idaho Bureau of Disaster Services, (R.M. Breckenridge).
- Federal Emergency Management Agency, inter-agency hazard mitigation team workshop and field trips, Idaho floods, Coeur d'Alene, February (R.M. Breckenridge).
- Fellow, Geological Society of America (B. Bonnicksen).
- Fellows, Society of Economic Geologists (B. Bonnicksen, V.S. Gillerman).
- Field trip, Seismology of the Grand Canyon area, Western States Seismic Policy Council, Flagstaff, Arizona, September (R.M. Breckenridge).
- Field trip, Soils and geomorphology investigations in Clearwater County, Clearwater Soil Survey Team, May (R.M. Breckenridge).
- Friends of the Pleistocene, third annual Pacific Northwest cell meeting and field trip, May (R.M. Breckenridge, Loudon R. Stanford).
- Geological Society of America, Cordilleran section meeting, Portland, Oregon, April (R.M. Breckenridge, V.S. Gillerman, K.L. Othberg).
- Grouse Creek gold mine dedication, August (E.H. Bennett).
- Guest leader and participant, Mars Pathfinder Landing Site Workshop II, Lunar and Planetary Institute, Spokane, Washington, September (R.M. Breckenridge).
- Idaho Academy of Science, annual conference, Moscow, April (R.M. Breckenridge).
- Idaho Department of Environmental Quality, Nonpoint Source Water Quality Workshop, Boise, January (V.S. Gillerman).
- Idaho Department of Lands, Minerals Workshop, Boise, February (V.S. Gillerman).
- Idaho Department of Lands, Reclamation Awards Lunch, Boise, November (V.S. Gillerman).
- Idaho Earth Science Teachers Association annual conference business meeting, Boise, October (K.L. Othberg).
- Idaho Earth Science Teachers Association business meeting, McCall, November (K.L. Othberg).
- Idaho Earth Science Teachers Association, summer and winter meetings (R.M. Breckenridge, K.L. Othberg).
- Idaho Friends of Loess, first annual field conference, Pocatello, October (R.M. Breckenridge, K.L. Othberg).
- Idaho Geographic Information advisory committee meeting, Boise, October (Loudon R. Stanford).
- Idaho Geological Survey advisory board meeting, Boise, December (V.S. Gillerman).
- Idaho Science Teachers Association Conference and Owyhee County field trip, Boise, October (V.S. Gillerman).
- Idaho Science Teachers Association and Idaho Earth Science Teachers Association annual conferences, Boise, October (K.L. Othberg).
- Instructor, Geology 405, earth science education issues and activities, University of Idaho, spring semester (K.L. Othberg).
- Instructor, Geology 408, field methods for earth science education majors, University of Idaho, fall semester (K.L. Othberg).
- Instructor, Geosciences 421L, ore deposits lab, Boise State University, spring semester (V.S. Gillerman).
- Instructor, team taught, Geology 360, geologic hazards, University of Idaho, spring semester (K.L. Othberg).

- Leader, field trips on Boise area geology, Liberty Elementary School Fifth Grade class and Ross Elementary School Sixth Grade class, May (V.S. Gillerman).
- Leader, field trip to the Silver Valley for the Coeur d'Alene Chamber of Commerce, April (E.H. Bennett).
- Leader, Geologic tour of the Potlatch Canyon 1996 flood damage, state and federal mitigation officers, March (R.M. Breckenridge).
- Leader, Idaho Earth Science Teachers Association annual conference field trip, Guffey Butte area, Snake River Valley, October (K.L. Othberg).
- Leader, tour of Thompson Creek mine for Idaho Earth Science Teachers Association, Challis, July (V.S. Gillerman).
- Liaison committee meetings, Association of American State Geologists, Washington, D.C., September and March (E.H. Bennett).
- Member, advisory board, College of Mines and Earth Resources, University of Idaho (E.H. Bennett).
- Member, advisory committee, National Geologic Mapping Act (E.H. Bennett).
- Member, American Geophysical Union (J.A. Welhan).
- Member, Association of Earth Science Editors (R.C. Stewart).
- Member, committee on research programs of the U.S. Bureau of Mines, Board on Earth Sciences and Resources, Commission on Geosciences, Environment, and Resources (E.H. Bennett).
- Member, executive committee, Western States Seismic Policy Council, January-September 1995 (R.M. Breckenridge).
- Member, Geological Society of Nevada (V.S. Gillerman).
- Member (ex-officio), Hazardous Waste Management Council, Idaho State University (J.A. Welhan).
- Member, Idaho Association of Professional Geologists (V.S. Gillerman).
- Member, Idaho Earth Science Teachers Association (K.L. Othberg).
- Member, Idaho Science Teachers Association (K.L. Othberg).
- Member, liaison committee, Association of American State Geologists (E.H. Bennett).
- Member, National Association of Geology Teachers (K.L. Othberg).
- Member, National Earth Science Teachers Association (K.L. Othberg).
- Member, Pend Oreille Anthropological Society (R.M. Breckenridge).
- Member, technical committee, Treasure Valley hydrologic modeling project, Boise (K.L. Othberg).
- Members, American Institute of Mining, Metallurgical and Petroleum Engineers (R.W. Bartlett, V.S. Gillerman).
- Members, American Quaternary Association (R.M. Breckenridge, K.L. Othberg).
- Members, Friends of the Pleistocene, Pacific Northwest and Rocky Mountain cells (R.M. Breckenridge, K.L. Othberg).
- Members, Geological Society of America (E.H. Bennett, V.S. Gillerman, K.L. Othberg).
- Members, Northwest Mining Association (E.H. Bennett, V.S. Gillerman).
- Mid-year meeting, Idaho Mining Association, Post Falls, August (E.H. Bennett).
- Newspaper interview on Idaho rocks, Idaho Statesman, Boise, August (V.S. Gillerman).
- Northwest Anthropological Conference, University of Idaho, March (R.M. Breckenridge).
- Northwest Mining Association Convention, 101st annual meeting, Spokane, Washington, December (E.H. Bennett, V.S. Gillerman).
- Organizer, northern Idaho meeting of Rocky Mountain Chapter of Urban and Regional Information Association (URISA), Moscow, May (Loudon R. Stanford).
- Pacific Northwest Metals and Minerals Conference, Portland, Oregon, April (V.S. Gillerman).
- Panelist, Idaho Mining Association annual meeting, discussion on the merits and problems of the Columbia Basin Eastside Ecosystem Study, Post Falls, August (E.H. Bennett).
- Panelist, Pi Sigma Alpha (Idaho State University's Political Science Department), Town meeting on "Nuclear Waste and Idaho's Future," Pocatello, December (J.A. Welhan).
- Participant, Idaho Earth Science Teachers Association field workshop, Challis, July (V.S. Gillerman).
- Participant, *Passport in Time*, Timber Mountain

Lookout Project, U.S. Forest Service, August (R.M. Breckenridge).

President, Idaho Earth Science Teachers Association, 1995-1997 (K.L. Othberg).

President-elect, Association of American State Geologists (E.H. Bennett).

Registered professional geologist, Idaho (E.H. Bennett).

Registered professional geologist, Oregon (R.M. Breckenridge).

Representative, ad hoc technical committee, Boise Valley ground-water study planning meetings, Boise (V.S. Gillerman).

Representative, Boise State University Department of Geosciences (V.S. Gillerman).

Representative, Earthquake Engineering Research Institute (R.M. Breckenridge).

Representative, Idaho Department of Lands mining advisory committee (V.S. Gillerman).

Representative, Idaho Department of Water Resources water planning coordination committee (V.S. Gillerman).

Representative, Pocatello-Chubbuck ground water guardian committee (J.A. Welhan).

Representative, Western States Seismic Policy Council, San Francisco (R.M. Breckenridge).

Reviewer, EPSCoR proposals for MONTs, Montanans On a New Trac for Science (R.M. Breckenridge).

Reviewers, Napias Creek Falls unpublished report (E.H. Bennett, R.M. Breckenridge).

Technical advisor and member, Ice Age Floods Institute, Spokane, Washington (R.M. Breckenridge).

Technical advisor on municipal water problems and assessing an adequate supply of fresh water, Twin Falls (B. Bonnicksen).

Technical advisor to Johnny Creek Subdivision Citizens' Committee on ground-water impacts of septic systems (J.A. Welhan).

Technical advisor to Shoshone-Bannock Tribes, Fort Hall Indian Reservation, on hydrologic data acquisition and future ground-water data needs related to monitoring of pesticide contamination of reservation ground-water supplies (J.A. Welhan).

Technical advisor to Twin Falls on wellhead protection in the Blue Lakes municipal water

supply area (J.A. Welhan).

Technical advisors, Idaho Water Resources Research Institute oversight projects, Idaho National Engineering Laboratory (R.M. Breckenridge, K.L. Othberg).

Technical liaison and resource person to Idaho Division of Environmental Quality, Pocatello regional office, on ground-water technical issues (J.A. Welhan).

Technical liaison to Bannock County commissioners for geotechnical work at Fort Hall Canyon county landfill (J.A. Welhan).

Technical liaison to Chubbuck and Pocatello for geotechnical work in the Pocatello-Chubbuck municipal aquifer system (J.A. Welhan).

Technical review, Franklin County solid waste landfill design proposal, solicited by Idaho Division of Environmental Quality, October (J.A. Welhan).

Technical witness in support of the reauthorization of the National Geologic Mapping Act of 1992, U.S. House of Representatives subcommittee on energy and mineral resources, April (E.H. Bennett).

Television interview, Earthquakes in the Pacific Northwest, KLEW-Channel 3, Lewiston, May (R.M. Breckenridge).

U.S. Forest Service, Region 1, Minerals and Lands Workshop, Coeur d'Alene, March (V.S. Gillerman).

Western States Seismic Policy Council, annual meeting, Flagstaff, Arizona, September (R.M. Breckenridge).

Writer, Geology Graduate Record Examination, National Testing Service (R.M. Breckenridge).

GRADUATE THESIS COMMITTEES

Jon Bair, M.S., Geology, University of Idaho (K.L. Othberg).

Thomas Dechert, Ph.D., Soils, University of Idaho (R.M. Breckenridge).

Mason Estes, M.S., Geology, Idaho State University (J.A. Welhan).

Marvin Eveland, M.S., Geology, University of Idaho (K.L. Othberg).

Rod Gabehart, M.S., Soils, University of Idaho (K.L.

Othberg).

Gwen Gerber, M.S., Geology, Idaho State University (J.A. Welhan).

John Glover, M.S., Geology, Idaho State University (J.A. Welhan).

Chris Meehan, M.S., Geology, Idaho State University (J.A. Welhan).

Lisa Morrow, M.S., Geology, University of Idaho (B. Bonnicksen).

Lee Morse, M.S., Geology, Idaho State University (J.A. Welhan).

Robert Mullener, M.S., Geology, Boise State University (V.S. Gillerman).

Susan Nash, M.S., Geological Engineering, University of Idaho (R.M. Breckenridge).

Jason Nelson, M.S., Biology, Idaho State University (J.A. Welhan).

Terrance Osier, M.S., Geology, Idaho State University (J.A. Welhan).

Brian Peterson, Ph.D., Geology, University of Idaho (R.M. Breckenridge, K.L. Othberg).

Michelle Pontac, Ph.D., Biology, Idaho State University (J.A. Welhan).

Ted Reid, M.S., Geology, Idaho State University (J.A. Welhan).

Ron Reuter, M.S., Soils, University of Idaho (K.L. Othberg).

Christine Russell, Ph.D., Geology, University of Idaho (B. Bonnicksen).

Charles Unsworth, M.S., Geology, Boise State University (V.S. Gillerman).

Scott Van Hoff, M.S., Geology, Idaho State University (J.A. Welhan).

GRANTS & CONTRACTS

Bibliographies of scientific studies: E.H. Bennett (National Park Service/Association of American State Geologists, \$29,437).

Development of a subsurface geologic model of the Pocatello aquifer: J.A. Welhan (Pocatello, funding extension, \$3,500).

Digital mapping: E.H. Bennett (U.S. Geological Survey STATEMAP project, \$27,304).

Geologic mapping and environmental alteration study, Missouri mine: V.S. Gillerman (Boise State University, Department of Chemistry, \$200).

Idaho earthquake and fault studies: R.M. Breckenridge and K.L. Othberg (Idaho Bureau of Disaster Services, October 1995-September 1996, \$25,413).

Inactive and abandoned mines research: E.H. Bennett (U.S. Forest Service, Region I, \$150,000).

Inactive and abandoned mines research on U.S. Forest Service land, contract extension: V.S. Gillerman and E.H. Bennett (U.S. Forest Service, Region IV, \$5,406).

Petrogenesis and geochemistry of basalts in the central Snake River Plain: B. Bonnicksen (National Science Foundation subcontract, \$10,302).

Spatial correlation analysis of aquifer lithology and permeability, and the development of a stochastic ground-water flow and transport model, first year: J.A. Welhan and G. Johnson (U.S. Department of Energy, \$109,000).

Transport and dispersion of pollutants in the subsurface environment, third year: J.A. Welhan (National Science Foundation EPSCoR, \$54,250).

Urban geologic mapping in Idaho, Coeur d'Alene, Pocatello, and Twin Falls: K.L. Othberg, B. Bonnicksen, and R.M. Breckenridge (U.S. Geological Survey STATEMAP project, May 1996-April 1997, \$78,555).

Urban geologic mapping in Idaho, Coeur d'Alene, Pocatello, and Twin Falls: K.L. Othberg, B. Bonnicksen, and R.M. Breckenridge (U.S. Geological Survey STATEMAP project, June 1995-May 1996, \$35,000).

Urban geologic mapping in Idaho, Pocatello and Twin Falls: K.L. Othberg and B. Bonnicksen (U.S. Geological Survey STATEMAP project, August 1994-July 1995, \$50,000).

FUNDING & BUDGET

The two-percent holdback Governor Batt ordered for the 1996 budget year hit the Survey especially hard. The reduction has also become permanent in the base budget for the following year. Bigger state agencies can largely offset a cut such as this through regular staff vacancies. Smaller agencies like the Survey cannot depend on customary personnel turnover and must cover the holdback by reducing funds available for general operations and new equipment. The Survey's holdback amounted to \$12,300 and had to be deducted from the original operating account of \$54,200. This left \$41,000 to run the entire agency for the year. The decreased amount obviously restricts operations. The Survey was able to obtain a half-time position for the Digital Mapping and Information Laboratory to use as matching funds for the National Cooperative Geologic Mapping Program. Fortunately, the Survey was again successful in attracting outside funding for projects that pay field expenses and other costs related to the agency's research and service activities.

The Survey obtained \$529,467 in grants and contracts, an amount close to the

state's support of \$604,200. Nationwide competition for these funds is keen, especially now as the federal government, the largest source of research dollars, continues to downsize and cut back its own funding. According to FY-95 data on state surveys compiled by the Association of American State Geologists, the Idaho Geological Survey ranked nationally a distant forty-third in the amount of state funding but a respectable twenty-fourth in the amount obtained from outside sources.

The Survey was involved in cooperative research programs with the U.S. Geological Survey, the U.S. Forest Service (Regions I and IV), the federal Bureau of Land Management, the Department of Energy, the National Science Foundation, the National Park Service, the state Bureau of Disaster Services, and the city of Pocatello. The funding for these programs enables the agency to undertake research and provide services far beyond what could be done with just the state's appropriation. The Survey is proud of the staff's success in procuring these highly competitive research dollars.

Recent Budget History—Fiscal Years 1992-1996

Fiscal Year	FY-92	FY-93	FY-94	FY-95	FY-96
Personnel	\$473,200	\$486,000	\$505,000	\$550,400	\$560,000
Operating Expense	60,100	61,300	53,100	54,200	41,900*
Capital Outlay	5,000	-0-	-0-	2,200	2,300
Total	\$538,300	\$547,300	\$558,100	\$606,800	\$604,200

* The Legislature approved \$54,200 for FY-96, but a 2% holdback ordered early in the year reduced this amount to \$41,900.

Overview of Grants and Contracts—Fiscal Year 1996

Funding Agency	Project	Amount
City of Pocatello	Aquifer study	\$ 3,500
Idaho Bureau of Disaster Services	Earthquake and fault studies	25,413
National Park Service/Association of American State Geologists	Bibliographies of scientific studies	29,437
National Science Foundation	Basalt study	10,302
National Science Foundation (EPSCoR)	Pollutants in the subsurface	54,250
U.S. Department of Energy	Flow and transport model	109,000
U.S. Forest Service (Region I)	Digital geologic compilations	36,300
U.S. Forest Service (Region I)	Inactive and abandoned mines evaluation	150,000
U.S. Forest Service (Region IV)	Extension of inactive and abandoned mines evaluation	5,406
U.S. Geological Survey	STATEMAP—digital/Pocatello 1:100,000	27,304
U.S. Geological Survey	STATEMAP—Coeur d'Alene, Pocatello, Twin Falls	78,555
TOTAL		\$529,467

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1996

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