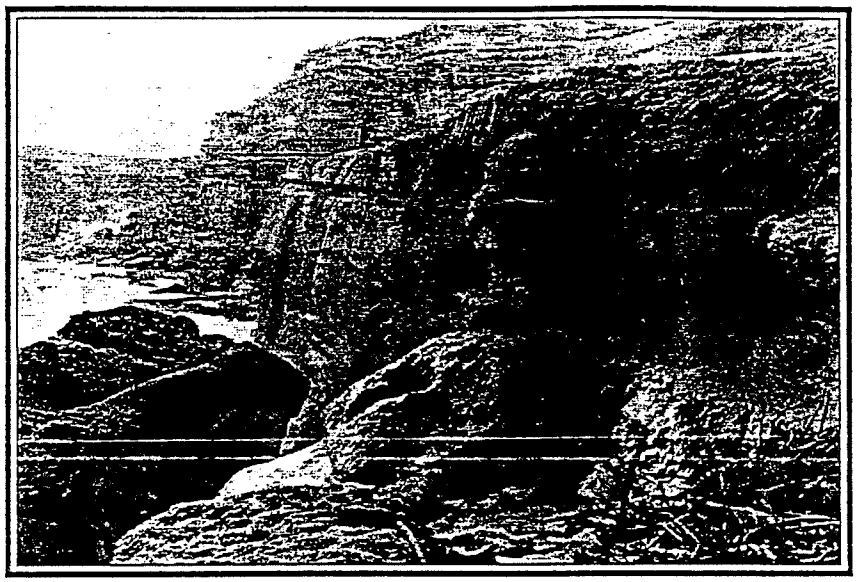

Annual Report 1998

Arizona Geological Survey

ARIZONA GEOLOGICAL SURVEY
OPEN-FILE REPORT
98-28

This report is preliminary and has not been edited or reviewed for conformity with Arizona Geological Survey standards

1989-98
A Decade of Progress

1989-98
A DECADE OF PROGRESS

The Arizona Geological Survey (AZGS) and its predecessors have served Arizonans since 1889, 23 years before Statehood. The AZGS became a stand-alone State agency July 1, 1988, after being administered by the University of Arizona since 1915.

1989

- Redirected by the legislature to be a stand-alone State agency that reports directly to the Governor.
- Established an in-state network of depository libraries for Arizona Geological Survey publications.
- Started the Contributed Report and Contributed Map publication series.

1990

- Initiated the Down-to-Earth publication series.

1991

- Assumed administrative responsibility for the Arizona Oil and Gas Conservation Commission.

1992

- Established the Earth Science Information Center.
- Became the distributor for Arizona Geological Society publications.

1993

- Organized the Arizona Geologic Mapping Advisory Committee.

1994

- Established the Center for Land-Subsidence and Earth-Fissure Information.

1995

- Moved the headquarters office to the State of Arizona Regional Complex in downtown Tucson.

1996

- Began to digitize geologic maps and make digital products available to data users.

1997

- Moved the Earth Science Information Center to the Arizona Geological Survey office.
- Organized the Speakers Bureau to give talks to adult groups.

1998

- Established the Poster series to provide non-technical information about scenic geologic features in Arizona.

Annual Report 1998

(July 1, 1997 to June 30, 1998)

Arizona Geological Survey

Larry D. Fellows
Director and State Geologist

State of Arizona
Arizona Geological Survey
416 W. Congress, Suite 100
Tucson, Arizona 85701
(520) 770-3500

Jane Dee Hull
Governor

Larry D. Fellows
Director and State Geologist

04 September 1998

The Honorable Jane Dee Hull
Governor of Arizona
Arizona State Capitol
1700 West Washington Street
Phoenix, AZ 85007

Dear Governor Hull:

Fiscal year 1997-1998 was a special year. Not only was it a productive one, but also it marked the last year of our first decade as a stand-alone State agency that reports to the Governor. Since the Legislature redirected the Arizona Geological Survey (AZGS), effective July 1, 1988, the agency has initiated significant new procedures (summarized on the inside of the front cover and described in more detail throughout the report) to better inform and assist the public. Additional changes will be made to bring the agency into the 21st century. Recommendations for improvement were made by a committee of the Arizona Section of the American Institute of Professional Geologists, which conducted an in-depth assessment of the performance of the AZGS. I requested this review to ensure that the AZGS is meeting the needs of Arizonans for geologic mapping and information. Many of the review committee's recommendations were incorporated into the AZGS Strategic Plan and Information Technology Plan.

The AZGS must accomplish four goals to fulfill its statutory mission: 1) provide information, 2) prepare geologic maps, 3) investigate geologic materials, processes, and resources, including potential hazards, and 4) provide administrative and staff support for the Arizona Oil and Gas Conservation Commission, which regulates the drilling for and production of oil, gas, helium, and geothermal resources. This report highlights accomplishments that were made in achieving those goals during Fiscal Year 1998.

Information about geologic processes and materials that can impact land and resource management is needed more than ever because of increasing population growth. Potential geologic impacts include earthquakes, land subsidence and earth fissures caused by overdraft of ground water, flooding, and cavernous bedrock and related problems in limestone terrain. AZGS staff collaborate with Federal and other State agencies on projects of mutual interest, using State funds to match Federal and other funds on cooperative projects.

I'm especially pleased to submit the annual report of the AZGS for Fiscal Year 1998. I welcome your questions about Arizona's geology and geologic resources or the operation of the AZGS.

Sincerely yours,

Larry D. Fellows
Director and State Geologist

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Book design: Peter F. Corrao

Cover photo: Grand Falls on the Little Colorado River, northeast of Flagstaff.
By Larry D. Fellows.

Contents photo: Rhyolite pinnacles in Chiricahua National Monument.
By Larry D. Fellows.

Page 11: Cathedral Rock on Oak Creek southwest of Sedona.
By Larry D. Fellows.

Page 15: Oil well at East Boundary Butte Field, Apache County.
By Steven L. Rauzi.

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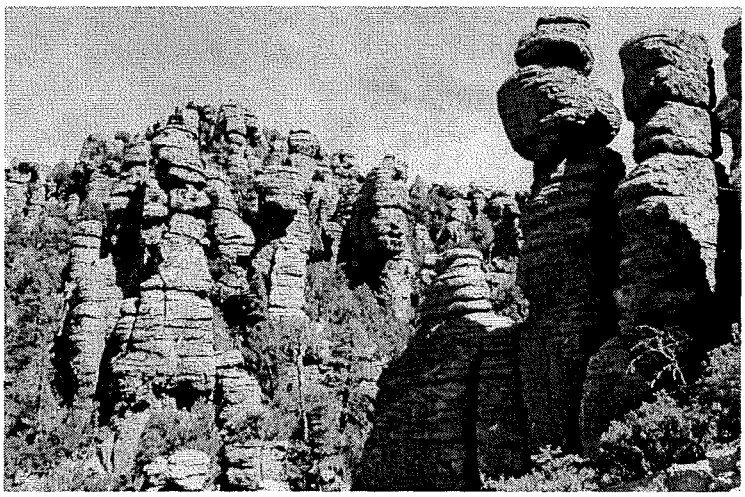

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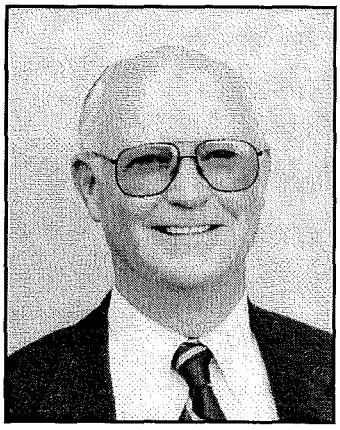
Executive Summary

INFORMATION

- Answered thousands of requests for geologic information or assistance.
- Sold 9,831 geologic maps and reports.
- Released the Geologic Highway Map of Arizona, which was prepared cooperatively with the Arizona Geological Society.
- Established a speakers bureau to give talks to adult groups.
- Gave 44 technical and non-technical talks on the geology of Arizona.



Larry D. Fellows
Director and State Geologist

MAPPING AND INVESTIGATIONS

- Released 32 geologic reports and maps, including:
  - nine geologic maps
  - six mineral resource investigations
  - four geologic hazard studies
  - three digital map products
  - two bibliographies
  - two non-technical reports in the Down-to Earth series
- Spent $779,034 and employed 13.25 full-time equivalent employees from the General Fund appropriation to do geologic mapping, conduct investigations, and provide information.
- Spent $281,439 and employed 11 part-time and temporary employees on externally funded projects done under contract. Used the General Fund appropriation as a partial match for these projects.

OIL AND GAS

- Issued two permits to drill for oil, natural gas, helium, and geothermal resources.
- Inspected 28 oil and gas wells to ensure that there were no safety and environmental problems.
- Revised and updated five oil and gas reports
- Held two regular meetings of the Arizona Oil and Gas Conservation Commission.

1989-98
A DECADE
OF PROGRESS

1989

DEPOSITORY LIBRARIES

To improve access to items in the Arizona Geological Survey Bulletin, Circular, Down-to-Earth, Folio, Map, and Special Paper publication series, staff cooperated with the Arizona Department of Library, Archives, and Public Records, to establish the following in-state depository libraries:

- Arizona State University
- Central Arizona College
- Cochise County
- Glendale Public
- Mesa Public
- Miami Memorial-Gila County
- Mohave Community College
- Northern Arizona University
- Northland Pioneer College
- Phoenix Public
- Tucson Public
- University of Arizona
- Yavapai College
- Yuma City-County

Mission, Description and Goals

MISSION

The mission of the Arizona Geological Survey (AZGS) is to provide unbiased information that enhances public understanding of geologic processes, materials, and resources and assists citizens, businesses, governmental agencies, and legislators in prudently managing Arizona's land, water, mineral, and energy resources.

DESCRIPTION

AZGS staff prepare and provide geologic maps, reports, and related information to interested or concerned citizens, governmental agencies, businesses, legislators and committee staff, teachers, and students. Geologists map and describe bedrock and surficial materials; metallic, nonmetallic, and energy resources; and geologic processes that may be hazardous to the public or limiting to land and resource management (e.g. earthquakes, land subsidence and earth fissures, flooding). Staff conduct investigations, write reports and prepare maps that summarize the results, and make this and related information available to the public. In addition, they compile and maintain data files and computer databases, a library that features the geology of Arizona, and a repository of selected rock cuttings and cores.

The Arizona Oil and Gas Conservation Commission, which regulates the drilling for and production of oil, gas, helium, and geothermal resources, is attached administratively to the AZGS. The AZGS provides staff support. Staff issue permits to drill, monitor drilling, inspect completed wells, compile drilling and production data, and maintain files of well cuttings and related information about subsurface geology. In addition, they prepare maps that show the distribution and thickness of bedrock formations in the subsurface, describe the character of those formations, disseminate information, and encourage the responsible exploration for and development of oil, natural gas, and related resources.

GOALS

INFORMATION. Provide objective information about Arizona's geologic setting to citizens, businesses, governmental agencies, and legislators in a timely, courteous manner.

GEOLOGIC MAPPING. Map and describe the bedrock and surficial geology of Arizona with emphasis on the Phoenix-Tucson urban corridor, which contains 80 percent of the State's population and is experiencing rapid development.

INVESTIGATIONS. Conduct geologic investigations and provide information to local, state, and federal governmental agencies that have responsibility for prudently managing Arizona's land, water, mineral, and energy resources.

OIL AND GAS. Administer the rules, regulations, and policies established by the Arizona Oil and Gas Conservation Commission to protect public health and safety relative to the drilling for and production of oil, gas, helium, and geothermal resources.

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Accomplishments

1989

CONTRIBUTED MAP AND REPORT SERIES

Many geologists, including university faculty members and graduate students, complete geologic maps and reports that are never published. In keeping with the mission of providing information, the Arizona Geological Survey (AZGS) established the Contributed Map and Contributed Map publication series to make selected items available to the public. Each contributed item is announced in *Arizona Geology* and included in the list of publications. Master copies are kept on file and photocopied on request. To date, 45 contributed maps and 42 contributed reports, all of which were completed by geologists not employed at the AZGS, have been released.

INFORMATION

Inquiries about Arizona Geology

Thousands of people requested information about bedrock and surficial geology, mineral and energy resources, potential geologic hazards, and geologic limitations to land-and-resource management in Arizona. Many purchased maps and reports, used the library, and had discussions with staff geologists. In response to public request, Arizona Geological Survey (AZGS) geologists gave talks, led field trips, served on committees, reviewed manuscripts and otherwise assisted the public and profession.

Earth Science Information Center (ESIC)

Revenue from the sale of AZGS reports and maps was $28,862, which was deposited in the Printing Fund to be used for expenses to print and distribute other AZGS publications. Sale of USGS topographic maps, Arizona Geological Society, and other publications brought in $32,024. This revenue is used to purchase other publications for resale and for ESIC operating expenses.

The AZGS sells more than 500 of its own published and unpublished geologic maps and reports. In addition, the AZGS has cooperative agreements to sell maps and reports published by the U.S. Geological Survey (USGS) and the Arizona Geological Society. AZGS staff also provide access to USGS databases and distribute general-interest publications and brochures prepared by the USGS.

Geology Library

More than 400 people visited the AZGS geology library, which contains publications of the AZGS, Arizona Oil and Gas Conservation Commission, Arizona Geological Society, U.S. Geological Survey, and selected publications of other governmental agencies. The library also contains theses and dissertations on Arizona geology, selected technical journal and bulletin series, textbooks, environmental impact statements and reviews, and unpublished maps and reports on the geology, water, energy, and mineral resources of Arizona. The library, supervised by T. G. McGarvin, is open to the public. The public may also view AZGS publications at the State Library in Phoenix and at a network of selected depository libraries throughout the State.

Databases and Files

R.A. Trapp, Database Manager, added citations for publications on Arizona geology to the database (AZGEOBIB). Citations for more than 12,300 publications are now in the system. Work continued on a database of stratigraphic names used in Arizona. More than 2,700 names have been compiled.

Computer databases are compiled from published and unpublished geologic investigations and maps. Other databases include GENLIB, a database of AZGS library holdings; AZMIN, a database for metallic mineral districts and production and mine names, including primary and secondary references; and AZAGE, a compilation of radiometric age determinations.

Rock Cuttings and Core Repository

Rock cuttings from 23 water wells were added to the repository. In addition, Ridgeway Arizona Petroleum Corporation provided slabbed core of the Fort Apache and Amos Wash units (Permian age) from the 11-21 State and 22-1X wells between St. Johns and Springerville. Carbon dioxide is present in those units in those wells.

The AZGS is charged by statute to maintain a central repository for rock cuttings and cores and associated supplemental data. Companies that drill for oil, gas, helium, or geothermal resources are

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DOWN-TO-EARTH SERIES

The Arizona Geological Survey (AZGS) and its predecessors have completed geologic maps and reports that were primarily intended for other geologists. The AZGS established the Down-to-Earth publication series to provide information to persons with little, if any, education or background in geology. Reports on the following subjects have been released:

- Energy resources of Arizona
- Radon gas, a potential geologic hazard
- Land subsidence and earth fissures
- How geologists tell time
- Things geologic
- Ice Age mammals in the San Pedro River Valley
- Highlights of northern Arizona geology

required by Arizona Oil and Gas Conservation statutes to submit rock cuttings and cores saved during drilling, together with well logs, results of tests conducted, and other pertinent information, to the AZGS. Because of space limitations, only representative samples of cores are usually saved. Cuttings from more than 4,000 oil and water wells, and cores from many mineral tests are in the repository, which may be used by the public.

Arizona Geology

Three 4-page issues and one 6-page issue of *Arizona Geology* were published and distributed. *Arizona Geology* is published quarterly to describe events related to geology, publicize new geologic maps and reports, and to highlight other activities or events that pertain to geology in Arizona. Practicing geologists or others who have a special interest in Arizona geology are the intended audience for *Arizona Geology*.

Land-Subsidence and Earth-Fissure Information

A study of the Bowie-San Simon area was completed and released as Open-File Report 97-19. AZGS staff also answered requests for information, referred the public to appropriate agencies for assistance, and compiled and assembled information.

Down-to-Earth Reports

The AZGS released two non-technical reports in the Down-To-Earth (DTE) Series. DTE 6, prepared in cooperation with the National Park Service, describes Ice Age mammals that lived in the San Pedro River Valley in southeastern Arizona about 10,000 years ago. The authors of DTE 7 summarized the geologic history of northern Arizona and described the major geologic attractions such as the Grand Canyon, Monument Valley, Canyon de Chelly, Black Mesa, the Painted Desert, Petrified Forest, Meteor Crater, San Francisco Mountains, and Sunset Crater.

Non-technical Talks

Arizona Association for Learning in and about the Environment, Phoenix Fall Conference (T.G. McGarvin)

Arizona Department of Water Resources, Phoenix (L.D. Fellows)

Arizona Science Teachers Association, Mesa Fall Conference (T.G. McGarvin)

Division of Emergency Management, Earthquake Program, Seismic Sleuths series, Tucson, Thatcher, Whiteriver, and Red Rock State Park (L.D. Fellows)

El Camino Baptist Church, Tucson WAVE Program (L.D. Fellows)

Flowing Wells School District, Tucson Environmental Education Workshop (T.G. McGarvin)

Grand Canyon University, Glendale geology class (L.D. Fellows)

Kiwanis Club at Sun City Vistoso, Tucson (T.G. McGarvin, S.L. Rauzi)

Lions Club at the Fountains, Tucson (L.D. Fellows, R. C. Harris, S.L. Rauzi)

Nanini Library, Tucson (T.G. McGarvin)

North Tucson Lions Club (R.C. Harris)

Pueblo Optimist Club, Tucson (L.D. Fellows, T.G. McGarvin)

Red Rock State Park, Sedona Sunday at the Park, (L.D. Fellows)

Rincon Kiwanis Club, Tucson (T.G. McGarvin)

Rincon Rotary Club, Tucson (R.C. Harris)

Saguaro Optimist Club, Tucson (L.D. Fellows)

Sunshine Kiwanis Club, Tucson (L.D. Fellows, T. G. McGarvin)

Tributes to Aging, Tucson (T.G. McGarvin)

Tucson Optimist Club (R. Frisch-Gleason, R.C. Harris)

Tucson Unified School District, David T. Smith Resource Center (T.G. McGarvin)

_____, Science Education Community Forum (T.G. McGarvin)

Tucson Wilmot Lions Club (L.D. Fellows)

Uptown Optimist Club, Tucson (R. Frisch-Gleason)

1989-98
A DECADE
OF PROGRESS

1991

OIL AND GAS CONSERVATION COMMISSION

To reduce expenditure from the General Fund, the Legislature abolished the Arizona Oil and Gas Conservation Commission agency and assigned administrative responsibility for the six-member governing Commission to the Arizona Geological Survey, effective July 1, 1991. Five members of the Commission are appointed by the Governor; the sixth, the State Land Commissioner, is an *ex officio* member. The Commission regulates the drilling for and production of oil, gas, helium, and geothermal resources. Arizona has 25 producing oil wells and 8 producing gas wells, all of which are in the northeastern corner of the State on the Navajo Reservation.

Lectures and Talks to Professional Groups

Arizona Geological Society, monthly meeting (S.M. Richard)

Arizona State University, Department of Geology, Tempe (P.A. Pearthree)

Geological Society of America, Annual Meeting, Salt Lake City (P.A. Pearthree)

_____, Rocky Mountain Section meeting, Flagstaff [P.K. House, J.E. Klawan, S.M. Richard, J.E. Spencer (2 talks), and H.D. Stenner]

Northern Arizona University, Department of Geology, Flagstaff (J.E. Spencer)

University of Arizona, Department of Geosciences (P.A. Pearthree)

Other Service to the Public and Profession

American Geophysical Union
J.E. Spencer reviewed a manuscript that was submitted for publication.

American Journal of Science
J.E. Spencer reviewed a manuscript that was submitted for publication.

Arizona Council for Earthquake Safety
L.D. Fellows, member of Executive Committee

P.A. Pearthree, member of Advisory Council and Technical Committee

Arizona Floodplain Management Association
P.A. Pearthree, member of the Technical Committee

Arizona Geological Society
P.F. Corrao designed the Geologic Highway Map of Arizona.

T.G. McGarvin, P.A. Pearthree, S.M. Richard, and J.E. Spencer provided geologic maps, cross sections, and text for the Geologic Highway Map of Arizona.

S.M. Richard, Vice President for Fieldtrips (arranged fieldtrips to Morenci mine and Catalina Mountains)

J.E. Spencer, Secretary

Arizona State Parks, Cottonwood Chamber of Commerce, and U.S. Forest Service
L.D. Fellows was co-leader of a geology fieldtrip to Jerome State Park as part of the annual Verde River Day celebration.

Arizona State University
P.A. Pearthree served on the thesis committee of one M.S. student in Department of Geology.

Association of American State Geologists
L.D. Fellows, member of Earth Science, Honorary Members, and Frye Award Committees

Geological Society of America
J.E. Spencer reviewed a manuscript that was submitted for publication.

Journal of Structural Geology
J.E. Spencer reviewed a manuscript that was submitted for publication.

National Science Foundation
J.E. Spencer reviewed a proposal that was submitted for funding.

Pima County Flood Control District
P.A. Pearthree, member of Advisory Committee

Tohono Chul Park
T.G. McGarvin led a docent-in-training fieldtrip to observe geologic features in the Tucson area.

U. S. Forest Service
L.D. Fellows was an invited speaker at the 1997 GEOFEST meeting in Denver

U. S. Geological Survey
L.D. Fellows was an invited participant at a Denver meeting of the Science Strategy Team for the Geologic Division

P.A. Pearthree was a contributor to the young-fault mapping team, Earthquake Hazards Program.

S.M. Richard reviewed aspects of the National Mineral Resource Assessment pertinent to Arizona; reviewed proposed USGS-AASG digital geologic map data model; and contributed a modified model for consideration by the Standards Working Group.

Western States Seismic Policy Council
L.D. Fellows was member of the Governing Board.

1989-98
A DECADE
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EARTH SCIENCE INFORMATION CENTER

The U. S. Geological Survey (USGS), established to provide geologic information in the National interest, has released large quantities of information. To better serve geologic data users, the Arizona Geological Survey and the USGS signed a memorandum of agreement to establish the Earth Science Information Center to distribute publications from both agencies from a single location. The Center was collocated with the USGS.

ARIZONA GEOLOGICAL SOCIETY PUBLICATIONS

The Arizona Geological Society is a nonprofit professional organization that was established to promote and encourage interest in the science of geology and the geology of the State of Arizona. The Society periodically publishes geologic maps and reports. To better serve geologic data users, the Arizona Geological Survey and the Society signed a memorandum of agreement that authorizes the Arizona Geological Survey to be the sole distributor of items published by the Society.

GEOLOGIC MAPPING

Mesa Quadrangle

Geologists completed detailed bedrock and surficial geologic maps of the following 7.5 minute quadrangles in the northwestern quadrant of the Mesa 1° x 2° quadrangle: New River Mesa, Humboldt Mountain, Boulder Mountain, Maverick Mountain, Tonto Basin, New River SE, Union Hills, Biscuit Flat, Hedgpeth Hills, and Daisy Mountain. They also did detailed mapping around the Ray Mine and Theodore Roosevelt Dam. Others compiled the surficial geology of the entire northwestern quarter of the Mesa 1° x 2° quadrangle at 1:100,000 scale. Geologic mapping was done as part of the National Geologic Mapping Program, a cooperative effort between State geological surveys and the U.S. Geological Survey. An advisory committee composed of representatives of land- and resource-management agencies and university geologists determined mapping priorities. Mapping north of Phoenix was funded in part by the U. S. Environmental Protection Agency State Indoor Radon Grant program. Geologists J.E. Spencer, P.A. Pearthree, S.M. Richard, C.A. Ferguson, W.G. Gilbert, R.S. Leighty, and S.J. Skotnicki participated in the geologic mapping effort.

Arizona Highway 88

In anticipation of widening and straightening Highway 88 northwest of Globe, the Arizona Department of Transportation contracted with the AZGS to do detailed geologic mapping along the highway in the Roosevelt-Ruin Basin area. S.J. Skotnicki prepared the map, which was released as Open-File Report 98-01.

Tucson Quadrangle

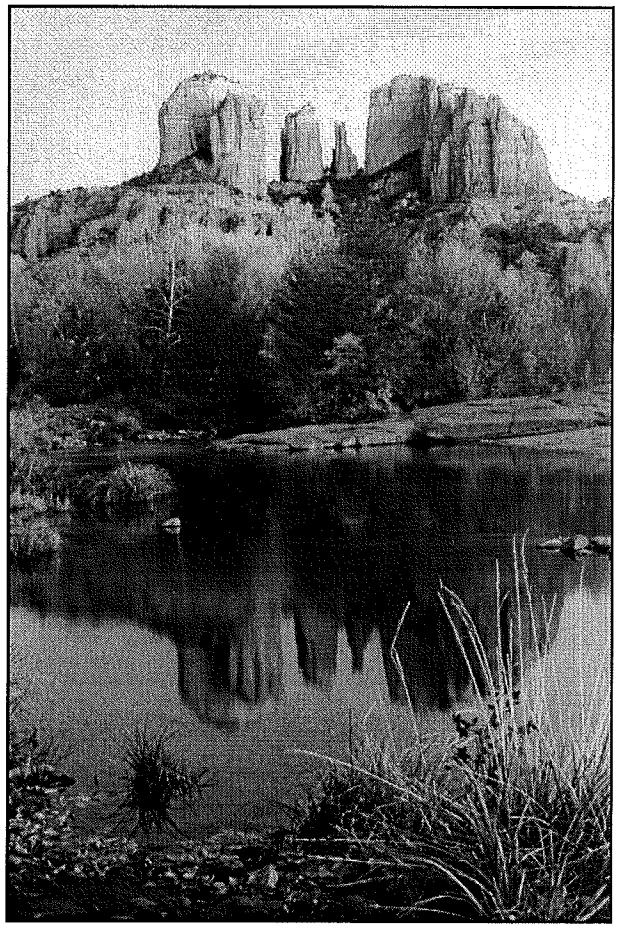
AZGS geologists began a new project in the northwestern quarter of the Tucson 1° x 2° quadrangle as part of our continuing effort to map the Phoenix-Tucson urban corridor. J.E. Klawon and P.A. Pearthree are mapping the surficial geology of six 7.5 minute quadrangles in the Casa Grande area. These maps will be released later in 1998.

Goldwater Air Force Range

AZGS geologists continued mapping the surficial geology of portions of the Goldwater Air Force Range in southwestern Arizona. The purpose of these investigations is to develop environmental data to support reauthorization of Air Force use of the range, which is required in 2001. AZGS geologists completed three reports that cover areas southeast and southwest of Gila Bend, and east of Yuma. A fourth report will be completed later in 1998. J.E. Klawon, T.H. Biggs, and P.A. Pearthree did the mapping.

San Bernardino Valley

AZGS geologist S. J. Skotnicki began a mapping project in the San Bernardino Valley in southeastern Arizona. Geologic and geomorphic data obtained will be incorporated with soils and vegetation information to help develop sustainable range-management practices in the Malpais Borderlands of Arizona and New Mexico. One 7.5 minute quadrangle has been completed. The rest of the mapping will be finished in 1999. The project is being done cooperatively with the U.S. Forest Service.



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GEOLOGIC MAPPING ADVISORY COMMITTEE

The National Geologic Mapping Act of 1992 authorized State geological surveys to submit proposals to the U.S. Geological Survey, the lead Federal agency, for funding to make detailed geologic maps. The Arizona Geologic Mapping Advisory Committee was established in 1993 to provide information to the State Geologist about areas that have the highest priority for geologic mapping. The 24-member Committee is composed of representatives of the environmental and engineering geology community, mineral exploration and mining companies, Arizona's three major universities, and State and Federal land- and resource-management agencies.

Digital Geologic Maps

A digital geologic map of the Little Horn quadrangle (1:100,000 scale) was completed. Work on the Mesa, Globe, and Theodore Roosevelt Dam 30 x 60 minute quadrangles is in progress. In addition, the index of geologic maps completed in Arizona was released in digital format. The digital geologic map of Arizona was edited to make data structure consistent with other AZGS digital geologic maps. Digitizing was done by Sean Kneale under the direction of S. M. Richard.

Geologic Highway Map of Arizona

Governor Jane Dee Hull was presented with the first copy of the newly released Highway Geologic Map of Arizona by members of the Arizona Geological Survey (AZGS) and Arizona Geological Society (Society). The full-color, 26x48-inch sheet includes a 1:1,000,000-scale geologic map, and much more. The map, printed on a waterproof synthetic paper, supersedes the previous edition that the Society published in 1967.

The geologic map, cross sections, and columnar sections are printed on the front side of the sheet, together with brief explanations of the geology of Arizona and how to use and interpret a geologic map. The map incorporates a substantial amount of new geologic mapping that has been done by AZGS and other geologists since 1982.

The reverse side of the sheet includes a discussion of rocks and minerals, shaded-relief map, geologic map and columnar section of the Grand Canyon near the South Rim Visitor Center, and four maps that depict specific aspects of Arizona's geologic history. Other maps, each accompanied by an explanatory text, show tectonic features, mineral resources, geologic hazards, and vegetation biotic communities of Arizona.

The Highway Geologic Map was prepared cooperatively by members of the Society and the AZGS. Society member Robert J. Kamilli served as co-editor with AZGS geologist Stephen M. Richard. A committee composed of Society members and AZGS staff planned the project and prepared the inset maps and text. AZGS graphic artist Peter F. Corrao did the design and layout.

INVESTIGATIONS

Uranium in rocks

The geology and uranium content of rocks were studied over a wide strip of ground on both sides of Interstate 17 between Phoenix and New River, as well as on the Colorado Plateau. R.C. Harris measured uranium concentrations using a portable gamma-ray spectrometer, and rock and soil was studied and mapped by R.S. Leighty. The Phoenix-New River study was done in cooperation with the Arizona Radiation Regulatory Agency, with partial funding from the U.S. Environmental Protection Agency.

Radon, a colorless, odorless radioactive gas, is produced by the natural radioactive decay of uranium. Radon has the potential to be hazardous if it is present in sufficient quantities and inhaled over prolonged periods. Indoor-radon levels generally correlate with the amount of uranium in underlying rock and soil.

Water quality, San Carlos-Safford-Duncan area

The relationship of geology to water quality in the upper Gila River area (Safford and Duncan basins) was studied with funds provided by the Arizona Department of Environmental Quality. A followup study, using isotopes to distinguish among different natural sources of dissolved solids, was initiated with funds from the Arizona Department of Water Resources. R.C. Harris did this study.

Earth fissures, Bowie and San Simon areas

Geologist R. C. Harris completed a study of the development of earth fissures in the Bowie and San Simon areas in Cochise County. The Arizona Department of Environmental Quality provided partial funding. These earth fissures are the result of declining water tables associated with water withdrawal for agriculture. Fissures continue to develop and can damage highways, railroads, pipelines, and other structures. Results of the study were released as Open-File Report 97-19.

Volcanic activity, Flagstaff area

R.C. Harris compiled data and J.E. Spencer wrote a report that included a compilation of 174 previously unpublished potassium-argon dates of volcanic rock samples from the San Francisco volcanic field. These dates will be used to evaluate the long-term history and likely future areas of volcanic activity in the area.

Potential erosion along Cave Creek

H.D. Stenner of the AZGS is studying the geomorphology of lower Cave Creek as part of a floodplain management study supported by the Flood Control District of Maricopa County. She is documenting the physical characteristics of the channels and terraces of Cave Creek in order to assess the potential for lateral erosion and downcutting along the wash.

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LAND SUBSIDENCE AND EARTH FISSURES

In large portions of southern Arizona ground water has been pumped faster than natural recharge has occurred. As a result the land surface has subsided and large cracks (fissures) have formed. Subsidence and fissures may have adverse impacts on many land- and resource-management activities. To keep governmental agencies and the public informed, the Arizona Geological Survey (AZGS) and the Department of Water Resources collaborated to form the Center for Land-Subsidence and Earth Fissure Information. The AZGS serves as a clearinghouse for pertinent information. A steering committee composed of representatives of 12 governmental agencies meets annually to discuss relevant activities.

Verde River floods

AZGS geologists are cooperating with geologists at the Desert Research Institute (Reno) and the University of Arizona on a study of the historical and prehistoric record of large floods on the Verde River in central Arizona. AZGS geologists J.E. Klawon and P.A. Pearthree, working with P.K. House of the Desert Research Institute, have documented floods ranging back several thousand years. The largest of these floods have been somewhat larger than any floods of the past century.

Hurricane fault

The AZGS and the Utah Geological Survey are cooperatively evaluating the seismic hazard associated with the Hurricane fault in southwestern Utah and northwestern Arizona. The research is jointly supported by the State geological surveys and the U.S. Geological Survey NEHRP program. Geologists have collected field data to estimate the late Quaternary fault slip rate and to estimate the age of youngest rupture along the fault at several places in Arizona. Preliminary analyses suggest a fault slip rate of about 0.2 to 0.4 m per thousand years near the Arizona-Utah border. The youngest rupture occurred there during the early to middle Holocene, but the documented displacement was less than 1 m. Farther south along the Hurricane fault on the north side of the Grand Canyon, the late Quaternary fault slip rate is about 0.1 m per thousand years. The youngest rupture along this part of the fault probably occurred in the latest Pleistocene or early Holocene. The length of this rupture was at least 15 km. These investigations will improve our understanding of seismic hazard in this rapidly growing region.

Quaternary faults

AZGS geologists, in cooperation with the U. S. Geological Survey (USGS) have nearly finished developing a Quaternary fault database and map for Arizona. Quaternary fault data will be incorporated in the next generation of nationwide seismic hazard maps being developed by the USGS. In Arizona, geologists have identified about 100 known or suspected Quaternary faults. Data for each fault have been included in the database. The USGS has digitized the traces of each of these faults. The AZGS is developing a 1:750,000-scale map to accompany the database. The map and database are scheduled for release as an open-file report in late 1998.

River navigability

The AZGS has compiled data on the historical geomorphology and hydrology of several rivers for the Arizona State Land Department. This work is part of the assessment of river navigability conducted by the Arizona Navigable Stream Adjudication Committee. During the past year, M.L. Wood completed an investigation of the historical character of the channel of the lower San Pedro River. Results of the study were released as Open-File Report 97-21. Staff are now documenting the geomorphology and hydrology of Big Sandy Creek, Burro Creek, and the Santa Maria River in western Arizona.

Maps and Reports Released by the Arizona Geological Survey

(AZGS authors are shown in bold type.)

American Institute of Professional Geologists, Arizona Section, 1997, Report of the Arizona Geological Survey Review Committee: Arizona Geological Survey Open-File Report 97-20, 67 p.

Amman, W.A.,Jr., Bezy, J.V., Ratkevich, Ron, and Witkind, W.M., 1998, Ice Age mammals of the San Pedro River Valley, southeastern Arizona: Arizona Geological Survey Down-To-Earth 6, 19 p.

Ash, N.A., 1997, Geologic map of the Santa Maria Mountains volcanic field, Yavapai County, Arizona: Arizona Geological Survey Contributed Map 97-B, scale 1:24,000.

Chenoweth, W.L., 1997a, The geology, leasing, and production history of the Sunnyside uranium-vanadium mine, Apache County, Arizona: Arizona Geological Survey Contributed Report 97-C, 11 p.

_____, 1997b, The geology, leasing, and production history of the Syracuse (R F and R) uranium-vanadium mine, Apache County, Arizona: Arizona Geological Survey Contributed Report 97-D, 14 p.

Dickinson, W.R., 1998, Facies map of post-mid-Miocene Quiburis Formation, San Pedro trough, Pinal, Pima, Graham, and Cochise Counties, Arizona: Arizona Geological Survey Contributed Map 98-A, 6 p., 10 sheets, scale 1:24,000.

Fellows, L.D., 1997, Annual report of the Arizona Geological Survey for Fiscal Year 1997: Arizona Geological Survey Open-File Report 97-22, 17 p.

Ferguson, C.A., and **Gilbert, W.G.**, 1997, Geology of the Mormon Flat Dam quadrangle, Maricopa County, Arizona: Arizona Geological Survey Open-File Report 97-14, 28 p., 3 sheets, scale 1:24,000.

Frisch-Gleason, Robin, *compiler and editor*, 1998, Highlights of northern Arizona geology: Arizona Geological Survey Down-to Earth 7, 44 p.

Gilbert, W.G., and **Ferguson, C.A.**, 1997, Geology of the Horse Mesa Dam quadrangle, Maricopa and Gila Counties, Arizona: Arizona

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NEW OFFICES

The Arizona Geological Survey (AZGS) moved into newly remodeled space in the State of Arizona Regional Complex in downtown Tucson. AZGS staff worked closely with the architect to create offices that enable the agency to function efficiently. The lobby, restored to its original condition when constructed in 1957, is used as a public reception and sales area. The library was expanded and new bookshelves were added. A large graphics area is available for preparation of geologic maps and digital products. Rock cuttings and cores are stored in the basement of an adjacent building. Ample free parking is available for customers. The AZGS' offices had been on or adjacent to the University of Arizona campus since 1915.

Geological Survey Open-File Report 97-15, 14 p., 3 sheets, scale 1:24,000.

Harris, R.C., 1997a, Land use in the San Carlos-Safford-Duncan nonpoint-source management zone: Arizona Geological Survey Open-File Report 97-18, 7 p., 3 sheets, scale 1:100,000 and 1:250,000.

_____, 1997b, Earth fissures in the Bowie-San Simon area, Cochise County, Arizona: Arizona Geological Survey Open-File Report 97-19, 10 p., 1 sheet, scale 1:24,000.

_____, 1998a, Bibliography of geothermal resources in the San Carlos-Safford-Duncan Nonpoint-Source Management Zone, Arizona: Arizona Geological Survey Open-File Report 98-06, 7 p.

_____, 1998b, Bibliography of geophysical studies and data in the San Carlos-Safford-Duncan Nonpoint-Source Management Zone, Arizona: Arizona Geological Survey Open-File Report 98-07, 9 p.

Harris, R.C., Leighty, R.S., Scarborough, R.B., and **Spencer, J.E.**, 1998, Uranium levels and radon potential in selected areas north of Phoenix, in the St. Johns area, and north of Tuba City, Arizona: Arizona Geological Survey Open-File Report 98-10, 13 p.

Harris, R.C., Leighty, R.S., and **Spencer, J.E.**, 1998, Prevalence of radon-resistant construction in the Phoenix and Tucson metropolitan areas, Arizona: Arizona Geological Survey Open-File Report 98-09, 8 p.

Harris, R.C., and **Richard, S.M.**, 1998, Mineralized areas in the San Carlos-Safford-Duncan nonpoint-source management zone, Arizona: Arizona Geological Survey Open-File Report 98-03, 37 p., 1 sheet, scale 1:1,000,000.

Klawon, J.E., 1998, Paleoflood hydrology and historic flood analysis in the upper Verde River basin, central Arizona: Arizona Geological Survey Open-File Report 98-05, 93 p.

Kneale, S.M., *digitizer*, 1998, Physiographic areas in Arizona used by the Arizona Geological Survey, by Trapp, R.A., and Reynolds, S.J.: Arizona Geological Survey Digital Information Series 10, ver. 1.0, 4 p., 1 disk.

Kneale, S.M., and **Richard, S.M.**, 1998, Arizona geologic index map: Arizona Geological Survey Digital Information Series 9, 5 p., 3 DOS HD disks.

Korroch, K.M., and **Thieme, J. P.**, *digitizers*, and **Richard, S. M.**, *editor*, 1997, Digital representation of the geological map of the Little Horn Mountains 30' x 60' quadrangle, southwestern Arizona, by Spencer, J.E., *compiler*: Arizona Geological Survey Digital Information Series 7, 3 p., 2 DOS HD disks.

McKee, E.H., Damon, P.E., Shafiqullah, M., **Harris, R.C.**, and **Spencer, J.E.**, 1998, Compilation of unpublished USGS and University of Arizona K-Ar dates of volcanic rocks of the San Francisco Volcanic Field, northern Arizona: Arizona Geological Survey Open-File Report 98-02, 25 p., 1 plate, scale 1:100,000.

Pearthree, P.A., Skotnicki, S.J., and **Demsey, K.A.**, 1997, Surficial geologic map of the Theodore Roosevelt Lake 30' x 60' quadrangle, Arizona: Arizona Geological Survey Open-File Report 97-17, 1:100,000 scale.

Richard, S.M., Ferguson, C.A., and **Skotnicki, S.J.**, 1997, Geology of the Fortuna mine, Yuma County, Arizona: Arizona Geological Survey Open-File Report 97-16, 14 p.

Richard, S.M., and **Harris, R.C.**, 1998, AZMILS-MRDS records for mineralized sites in the San Carlos-Safford-Duncan Nonpoint-Source Management Zone, Arizona: Arizona Geological Survey Open-File Report 98-04, 48 p., scale 1:500,000.

Skotnicki, S.J., 1998, Geologic map of the State Route 88 corridor from Pinal Creek to Pinto Creek, Gila County, Arizona: Arizona Geological Survey Open-File Report 98-01, 7 p., scale 1:12,000.

Skotnicki, S.J, and **Leighty, R.S.**, 1997a, Geologic map of the Adams Mesa quadrangle, Maricopa County, Arizona: Arizona Geological Survey Open-File Report 97-10, 13 p., 1 sheet, scale 1:24,000.

_____, 1997b, Geologic map of the Mine Mountain quadrangle, Maricopa and Gila Counties, Arizona: Arizona Geological Survey Open-File Report 97-11, 11 p., 1 sheet, scale 1:24,000.

_____, 1997c, Geologic map of the Stewart Mountain quadrangle, Maricopa County, Arizona: Arizona Geological Survey Open-File Report 97-12, 19 p., 1 sheet, scale 1:24,000.

Trapp, R.A., 1997, Bibliography of uranium- and copper-bearing breccia pipes on or near the Colorado Plateau of Arizona: Arizona Geological Survey Open-File Report 97-13, 11 p.

Wood, M.L., 1997, Historical channel changes along the lower San Pedro River, southeastern Arizona: Arizona Geological Survey Open-File Report 97-21, 44 p., 3 sheets, scale 1:24,000.

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1996

DIGITAL GEOLOGIC MAPS

The Arizona Geological Survey acquired staff and equipment needed to digitize geologic maps and make them available in digital format. This was made possible by funding from the State General Fund and the National Geologic Mapping Act. Ten digital products have been released prior to the end of Fiscal Year 1997-98.

OIL AND GAS

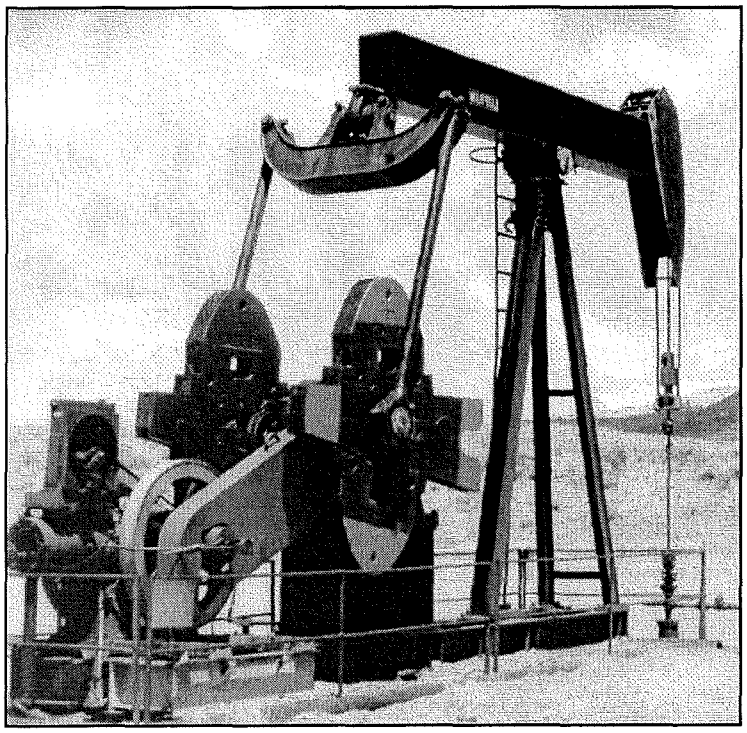
Arizona Oil and Gas Conservation Commission

The Arizona Oil and Gas Conservation Commission (OGCC) has statutory responsibility to regulate the drilling for and production of oil, gas, helium, and geothermal resources. The OGCC consists of five members appointed by the Governor and one ex-officio member, the State Land Commissioner. The Arizona Geological Survey (AZGS) provides administrative and staff support. Commission members are J. Dale Nations, Flagstaff, Chairman; Donald C. Clay, Yuma; James C. Lanshe Phoenix; and J. Dennis Wells, State Land Commissioner. The OGCC held two regular meetings.

Production, Refining, and Storage

In 1997, 82,085 barrels of oil were produced from 25 producing wells, compared with 84,047 barrels from 22 wells in 1996. Gas production in 1997 totaled 453 million cubic feet from 8 producing gas wells, down from 464 million cubic feet from 7 wells in 1996. There were three active produced-water disposal wells. Ten oil wells, three gas wells, and one disposal well were shut in at yearend.

Arizona's two refineries were inactive during 1997. The Intermountain Refinery near Fredonia was removed from active status in January 1997. The Sunbelt Refinery near Coolidge was removed from active status in August 1993.



Liquified petroleum gas (LPG) transferred in 1997 through storage wells near Luke Air Force Base and Adamana included 106 million gallons in receipts and 88 million gallons in deliveries, up from 86 million gallons received and 75 million gallons delivered in 1996. About 57 million gallons of LPG were in storage at yearend, up from the 40 million gallons the previous year. Fourteen storage wells are constructed into subsurface salt.

Oil and Gas Leasing

A total of 417,000 acres were under lease. State Trust Land under lease on June 30, 1998, totaled 305,000 acres, down from 333,000 acres in June 1997. Public land under lease on June 30, 1998, totaled 112,000 acres, up from 78,000 acres in June 1997. The State Land Department administers leasing on State Trust Land. The U.S. Bureau of Land Management administers leasing on public lands.

Drilling

Two permits to drill were issued. The first was to Central Resources for an infill well at the East Boundary Butte Field in northeastern Arizona. The second was issued to Premco Western for an exploration well on the Arizona Strip in northwestern Arizona. Drilling started on the Premco Western well in April 1998. Drilling had not started on the Central Resources well as of June 1998.

Inspection and Enforcement

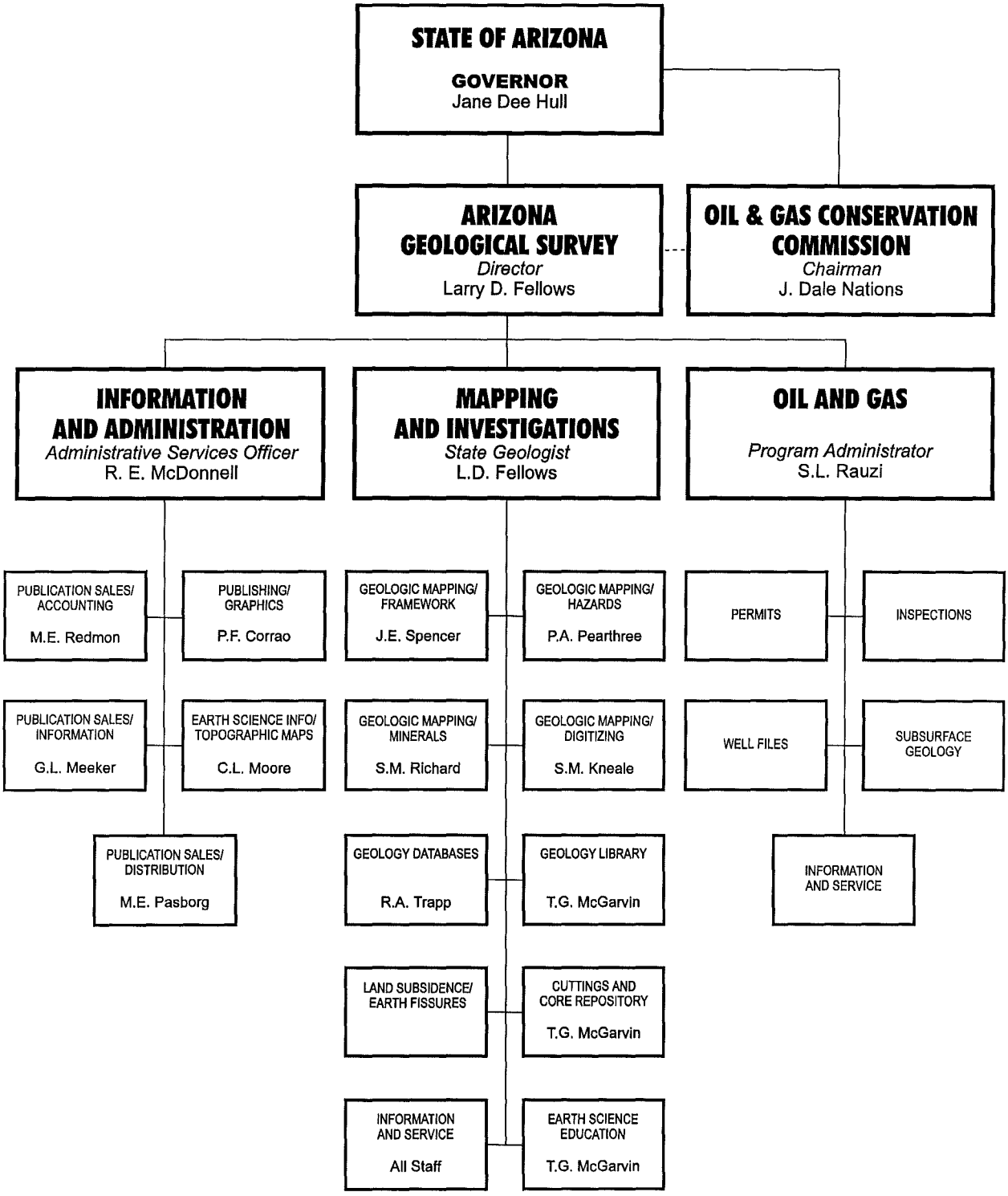
The 14 hydrocarbon-storage wells near Luke Air Base and Adamana were inspected semiannually to ensure that wellhead valves, safety alarms, and emergency shutdown systems are in good working condition.

Subsurface Data

The OGCC requires that subsurface data, including rock samples, logs, and testing results, be submitted by drillers for filing and archiving at the AZGS. These samples add to the general understanding of Arizona's geologic framework and subsurface mineral and energy resources. The AZGS maintains a series of maps that show the locations of oil, gas, and geothermal wells and the types of subsurface data that are available for examination. Samples from 23 water-exploration wells were added to the AZGS sample repository. Three well-location maps were updated (see Appendix).

Administration

ORGANIZATION AND FUNCTIONS



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EARTH SCIENCE INFORMATION CENTER MOVED

The Earth Science Information Center (ESIC) was established in 1992 and collocated with the U. S. Geological Survey office. Because the newly renovated offices of the Arizona Geological Survey offered superior access to the public, the ESIC was relocated there. The number of office visitors and the sale of topographic maps and geologic publications have steadily increased since the move.

SPEAKERS BUREAU

For many years the Arizona Geological Survey has provided information about Arizona geology to science, earth science, and geology teachers. A Speakers Bureau was established to address non-student adult groups.

PERSONNEL

LARRY D. FELLOWS,
Director and State Geologist.
B.S., Iowa State University; M.A., University of Michigan;
Ph.D., University of Wisconsin.

GEOLOGISTS

SEAN M. KNEALE,* Geologist I.
B.A., University of Arizona.

THOMAS G. McGARVIN, Geologist I.
B.A., California Lutheran College.

PHILIP A. PEARTHREE, Research Geologist.
B.A., Oberlin College; M.S., University of Arizona;
Ph.D., University of Arizona.

STEVEN L. RAUZI, Oil and Gas Program Administrator.
B.S. and M.S., Utah State University.

STEPHEN M. RICHARD, Research Geologist.
B.S. and M.S., University of Arizona;
Ph.D., University of California, Santa Barbara.

JON E. SPENCER, Research Geologist.
B.S., University of California, Santa Cruz;
Ph.D., Massachusetts Institute of Technology.

RICHARD A. TRAPP, Geologist II.
B.S., University of Nebraska, Omaha; M.S.,
University of Arizona.

OTHERS EMPLOYED

Thomas H. Biggs,* Ph.D., Charles A. Ferguson,* Ph.D., Robin Frisch-Gleason, M.S., Wyatt G. Gilbert,* Ph.D., Raymond C. Harris,* M.S., P. Kyle House,* Ph.D., Jeanne E. Klawon,* M.S., Kraig M. Korroch,* B.S., Robert S. Leighty,* Ph.D., Kari L. Moshenberg*, Steven J. Skotnicki,* M.S., Heidi D. Stenner,* B.S., Jennifer P. Thieme,* B.A., Michelle L. Wood,* B.S.

ROSE ELLEN McDONNELL,
Administrative Services Officer II.
B.S., University of Arizona.

SUPPORT STAFF

PETER F. CORRAO, Program and Project Specialist II.
B.A., Arizona State University.

GEORGEANNA L. MEEKER, Secretary.

CATHY L. MOORE, Geologist I.
B.S. University of Wisconsin;
M..S. Universtiy of Arizona.

MARY E. PASBORG*, Secretary.

MARY E. REDMON, Administrative Assistant III.

OTHERS EMPLOYED

Irene Arbizu, Darren C. Green, Gregory D. Harmon, Heather C. Thrall

The Arizona Geological Survey is authorized to employ 13.25 full-time-equivalent staff members with appropriated General Revenue funds. Employees whose names are designated with asterisks were paid partially or entirely from external funds.

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POSTER SERIES

The Poster Series was established to publicize scenic or unusual rocks, landforms, or other geologic features. A nontechnical summary of the age, origin, composition, or significance of the feature is provided. The first poster was of the Catalina Gneiss as it appears within the Sabino Canyon Recreation Area, one of the most visited natural attractions in the Tucson area.

AIPG REVIEW

The Arizona Section of the American Institute of Professional Geologists conducted a thorough review of the Arizona Geological Survey (AZGS) and recommended changes that will be needed to bring the AZGS into the 21st century.

EXPENDITURES

GENERAL FUND

Category	FY 1997 Expended	FY 1998 Expended	FY 1999 Budgeted
Personal Services	426,573	445,864	465,100
Benefits	81,374	86,048	90,900
Operations	183,755	186,940	191,600
In-State Travel	26,136	34,191	37,800
Out-of-State Travel	2,500	3,193	2,000
Capital Equipment	22,413	22,698	9,100
TOTAL	742,752	779,034	796,500

PRINTING REVOLVING FUND

	Personal Services	Benefits	Operations	Total
Publications				
Arizona Geological Survey	3,279	1,269	21,518	26,066
Arizona Geological Society	12	2	8,370	8,384
U.S. Geological Survey	0	0	9,434	9,434
Other Publications	0	0	1,967	1,967
TOTAL	3,291	1,271	41,289	45,851

EXPENDITURES

CONTRACTED PROJECTS

Project (Fund Source)	Principal Investigator	Personal Services	Benefits	Operations	In-State Travel	TOTAL
Uranium Levels in Rocks (U.S. Environmental Protection Agency)	Spencer	23,492	2,585	261	0	26,338
Earth Science Information Center (U.S. Geological Survey)	McDonnell	5,035	1,105	0	0	6,140
Geologic Mapping Phoenix Quadrangle (U.S. Geological Survey)	Spencer	95,172	15,077	32,660	3,987	146,896
Paleosesmicty and Seismic Hazard (U.S. Geological Survey)	Pearthree	9,848	977	3,629	6,137	20,591
San Bernardino	Pearthree	10,060	2,149	536	1,115	13,860
Black Mountains	Fellows	5,556	822	12	0	6,390
Printing and Distribution (Arizona Geological Society)	McDonnell	12	2	8,370	0	8,384
Geologic Mapping - Wheatfield (AZ Dept. of Transportation)	Spencer	1,812	306	0	538	2,656
Growler Wash Survey (Geraghty & Miller, Inc.)	Pearthree	17,802	2,103	454	89	20,448
Nonpoint Source (AZ Dept. of Evinronmental Quality)	Richard	7,787	1,379	432	234	9,832
New Verde River (Desert Reserarch Insitute)	Pearthree	7,372	770	149	277	8,568
San Pedro Navigability (JEF, Inc.)	Pearthree	1,440	143	185	0	1,768
Safford Isotope	Richard	6,982	1,276	30	0	8,288
Various Navigable Rivers	Pearthree	1,161	119	0	0	1,280
TOTAL		193,531	28,813	46,718	12,377	281,439

AIPG REVIEW — EXECUTIVE SUMMARY

J. Alan Coope, Dawn H. Garcia (Chair), Walter E. Heinrichs, Jr., and Erick F. Weiland

A committee of the Arizona section of the American Institute of Professional Geologists (AIPG) has completed a review of the activities of the Arizona Geological Survey (AZGS) relative to the agency's mission.

The AZGS and its predecessor agencies have been recording and interpreting Arizona geology for over 108 years. During this period, the Survey has produced hundreds of reports and maps documenting the geological framework of the state for use by geologists, ecologists, other scientists, engineers, developers, recreationists, environmentalists, regulators and legislators, and members of the general public. The accumulated geological database represents a valuable investment on the part of the people of Arizona. This value is becoming more apparent through the wider appreciation that this geological database is fundamentally important not only to the economic development of the state but also to the management of ecosystems and a better understanding of our social environment.

The Review Committee has formulated 29 conclusions and 26 recommendations relating to AZGS competencies, products and services, productivity, office equipment, public visibility and marketing strategies.

The fundamental relationship between geology and Arizona's economic and social development and the corresponding diverse responsibilities of the AZGS warrants that it remain a separate, scientific agency within the state government.

AZGS customers in industry, private consulting, education and public agencies rate the Survey's products to be reliable and of high quality. The **AZGS office in downtown Tucson is well and popularly located** for the greater majority of statewide customers and the staff form a very professional research and service oriented group with an excellent reputation for prompt attention to customer requests.

Although the Survey's contributions have received wide commendation among geology professionals, AZGS has not gained an appreciation and a visibility among the general public worthy of its importance and achievements. This can be overcome through the **promotion of non-technical publications and more aggressive marketing of the basic fundamentals of geology** and how they impact on the human environment.

The rapid development of electronic communications is signaling unavoidable changes in the way the AZGS will distribute its products and services. There is an escalating demand for digital map information among industrial and private consulting clients and this same constituency is seeking access to several of the Survey's comprehensive electronic databases through the Internet. Electronic transfer of all types of information will be conventional practice among all customer groups by the turn of the century necessitating **significant updates in computer equipment and software** and a corresponding **expansion of AZGS electronic communication skills**.

In order to serve as a primary source of geological information in Arizona - a principal goal of the AZGS under state statutes - the Survey should **keep appropriate records of other geologic and geologically-related databases** that are maintained, also under statute, by other state agencies. It would be mutually beneficial to all parties if the AZGS **developed information sharing programs with other state and federal agencies** who have a frequent and essential need for unbiased and reliable geological information.

Geologic mapping, in its broadest sense, is a primary activity of the AZGS. Through the production of Open-File Reports, the Survey geologists have generated a timely flow of new map information for customer use. An examination of the demand for AZGS publications confirms the popularity of the map product, but the Survey should **monitor the customer demand for all of its publications** to determine the presentation preferences and needs with respect to the delivery of its geologic output.

Geologic mapping is invariably enhanced when integrated with geophysical and applied geochemical surveys. The identification of geophysical and geochemical features and trends aids interpretation and understanding, improves the map product, enhances economic and environmental assessments, and increases overall productivity. Whenever budgets, special appropriations, or future hiring opportunities allow, the AZGS should **acquire applied geophysical and geochemical skills** to further improve the widely-used, primary mapping product.

While endorsing the recommendations of previous advisory committees, it is apparent to the present Review Committee that the state of Arizona, in these times of budget constraints, is unlikely to invest significant dollars in **drill core and cutting storage** to improve the present, inadequate, user-unfriendly facilities. In spite of this, the AZGS should continue to preserve the important information contained in these expensive-to-obtain, sub-surface samples through a program of digitally imaging (or photographing) all submitted drill core and cutting materials and digitally recording all logs and other relevant information.

A productive AZGS is essential to the on-going economic and social development of the State of Arizona. The implementation of the Review Committee's recommendations will require **short-term expenditures for appropriate new computer hardware and software** (estimated at $30,000) and the **addition of a competent and experienced geotechnical staff member** to meet the predictable growing customer demand for electronic information and services. **Geochemical and geophysical expertise** for integrated mapping and interpretation should initially be covered by contract funding and gradually phased into the strategic plan as needs and benefits become apparent. **Hydrogeological and engineering geology skills** can be similarly incorporated to cover the projected need for groundwater-related expertise. In the longer term, these additions will lead to operating efficiencies commensurate with customer needs and in keeping with standards of efficiency that the AZGS has established.

PRECIS

MISSION

To provide unbiased information that enhances public understanding of geologic processes, materials, and resources and assists citizens, businesses, governmental agencies, and legislators in prudently managing Arizona's land, water, mineral, and energy resources.

GEOLOGIC DATA USERS

- Consultants
- Elementary and secondary teachers and students
- Environmental and engineering geology companies
- Governmental agencies
- Insurance companies
- Interested or concerned citizens
- Lawyers
- Legislators and legislative staff
- Libraries
- Mineral exploration and mining companies
- News media representatives
- Oil and gas exploration and development companies
- Professional societies
- Realtors
- Tourists
- University faculty and students

HOW TO CONTACT US

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INFORMATION

- Inquiries about Arizona geology
- Maps and reports
  - Arizona Geological Survey
  - Arizona Geological Society
  - U.S. Geological Survey
- Geology library
- Databases and files
- Rock cuttings and core repository
- *Arizona Geology* (Quarterly)
- Earth science education activities
- Down-to-earth reports (non-technical)
- Talks and lectures

MAPPING AND INVESTIGATIONS

- Bedrock and surficial geology
- Geologic hazards and limitations
- Mineral and energy resources
- Geologic maps and reports

OIL AND GAS

- Administrative and staff support for the Oil and Gas Conservation Commission
- Information about oil, gas, helium, and geothermal resources
- Oil and gas well files
- Subsurface geology

Office hours:
Monday through Friday
8:00 a.m. to 5:00 p.m.