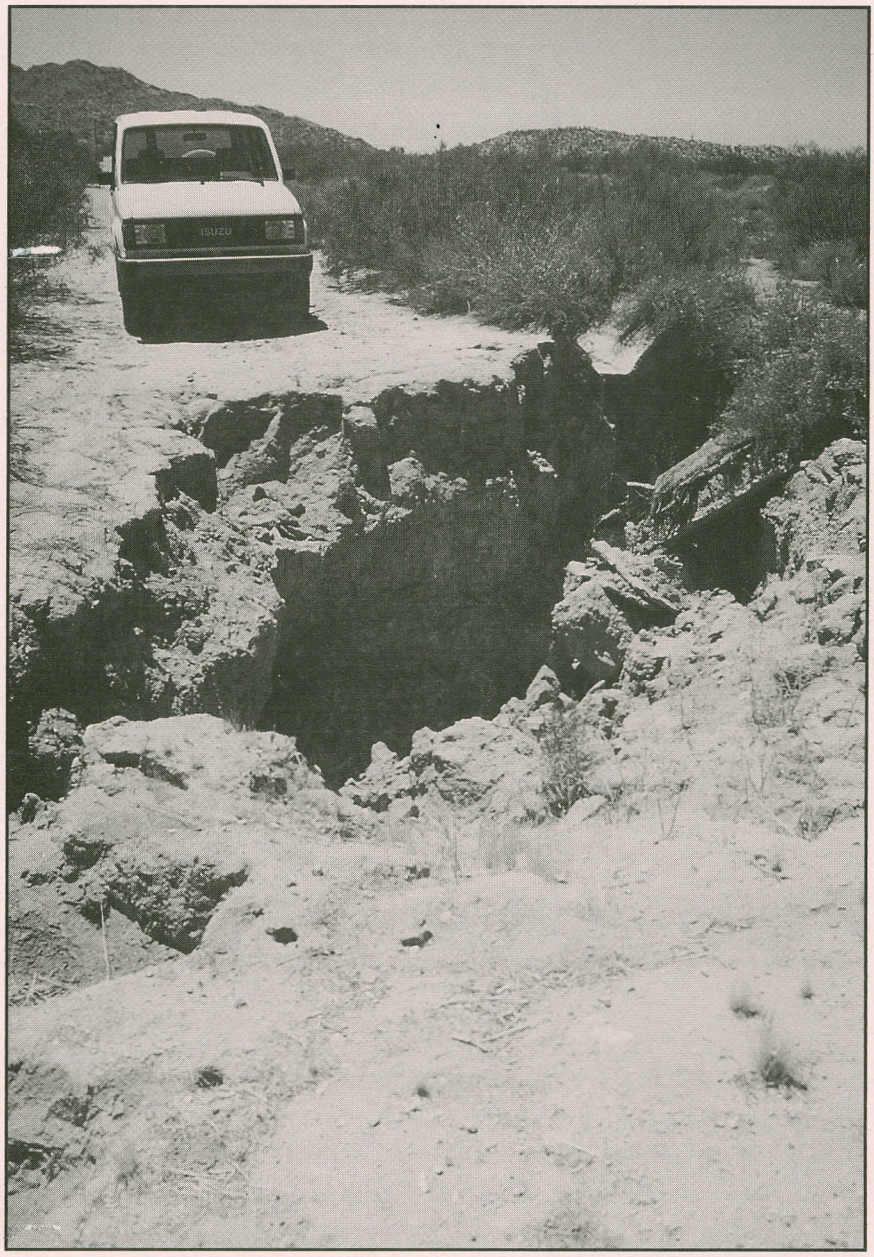
ARIZONA GEOLOGICAL SURVEY

105 YEARS OF SERVICE



ARIZONA GEOLOGICAL SURVEY
OPEN-FILE REPORT

94-26

ANNUAL REPORT 1993-94

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

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State of Arizona
Arizona Geological Survey
845 North Park Avenue, #100
Tucson, Arizona 85719
(602) 882-4795

Fife Symington
Governor

Larry D. Fellows
Director and State Geologist

August 20, 1994

The Honorable Fife Symington
Governor of Arizona
Arizona State Capitol
1700 West Washington Street
Phoenix, AZ 85007

Dear Governor Symington:

I am proud to submit this Annual Report of the Arizona Geological Survey (AZGS) for Fiscal Year 1993-94, the 105th year since the first Territorial Geologist was appointed in 1889.

The mission of the AZGS is to assist the public, businesses, and governmental agencies in understanding and prudently using Arizona's land, water, mineral, and energy resources by providing objective earth-science information. To do this, staff map the distribution and determine the character of bedrock and surficial geologic units, describe and assess potential for mineral and energy resources, and identify and study potential geologic hazards and limitations to development, such as the earth fissure shown on the cover of this report. The agency also provides administrative support for the Arizona Oil and Gas Conservation Commission, which regulates the drilling for and production of oil, gas, helium, and geothermal resources.

Maps, reports, and data that are produced, together with the information, interpretations, and assistance that are provided, serve as the basis for *informed* land- and resource-management decisions. During the year staff provided information and assistance to nearly 14,000 individuals and groups and released 41 reports and maps that depict and describe Arizona's geology and non-renewable natural resources. AZGS geologists also worked on ten cooperative investigations that were partially funded by other governmental agencies or groups.

The need to better understand Arizona's geologic character, hazards and limitations, and water, mineral, and energy resources has increased as the population has grown, the economy has expanded, and competition for land and resources has accelerated.

It was a pleasure to work with you and your staff during the year. I welcome your questions about the AZGS' mission, activities, and plans, or about the geology, mineral and energy resources, and geologic hazards and limitations in Arizona.

Sincerely yours,

Larry D. Fellows

Larry D. Fellows
Director and State Geologist

EXECUTIVE SUMMARY

INFORMATION

Arizona Geological Survey (AZGS) staff responded to more than 13,800 requests for information and assistance from persons who wrote, telephoned, or visited our offices to buy publications, use the library, or confer with a geologist. Requests for information were made by representatives of governmental agencies, the business community, public groups, and interested citizens. Geologic reports and maps were sold at the headquarters office and the Earth Science Information Center, which is a cooperative venture with the U.S. Geological Survey. Publication sales totaled $36,544, an increase of almost $3,000 from last year.

Geologists presented 29 talks, workshops, and fieldtrips to inform the public about the geology of Arizona.

INVESTIGATIONS

AZGS geologists completed 41 geologic maps and reports. The investigations completed dealt with potential geologic hazards and limitations to development, such as earthquakes, land subsidence and earth fissures caused by overpumping ground water; piedmont flooding; and radon gas. Other studies described the distribution and character of bedrock and surficial materials and the occurrence of oil, gas, and mineral resources. Geologists also prepared digital databases and compiled lists and indexes of available maps and reports.

AZGS geologists released the results of cooperative investigations with other agencies and groups, including the Arizona Departments of Emergency and Military Affairs, Environmental Quality, and Water Resources; Arizona Radiation Regulatory Agency; Arizona Geological Society; Federal Emergency Management Agency; Flood Control District of Maricopa County; Pima County Flood Control District; and the U. S. Bureau of Reclamation, Environmental Protection Agency, and Geological Survey. Funding for these projects was provided, under contract, with the agencies involved. Expenditure of contract funds totaled $160,860.

The AZGS established a Geological Mapping Advisory Committee to determine priorities for geologic mapping during the coming year. The Land Subsidence and Earth Fissure Information Center was established in cooperation with the Arizona Department of Water Resources. Representatives from 10 governmental agencies met to discuss data needs and priorities relative to subsidence and earth fissures. This group will meet periodically to provide guidance and oversight for Information Center functions and activities.

OIL AND GAS

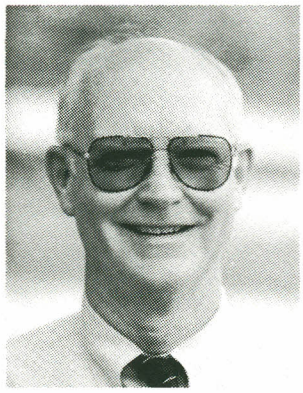
The AZGS supports the Arizona Oil and Gas Conservation Commission by administering the rules and regulations promulgated by the Commission, a 5-member board whose members are appointed by the Governor. The Commission held three regular meetings and one hearing.

One oil test was permitted and drilled, in northwestern Mohave County, but was dry and abandoned. The Arizona Department of Commerce, in cooperation with the U.S. Department of Energy, funded a geothermal test hole that was drilled near Alpine to determine the potential for hot dry rock (HDR) in the area. The project consultant concluded that the HDR potential for near-term electrical power generation at that location is not economical. A show of oil in the hole, however, revived interest in the petroleum potential of the region.

Staff inspected 69 wells to ensure that equipment was functioning safely. At year end Arizona had 20 producing oil wells, 6 producing gas wells, one refinery, and two underground LPG-storage facilities.

PERSONNEL AND BUDGET

The AZGS' General Fund appropriation was $613,200, from which a team of 13.25 full-time-equivalent (FTE) geologists and support staff were employed. One FTE position was eliminated because of a reduction in the General Fund appropriation. Twelve part-time, temporary employees were paid from contracted projects.



Larry D. Fellows
DIRECTOR AND STATE GEOLOGIST
ARIZONA GEOLOGICAL SURVEY

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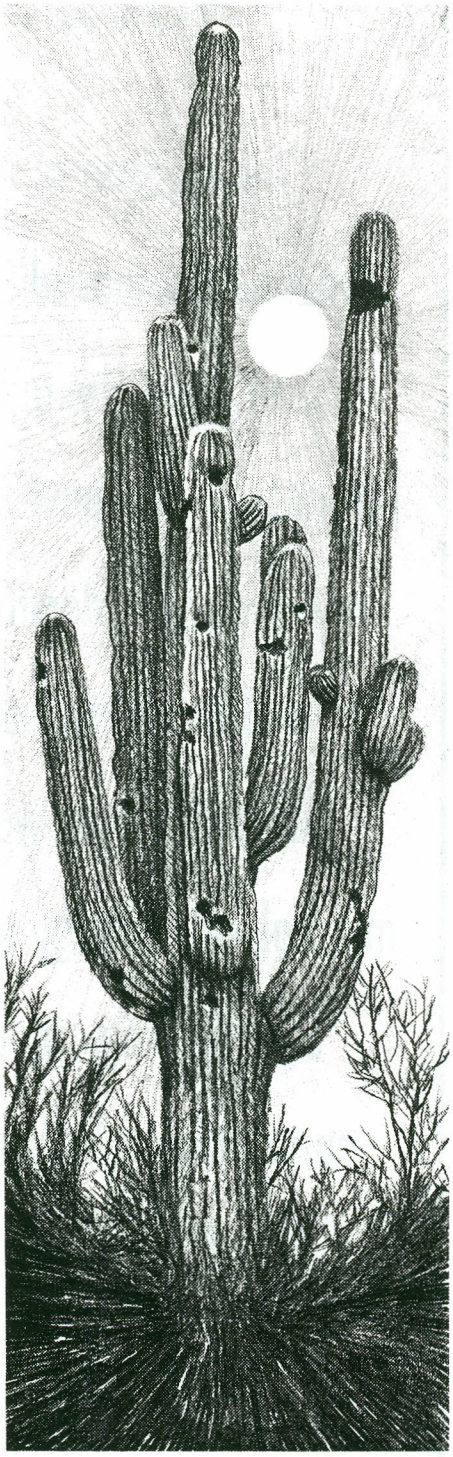


MISSION

MISSION

The mission of the Arizona Geological Survey is to assist the public, businesses, and governmental agencies in understanding and prudently using Arizona's land, water, mineral, and energy resources by providing objective earth-science information and advice.

GEOLOGIC DATA USERS:

PUBLIC

- colleges and universities
- elementary and secondary schools
- professional organizations and associations
- other groups
- interested citizens

BUSINESSES

- environmental and engineering geology
- mineral exploration and mining
- oil and gas exploration
- other companies and consultants

GOVERNMENTAL AGENCIES

- State of Arizona
- Arizona county, city, and town
- Federal
- Indian
- other states and countries

FUNCTIONS AND ACTIVITIES

INFORMATION AND ASSISTANCE

- Inform the public about Arizona's geologic processes and materials
- Answer requests for information
- Provide technical advice and assistance
- Sell and distribute publications
- Operate the Earth Science Information Center
- Maintain the Geologic Library, open to the public
- Maintain the rock cuttings and core repository, open to the public
- Maintain the Arizona Geologic Information System
- Maintain the Land Subsidence and Earth Fissure Information Center
- Maintain oil, gas, geothermal, and helium well files
- Maintain cuttings saved from drilling wells
- Publish *Arizona Geology*
- Publish nontechnical reports about the geology of Arizona
- Give talks, lead fieldtrips, and host meetings

MAPPING AND INVESTIGATIONS

- Identify potential hazards and limitations to development
- Prepare geologic maps of bedrock and surficial deposits
- Describe the character of bedrock and surficial deposits
- Investigate and describe oil, gas, and mineral resources
- Compile geologic data and enter it into the computerized system
- Prepare geologic maps and reports that summarize the results of investigations
- Present talks on the results of investigations

SUPPORT FOR OIL AND GAS CONSERVATION COMMISSION

- Interact with the Commission, exploration and production communities, and the public
- Conduct regular Commission meetings and special hearings
- Review applications for permits to drill, and approve if properly completed
- Inspect wells for compliance, both during drilling and after completion
- Monitor oil, gas, geothermal, and helium drilling activities in Arizona
- Compile oil, gas, geothermal, and helium production statistics

INFORMATION AND ASSISTANCE

REQUESTS FOR INFORMATION

Arizona Geological Survey (AZGS) staff responded to more than 13,800 requests for information and assistance, which were directed to the AZGS' main office at 845 N. Park Avenue and the Earth Science Information Center at 340 N. Sixth Avenue.

At the Park Avenue office visitors purchase publications, confer with geologists, and use the geologic library and data files. Mail orders are also processed from that office. More then 1,900 of the inquiries were answered from the ESIC, where visitors purchase U.S. Geological Survey (USGS) reports and topographic maps, in addition to AZGS publications.

A partial list of agencies and groups that requested information and assistance during the fiscal year is given on p. 19-23.

EARTH SCIENCE INFORMATION CENTER (ESIC)

The Tucson ESIC completed its first full fiscal year of operation. The ESIC, a cooperative effort between the AZGS and the USGS Geologic and National Mapping Divisions, was established to improve service to the public by providing earth-science and mineral-resource information from both agencies. It is located with the USGS Mineral Information Office and Center for Inter-American Mineral Resources Information. Diane Murray, an AZGS employee, manages the ESIC, with support and coordination provided by Frances Pierce and Karen Bolm, employees of the USGS.

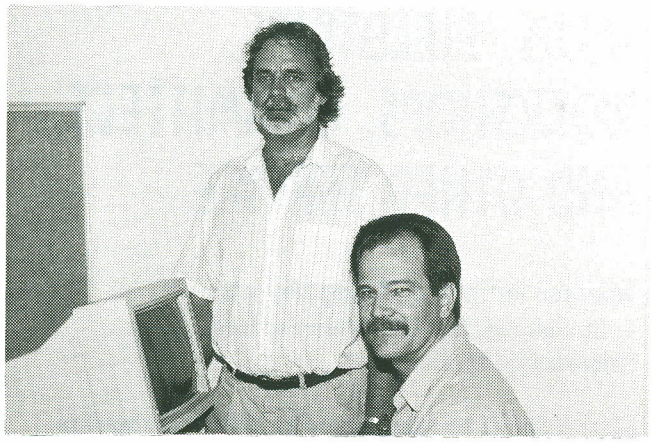
Multipurpose cartographic, hydrologic, geologic, and mineral-resource data are available at the ESIC in paper (maps and books), CD-ROM, and microfiche formats. Examples of materials available include AZGS publications; USGS topographic, geologic, and thematic maps for Arizona; and selected USGS publications on Arizona and general geology. The ESIC also distributes selected USGS publications dealing with Latin American geology to support the USGS Center for Inter-American Mineral Resource Investigations.

Information and databases in CD-ROM and other computer formats, on microfiche, and in hard copy provide ESIC staff with the capability to answer a wide variety of questions. Coordination with the AZGS headquarters ensures complete access to current research on Arizona's geology and non-renewable resources. Visitors who need more detailed information on such topics are referred to geologists or the library at AZGS' main office.

PUBLICATIONS

Publication sales from the headquarters office totaled $36,544, up from $33,689 in FY 1992-93. Most of the items sold were maps and reports published by the AZGS. The AZGS also sells publications of the Arizona Geological Society, a professional society that was organized to encourage interest in the science of geology and the geology of Arizona. Sales at the Earth Science Information Center, primarily USGS publications and topographic maps, totaled $13,181. Revenue from the sale of AZGS publications is deposited in the Geological Survey Printing Revolving Fund and is used for expenses incurred to print other publications of the AZGS.

Staff at the AZGS office assist in preparing geologic maps and reports for release and in distributing publications and other information. They are (left to right): Mary Redmon, Debra Wilkie, Lauri Colton, Pam Lott, Rose Ellen McDonnell, and Pete Corrao.



Geologists Tom McGarvin and Rick Trapp provide geologic information and assistance.

(left to right) Rose Ellen McDonnell, AZGS, Karen Bolm, USGS, Frances Pierce, USGS, and Diane Murray, AZGS, serve the public at the Earth Science Information Center.

ARIZONA GEOLOGY

Arizona Geology is published quarterly to summarize recent events related to geology and to briefly describe new geologic maps and reports that have been completed by the AZGS. Because of a reduction in the General Fund appropriation, effective July 1, 1994, the length of each issue of *Arizona Geology* was reduced from 12 pages to 4 pages.

ARIZONA GEOLOGIC INFORMATION SYSTEM (AGIS)

The AGIS is a computer database that was developed to store and provide access to data on Arizona geology. Data are compiled from original geological investigations and maps completed by AZGS staff and other professionals. Major components of AGIS include GENLIB, a database of AZGS library holdings; AZMIN, a database for metallic mineral districts and production, mine names, and primary and secondary bibliographic references; AZAGE, a compilation of radiometric age determinations; and AZGEOBIB, a bibliography of Arizona geology.

Richard A. Trapp, AGIS manager, continued to apply subject keywords and location information to more than 10,000 citations in AZGEOBIB. In addition, he is editing the citations to ensure consistency in style, eliminate duplicate entries, and cross-reference AZGEOBIB with AZMIN, the database on Arizona mineral deposits. More than 1,000 citations have been added. Early in Fiscal Year 1994-95 AZGEOBIB will be made available for use at the AZGS.

AZGEOBIB was the primary source of subject-specific bibliographies of earthquakes and of land subsidence and earth fissures that were compiled during the year. Several more publications, including a list of rock-unit names used in Arizona, will be produced during the coming year. New citations are added to AZGEOBIB on a continuing basis.

GEOLOGIC LIBRARY

The AZGS library contains more than 25,000 volumes, including all publications of the AZGS and its predecessors, the Arizona Oil and Gas Conservation Commission, and many publications from other government agencies. In addition, the library 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 Thomas G. McGarvin, is open to the public.

ROCK CUTTINGS AND CORE REPOSITORY

The AZGS has statutory responsibility for maintaining a central repository for rock cores, well cuttings, and associated supplemental data. Companies that drill for oil, gas, helium, or geothermal resources are required by Oil and Gas Conservation statutes to collect drill cuttings and submit them to the AZGS, together with logs and other pertinent information. The repository includes cuttings and cores, which may be examined by the public, from approximately 4,000 oil and water wells and mineral tests.

WELL FILES

Information about oil, gas, helium, and geothermal wells drilled in Arizona is filed at the AZGS and is available for public examination. The files, organized by Oil and Gas Conservation Commission drilling permit number, include information about drilling depths, rock formations penetrated, casing records, and completion procedures. Well locations and other information are plotted on a series of county and regional maps. Well files are maintained by Steven L. Rauzi, Oil and Gas Program Administrator.

LAND SUBSIDENCE AND EARTH FISSURE INFORMATION CENTER

Portions of southern Arizona have subsided (by as much as 18 feet, locally) and large cracks in the ground, called *earth fissures*, have developed in many areas. Several State and other governmental agencies have responsibilities for which an understanding of subsidence and earth fissures is important.

The AZGS, in cooperation with the Arizona Department of Water Resources, established an information center to field requests for information, refer the public to appropriate agencies for assistance, assemble existing information at a single location, map and monitor the extent of subsidence and fissuring, and investigate subsidence and fissures. The ultimate objective is to identify areas that may have potential for subsidence and related problems in the future.

A steering committee composed of representatives of 10 governmental agencies was formed in May 1994. The committee will meet regularly to discuss current developments and to determine priorities for activities and investigations.

GROUND WATER HAS BEEN PUMPED FASTER THAN NATURAL RECHARGE HAS OCCURRED IN LARGE PORTIONS OF SOUTHERN ARIZONA. AS A RESULT, THE LAND HAS SUBSIDED AND CRACKS, CALLED EARTH FISSURES, HAVE FORMED. A CENTER FOR LAND-SUBSIDENCE AND EARTH-FISSURE INFORMATION IS BEING DEVELOPED IN COOPERATION WITH THE ARIZONA DEPARTMENT OF WATER RESOURCES.

TALKS, FIELDTRIPS, WORKSHOPS, COMMITTEES, AND OTHER SERVICE

American Institute of Mining Engineers

L.D. Fellows, Board Member at Large, Arizona Conference.

_____: Diane Murray served as 1994 Membership Chairman and as a member of the Government, Education, and Mining Committee of the Tucson Section.

Arizona Association for Learning in and about the Environment

T.G. McGarvin led two field trips to observe local geologic features and gave a talk, at the 1993 conference, on the geology from Tucson to Kohl's Ranch.

Arizona Floodplain Management Association

P.A. Pearthree organized and presented a seminar on geomorphology applied to floodplain-management issues.

_____: P.A. Pearthree served on the Technical Review Committee.

Arizona Geological Society, Tucson

J.E. Spencer, member of Executive Council.

_____: P.A. Pearthree organized and led a field trip to observe geology and flood hazards on the western piedmont of the White Tank Mountains, Maricopa County.

Arizona Mining Association

L.D. Fellows gave a talk on the geology and non-copper minerals in Arizona at the Minerals in Society program for elementary and secondary teachers in Tucson.

Arizona Science Teachers Association

T.G. McGarvin conducted a workshop on faults at the 1993 Conference in Mesa.

Arizona State University

J.E. Spencer gave a talk on radon gas at a Department of Geology Colloquium.

_____, P.A. Pearthree made a presentation on piedmont flood hazards in Arizona at a Department of Geology Colloquium.

Cholla Bay Sportsmen Club
T.G. McGarvin spoke on earthquakes and the Gulf of California.

Geological Society of America
J.E. Spencer reviewed a manuscript that was submitted for publication in *Geology* and two manuscripts that were submitted for publication as Special Papers.

Grand Canyon University, Phoenix
L.D. Fellows spoke on the geology of Arizona.

Journal of Geophysical Research
J.E. Spencer reviewed a manuscript that was submitted for publication in the Journal.

Old Pueblo Lapidary Club
T.G. McGarvin gave a presentation on the geologic history of Arizona.

Pima Association of Governments,
Water Quality Subcommittee of the Environmental Planning Advisory Committee, Tucson: L. D. Fellows gave a talk on services and products that are available from the Arizona Geological Survey.

Saguaro National Monument, Rincon Mountain Unit,
Tucson: J.E. Spencer gave a talk about radon gas.

Tohono Chul Park, Tucson
T.G. McGarvin assisted with the Docent Training Program by giving a talk on logic in geologic processes and leading a field trip to observe geologic features in the Tucson basin.

Tucson Estates Nature Club
T.G. McGarvin led a field trip to observe geologic features in the Tucson Mountains.

Tucson Gem and Mineral Society
R.A. Trapp led field trips to Patagonia Mountains and the Payson area to discuss geology and collect minerals; served as Assistant Treasurer for the 1994 Tucson Gem and Mineral Show and Treasurer for the 1995 Show; was a member of the Executive Council, and a member of the Editorial Committee.

Tucson Unified School District, Science Resource Center
T.G. McGarvin and P.A. Pearthree led a field trip to observe surficial geologic processes in the Tucson area.

U.S. Soil Conservation Service,
State Soil Scientists National Workshop, Scottsdale: L.D. Fellows spoke about the Association of American State Geologists and geological mapping activities.

University of Arizona
J.E. Spencer discussed radon gas at a Department of Geosciences Colloquium.

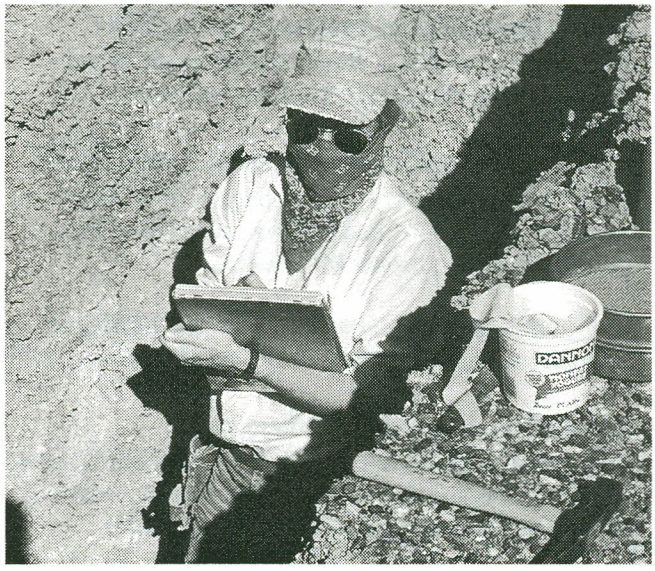
_____: P.A. Pearthree gave a talk on paleoseismology to a graduate seismology class in the Department of Geosciences.

_____: P.A. Pearthree served on the dissertation committee of two students working on Ph.D. degrees in the Department of Geosciences; J.E. Spencer served on the thesis committee of one student working on a masters degree.

University of Arizona Press
P.A. Pearthree reviewed a manuscript that was submitted for publication.

University of California, Santa Barbara
S.M. Richard served on the dissertation committee of a Ph.D. candidate in the Department of Geological Sciences.

Western Way RV Resort, Tucson
T.G. McGarvin gave a talk on the geology of the Tucson Mountains.



Geologist Elise Pendall examines a soil developed in a surficial deposit near Table Top Mountain in Pinal County. Soil development can be used to estimate the age of alluvial deposits, and thus determine which portions of desert piedmonts have been subject to flooding in the past few thousand years.

COOPERATION WITH GOVERNMENTAL AGENCIES

State, County, and local governmental agencies routinely use geologic maps and data that are prepared by AZGS geologists or are in AZGS data files and the library. If data are not available, cooperative projects may be undertaken to provide the needed information. Cooperative projects and activities between the AZGS and other governmental agencies are described below.

Arizona Attorney General's Office

S.L. Rauzi and a representative of the AG's office collaborated on certification of Arizona Oil and Gas Conservation Commission rules on bonding, permitting, well casing, and safety requirements.

Arizona Department of Emergency and Military Affairs,

Division of Emergency Management, Earthquake Program: L.D. Fellows served as a member of the Executive Committee of the Arizona Council on Earthquake Safety (ACES); P.A. Pearthree served on the Engineering and Geotechnical Sciences Committee of the ACES.

_____: P.A. Pearthree supervised preparation of an earthquake bibliography, funded by the Federal Emergency Management Agency through the Division of Emergency Management.

Arizona Department of Commerce, Energy Office

L.D. Fellows and S.L. Rauzi served on an advisory committee for the Alpine Geothermal Project.

Arizona Department of Environmental Quality (ADEQ)

AZGS completed a contracted project to compile geologic, hydrologic, and mining information for a portion of the Bradshaw Mountains.

_____: S.L. Rauzi collaborated with the ADEQ on discussions about regulation of Class II injection wells.

Arizona Department of Water Resources

The AZGS and ADWR established a Land Subsidence and Earth Fissure Information Center and a steering committee to provide guidance and oversight.

Arizona Radiation Regulatory Agency (ARRA)

The AZGS, in cooperation with the ARRA, investigated the distribution of uranium, a source of radon gas, in rocks. Funding was provided by the U.S. Environmental Protection Agency. J.E. Spencer was Principal Investigator.

Arizona State Land Department

L.D. Fellows and R.A. Trapp served as members of the Arizona Geographic Information Council.

_____: P.A. Pearthree supervised investigations of the geology, geomorphology, and historic channel changes of the Gila, Verde, and San Pedro Rivers. The project was done under contract with the Land Department.

Pima County Flood Control District Advisory Committee

P.A. Pearthree served as Chairman.

Salt River Project (SRP)

P.A. Pearthree supervised investigations of the 1993 floods of the Verde and Salt Rivers. The project was done under contract with the SRP.

U.S. Bureau of Land Management (BLM)

The BLM provided air photos needed by AZGS geologists to do geologic mapping. The AZGS provided copies of maps produced during the year.

U.S. Geological Survey (USGS)

AZGS geologists completed the ninth year of geologic mapping in the Phoenix 1° x 2° Quadrangle and in other parts of the State. Funding was provided from the Statemap component of the National Geologic Mapping Act of 1992.

_____: P.A. Pearthree served on the 1994 External Review Panel for the USGS' National Earthquake Hazard Reduction Program.

_____: AZGS served as a co-sponsor of the USGS' 1994 V.E. McKelvey Forum on Mineral Resources, held in Tucson. L.D. Fellows co-chaired the session on minerals-related environmental studies.

_____: AZGS, in cooperation with the USGS, operated the Earth Science Information Center to more effectively provide the public with information from both agencies.

THE AZGS PROVIDES UNBIASED GEOLOGIC INFORMATION NEEDED BY LAND- AND RESOURCE-MANAGEMENT AGENCIES TO CARRY OUT THEIR MISSIONS. ON OCCASION, PROJECTS ARE COMPLETED UNDER CONTRACT.

MAPPING AND INVESTIGATIONS

PUBLISHED BY ARIZONA GEOLOGICAL SURVEY

[Note: projects marked by an asterisk (*) have already been listed but belong in more than one category.]

POTENTIAL HAZARDS AND LIMITATIONS TO DEVELOPMENT

Down to Earth 3, Land subsidence and earth fissures in Arizona: Steven Slaff, 24 p.

Open-File Report 93-11, Earth fissures and related subsidence features adjacent to the Tucson aqueduct, Central Arizona Project, Pinal and Pima Counties, Arizona: Steven Slaff, 18 p., 6 sheets, scale 1:24,000. Prepared under contract with the U.S. Bureau of Reclamation.

_____ **93-13**, Surficial geologic maps of the northern Avra Valley-Desert Peak area, Pinal and Pima Counties, southern Arizona: J.J. Field and P.A. Pearthree, 11 p., 9 sheets, scale 1:24,000.

_____ **93-14**, Detailed surficial geologic map of the southern piedmont of the Tortolita Mountains, Pima County, southern Arizona: K.A. Demsey, P.K. House, and P.A. Pearthree, 8 p., scale 1:24,000. Prepared in cooperation with the Pima County Flood Control District and the U.S. Geological Survey.

_____ **93-15**, Surficial geology of the Superstition Mountain piedmont area, northern Pinal and eastern Maricopa Counties, Arizona: Gary Huckleberry, 33 p., 6 sheets, scale 1:24,000. Prepared in cooperation with the U.S. Geological Survey.

_____ **94-2**, Basic geologic and hydrologic information, Bradshaw Mountains, Yavapai County, Arizona: P.S. Scott, 69 p., 12 sheets, scale 1:100,000. Prepared in cooperation with the Arizona State Land Department, under contract with the Arizona Department of Environmental Quality.

_____ **94-3**, Bibliography of earthquake hazards in Arizona: Scott Beyer and P.A. Pearthree, 44 p. Prepared in cooperation with the Arizona Division of Emergency Management, with funding provided by the Federal Emergency Management Agency.

_____ **94-4**, Uranium distribution in sediments of the Safford and Duncan basins, southeast Arizona, and implications for indoor radon: R.C. Harris, 11 p., 2 sheets, scale 1:100,000 and 1:24,000. Prepared in cooperation with the Arizona Radiation Regulatory Agency, with funding provided by the U.S. Environmental Protection Agency.

_____ **94-6**, Surficial and environmental geology of the Sierra Vista area, Cochise County, Arizona: K.A. Demsey and P.A. Pearthree, 14 p., scale 1:24,000. Prepared in cooperation with Cochise County, the U.S. Soil Conservation Service, U.S. Forest Service, and U.S. Geological Survey.

_____ **94-11**, A reconnaissance of earth fissures near Apache Junction, Chandler Heights, and southwestern Picacho basin: R.C. Harris, 5 p., 2 sheets, scale 1:24,000 and 1:27,000.

_____ **94-12**, Surficial processes on two fluvially dominated alluvial fans in Arizona: J.J. Field, 31 p. Prepared in cooperation with the Flood Control District of Maricopa County and the Arizona Department of Water Resources.

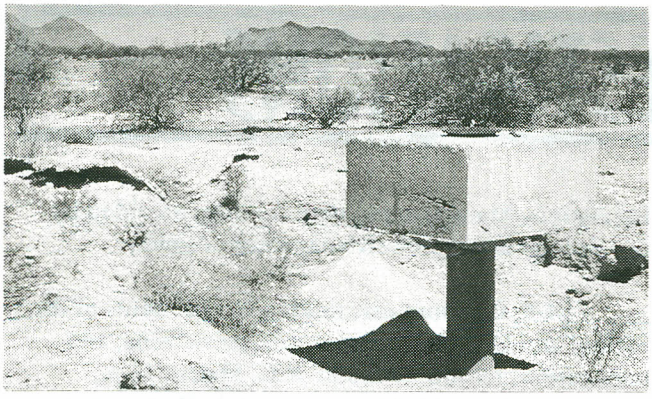
_____ **94-13**, Processes of channel migration on fluvially dominated alluvial fans in Arizona: J.J. Field, 41 p. Prepared in cooperation with the Flood Control District of Maricopa County and the Arizona Department of Water Resources.

_____ **94-16**, Bibliography of subsidence and earth fissures within Arizona: Robin Frisch-Gleason, Steven Slaff, and R.A. Trapp, 19 p.

DISTRIBUTION AND CHARACTER OF BEDROCK AND SURFICIAL MATERIALS

Open-File Report 93-7, Geologic map of the Painted Rock Mountains, Maricopa County, Arizona: S.J. Skotnicki, 5 p., scale 1:24,000. Prepared in cooperation with the U.S. Geological Survey.

_____ **93-9**, Preliminary geologic map of the southern Plomosa Mountains, LaPaz County, Arizona:



It looks like this water-well casing popped right out of the ground, but it hasn't moved. The ground went down!

S.M. Richard, J.E. Spencer, R.M.Tosdal, and Paul Stone, 27 p., scale 1:24,000.

_____ **93-10**, Geologic map of Face Mountain and Oatman Mountain, south-central Gila Bend Mountains, Maricopa County, Arizona: Steve Skotnicki, scale 1:50,000. Prepared in cooperation with the U.S. Geological Survey.

_____ **93-12**, Geologic map of the western Eagletail Mountains, La Paz County, Arizona: J.E. Spencer, S.M. Richard, and M.H. Ort, 11 p., scale 1:24,000. Prepared in cooperation with the U.S. Geological Survey.

_____ **93-13**, Surficial geologic maps of the northern Avra Valley-Desert Peak area, Pinal and Pima Counties, southern Arizona: J.J. Field and P.A. Pearthree, 11 p., 9 sheets, scale 1:24,000.

_____ **93-15***, Surficial geology of the Superstition Mountain piedmont area, northern Pinal and eastern Maricopa Counties, Arizona: Gary Huckleberry, 33 p., 6 sheets, scale 1:24,000. Prepared in cooperation with the U.S. Geological Survey.

_____ **93-16**, Surficial geology of the northern Verde Valley, Yavapai County, Arizona (Clarkdale, Page Springs, Cottonwood, and Cornville Quadrangles): P.K. House and P.A. Pearthree, 19 p., 4 sheets, scale 1:24,000. Prepared in cooperation with the U.S. Geological Survey.

_____ **93-17**, Geologic map of the Phoenix North 30' x 60' Quadrangle, central Arizona: S.J. Reynolds and M.J. Grubensky, compilers, scale 1:100,000.

_____ **93-18**, Geologic map of the Phoenix South 30' x 60' Quadrangle, central Arizona: S.J. Reynolds and S.J. Skotnicki, compiler, scale 1:100,000.

_____ **93-19**, Index to geologic maps in the Mesa 1° x 2° Quadrangle, Arizona: S.J. Skotnicki, compiler, 18 p., 3 sheets, scale 1:250,000. Prepared in cooperation with the U.S. Geological Survey.

_____ **94- 5**, Preliminary reconstruction of Miocene extension in the Basin and Range of Arizona and adjacent areas: S.M. Richard, 11 p., scale 1:1,000,000.

STATE GEOLOGIC MAPPING ADVISORY COMMITTEE

Larry P. Bauer
U.S. Bureau of Land Management

James A. Briscoe
JABA, Inc.

William R. Dickinson, Ph.D.
University of Arizona, Emeritus

Kenneth M. Euge
Geological Consultants

Ted H. Eyde
GSA Resources, Inc.

Charles G. Graf
Arizona Department of Environmental Quality

Robert D. Higgins
National Park Service

James D. Loghry
Consulting Geologist

Charles P. Miller, Ph.D.
Miller Resources, Inc.

Errol L. Montgomery
Montgomery & Associates

J. Dale Nations, Ph.D.
Northern Arizona University

Barney Oldfield
U.S. Forest Service

Michael Pryor
U.S. Bureau of Reclamation

Stephen J. Reynolds, Ph.D.
Arizona State University

Michael J. Rice
Arizona State Land Department

James D. Sell
ASARCO, Inc.

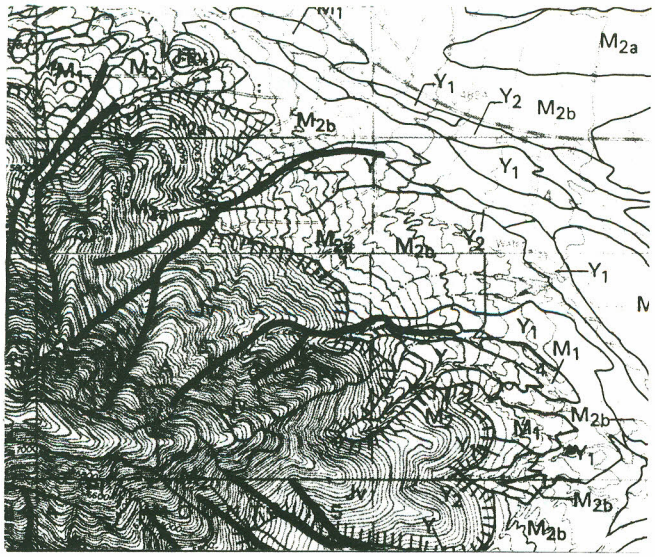
Frank S. Turek
Greeley & Hansen

Gregory L. Wallace
Arizona Department of Water Resources

Ralph E. Weeks
SHB AGRA, Inc.

William G. Wellendorf
Southwest Ground-Water Consultants

William H. Wilkinson
Phelps Dodge Corporation



A portion of a surficial and environmental geologic map of the Sierra Vista area. This map depicts surficial geologic deposits ranging in age from very young (Y2) to very old (O) and generalized bedrock lithologies in the mountains. The area that may be subject to debris flows is covered by gray shading. Heavy lines indicate locations of debris flows that occurred following a forest fire in 1988.

_____ **94-6***, Surficial and environmental geology of the Sierra Vista area, Cochise County, Arizona: K.A. Demsey and P.A. Pearthree, 14 p., scale 1:24,000. Prepared in cooperation with Cochise County, the U.S. Soil Conservation Service, U.S. Forest Service, and U.S. Geological Survey.

_____ **94-7**, Surficial geology of the Santan Mountains piedmont area, northern Pinal and eastern Maricopa County area, Arizona: Gary Huckleberry, 32 p., 2 sheets, scale 1:24,000.

_____ **94-8**, Bedrock geology of the eastern and central Tank Mountains, Yuma County, Arizona: C.A. Ferguson, S.J. Skotnicki, and J.E. Spencer, 33 p., 2 sheets, scale 1:24,000. Prepared in cooperation with the U.S. Geological Survey.

_____ **94-9**, Geologic map of the Palomas Mountains, Yuma County, Arizona: S.J. Skotnicki and C.A. Ferguson, 13 p., scale 1:24,000. Prepared in cooperation with the U.S. Geological Survey.

_____ **94-10**, Surficial geology of the Apache Junction area, northern Pinal and eastern Maricopa Counties, Arizona: Gary Huckleberry, 25 p., 2 sheets, scale 1:24,000.

_____ **94-14**, Detailed geologic map and cross sections of the Ramsay mine area, southeastern Plomosa Mountains, west-central Arizona: S.M. Richard and J.E. Spencer, 16 p. text, 2 sheets, scale 1:12,000.

OIL, GAS, AND MINERAL RESOURCES

Oil and Gas Publication 11, Well location map, Colorado Plateau province, Arizona - Apache, Coconino, Navajo, and portions of adjacent counties: S.L. Rauzi, 1994, 48 p. plus 3-p. addendum, scale 1:500,000.

Open-File Report 94-1, Implications of live oil shows in eastern Arizona geothermal test: S.L. Rauzi, 16 p., 12 sheets, scale 1:500,000.

_____ **94-2***, Basic geologic and hydrologic information, Bradshaw Mountains, Yavapai County, Arizona: P.S. Scott, 69 p., 12 sheets, scale 1:100,000. Prepared in cooperation with the Arizona State Land Department, under contract with the Arizona Department of Environmental Quality.

_____ **94-5***, Preliminary reconstruction of Miocene extension in the Basin and Range of Arizona and adjacent areas: S.M. Richard, 11 p., scale 1:1,000,000.

_____ **94-14***, Detailed geologic map and cross sections of the Ramsay mine area, southeastern Plomosa Mountains, west-central Arizona: S.M. Richard and J.E. Spencer, 16 p., 2 sheets, scale 1:12,000.

GEOLOGIC DATA

Map 31, Index of published geologic maps of Arizona - 1982 to mid-1993: R.C. Harris, R.A. Trapp, T.G. McGarvin, and J.E. Spencer, compilers, 1994, 45 p., 3 sheets, scale 1:1,000,000.

Digital Information 1, Digital geologic map of Arizona: S.J. Reynolds and S.M. Richard, 2 p., 2 floppy disks.

_____ **2**, AZWELL: A digital database of the Arizona Geological Survey well-cuttings repository: T.G. McGarvin and R.A. Trapp, 1 floppy disk.

Open-File Report 93-19*, Index to geologic maps in the Mesa 1° x 2° Quadrangle, Arizona: S.J. Skotnicki, compiler, 18 p., 3 sheets, scale 1:250,000.

_____ **94-3***, Bibliography of earthquake hazards in Arizona: Scott Beyer and P.A. Pearthree, 44 p.

Prepared in cooperation with the Arizona Division of Emergency Management, with funding provided by the Federal Emergency Management Agency.

_____ **94-16***, Bibliography of subsidence and earth fissures within Arizona: Robin Frisch-Gleason, Steven Slaff, and R.A. Trapp, 19 p.

PUBLISHED BY PROFESSIONAL SOCIETIES OR OTHER GROUPS

Oil and Gas Journal, Geothermal test hints at oil potential in eastern Arizona volcanic field: S.L. Rauzi, 1994, v. 92, no. 1, p. 52-54.

San Bernardino County Museum Association, San Bernardino, California: Geological investigations of an active margin: S.F. McGill and T.M. Ross, eds., 1994, Field Trip Guidebook, 364 p., includes the following:

> Mesozoic structure of the Maria Belt, southeastern California and southwestern Arizona: S.M. Richard, S.N. Ballard, W.B. Hamilton, S. Boettcher, T.D. Hoisch, and R.M. Tosdal, p. 272-292.

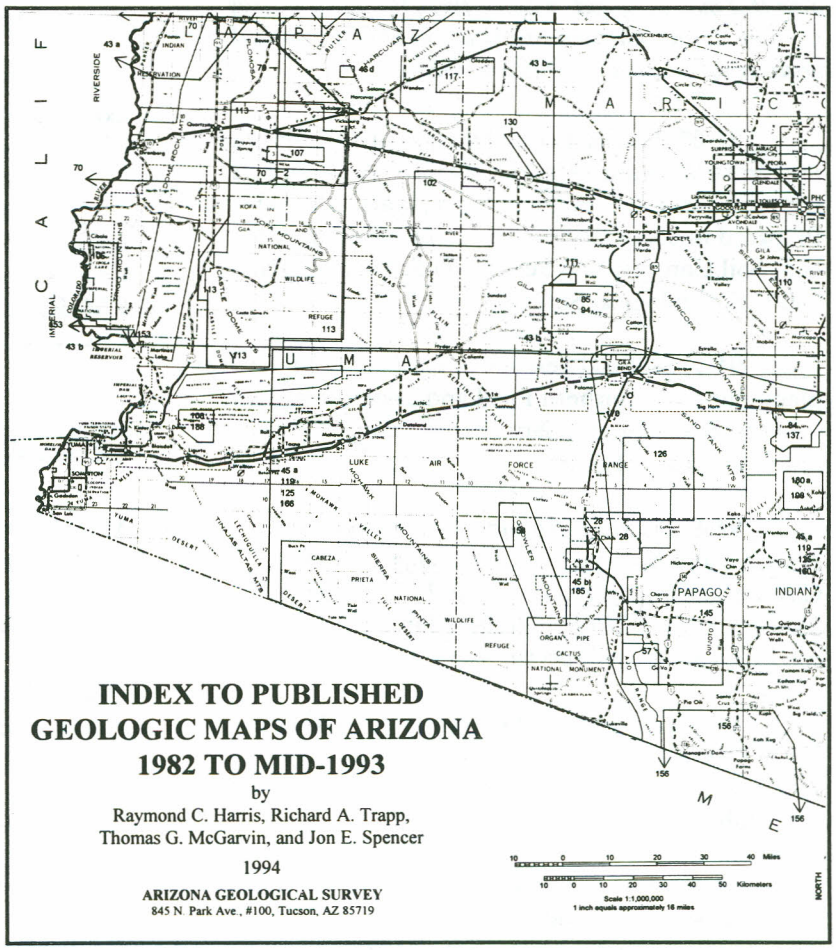
Tectonics, Palinspastic reconstruction of southeastern California and southwestern Arizona for the Middle Miocene: S.M. Richard, 1993, v. 12, p. 830-854.

U.S. Geological Survey, Tertiary stratigraphy of the highly extended terranes, California, Arizona, and Nevada: D.R. Sherrod and J.E. Nielson, eds., 1993, Bulletin 2053, 250 p., includes the following:

> Stratigraphy of middle Tertiary rocks in the central and eastern Buckskin Mountains, west-central Arizona: J.E. Spencer and S.J. Reynolds, p. 149-150,
>
> Introduction to Tertiary stratigraphy of the area south of I-10, Arizona and California: S.M. Richard and D.R. Sherrod, p. 171-176,
>
> Tertiary stratigraphy of a transect from the Hieroglyphic to the Big Horn Mountains west-central Arizona: S.M. Richard, p. 177-181,
>
> Tertiary stratigraphy of the Middle and Chocolate Mountains of southwestern Arizona: S.M. Richard, p. 193-197, and
>
> Stratigraphy of the Ferguson Wash area, southeastern California, and adjacent parts of southwestern Arizona: S.M. Richard, p. 199-203.

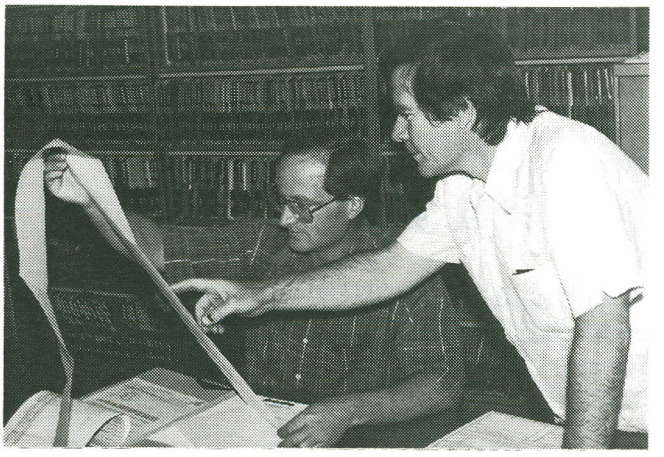
TALKS TO PROFESSIONAL SOCIETIES (ABSTRACT PUBLISHED)

Association of American Geographers, San Francisco: P.K. House presented a paper entitled "Important hydrological and geological characteristics of extreme



One of the first things a practicing geologist needs to know when he or she begins a new project is what maps and reports have already been done in the area. For this reason, the AZGS prepares map indexes and bibliographies. Map 31, a portion of which is shown above, is an index of geologic maps that were published from 1982-1993. It was released in 1994.

Research geologists Phil Pearthree, Jon Spencer and Steve Richard prepare detailed geologic maps and investigate Arizona's complex, inadequately known geology.



Steve Rauzi, right, the Oil and Gas Program Administrator, assists the Arizona Oil and Gas Conservation Commission in carrying out their rules and regulations. Ray Harris is a project geologist.

winter flooding in Arizona, 1993." The abstract was published in Abstracts, Association of American Geographers, 90th annual meeting, p. 165.

Geological Society of America, Cordilleran Section meeting, San Bernardino, CA: P.K. House presented a paper entitled "Geological perspectives on extreme winter flooding in Arizona, 1993." Abstract was published in Abstracts with Programs, 1994, v. 26, no. 2, p. 60-61.

_____, Cordilleran Section meeting, San Bernardino, CA: S.M. Richard was co-author of a paper, presented by N.R. Riggs, entitled "Timing of post-Permian uplift in southern and western Arizona." Abstract was published in Abstracts with Programs, 1994, v. 26, no. 2, p. 84.

_____, Rocky Mountain Section Meeting, Durango, CO: J.E. Spencer presented a paper entitled "Uplift of the Colorado Plateau: Possible mechanisms related to low-angle subduction." Abstract was published in Abstracts with Programs, 1994, v. 26, no. 6, p. 64.

_____, Cordilleran Section Meeting, Bakersfield, CA: J.E. Spencer presented a paper entitled "Space-time patterns of Cenozoic magmatism and extension in southwestern Arizona." S.M. Richard, W.G. Gilbert, S.J. Reynolds, R.J. Miller, and M. Shafiqullah were co-authors. The abstract was published in Abstracts with Programs, 1994, v. 26, no. 2, p. 95.

SUBMITTED FOR REVIEW OR IN PRESS

Arizona Geological Survey, Geologic map of the Big Horn and Belmont Mountains, west-central Arizona: J. Stimac, S.M. Richard, M.J. Grubensky, compilers.

Arizona State Land Department, Historical channel changes on the San Pedro River, Arizona: Gary Huckleberry.

_____, Geology and geomorphology of the Verde River: P.A. Pearthree.

_____, Historical geomorphology of the Gila River: Gary Huckleberry.

Geological Archeology, Archeological implications of late Holocene channel changes on the middle Gila River, Arizona: Gary Huckleberry.

Geological Society of America, Hydraulic and geomorphic re-evaluation of an extraordinary flood discharge estimate, Bronco Creek, Arizona: P.K. House and P.A. Pearthree, abstract.

Geology, Contrasting channel response to floods of the middle Gila River, Arizona: Gary Huckleberry.

Journal of Geophysical Research, Spatial and temporal relationship between mid-Tertiary magmatism and extension in southwestern Arizona: J.E. Spencer, S.M. Richard, S.J. Reynolds, R.J. Miller, M. Shafiqullah, M.J. Grubensky, and W.G. Gilbert.

Salt River Project, Paleoflood hydrology: An assessment of the methodology based on 1993 flood data for the Salt and Verde rivers, Arizona: P.K. House, J.E. Fuller, and P.A. Pearthree.

PROJECTS COMPLETED BY GEOLOGISTS FROM OTHER AGENCIES OR GROUPS AND RELEASED BY THE ARIZONA GEOLOGICAL SURVEY

Contributed Map 93-E, Geologic map of volcanic rocks along the east side of central Chino Valley, Yavapai County, Arizona: W.L. Stefanov, 1993, 9 p., scale 1:12,000.

_____ **93-F**, Geologic map of the Black Mountains accommodation zone, Mohave County, Arizona: J.E. Faulds, 1993, 4 sheets, scale 1:12,000.

_____ **94-A**, Geology of the Enebro Mountain area, Greenlee County, Arizona: E.B. Melchiorre, 1994, scale 1:10,600.

_____ **94-B**, Geologic map of Star Flat-Willow Springs area, Pinal County, Arizona: W.R. Dickinson, 1994, 3 p., scale 1:24,000.

_____ **94-C**, Geologic map of the Mormon Lake Quadrangle, Coconino County, Arizona: R.F. Holm, 1994, 24 p., scale 1:24,000.

Contributed Report 93-B, Geology and production history of the uranium ore deposits in the Cameron area, Coconino County, Arizona: W.L. Chenoweth, 1993, 30 p., scale 1:62,500.

_____ **93-C**, Several flow events on the margin of the Algerian-Moroccan Sahara and their morphological consequences: Fernand Joly (translated by Julie Woodward), 1993, 14 p.

_____ **94-A**, The Black Mustache uranium-vanadium mine, Apache County, Arizona, and the probable source of the ore shipments: W.L. Chenoweth, 1994, 11 p.

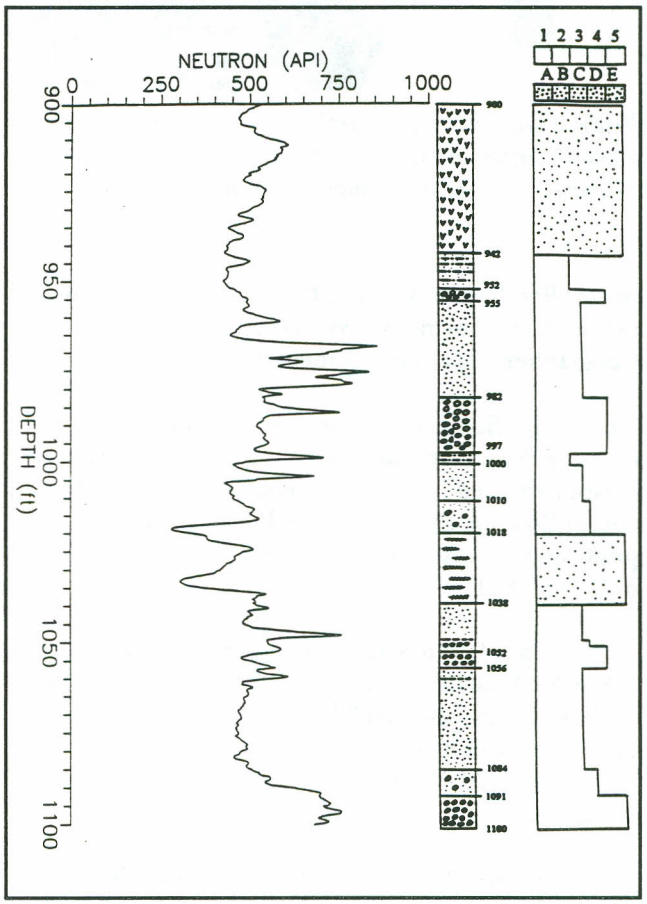
_____ **94-B**, The location and production history of the Chimney No. 1 uranium-vanadium mine, Apache County, Arizona: W.L. Chenoweth, 1994, 7 p.

_____ **94-C**, Geology and production history of the Alma-Seegan uranium mine, Navajo County, Arizona: W.L. Chenoweth, 1994, 9 p.

_____ **94-D**, Alpine 1/Federal final report executive summary: J.C. Witcher, 1994, 20 p.

_____ **94-E**, Alpine 1/Federal final report - Part 1, drilling report: J.C. Witcher, Larry Pisto, W.R. Hahman, and C.A. Swanberg, 1994, 92 p.

_____ **94-F**, Alpine 1/Federal final report - Part 2, temperature gradients, geothermal potential, and geology: J.C. Witcher, W.R. Hahman, and C.A. Swanberg, 1994, 127 p.



Many practicing geologists and geology graduate students prepare geologic maps and reports that either do not get published or that are not readily available to the public. The AZGS releases such items in the Contributed Map or Contributed Report Series and makes them available for use by the public.

The illustration above, taken from Contributed Report 94-F, shows logs of a portion of the geothermal test hole that was drilled near Alpine, Arizona, in 1993.

OIL AND GAS CONSERVATION COMMISSION

The Commission

The Arizona Oil and Gas Conservation Commission, which has statutory responsibility to regulate the drilling for and production of Arizona's oil, gas, helium, and geothermal resources, is composed of five members appointed by the Governor. In addition, the State Land Commissioner serves as an ex-officio member. The Arizona Geological Survey provides administrative and staff support.

Commission members at year end were J. Dale Nations, Flagstaff, Chairman; James C. Lanshe, Paradise Valley; Zed Veale, Flagstaff; Jan C. Wilt, Tucson; Lisa C. Worthington, Paradise Valley; and M.J. Hassell, ex-officio member. The Commission held three regular meetings and one petitioned hearing in fiscal year 1993-94.

Production and storage

Oil production in Arizona in 1993 totaled 73,141 barrels from 20 producing wells, down from 94,377 barrels in 1992. Gas production in 1993 totaled 618 million cubic feet from six producing wells, down from 764 million cubic feet in 1992.

The two refineries in Arizona produced 1.1 million barrels of product in 1993, down from 2.4 million barrels in 1992. Products consisted mostly of asphalt, diesel fuel, and jet fuel. The Sunbelt Refining Company near Coolidge, which shut down in August 1993, processed heavy crude oil that came from California and the North Slope of Alaska in the All-American Pipeline. The Intermountain Refining Company near Fredonia processes crude oil that is shipped in trucks from fields in Nevada.

Products transferred in 1993 through the two liquified-petroleum-gas (LPG) storage-well facilities near Luke Air Force Base and Adamana included about 58 million gallons in receipts and about 56 million gallons in deliveries. About 43 million gallons were in storage at the end of the year. These facilities store propane and iso-, normal, and mixed butane in caverns in thick deposits of subsurface salt.

Oil and gas leasing

State Trust land under lease as of June 30, 1994, totaled 58,700 acres, down from 72,593 acres in June 1993. Federal land under lease as of June 1994 totaled 120,406 acres down from 226,989 in 1993.

Drilling

One permit to drill was issued to Medallion Oil Company for the 1-15 Federal well in northwestern Mohave County, about 27 miles south of the Utah border. The hole, drilled to a total depth of 5,000 feet in June 1993, was plugged and abandoned.

A geothermal test, funded by the Arizona Department of Commerce and the U.S. Department of Energy, was drilled under a permit issued in fiscal year 1992-93. Tonto Drilling Services drilled the hole near Alpine in southern Apache County in July and August 1993. The hole was cored to a total depth of 4,505 feet to determine the hot-dry-rock geothermal potential of the area. The hole did not penetrate granite, as was anticipated. On the basis of the bottom-hole temperature, the consultant concluded that generation of electrical power from hot dry rock would not be economical at that site. The Department of Commerce transferred the hole to the U.S. Geological Survey for scientific studies and possible deepening.

Inspection and enforcement

Sixty-nine inspections were made, including 26 producing wells, 12 shut-in and temporarily abandoned wells, 21 LPG storage wells, 3 salt water disposal wells, and 1 drilling well. Inspection of the drilling well included observation of the cementing of the surface casing and the pressure testing of the blow-out prevention equipment.

Porosity in the core from the Alpine geothermal test hole. A show of oil in this hole triggered interest in the oil potential of the area.

PERSONNEL*

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

GEOLOGISTS

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:
Robin Frisch-Gleason, Geologist I
Raymond C. Harris, Geologist II
Steven Slaff, Project Geologist
Kirk Vincent, Project Geologist

SUPPORT STAFF

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

LAURETTE E. COLTON, Administrative Support Supervisor I.

PETER F. CORRAO, Graphic Designer II;
B.S., Arizona State University.

PAMELA J. LOTT, Secretary;
B.S., Texas Wesleyan College.

DIANE MURRAY**, Librarian I;
B.S., New Mexico Institute of Mining and Mineral Resources;
M.L.S., University of Arizona.

MARY REDMON, Accounting Technician II.

DEBRA WILKIE, Student Aide;
B.M. and M.M., Indiana University.

Others employed:
Damian N. Cuffel, Student Aide
Clarissa Jackson, Clerical Assistant
Evelyn M. VandenDolder, Public Information Officer III
Peggy Williams, Clerical Assistant

*Persons employed June 30, 1994. All are funded from General Revenue, except for one support staff, as noted. The agency has 13.25 full-time equivalent positions.

**Not paid from General Revenue

BUDGET

GENERAL FUND

Category	FY 1992-93 Expended	FY 1993-94 Expended	FY 1994-95 Budgeted
Personal Services	$393,743	390,398	402,700
Benefits	91,331	89,609	84,500
Operations	125,519	117,867	124,300
In-State Travel	8,595	8,820	12,400
Out-of-State Travel	3,262	3,201	2,000
Capital Equipment	0	3,100	0
TOTAL	$622,450 [a]	612,995 [b]	625,900

a) Appropriation was $623,900.

b) The agency budget was reduced $32, 400 and one FTE position was eliminated. Appropriation was $613,200.

PRINTING REVOLVING FUND

Revenue	
Received during FY 1992-93	$42,141
Expenditures	
Salaries	1,258
Benefits	447
In - State Travel	0
Operations	25,782
Equipment	3,191
TOTAL EXPENDITURES	$30,678

Persons Employed: T.B. Becksted, C.R. Jackson, R.J. Valles, D.P. Wilkie

CONTRACTED PROJECTS

CONTRACTED PROJECTS

Project (Funding Source)	Principal Investigator	Personal Services	Benefits	Operations	In-State Travel	TOTAL
Land Subsidence (U.S. Bureau of Reclamation)	Pearthree	$589	60	54	0	703
Geologic Mapping - Bedrock Phoenix Quadrangle (U.S. Geological Survey)	Spencer	48,107	5,070	2,140	5,882	61,199
Geologic Mapping - Surficial Materials (U.S. Geological Survey)	Pearthree	22,561	2,281	6,110	1,834	32,786
Uranium Levels in Rocks (U.S. Environmental Protection Agency)	Spencer	15,465	2,324	0	0	17,789
Earth Science Information Center (U.S. Geological Survey)	McDonnell	20,977	3,622	0	0	24,599
Printing and Distribution (Arizona Geological Society)	McDonnell	0	0	665	0	665
Earthquake Bibliography (AZ Division of Emergency Management)	Pearthree	733	76	0	61	870
Geologic Data Compilation-Bradshaw Mountains (AZ Department of Environmental Quality)	Fellows	4,834	496	97	70	5,497
CH2M Hill, Salt River	Pearthree	6,241	603	106	70	7,019
CH2M Hill, River Navigability	Pearthree	8,630	970	132		9,733
TOTAL EXPENDITURES		$128,137	15,502	9,304	7,917	160,860

Persons Employed: J.W. Downey, Charles Ferguson, R. Frisch-Gleason, R.C. Harris, P.K. House, G.A. Huckleberry, D. Murray, E.C. Pendall, P.S. Scott, S.J. Skotnicki, Steven Slaff, T.R. Vidra

GEOLOGIC DATA USERS

A partial list of agencies, companies, or groups that contacted the Arizona Geological Survey to request information, use the geologic library, or purchase publications during Fiscal Year 1993-94 is provided below.

I. PUBLIC GROUPS

COLLEGES AND UNIVERSITIES - ARIZONA

Arizona State University: Geology and Geophysics, Environmental Planning, Journalism
Central Arizona College
Cochise College, Douglas
Eastern Arizona College, Thatcher
Grand Canyon University, Glendale
Mohave Community College: Kingman, Lake Havasu City
Northern Arizona University: Geology, Bilby Research Center, Bookstore
Northland Pioneer College: Holbrook, Show Low
Phoenix College: Science & Technology Dept.
Pima Community College: Corporate & Community Education, Geology
Scottsdale Community College
University of Arizona: Astronomy, Drachman Institute, Ecology, Education, Extended University, Geography, Geosciences, Hydrology & Water Resources, Library and Information Science, Lunar and Planetary Laboratory, Map Library, Mineral Museum, Mining & Geological Engineering, Office of Arid-Lands Studies, Science Library, Tritium Laboratory, Univ. of Arizona Press, Water Resources Research Center.
Yavapai College, Prescott

COLLEGES AND UNIVERSITIES - OTHER STATES

Ambassador College, TX
Appalachian State University, Boone, NC
Augustana College, IL
Brown Univ., Providence, RI
California Inst. of Technology, Pasadena
California State Polytechnic, Pomona
California State University: Dominguez Hill, Northridge
College of Wooster, Wooster, OH
Dartmouth College, NH
Dixie College, UT
Eastern Washington University, Cheney
Ft. Lewis College, CO
Harvard Univ., MA
Indiana State University, Terre Haute
Lamont-Doherty Observatory, Palisades, NY
Leicester University, Leicester, ENGLAND
Millsaps College, Jacksonville, FL
Navajo Community College, NM
New Mexico Highlands Univ, Las Vegas, NM
New Mexico Tech, Socorro
Occidental College, Eagle Rock, CA
Penn State University
Portland State Univ., Portland, OR
Princeton Univ., NJ
Southern Illinois Univ.: Carbondale, Edwardsville
University of California: Davis, Los Angeles, Riverside, Santa Barbara
_____ Chicago, IL
_____ Colorado, Boulder
_____ Exeter, UNITED KINGDOM
_____ Illinois, Urbana
_____ Iowa, Iowa City
_____ Kansas, Lawrence
_____ Michigan, Ann Arbor
_____ Minnesota, Minneapolis
_____ Missouri, Rolla
_____ Nevada: Las Vegas, Reno
_____ New Mexico, Albuquerque
_____ Oklahoma, Norman
_____ Oregon, Eugene
_____ Pittsburgh, PA
_____ Southern California, Los Angeles
_____ Texas: Austin, El Paso
_____ Wisconsin, Kenosha
_____ Wyoming, Western Research Institute
_____ Zagreb, Zagreb, CROATIA
Vanderbilt Univ., Nashville, TN
Washington & Lee Univ., Lexington, VA

EARTH SCIENCE EDUCATION ADVISORY COMMITTEE

Carlon Ami
Navajo Community College

Susan Bollin
Scottsdale

Bonnie Briscoe
Eastern Arizona College

Suzanne Cash
Cortez High School

Donald Clay, Ph.D.
Arizona Western College

Chris Cotter
Mountain View High School

Raymond W. Grant, Ph.D.
Mesa Community College

David Harbster
Chandler

Peter L. Kresan
University of Arizona

Michael G. Lang
Arizona Department of Education

Allan Morton
Central Arizona College

J. Dale Nations, Ph.D.
Northern Arizona University

Beth Nichols-Boyd
Yavapai College

Anthony L. Occhiuzzi
Tempe High School

Joseph F. Schreiber, Jr., Ph.D.
University of Arizona

Jeff Simpson
Peoria

Edmund Stump, Ph.D.
Arizona State University

J. Robert Thompson, Jr., Ph.D.
Glendale Community College

Roger Weller
Cochise College

ELEMENTARY AND SECONDARY SCHOOLS - ARIZONA

Acacia Elementary School, Vail
Apache Junction Unified School
Apollo Middle School, Tucson
Borman Jr. High School, Phoenix
Canyon Del Oro High School, Tucson
Camelback High School, Phoenix
Cavett Elementary School, Tucson
Chinle School, Chinle
Copper Creek Elementary School, Tucson
Emily Gray Junior High School, Tucson
Green Fields Country Day School, Tucson
Ironwood High School, Phoenix
Kingman High School - North
Laguna Elementary School, Tucson
Manzo Elementary School, Tucson
Mesa High School, Mesa
Mesa Unified School District #4
Mountain View High School, Tucson
Mountain Vista Elementary School, Oracle
Oakwood Elementary School, Peoria
Our Mother of Sorrows School, Tucson
Palo Verde High School, Tucson
Payson High School
Phoenix Country Day School, Phoenix
Phoenix Union High Schools
Seven Mile School, Whiteriver
Schumaker Elementary School, Tucson
St. Gregory College Preparatory School, Tucson
Tucson High School
Tucson Unified School District: Engineering & Support Services; Science Resource Center.
Tully Elementary School, Tucson

ELEMENTARY AND SECONDARY SCHOOLS - OTHER STATES

Cashwell Elementary, Olney, MD
Coral Springs High School, North Lauderdale, FL
Franklin Smith School, Blue Springs, MO
Holly Hill Elementary, Holly Hill, SC
J.C. Booth Middle School, Peachtree City, GA
Killough Middle School, Houston, TX
Maine-Endwell Middle School, Endwell, NY
Morrilton Jr. High School, Morrilton, AR
Myrtle Beach Elementary, Myrtle Beach, SC
Oak Ridge Elementary School, Eagan, MN
Starr-Iva Middle School, Starr, SC
Taylor Street Middle School, Griffin, GA
Cross Country High School, Wynne, AR
Millis High School, Millis, MA

PROFESSIONAL ORGANIZATIONS AND ASSOCIATIONS

Arizona Association for Learning in and About the Environment, Phoenix
Arizona Museum of Science & Technology, Phoenix
Arizona Science Teachers Association, Phoenix
Arizona-Sonora Desert Museum, Tucson
Desert Botanical Garden, Phoenix
Geological Society of America, Boulder, CO
Journal of Geophysical Research
Mesa Southwest Museum, Mesa
Museum of Northern Arizona, Flagstaff
Natural History Museum, Salt Lake City, UT
Southwest Paleontology Society, Mesa

OTHER GROUPS

Arizona Cancer Center, Tucson
Audubon Society, Los Angeles, CA
Cholla Bay Sportsmen Club, Tucson
Desert Gold Diggers, Tucson
Inst. for Creation Research, Santee, CA

II. BUSINESSES

ENVIRONMENTAL AND ENGINEERING GEOLOGY

Abacus Project Management, Tucson
ABB Environmental Services, NJ
Albritco Development Corp., Phoenix
Alexander Engineering, Greenville, MI
American Engineering, Phoenix
American Prescott Geosurvey, Prescott
Anderson-Nelson, Inc., Phoenix
Apex Environmental, San Antonio, TX

ENVIRONMENTAL & ENGINEERING GEOLOGY ADVISORY COMMITTEE

Kenneth M. Euge, RG
Geological Consultants

George A. Kiersch, Ph.D., RG, PE
Kiersch Associates, Inc.

R. Bruce Mack
Salt River Project

Barbara H. Murphy
Dames & Moore

Stephen D. Noel, PG
Southwest Ground-Water Consultants, Inc.

Troy L. Péwé, Ph.D.
Consulting Geologist

Frank S. Turek
Greeley and Hansen

Ralph E. Weeks, PG
SHB-AGRA, Inc.

William G. Wellendorf, PG
Southwest Ground-Water Consultants, Inc.

Lisa Worthington
Consulting Geologist

Applied Earth Sciences, Bainbridge Island, WA
Archaeological Consulting Service, Tempe
Arizona Floodplain Management Association, Tucson
Arizona Hydrological Society, Phoenix
Arroyo Engineering, Tucson
ASL Hydrologic & Evironmental, Phoenix
Associated Earth Sciences, Kirkland, WA
ATEC Associates Inc., Louisville, KY
ATEC Environmental Consultants, Ventura, CA
Baker Engineers, Phoenix
Beacon Environmental, Oklahoma City, OK
Black & Veatch: Kansas City, MO; Phoenix; Tucson
Balleau Groundwater, Albuquerque, NM
Basin & Range Hydrogeologists, Inc., Phoenix
Beacon Environmental Geology, Oklahoma City
BRH-Garver, Inc., Houston, TX
Brown & Caldwell Consultants, Phoenix
Call & Nicholas, Tucson
Cannon & Assoc., Tucson
C C Pollen Co,, Phoenix
Center for Nuclear Waste Regulatory Analysis, San Antonio, Texas.
Chambers Group, Inc., Riverside, CA
CH2M Hill, Tempe; Las Vegas, NV
Cochise Environmental, Hereford
Companies West Group, Denver, CO
Converse Consultants West, Pasadena, CA
Coronado Engineering, Chandler
CRC Environmental Risk Management, Metairie, LA
CSWTA, Inc., Tuba City
CURA, Dallas
Dames & Moore: Cincinnati, Phoenix
Darmiento Environmental Mgt., Scottsdale
David S Gast & Assoc. San Francisco, CA
DMB Associates, Inc., Phoenix
Douglas Mountain Exploration, Palisade, CO
Earth Information, Boulder, CO
Earth Information Systems, Austin, TX
Earth Resource Assoc., Inc., Lebanon, PA
Earth Tech, Irvine, CA
Earth Technology, Tucson
Eberhart & Stone, Inc., Orange, CA
Eckland Consultants, Inc., Lake Forest, IL
EMCON & Assoc., Phoenix
Engineered Designs, Inc., Phoenix
Engineering-Science, Austin, TX; Phoenix
Engineers International, Tucson
ENV America, Inc., Irvine, CA
Environmental Consulting, NJ
Environmental Database, Inc., Littleton, CO
Environmental & Earth Science Consultants, Phoenix
Environmental Engineering Consultants, Tucson
Environmental Property Audit, Lakewood, CO
Envir. Risk Info. & Imaging, Alexandria, VA
Environmental Science & Engineering, Denver; Phoenix
EnviroTest, Houston, TX
Erathem-Vanir Geological, Santa Barbara, CA
Errol L. Montgomery & Assoc., Scottsdale; Tucson
Evans, Colbaugh & Assoc., Inc., Carlsbad, CA
Foree & Vann, Inc., Phoenix

Frankovich, Spokane, WA
FRS Geotechnical, Denver, CO
FUGRO, Inc., Ventura, CA
FUGRO-McClelland Environmental, Inc., Houston, TX
Gaiatech Inc., Chicago, IL
Garrand Corporation, Salt Lake City, UT
Geodyne Consulting Services, North Sydney, AUSTRALIA
Geosoils, Inc., San Diego, CA
Geraghty & Miller, Inc., Phoenix
Giles Engineering, Anaheim, CA
GPI Environmental, Inc., Phoenix
Gray and Associates, El Dorado Hills, CA
GRC Consultants, Tucson
Greiner Engineering, Tucson
Ground Technology, Louisville, KY
Groundwater Technology, Tempe
Guyton & Assoc., Austin, TX
GZA GeoEnvironmental, Phoenix
Harding, Lawson, and Associates, Tucson
Hargis & Assoc., Tucson
H.G. McNeill Engineer/Contractor, Minden, NV
HKM Assoc., Billings, MT
HTS Environmental Group, Columbia, MD
ICF Kaiser, Pittsburgh, PA
Independent Hydro Developers, Inc., Minneapolis, MN
Integrated Water Products, Tucson
JABA, Inc., Tucson
Jack Barnes & Assoc., Chicago, IL
Jacobs Engineering, Albuquerque; Santa Barbara, CA
John W. Shomaker, Inc., Albuquerque, NM
Law Engineering, Houston, TX
Leonard Rice Engineers, Denver, CO
Malcolm Pirnie, Inc., Tucson
ManTech Field Engineering, Washington, DC
Maverick Consultants, Simi Valley, CA
McGann & Assoc., Tucson
Medall Geotechmical Assoc., Inc., Irvine, CA
Metcalf & Eddy, St. Louis, MO
Mining & Environmental Consultants, Phoenix
Mission Geoscience, Newport Beach, CA
Molecular Simulations, Inc., Burlington, MA
National Environmental Consulting, Tucson
O'Brien-Gere Engineering, Blue Bell, PA
Papadopolous Assoc., Bethesda, MD
Petra Geotechnical, Inc., Costa Mesa, CA
PHR Environmental Consultants, Westlake Village, CA
Poteet Engineering Co.: Farmington, NM; Tempe
Radian Corp., Denver
Raimonde Drilling Co., Chicago, IL
RERC Enivironmental, Dallas
Riverside Technology, Ft. Collins, CO
Saguaro Environmental Services, Tucson
Sanguinetti Engineering, Vancouver, BC, CANADA
Schreiber, Allard, & Bohannon, Inc., Phoenix
Secor Environmental, Phoenix
Seacor, Redlands, CA
Schreiber, Grana, & Yorley, Knoxville, TN
SCS Engineers, Phoenix
SHB AGRA, Inc., Phoenix; Tucson
Simmons Li, Associates, Tucson
SOTA Environmental, Phoenix
Southwest Groundwater Consultants, Prescott
SRI International, Menlo Park, CA
Stetson Engineers Inc., San Rafael, CA
SWCA, Inc.: Flagstaff, Tucson
Tait Environmental Management, Orange, CA
Technical Action Group, Inc., Beaverton, OR
Terracon Consultants Western: Las Vegas, NV; Tucson
The Winters Company, Tucson
Trueman Consulting Ltd., British Columbia, CANADA
Versar, Denver, CO
Water Development Corp., Tucson
Water Resources Associates, Inc., Phoenix
Western Environmental Technology, Las Vegas, NV
Western Technologies, Phoenix; Tucson
Wiss, Janney, Elstner Assoc., Emeryville, CA
Woodward-Clyde: Denver; Oakland, CA; Phoenix; San Diego
WRA Engineering, Tucson
Wyman Engineering Consultants, Boulder City, NV
Zenitech Corp., Tucson

MINERAL EXPLORATION AND MINING

Alpine Exploration, Tucson
Altar Resources, Nome, AK
American Institute of Mining Engineers
Arizona Geological Society
Arizona Prospectors, Tempe
Arizona Mining Association, Phoenix
Arizona Western Mines, Arivaca
ASARCO, Tucson
Balfour Holdings, Littleton, CO
Barnett & Associates, Tucson
Barrick Gold, San Diego, CA
Battle Mountain Exploration, Tucson
BHP Minerals: Ontario, CA; Tucson
Cameron Minint Co., Salt Lake City
Chemgold, Inc., Winterhaven, CA
Chemical Lime Co., Fort Worth, TX
Chesbar Resources, Tucson;
Cominco Alaska Exploration, Anchorage, AK
Cominco American Resources Inc., Spokane, WA
Cominco Resources International, Vancouver, BC, CANADA
Compania Mineria Zapata, Hermosillo, MEXICO
Compass Minerals Ltd., Reno, NV
Concord Mining & Energy Fuels, Denver, CO
Continental Lime, Salt Lake City, UT
Corn & Ahern, Tucson
CRA Exploration, Box Hill, Victoria, AUSTRALIA
Cougar Mining Co., Aguila
Cyprus Bagdad Copper Corp., Bagdad
Cyprus Minerals Company: Casa Grande; Twin Buttes
Dawson Geological Consultants, Vancouver, BC, CANADA
DDH Geomanagment, Ltd., Vancouver, BC, CANADA
Del Norte Resource and Development, Yuma
Echo Bay Mines, Denver, CO
Echo Bay Exploration, Reno, NV
Ensearch Exploration Inc., Dallas, TX
Freeport Exploration, Tucson
Gibraltar Mines Exploration Co., Reno, NV
Golden Spider Mine, Cambria, CA

MINERAL RESOURCES ADVISORY COMMITTEE

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U.S. Borax

James A. Briscoe
JABA, Inc.

Russell M. Corn
Consulting Geologist

Ted H. Eyde
GSA Resources, Inc.

Walter Heinrichs
Heinrichs Geoexploration Co.

James D. Loghry
Consulting Geologist

Charles P. Miller, Ph.D.
Miller Resources

James D. Sell
ASARCO, Inc.

William H. Wilkinson
Phelps Dodge Corp.

Gradient Geophysics, Missoula, MT
Great Basin Exploration & Mining, Reno, NV
Great Gray Resources, Ltd., Calgary, Alberta, CANADA
GSA Resources, Inc., Cortaro
Hecla Mining Co., Coeur d'Alene, ID
H.J. Downey, Inc., Tucson
Horn Silver Mines, Inc., Salt Lake City, UT
JABA, Inc., Tucson
Kaaterskill Exploration, Prescott
Kennecott Corporation, Salt Lake City, UT
Leonard C. Halpenny Consultants, Tucson
Lombard Resources, S.A., Mancos, CO
Magee Consulting, Tucson
Magma Copper Corp., Tucson
Maya Mining Co., Delray Beach, FL
Miller Resources, Tucson
Mills Resources, Inc., Wickenburg
Mills Resources, Tampa Bay, FL
M.I.M. Exploration, Brisbane, AUSTRALIA
Minera Homestake Chile, Santiago, CHILE
Mining & Environmental Consult., Phoenix
Minnova (US) Inc., Sparks, NV
Moore Minerals, Lake Jackson, TX
New Claymore Resources, Ltd., Vancouver, BC, CANADA
New Mexico & Arizona Land Co., Albuquerque, NM
Newmont Gold Co., Carlin, NV
Noranda Exploration, Inc., Denver, CO
North Mining Inc., Denver, CO
Morton Salt Co., Phoenix
Oracle Minerals Inc., Vancouver,

BC, CANADA
Orcand Resources, Hermosillo, MEXICO
Peabody Western, Kayenta
Pegasus Gold: Reno, NV; Spokane, WA.
Pembroke V, Virginia Beach, VA
Phelps Dodge Morenci Inc., Morenci
Phelps Dodge Western Exploration, Tucson
Queenstake Resources, Ltd., Vancouver, BC, CANADA
Republic Goldfields, Congress
Riken Resources, Sumpter, OR
Santa Fe Pacific Mining Co., Reno, NV
South Branch Resources, Globe
Southwest Exploration, Inc., Silver City, NM
Southwest Ground Water Consultants: Phoenix, Prescott
Sterling Exploration, Albuquerque, NM
Stillwater Enterprises, Vancouver, BC, CANADA
Superior Companies, Phoenix
Tanner Co., Tucson
Teck Exploration, Ltd., Vancouver, BC, CANADA
Terra Mining Co., New York, NY
U.S. Borax & Chemical Corp., Tucson
Western Mining Corporation: Englewood, CO; Reno, NV; Vancouver, BC, CANADA.
Winslow Gold Corp., Calgary, Alberta, CANADA

OIL AND GAS EXPLORATION

Agency Information Consultants, Austin, TX
American Petroleum Institute, Washington DC
Amerigas, Inc., Glendale
ARCO Oil & Gas Co., Dallas, TX
Arrowhead Resources, Denver, CO
BDM-Oklahoma, Inc., Bartlesville, OK
BTA Oil Producers, Denver, CO
Bridge Oil Company, Dallas, TX
Burnett Oil, Denver, CO; Fort Worth, TX
Chuska Energy, Farmington, NM
Coastal Corporation, Houston, TX
Cross Creek Corporation, OK
Donegan Resources, Albuquerque, NM
Dry Mesa Corporation, Wichita, KS
Dwight's Energy Data, Dallas, TX
Energy Fuels Nuclear, Inc., Denver, CO
Energy Ventures, VA
EXXON Production Research, Houston, TX
Ferrellgas, Inc., Holbrook
Gary-Williams Energy Company, Denver, CO
Giant Petroleum Company, Farmington, NM
Gus Berry Oil Producers, Okmulgee, OK
Harken Southwest Energy Company, Dallas, TX
High Plains Petroleum, Boulder, CO
Humble Geochemical Services, TX
Hunt Oil Co., Dallas, TX
J & L Exploration, Roswell, NM
Kerr-McGee Corporation, Farmington, NM
Klabzuba Oil & Gas, Fort Worth, TX
Maxx Petroleum Ltd., Scottsdale
Medallion Oil Company, Houston, TX
Meridian Oil, Midland, TX
Merrion Oil and Gas Corp., Farmington, NM
Mountain States Petroleum, Roswell, NM
Munger Oil Information Services, Los Angeles, CA
New Mexico and Arizona Land Company, Albuquerque, NM
Paarup Oil Ltd., Calgary, Alberta, CANADA
PB-KBB, Houston, TX
Petroleum Exploration and Development, Casper, WY
Petroleum Information Corp., Littleton, CO
Petro Western Energy Corp., OK
Premco, Inc., Dallas, TX
Purvin and Gertz, Dallas, TX
Quest Petroleum Corp., Reno, NV
Rangeland Exploration Company, Midland, TX
Reed Oil Company, TX
Ridgeway Arizona Oil Company, Calgary, Alberta, CANADA
Rocky Mountain Helium, Denver, CO
Thomasson Partner Assoc., Denver, CO
United Gas Search, OK
Ventura Coastal Corporation, Ventura, CA
Western Gas Resources, Denver, CO
Western Oil World, Denver, CO

OTHER COMPANIES AND CONSULTANTS

Airborne Express, Tucson
All Seasons Moving & Storage, Tucson
Archeological Research Service, Tempe
Arizona Test Center, Stanfield
Arnold and Porter, Denver, CO
Asta Planning and Zoning, Tucson
ATech Associates, Arvada, CO
AT&T Bell Labs, Naperville, IL
B & B Publishers, WI
Bank One, Arizona, St. Johns
Bud Research Inc., Stony Brook, NY
Cal-Gold Enterprises, Pasadena, CA
Carefree Insurance Co., Tucson
Charles B. Reynolds & Assoc., Albuquerque, NM
Cooper Aerial Surveys, Tucson
Crystal Water Co., Tucson
DBA Precious Colors, Seattle, WA
Delta Floral Distributors, Los Angeles, CA
Desert Archeology, Tucson
DMB Associates, Inc., Phoenix
Donley Farms, Yuma
E-Quest Corp., Ft. Collins, CO
Escudilla Cattle Company, Mesa
Evans, Colbaught & Assoc., Inc., Carlsbad, CA
Faxon Co., Inc., Ann Arbor, MI
Fennemore Craig: Phoenix; Tucson
Filtemp Sales, Phoenix
Fischer Petrologic, Inc., Denver, CO
Ford Motor Company, Yucca
Fuller International, Inc., Bethlehem, PA
Global Gem Traders, Sierra Vista
Granges Inc., Vancouver, B.C., CANADA
Haggard & Kurtz, P.C., Phoenix
High-Grade Publications, Santa Cruz, CA
Hoover, Berg, Desmond, Architects, Tucson
IHL Geocenter, Internationales, Stuttgart, GERMANY
Instructional Video, Toledo, OH
IntraSearch, Englewood, CO
Jay E. Fuller Construction Co., Tucson
Jennings, Strauss & Salmon, P.C., Phoenix
J.S. Yanez Surveyors, Tucson
Kenny Rogers Show, Nashville, TN
Korn and Waterman, P.C., Tucson
KVOA Channel 4, Tucson
KXCI Radio, Tucson
Law & Economics Consulting Group, Chicago, IL
Many Feathers Books & Maps, Phoenix
Map Center Inc., San Diego, CA
Mastorakos-Hurd, Inc., Phoenix
McClintock & Westin, P.C., Los Angeles, CA
McLain Harbers Co., Tucson
Omni Resources, Inc., Burlington, NC
Optical Data, Warren, NJ
Oxygen Service Co., Kingsport, TN
PBS, Seattle, WA
Powers Elevation Co., Inc., Aurora, CO
Prescott Remodeling & Construction, Prescott
Professional Book Service, Tempe
Prospector Newsletter, Vancouver, B.C., CANADA
Pulte Homes, Phoenix
Pyeatt Ranch, Ft. Huachuca
Regulatory Compliance Specialists, TX
Reproductions, Inc., Tucson
Ritchie Realty, Tucson
Riverside Publishers, Chicago, IL
R & R Technical Bookfinders, Littleton, CO
Ryder-Brown Enterprises, Phoenix
Salt River Project, Phoenix
Santa Cruz Valley Sun, Green Valley
Scottsdale Progress Tribune, Scottsdale
Snell & Wilmer, Tucson
Speedie & Associates, Phoenix
Stephan N. Warr & Assoc., Salt Lake City, UT
Stock Search International, Tucson
Stripes Film Co., Toronto, Ontario, CANADA
TET Prospecting Equipment, Sierra Vista
The Book House, Inc., Jonesville, MI
Tucson Blueprint Co.
Tucson Map & Flag
Tucson Weekly
University Text & Tools, Flagstaff
Unsolved Mysteries Television Program
Ward's Natural Science, Rochester, NY

III. GOVERNMENTAL AGENCIES

STATE OF ARIZONA

Attorney General
Department of Administration: Construction
_____ Agriculture
_____ Commerce: Energy Office
_____ Corrections: Internal Affairs
_____ Education, Environmental Education
_____ Emergency and Military Affairs: Earthquake Program
_____ Environmental Quality: Office of Water Quality, Plans and permits, Waste disposal, Flagstaff office
_____ Library, Archives, and Public Records
_____ Mines and Mineral Resources
_____ Real Estate: Subdivision Section
_____ Revenue: Property Evaluation
_____ Transportation: Materials, Environmental Services
_____ Water Resources: Hydrology, Tucson AMA, Adjudications
Game and Fish Department
Industrial Commission: Elevator Inspection

Radiation Regulatory Agency
State Land Department: Minerals Division, Urban Planning Division
State Mine Inspector
State Museum
State Parks: Natural Areas, Red Rock State Park

ARIZONA COUNTY, CITY, AND TOWN

Apache County Library
Central Arizona Association of Governments, Florence
City of Apache Junction
_____ Avondale: Public Works
_____ Cave Creek: Zoning Commission
_____ Glendale: Teague Branch Library
_____ Globe: Administration Division
_____ Miami: Memorial Library
_____ Morenci: Library
_____ Phoenix
_____ Scottsdale: Planning Department
_____ Sierra Vista: Public Library
_____ Tempe
_____ Tucson: City Attorney's Office, Police Dept., Public Library-Columbus Branch, Water Department
Coconino County: Public Health
Maricopa County: Solid Waste Management
Mohave County: Detention Center - Kingman
Navajo County: Board of Supervisors
Pima Association of Governments, Tucson
Pima County: Environmental Quality, Floodplain Management, Wastewater Treatment
Pinal County
Santa Cruz County
Sharlot Hall Museum, Prescott
Town of Kirkland
Yavapai County: Emergency Management
Yuma County Library

FEDERAL

Air Force: Davis-Monthan AFB
Argonne National Laboratory, Elmhurst, IL
Army: Ft. Huachuca Wildlife Office
Army Corps of Engineers: Los Angeles and Phoenix offices
Bureau of Indian Affairs: Ft. Apache Agency, Whiteriver: Indian Health Service, Pinetop and Sells offices Mineral Project Coordinator, Denver; Water & Land Resources, Washington, DC.
Bureau of Land Management: Arizona State Office, Phoenix; Phoenix District; Safford District; Sierra Vista; St.George, UT; Tucson.
Bureau of Mines: Chief Staff Officer, Washington, DC; Intermountain Field Office, Denver; Minerals Availability Field Office, Denver; Minneapolis Field Office; Office of Mineral Institutes, Washington, DC; Rolla Research Center, MO; State Resource Officer, Denver.
Bureau of Reclamation, Phoenix
Customs Service
Department of Agriculture, New Orleans
Department of Justice: Inspector General's Office, Tucson
Energy Information Administration
Environmental Protection Agency, Las Vegas
Federal Emergency Management Administration, San Francisco
Fish and Wildlife Service: Albuquerque, NM; Parker, AZ
Forest Service: Arizona Zone Office, Phoenix; Coconino National Forest, Flagstaff; Coronado National Forest; Land & Minerals, Tucson; Lands and Minerals, Albuquerque, NM; Prescott National Forest, Chino Valley Ranger Dist.; Bradshaw Ranger Dist., Prescott; Tonto National Forest, Phoenix.
General Services Administration
Geological Survey: Geochemistry, Denver, CO; Geophysics, Reston, VA; Center for Inter-American Mineral Resource Investigations, Tucson; Director's Office, Reston, VA; Earth Science Information Center, Anchorage, AK and Denver, CO; Library, Reston; Minerals Information Office, Tucson;
Office of Regional Geology, Reston, VA; Resource Analysis, Tucson; Tucson Field Office; Volcanoes and Geothermal, Menlo Park, CA; Water Resources Division, Las Vegas, NV, Phoenix, and Tucson; Western Regional, Denver and Flagstaff.
National Agriculture Library
National Park Service: Lake Mead National Recreation Area, AZ; Bandelier National Mon., NM;
National Science Foundation, Washington, DC
Oak Ridge National Laboratory, Grand Junction, CO
Soil Conservation Service, Phoenix
Wilmot Federal Prison, Tucson

INDIAN TRIBES

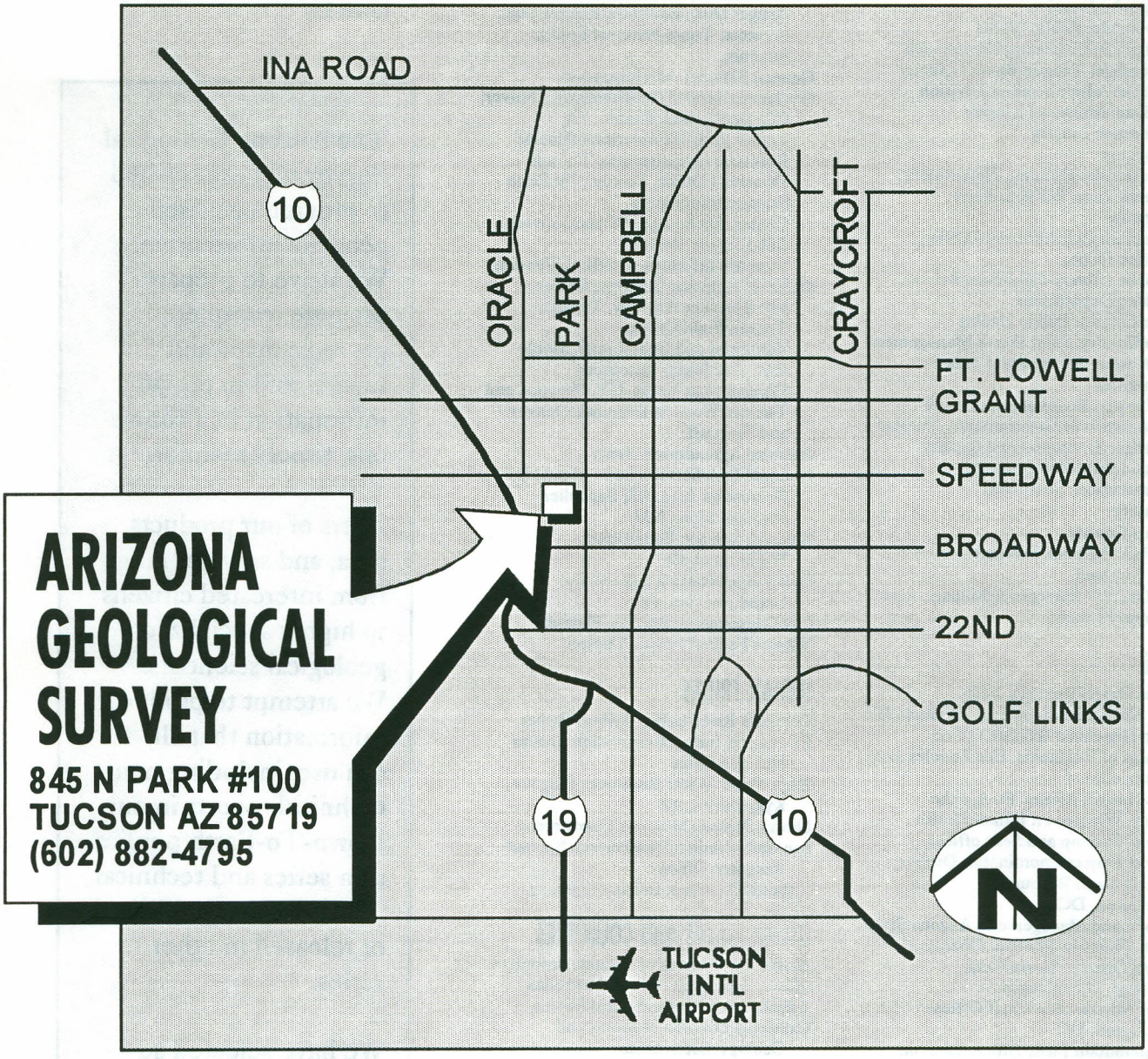
Colorado River Indian Tribes, Parker
Ft. Apache Indian Reservation: Indian Health Service
Hopi Tribe: Water Resources Program, Kykotsmovi, AZ
Navajo Nation: Minerals Department
San Carlos Indian Reservation: Natural Resource Office
Tohono O'Odham Indian Nation

OTHER STATES AND COUNTRIES

Alaska Department of Natural Resources
Alaska Geological Survey, Fairbanks
British Columbia Geological Survey
California Division of Mines and Geology, Sacramento
California Division of Oil and Gas
Colorado Geological Survey, Denver
Geological Survey of Canada
Indiana Geological Survey, Bloomington
Instituto Geologico Metalurgico, Lima, PERU
Minnesota Bureau of Mines
Nevada Bureau of Mines and Geology, Reno
New Mexico Bureau of Mines and Mineral Resources, Socorro
New Mexico Energy, Minerals, and Natural Resources Department: Oil Conservation Division, Santa Fe
North Carolina Geological Survey, Raleigh
Oklahoma Corporation Commission, Oklahoma City
Oklahoma Department of Mines, Oklahoma City
Saskatchewan Research Council, Saskatoon, CANADA
Texas Energy Resources Commission, Austin
Texas Bureau of Economic Geology, Austin
Utah Geological Survey, Salt Lake City
Wisconsin Dept. of Natural Resources, Green Bay

The Arizona Geological Survey was established to provide unbiased geologic information. We strive to prepare accurate, complete geologic maps and reports and to provide information in a courteous, timely manner.

Users of our products, data, and services range from interested citizens to highly specialized geological scientists. We attempt to produce information that all can use, including non-technical reports in our Down-To-Earth publication series and technical items that are published or released in other series.

We have selected advisory committees, representative of major user groups, to help us determine priorities and to periodically review our progress and direction.

LOCATION MAP