

Arizona Geology

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THE STATE AGENCY FOR GEOLOGIC INFORMATION

MISSION

To inform and advise the public about the geologic character of Arizona in order to increase understanding and encourage prudent development of the State's land, water, mineral, and energy resources.

ACTIVITIES

PUBLIC INFORMATION

Inform the public by answering inquiries, preparing and selling maps and reports, maintaining a library, databases, and a website, giving talks, and leading fieldtrips.

GEOLOGIC MAPPING

Map and describe the origin and character of rock units and their weathering products.

HAZARDS AND LIMITATIONS

Investigate geologic hazards and limitations such as earthquakes, land subsidence, flooding, and rock solution that may affect the health and welfare of the public or impact land and resource management.

ENERGY AND MINERAL RESOURCES

Describe the origin, distribution, and character of metallic, non-metallic, and energy resources and identify areas that have potential for future discoveries.

OIL AND GAS CONSERVATION COMMISSION

Assist in carrying out the rules, orders, and policies established by the Commission, which regulates the drilling for and production of oil, gas, helium, carbon dioxide,



GEOLOGIC MAPPING IN ARIZONA

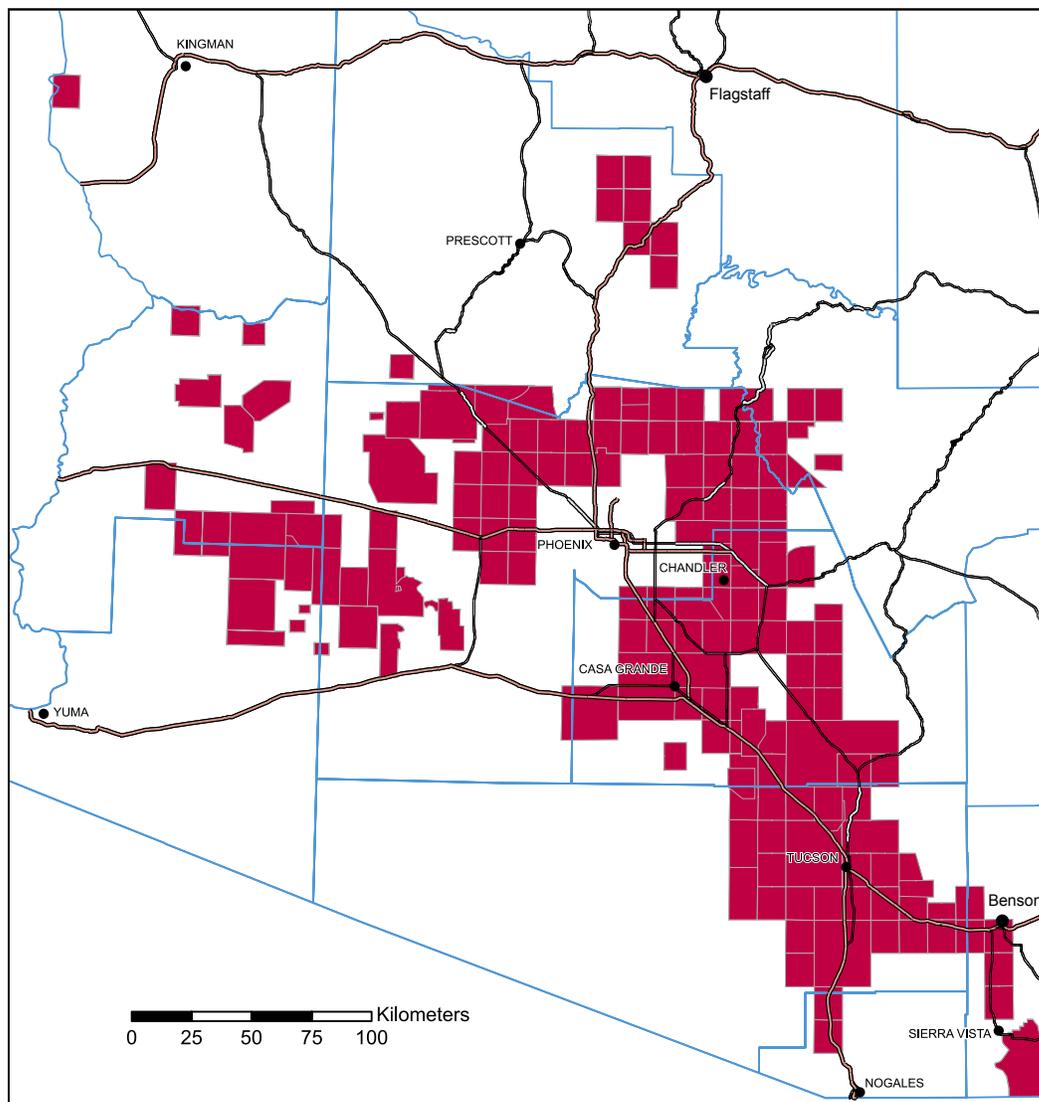


Figure 1. Geologic mapping funded by COGEMAP and the National Geologic Mapping Program in Arizona, 1984 - 2004.

How can a small state geological survey be effective in a large, geologically complex, mineral-rich state with a high rate of population growth? In 1979 we concluded, after consulting with more-experienced and wiser members of the geological community, that the Arizona Geological Survey

(AZGS) could make a significant contribution to the State and profession by preparing basic geologic maps. Figure 1 shows the areas of the State that AZGS geologists mapped since that decision was made.

When the U.S. Geological Survey (USGS) started the Cooperative Geologic Mapping

Program in 1983, we already had a mapping program in place. The AZGS was awarded \$495,922 in federal funds and provided slightly more in state matching funds from this program during fiscal years 1984-92. The National Geologic Mapping Act (NGMA) of 1992 was passed and signed by President George H.W. Bush. This act, which has been reauthorized and amended twice, has been by far the most productive cooperative federal program we have been part of in the last 25 years.

Leaders of the Association of American State Geologists (AASG), composed of the directors of the 50 State geological surveys, are to be commended for their wisdom and efforts in getting the NGMA passed and signed. Although most of the State Geologists who were actively involved in that effort have retired, they continue to share their wisdom and expertise.

Members of the U.S. Congress are to be commended for recognizing that the NGMA is apolitical and benefits each state in which much-needed basic geologic maps and data are produced. A major aspect of the act that appeals to them is that the federal government pays for only half of the highly productive State component – state governments fund the other half. That’s an attractive model for potential cooperative programs between the federal government and State geological surveys.

The USGS is the lead federal agency responsible for planning, coordinating, and managing the geologic mapping program and for developing relevant national priorities and standards. A national panel reviews proposals for funding from State geological surveys each year and makes awards on a matching-fund basis; each State survey must contribute at least as much as the federal award made for each mapping project. The AZGS received \$217,439 for geologic mapping this year. A proposal for the 2005-2006 contract period was submitted in November. To date, the AZGS has received \$1,800,386 in federal funds from the State component and has provided an equal amount of state general-fund dollars to match.

The NGMA specifies that, for the State component, state panels that represent a broad range of users of geologic maps shall determine mapping priorities. Members of the Arizona panel (Table 1) represent land- and resource-management agencies and private-sector companies, have in-depth knowledge of areas with the greatest need for new mapping, and work together to identify areas they believe should be mapped next to best meet the interests of the State of Arizona. When the National Geologic Mapping Program began in 1993, Arizona’s advisory panel recommended that mapping begin in the Phoenix-Tucson corridor, which encompasses only about 20 percent of Arizona’s

land, but includes about 80 percent of its citizens (Figure 1).

A few of the many issues AZGS geologists addressed while mapping in the Phoenix-Tucson corridor were: 1) Accurately describing and depicting bedrock and surficial units mapped. Those in the professional community depend on carefully prepared, detailed geologic maps as the starting point for a host of site-specific applications in engineering and applied geology and hydrology, and in developing exploration target areas for metallic and nonmetallic mineral resources, oil and gas, helium, geothermal, carbon dioxide, and other resources. 2) Identification of pediments, which are gently sloping land surfaces covered with only a thin veneer (1-2 m) of sand and gravel. These areas have limited groundwater resources and are difficult to excavate. 3) Projection of newly mapped faults into the subsurface to delineate the geometry of fault zones that may form fractured-rock aquifers. Mapping of a gently dipping normal fault in the Durham Hills north of Tucson provided information needed to drill a high yield water well. 4) Identification of “Holocene alluvium” along the larger streams. Wells drilled in this alluvium are legally considered to be extracting river water, whereas wells in other units

produce groundwater. 5) Mapping surficial deposits that show areas that may be prone to flooding. Flash floods on tributary streams, generated by intense thunderstorms, can be devastating to homes built along washes or on active alluvial fans because of the large area flooded and the potential for developing new channels.

Because the Phoenix-Tucson corridor has largely been mapped (Figure 1),

the advisory committee is directing us into other parts of the State. This field season mapping is being focused in the upper San Pedro River Valley, between Benson and the International Border, where a better understanding of hydrogeology is needed for management of groundwater resources. Mapping is also being done along the Hassayampa River west of Phoenix, where rapid development will soon take place. We appreciate the direction the advisory committee has provided in identifying areas in which societal needs for mapping are the greatest.

This is the 22nd consecutive year the AZGS has produced detailed geologic maps in Arizona. The combined total expenditure for mapping will soon surpass \$5 million. The Arizona Geological Survey geologic mapping team, with the help of federal funds, has made a substantial contribution to understanding Arizona’s geology. *Larry D. Fellows, Director and State Geologist and Jon E. Spencer, Senior Geologist.*

Al Burch, US Bureau of Land Management
Charles G. Graf, Arizona Department of Environmental Quality
William M. Greenslade, Southwest Ground-water Consultants, Inc.
Barbara H. Murphy, Clear Creek Associates
Nicholas M. Priznar, Arizona Department of Transportation
Frank Putnam, Arizona Department of Water Resources
Michael J. Rice, Arizona State Land Department
Ralph E. Weeks, AMEC Earth & Environmental

Table 1. Members of the AZGS Geologic Mapping Advisory Committee

DOWN-TO-EARTH GEOLOGY

The purpose of the AZGS' "Down-to-Earth" publication series is to inform those who are interested in geology but have had no formal training in the subject. The series, which has grown by trial and error, currently gives emphasis to the most frequently visited state and national parks and monuments, but also includes books on geologic hazards and resources in Arizona. These books may be purchased at the AZGS. Numbers 9-12 and 14-17 may also be purchased at the respective park visitor centers. These "down-to-earth" books will enhance your appreciation of Arizona's geologic features, hazards, and resources.

1. **Energy Resources of Arizona**, by J.T. Duncan and F.P. Mancini, 1991, 17 p. This book was done in cooperation with the Arizona Department of Commerce, Energy Office. \$6.50*
2. **Radon Gas: A Geologic Hazard in Arizona**, by J.E. Spencer, 1992, 17 p. \$2.50*
3. **Land Subsidence and Earth Fissures in Arizona**, by S. Slaff, 1993, 24 p. This book won the John C. Frye Award for Environmental Geology in 1996. \$4.50*
4. **How Geologists Tell Time**, by E.M. VandenDolder, 1995, 33 p. Because geologists study events that happened millions of years before people started keeping records, special techniques must be used to determine ages of rocks. 33 p. \$5.00*
5. **Things Geologic**, a collection of writings by H.W. Peirce, edited by R. Frisch-Gleason, 1996, 39 p. Dr. Peirce emphasized the importance of "things geologic" in our daily lives. \$8.00*
6. **Ice Age Mammals of the San Pedro River Valley**, by A.W. Amman, Jr., J.V. Bezy, R. Ratkevich, and W.M. Witkind, 1997, 19 p. As recently as 11,000 years ago large animals grazed throughout southern Arizona. Some, including the dire wolf, Columbian mammoth, American mastodon, and primitive horses, became extinct at the end of the Ice Age. Remains of these animals have been found in numerous places in Arizona, including in the San Pedro River Valley. \$6.95*
7. **Highlights of Northern Arizona Geology**, compiled and edited by R. Frisch-Gleason, 1998, 44 p., black and white. This book includes articles on geologic features in northern Arizona, side canyons of the Colorado River, and petrified wood (Arizona's state fossil), plus air photos of some of the spectacular geologic features there. \$7.95*
9. **A Guide to the Geology of Organ Pipe Cactus National Monument and the Pinacate Biosphere Reserve**, by J.V. Bezy, J.T. Gutman, and G.B. Haxel, 2000, 63 p. Rocks and landforms formed by volcanic eruptions dominate these preserves. The features described (21) can be observed from park roads or on short hikes. \$7.95*
10. **Guide to Geologic Features at Petrified Forest National Park**, by J.V. Bezy and A.S. Trevena, 2000, 48 p. Giant petrified logs have been eroded from the soft sedimentary rock. Volcanic rock is present in the Painted Desert section of the park. Running water and wind formed many of the features. \$6.95*
11. **Rocks in the Chiricahua National Monument and Fort Bowie National Historic Site**, by J.V. Bezy, 2001, 48 p. Volcanic eruptions about 27 million years ago formed the Chiricahua Mountains. The geology at Fort Bowie played a major role in westward migration during the 1800s. \$7.95*
12. **A Guide to the Geology of Catalina State Park and the Western Santa Catalina Mountains**, by J.V. Bezy, 2002, 48 p. The west face of the Catalina Mountains is bounded by a major fault. The author describes rock features in the park and northward to the Biosphere and the town of Oracle. \$7.95*
13. **A Home-Buyer's Guide to Geologic Hazards in Arizona**, by R.C. Harris and P.A. Pearthree, 2002, 36 p. Every Arizona county has at least one potential geologic hazard or problem that can cause personal injury or property damage, including earthquakes, floods, land subsidence, earth fissures, and rock solution and collapse. The book, which describes the major problems and tells where one can get more information about them, won the John C. Frye Award in Environmental Geology in 2004. \$8.95*
14. **A Guide to the Geology of the Flagstaff Area**, by J.V. Bezy, 2003, 56 p. The author describes volcanic features at San Francisco Mountain, Red Mountain, Grand Falls, Sunset Crater, and SP Crater; erosional features in Wupatki and Walnut Canyon National Monuments; and the origin of Meteor Crater. \$7.95*
15. **Roadside Geology: Wupatki and Sunset Crater Volcano National Monuments**, by S.L. Hanson, 2003, 32 p. Varied rocks and landforms are present along the road that connects the monuments. \$6.95*
16. **A Guide to the Geology of the White Mountains and the Springerville Volcanic Field, Arizona**, by J.V. Bezy and A.S. Trevena, 2003, 56 p. Features described (26) in this area were formed by a variety of geologic processes. \$7.95*
17. **A Guide to the Geology of Sabino Canyon and the Catalina Highway, Coronado National Forest**, by J.V. Bezy, 2004, 45 p. Sabino Canyon follows the trend of a major fault that strongly influenced the development of the Canyon. Excellent exposures of a variety of rock types may be observed in roadcuts along the Mt. Lemmon Highway. \$7.95*

*plus tax for Arizona residents and shipping and handling costs explained on page 6 of this issue

JUST RELEASED

Geologic map of the Buckeye NW 7.5' Quadrangle, Maricopa County, Arizona: Field, J.J., Pearthree, P.A., and Ferguson, C.A., 2004, Arizona Geological Survey Digital Geologic Map 37, v. 1.0 (DGM 37), 1 CD ROM that includes a 1:24,000-scale geologic map. \$15.00 plus tax (Arizona residents) and shipping charges. A color paper copy of the map is available for \$12.00 plus tax (Arizona residents) and shipping charges.

Geologic map of the Wagner Wash Well 7.5' Quadrangle, Maricopa County, Arizona: Ferguson, C.A., Spencer, J.E., Pearthree, P.A., Youberg, Ann, and Field, J.J., 2004, Arizona Geological Survey Digital Geologic Map 38, v. 1.0 (DGM 38), 1 CD ROM that includes a 1:24,000-scale geologic map and 7 p. text. \$15.00 plus tax (Arizona residents) and shipping charges. A color paper copy of the map and text is available for \$17.00 plus tax (Arizona residents) and shipping charges.

Geologic map of the Dags Tank 7.5' Quadrangle, Maricopa County, Arizona: Pearthree, P.A., Youberg, Ann, Field, J.J., Ferguson, C.A., and Spencer, J.E., 2004, Arizona Geological Survey Digital Geologic Map 39, v. 1.0 (DGM 39), 1 CD ROM that includes a 1:24,000-scale geologic map. \$15.00 plus tax (Arizona residents) and shipping charges. A color paper copy of the map is available for \$12.00 plus tax (Arizona residents) and shipping charges.

Geologic map of the Wickenburg SW 7.5' Quadrangle, Maricopa County, Arizona: Shipman, T.C., and Grubensky, M.J., 2004, Arizona Geological Survey Digital Geologic Map 40, v. 1.0 (DGM 40), 1 CD ROM that includes a 1:24,000-scale geologic map. \$15.00 plus tax (Arizona residents) and shipping charges. A color paper copy of the map is available for \$12.00 plus tax (Arizona residents) and shipping charges.

Geologic map of the Star Well 7.5' Quadrangle, Maricopa County, Arizona: Youberg, Ann, Spencer, J.E., and Ferguson, C.A., 2004, Arizona Geological Survey Digital Geologic Map 42, v. 1.0 (DGM 42), 1 CD ROM that includes a 1:24,000-scale geologic map. \$15.00 plus tax (Arizona residents) and shipping charges. A color paper copy of the map is available for \$12.00 plus tax (Arizona residents) and shipping charges.

Geologic map of the Tucson SE 7.5' Quadrangle, Pima County, Arizona: Shipman, T.C., 2004, Arizona Geological Survey Digital Geologic Map 43, v. 1.0 (DGM 43), 1 CD ROM that includes a 1:24,000-scale geologic map. \$15.00 plus tax (Arizona residents) and shipping charges. A color paper copy of the map is available for \$12.00 plus tax (Arizona residents) and shipping charges.

Compilation geologic map of the Reno Pass area, central Mazatzal Mountains, Maricopa and Gila Counties, Arizona: Spencer, J.E., Leighty, R.S., Conway, C.M., Ferguson, C.A., and Richard, S.M., 2004, Arizona Geological Survey Open-File Report 04-03 (OFR 04-03), 28 p., 1 sheet, scale 1:24,000 \$7.50 plus tax (Arizona residents) and shipping charges

Geoscience terminology development for the National Geologic Map Database: Richard, S.M., Matti, J.C., and Soller, D.R., 2004, in Soller, D.R., ed., Digital mapping techniques '03 – Workshop proceedings: U.S. Geological Survey Open-File Report 03-471, p. 157-167. (This publication is not available for purchase from the AZGS, but may be reviewed in the library.)

Geologic Map Database implementation in the ESRI Geodatabase environment: Richard, S.M., 2004, in Soller, D.R., ed., Digital mapping techniques '03 – Workshop proceedings: U.S. Geological Survey Open-File Report 03-471, p. 169-183. (This publication is not available for purchase from the AZGS, but may be reviewed in the library.)

AGI RELEASES NEW BOOKS

The American Geological Institute (AGI) recently released another book in its Environmental Awareness Series.

Meeting Challenges with Geologic Maps provides varied information about geologic maps and how they are made and used. In fact, sixteen chapters describe in detail how geologic maps can be used. The uses of maps described include: predict habitat, identify cave resources, find mineral resources, identify landslide hazards, evaluate sinkhole susceptibility, protect groundwater, predict earthquake damage, define post-wildfire hazards, delineate ecosystems, volcanic hazards, and sand and gravel resources, identify coal resources and past mining, guide transportation planning, mitigate earthquake damage, and find groundwater.

The 64-page book was done by the AGI in cooperation with the Association of American State Geologists, Geological Society of America, National Park Service, and U.S. Geological Survey. The book, in full color, is in 8.5 x 11 format.

For information about this and other AGI publications go to: www.agiweb.org/pubs/pubindex. The AGI is a non-profit federation of 43 scientific and professional associations that represent more than 120,000 geologists, geophysicists, and other earth scientists.

FRYE AWARD PRESENTED



Raymond C. Harris (left), Arizona Geological Survey, received the Frye Award plaque on behalf of the co-author, Philip A. Pearthree, and the Arizona Geological Survey from Walter Schmidt, Florida Geological Survey, who chaired the award committee.



Philip A. Pearthree, Arizona Geological Survey, co-recipient of the John C. Frye Award in Environmental Geology for 2004.

A Home Buyer's Guide to Geologic Hazards in Arizona, published by the Arizona Geological Survey as Down-to-Earth 13, received the John C. Frye Memorial Award in Environmental Geology for 2004. The book was written by Raymond C. Harris and Philip A. Pearthree, Arizona Geological Survey geologists. The award is given annually by the Geological Society of America (GSA) and the Association of American State Geologists (AASG). The award was presented by Walter Schmidt, State Geologist and Chief of the Florida Geological Survey, November 9, 2004, at the business meeting of the AASG held during the annual meeting of the GSA in Denver.

Papers eligible for the award must have been published by a State geological survey or the GSA during the preceding three calendar years. Award committee members evaluate and rank each paper nominated to determine whether the paper 1) identifies or recognizes a geologically based environmental problem or issue, 2) provides technically sound substantive information on the basic geology or geologic process pertinent to the problem, 3) relates the geology to the problem or issue, and 4) presents information in a manner that is understandable and directly useable by geologists and other professionals such as land-use planners and engineers. It is highly desirable that the paper be easily understood by informed laypersons.

The GSA and AASG present this award to recognize the substantial contributions John C. Frye made to the understanding of environmental geology. Dr. Frye was Director of the Kansas Geological Survey for nine years before he became director of the Illinois Geological Survey in 1954. He directed that agency for 20 years and then served as Executive Director of the GSA until he retired in 1982.

Dr. Frye's major scientific interests were in Quaternary geology and environmental geology.

He defined "environmental geology" as an attitude of mind, an orientation, the application of the best most sophisticated scientific work we are capable of doing to the problem of accommodating a rapidly shrinking living space and resource base to the needs of man. He started using this term while he was Chief of the Illinois State Geological Survey.

Environmental geology provides a means of focusing public and professional interest on the many applications of geology to society. This sub-discipline of geology is now widely accepted as the public has become more aware of and has shown more concern for the natural world. Today, most geological surveys give strong emphasis to environmental geology.

In 1980, Frye said "In the next few decades, geologic data and advisory input will be needed more urgently than has ever been the case...When we view an exponentially increasing population set in apposition to finite mineral and land resources, the urgency of the situation becomes apparent." *Larry D. Fellows.*



Left to right: Rob Van der Voo, University of Michigan, President of the Geological Society of America; Raymond C. Harris, Arizona Geological Survey and co-recipient of the Frye Award; Robert G. Marvinney, State Geologist and Director of the Maine Geological Survey and President of the Association of American State Geologists; and Larry D. Fellows, State Geologist and Director of the Arizona Geological Survey.

PUBLICATION ORDERING INFORMATION

You may purchase publications at the AZGS office or by mail. Address mail orders to AZGS Publications, 416 W. Congress St., Suite 100, Tucson, AZ 85701. Orders are shipped by UPS, which requires a street address for delivery. All mail orders must be prepaid by a check or money order payable in U.S. dollars to the Arizona Geological Survey or by Master Card or VISA. Do not send cash. Add 7.6% sales tax to the publication cost for orders purchased or mailed in Arizona. Order by publication number and add these shipping and handling charges to your total order:

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Other countries, request price quotation

Shipping and handling charges include insurance.
For rolled maps, add \$1.00 for a mailing tube.

MARK YOUR CALENDAR

The Tucson Gem and Mineral Society will present the Tucson Gem and Mineral Show February 10-13, 2005 at the Tucson Convention Center. The 2005 theme is "Minerals of China." The show features gems, minerals, jewelry, and gifts. Dealers from the U.S. and many other countries will be present. For details click on the Arizona Geological Society website (www.tgms.org).

The Arizona Geological Survey will have a booth in the Convention Center. We encourage you to visit our booth or stop at our office just a few blocks north.

The Arizona Section of the American Institute of Professional Geologists will hold a quarterly meeting at the AZGS office February 12 (Saturday). Visitors are welcome to attend.

STATE OF ARIZONA Janet Napolitano, Governor

ARIZONA GEOLOGICAL SURVEY

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