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ARIZONA GEOLOGICAL SURVEY
Information to Arizonans since 1889

MISSION

To provide unbiased information to the public to enhance understanding of Arizona's geologic framework and support prudent management and use of land, water, mineral, and energy resources.

FUNCTIONS

- *Provide information about Arizona geology*
- *Map and describe bedrock and surficial geology*
- *Map and characterize mineral and energy resources*
- *Investigate geologic hazards and limitations*
- *Prepare and publish geologic maps and reports*
- *Maintain databases and files*
- *Maintain geology library*
- *Maintain rock cuttings and core repository*
- *Provide administrative and staff support for Oil and Gas Conservation Commission*

A.R.S. § 27-152

Headline News

Larry D. Fellows, Director
Arizona Geological Survey

Geologic processes, including flooding, earthquakes, and volcanic eruptions, have been major news stories this year. During July and August alone, flooding in Arizona caused a train derailment near Kingman, evacuation of the village of Supai near the Grand Canyon, drowning of eleven hikers in Antelope Canyon (a slot canyon near Page) and drowning of eight people who were trying to enter the U.S. illegally through a drainage tunnel in Douglas. Meteorologists now advise us that the developing El Niño system appears to be the strongest in at least the last 50 years. The 1983 El Niño was associated with extensive flooding in Arizona, which resulted in 13 deaths and about $300 million damage statewide (figure 1).

Any dry wash in Arizona can become a raging torrent if substantial amounts of rain fall on a drainage basin in a short period of time. In the early 1980s back-to-back 100-year floods occurred in southern Arizona. If the concept of the 100-year flood was valid, there would have been about 10,000 of them during the last million years alone.

Although flooding is Arizona's leading natural hazard, it's not the only one. Faulting and volcanism have also played a major role in shaping the State. Rock units throughout the State have been displaced by faults, most of which have long been inactive. Some faults have been active in the not-too-distant geologic past, however, and have potential to generate large earthquakes. Lava flows that cooled as basalt, volcanic ash beds, and volcanic cinder cones are evidence of relatively young volcanic eruptions. Although there is no indication that a volcanic eruption in Arizona is imminent, we might have to shovel ash if an eruption occurs in Mammoth Lake, California when the winds are blowing our way. In portions of Maricopa, Pinal, Pima, and Cochise Counties, land subsidence caused by overpumping groundwater will cause property damage as development continues.

Even those who

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***Figure 1.** Damage caused by flooding of the Rillito River in Tucson, October 1983. Photo provided by Peter L. Kresan*

Headline News (continued from page 1)

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Arizona **Geology**
is published quarterly by the Arizona Geological Survey (AZGS) to provide information about geologic materials and processes and their impacts on the development and use of Arizona's land, water, mineral and energy resources. We encourage your comments and suggestions.

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venture out to observe Arizona's spectacular geology are not immune from risk. In late August, a tourist fell 800 feet to her death at Toroweep Point in the Grand Canyon, the fourth fatal fall this year. On average, six people die that way every year.

Yuma has the highest earthquake risk of any place in Arizona because of closeness to active faults in southern California. Chino Valley, the Flagstaff and Grand Canyon areas, and southeastern Arizona have moderate hazard. In May 1887, movement along a fault 30 miles southeast of Douglas generated an earthquake that caused deaths and property damage in Sonora and damage throughout southeastern Arizona. A comparable quake today would cause even more damage, because many more people now live in the area.

Level of risk from geologic processes varies from state to state. On the basis of frequency and magnitude of historic earthquakes, risk is greater in California, Nevada, and Utah than in Arizona. Arizona's earthquake risk is more difficult to assess because the known faults have longer intervals between times of movement. We could be in for a major surprise. Will we be prepared?

After Mount Pinatubo erupted in the Phillippines in 1991, we printed a guest commentary by Charles Osgood, CBS News, in *Arizona Geology* (v. 21, no. 3). His conclusion is as appropriate today as it was then: "It's difficult for us, whose lives are so short, to worry about something that only happens every few centuries or so... But because there hasn't been an eruption in a given place for a while, we get to thinking, or at least pretending, that it isn't going to happen... We go on taking our chances, building our cities, planning our futures, as if only the things that have happened lately were what we have to worry about. The lesson of history is that, for better or for worse, just because something hasn't happened in a long time, doesn't mean it isn't going to happen now."

The Arizona Legislature assigned responsibility for describing and characterizing the State's geologic hazards and limitations to the Arizona Geological Survey (AZGS). AZGS geologists have conducted investigations, prepared bedrock and surficial geologic maps, compiled data, and released publications on channel migration on alluvial fans, paleoflood hydrology, river channel morphology, young faults, earthquakes, and land subsidence and earth fissures. The AZGS sells more than 70 publications that describe geologic processes in Arizona, 35 of which are listed in a free brochure, *Geologic Hazard Publications*. The brochure includes prices and ordering information. Many detailed maps of bedrock and surficial geology have also been released. AZGEOBIB, the 12,000-citation bibliographic database, is keyworded and searchable. Check out the wealth of reports, maps, data, and related information that are available. They're yours.

ARIZONA'S MINES LEAD NATION

Arizona led the nation in value of commodities mined in 1996, according to a national study released by the National Mining Association. All but a small percentage of Arizona's mine output is copper. Value of minerals mined in Arizona was $4.98 billion, which is 8.3 percent of the total output of the Nation. Arizona was followed by West Virginia, Kentucky, Nevada, and California. Mining employed 12,600 Arizonans. Mining and mining-related employment, including trade, service, and government jobs, was about 73,000. Nearly 137,000 jobs in Arizona were directly and indirectly related to mining.

Mining's direct economic impact in Arizona in 1996 was $2.3 billion. The combined direct and indirect impact was $13.7 billion.

New Publications

The Arizona Geological Survey (AZGS) released the following reports and maps since May 1997:

National Geologic Mapping Program: The five maps listed below depict surficial and bedrock geology. The area mapped includes the north side of the Superstition Mountains, southwestern Mazatzal Mountains, and the area along State Highway 87 between Sycamore Creek and Stewart Mountain.

(1) Geologic map of the Adams Mesa Quadrangle, Maricopa County, Arizona: S. J. Skotnicki and R. S. Leighty, 1997, Arizona Geological Survey Open-File Report 97-10 (Pub. number OFR 97-10), 13 p., scale 1:24,000. $5.00

(2) Geologic map of the Mine Mountain Quadrangle, Maricopa and Gila Counties, Arizona: S. J. Skotnicki and R. S. Leighty, 1997, Arizona Geological Survey Open-File Report 97-11 (Pub. number OFR 97-11), 11 p., scale 1:24,000. $5.00

(3) Geologic map of the Stewart Mountain Quadrangle, Maricopa County, Arizona: S. J. Skotnicki and R. S. Leighty, 1997, Arizona Geological Survey Open-File Report 97-12 (Pub. number OFR 97-12), 19 p., scale 1:24,000. $5.00

(4) Geology of the Mormon Flat Dam Quadrangle, Maricopa County, Arizona: C. A. Ferguson and W. G. Gilbert, 1997, Arizona Geological Survey Open-File Report 97-14 (Pub. number OFR 97-14), 28 p., 3 sheets, scale 1:24,000. $10.00

(5) Geology of the Horse Mesa Dam Quadrangle, Maricopa and Gila Counties, Arizona: W. G. Gilbert and C. A. Ferguson, 1997, Arizona Geological Survey Open-File Report 97-15 (Pub. number OFR 97-15), 14 p., scale 1:24,000. $6.00

National Geologic Mapping Program and the Environmental Protection Agency Indoor-Radon Program: The two maps listed below were funded by these Federal programs and the AZGS. Large areas of Quaternary surficial deposits and Proterozoic bedrock are present, in addition to a belt of tilted Tertiary sedimentary and volcanic rocks. The latter include tuffaceous marl with elevated levels of uranium.

(1) Geologic map of the Cave Creek Quadrangle, Maricopa County, Arizona: R. S. Leighty, S. J. Skotnicki, and P. A. Pearthree, 1997, Arizona Geological Survey Open-File Report 97-1 (Pub. number OFR 97-1), 38 p., 2 sheets, scales 1:24,000 and 1:12,000. $12.00

(2) Geologic map of the Wildcat Hill Quadrangle, Maricopa County, Arizona: S. J. Skotnicki, R. S. Leighty, and P. A. Pearthree, 1997, Arizona Geological Survey Open-File Report 97-2 (Pub. number OFR 97-2), 17 p., scale 1:24,000. $5.00

Digital geologic maps: The two maps listed below are digital versions of previously released maps. The geology is presented in four separate files or coverages: 1) contacts and faults, 2) other linear features (dikes, veins), 3) structural data, and 4) volcanic centers (degenerate areas). Data are in Arc/Info export files (.e00). Other data files include an ESRI shapefile that shows source maps used in the original compilation and xBase (.dbf) tables with descriptions of the rock units and suggested colors for displaying the map. A standard metadata text file contains a complete description of the data set. A copy of Open-File Report 97-5, which describes the database structure and feature coding used, is included as a computer file (MS Word and HTML).

1) Digital representation of the geological map of the Salome 30' x 60' Quadrangle, west-central Arizona: S. M. Richard, J. E. Spencer, and S. J. Reynolds; J. P. Thieme, digitizer; and S. M. Richard, editor, 1997, Arizona Geological Survey Digital Information Series 6, version 1.1 (Pub. number DI-6), 2 HD disks, 3 p. $30.00

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How to Order Them

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% 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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40.01- 50.00,	add 8.00
50.01- 100.00,	add 10.25
Over 100.00,	add 12%

Other countries, request price quotation.

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

If you purchase Open-File Reports, Contributed Maps, or Contributed Reports at the AZGS office, allow up to two days for photocopying.

NEW PUBLICATIONS, from page 3

2) Digital representation of the geological map of the Little Horn Mountains 30' x 60' Quadrangle, southwestern Arizona: J. E. Spencer, compiler; K. M. Korroch and J. P. Thieme, digitizers; and S. M. Richard, editor, 1997, Arizona Geological Survey Digital Information Series 7, version 1.1 (Pub. number DI-7), 3 HD disks, 3 p. $30.00

Geologic map of Arizona, GIS database, v1.0: S. M. Richard, compiler, Arizona Geological Survey Digital Information Series 8 (Pub. number DI-8), 2 HD disks. $30.00

This is a digital version of AZGS Map 26, scale 1:1,000,000. Data from the original version have been translated into Arc/Info and edited to improve accuracy. Minor revisions have been made to the classification of rock units. Because of the history of this data set, faults and contacts are in separate layers (coverages). Outlines of regions of Mesozoic metamorphism and Tertiary mylonitization, shown on Map 26, are included in a separate layer. These geographic data are in Arc/Info export format (e00). Tables containing descriptions of rock units and suggested colors for displaying the map are in xBase (dbf) format. An index of source maps used in the original compilation is included in an ESRI shapefile, with bibliographic citations in an associated xBase (dbf) table.

Geologic maps of parts of the Gila Bend Mountains near Woolsey Peak and Signal Mountain: J. E. Spencer and W. G. Gilbert, 1997, Arizona Geological Survey Open-File Report 97-8 (Pub. number OFR 97-8), scale 1:24,000. $2.00

These geologic maps clarify the nature of lower Miocene rocks and structures in the Gila Bend Mountains. Volcanic landforms and igneous intrusion played a significant role in causing basin formation and disrupting basin-filling sediments.

An unconventional, multidisciplinary approach to evaluating the magnitude and frequency of flash floods in small desert watersheds: P. K. House, 1997, Arizona Geological Survey Open-File Report 97-9 (Pub. number OFR 97-9), 61 p. $10.00

The author used techniques of paleoflood hydrology, air photo analysis, and historical research, together with sparse hydrological and meteorological data, to compile a regional flood chronology. In the nine small drainage basins studied, flash floods have occurred over more than the last 1,200 years.

Bibliography of uranium- and copper-bearing breccia pipes on or near the Colorado Plateau of Arizona: R. A. Trapp, 1997, Arizona Geological Survey Open-File Report 97-13 (Pub. number OFR 97-13), 11 p. $3.00

This is a list of 205 citations from AZGEOBIB, a computerized, annotated bibliographic database with more than 12,000 citations on the geology of Arizona.

Geologic map of the eastern Plomosa Pass area, northern Plomosa Mountains, La Paz County, Arizona: T. R. Steinke, 1997, Arizona Geological Survey Contributed Map 97-A (Pub. number CM 97-A), scale 1:3,570. $3.00

This geologic map reveals complex deformation of Paleozoic and Mesozoic rocks produced by multiple episodes of Mesozoic deformation.

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Address Correction Requested