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# Arizona Geology

*A publication of the Arizona Geological Survey*

*INFORMATION AND SERVICE SINCE 1889*

- *geologic information*
- *geologic library and databases*
- *mapping and framework*
- *hazards and limitations*
- *mineral resources*
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*ARS 27-152*

**INSIDE**



# Does Arizona Have Earthquakes?

**Larry D. Fellows**
*Director and State Geologist*

Does Arizona have earthquakes? Do you have a map that shows active faults? Do you have information about earthquakes in Prescott, Scottsdale, Green Valley, and Phoenix (in that order)?

More than 40 people, mostly from southern California, have called the Arizona Geological Survey (AZGS) to ask these questions since the Northridge, California, earthquake in January. The AZGS has prepared a packet of information, summarized below, to answer these questions.

**What is the earthquake risk in Arizona?** Assessment of earthquake risk involves evaluation of the historical record of earthquakes and the results of geologic investigations of active or potentially active faults. The historical record in Arizona was incomplete until about the 1870s. Most active faults world-wide, and all active faults in Arizona, have recurrence intervals (time between movements) that are greater than 150 years. A record of only the last 125 years may not be a true representation of the actual level of earthquake activity.

The historical record indicates that the risk from earthquakes originating within Arizona is low to moderate, and the risk posed by earthquakes adjacent to Arizona is probably greater. No deaths or personal injuries, and only relatively modest amounts of property damage have been caused by earthquakes in Arizona during the past 125 years. Many earthquakes ranging in magnitude up to about 6.0 have occurred within Arizona during historic time. Some of them caused minor damage. The largest historical earthquakes in Arizona occurred in the Flagstaff and Grand Canyon area in the early 1900s.

Arizona residents have felt strong earthquakes that were generated by the San Andreas and related faults in southern California and northern Mexico. Some of those quakes caused significant property damage in the Yuma area, which has the highest earthquake risk in Arizona. This is a major reason why the National Earthquake Hazard Reduction Program recently categorized Arizona as "high risk," their second most serious category. The

*see EARTHQUAKES, page 2*

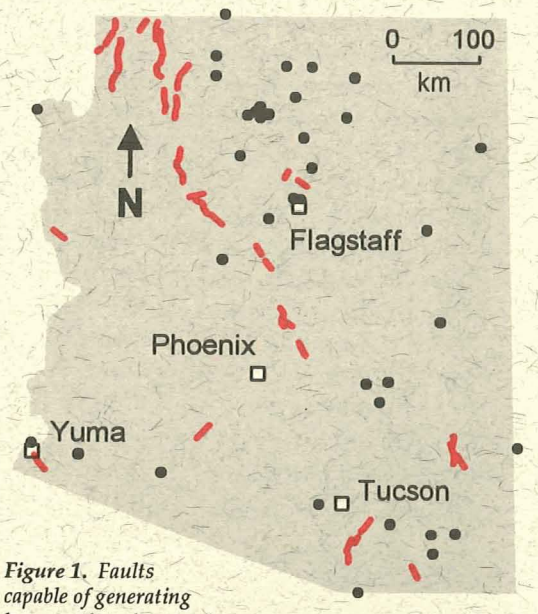


*Figure 1. Faults capable of generating large earthquakes are shown as orange lines. Epicenters of moderate earthquakes (magnitude 4 to 6) that have occurred in Arizona in historic times are shown as black dots.*

# Earthquake Bibliography

## Geologic Hazards Publications

Earthquakes, flooding, subsidence and earth fissuring, landslides, and other geologic processes may be hazardous or limit the use of Arizona's land, water, mineral, and energy resources. Those who site, design, construct, and maintain housing subdivisions, water supply and waste disposal facilities, highways, industrial complexes, and many other types of structures need to be aware of these known or potential hazards and limitations.

AZGS geologists map and characterize geologic processes and materials. Results of these studies may be used help make land- and resource-management decisions. **A list of publications on known and potential geologic hazards and limitations in Arizona is available** and may be obtained (at no cost) from the AZGS. Most of the items listed were written for geologists, hydrogeologists, hydrologists, engineers, and other professionals. Data users may obtain additional information and assistance from AZGS geologists.

The AZGS recently released **Open-File Report 94-3, Bibliography of earthquake hazards in Arizona**, which lists more than 400 publications on earthquakes and related hazards. Selected references are included that describe earthquakes in southern California and northern Mexico that have potential to impact Arizona. References are grouped into nine categories to enable users to focus on areas of specific interest.

The project was funded by the Federal Emergency Management Agency, the Earthquake Program of the Arizona Division of Emergency Management, and the AZGS. Scott Beyer, a graduate student in geology at Arizona State University, did the compilation, under the direction of Dr. Philip A. Pearthree, AZGS project manager. Information about how to order this publication is given on page 3.

*EARTHQUAKES, from page 1*

1887 earthquake, which originated in Sonora about 40 miles southeast of Douglas, Arizona, was felt throughout southern Arizona and caused some damage to buildings.

Geologic investigations of large prehistoric earthquakes (greater than magnitude 6.5) indicate that at least 23 faults in or very near Arizona have been active in the past 100,000 years. These faults have potential to generate large earthquakes, although none have occurred along them in historic times.

Even though the probability of a destructive earthquake in Arizona is fairly low, a large earthquake could happen here. As an analogy, a "100-year flood" has only a 1 percent probability of happening in any one year, but several of Arizona's large rivers have experienced more than one 100-year flood in the last 15 years.

**Where can I get more information about earthquakes in Arizona?** Much information about historical earthquakes and the locations and character of active or potentially active faults is available. The AZGS has published a bibliography of earthquake publications (**Open-File Report 94-3**, described in more detail above), a catalog of Arizona earthquakes, 1776-1980 (**Bulletin 193**); a special report on the 1887 earthquake (**Special Paper 3**); a map of young faults and volcanic activity (**Map 22**); and other detailed reports and maps related to potentially active faults and earthquake risk. Please contact the AZGS for additional information.

Earthquake preparedness and safety activities are handled by the Earthquake Program (EP) of the Division of Emergency Management Arizona Department of Emergency and Military Affairs, 5636 E. McDowell Road, Phoenix, AZ 85008 [telephone (602) 231-6238]. The EP and the AZGS have prepared a free brochure entitled ***Arizona Earthquakes: Are we at risk?***, which may be obtained from the EP. Reginald A. Yates, the EP Manager, can also provide the names, addresses, and telephone numbers of the principal contact persons at the Arizona Earthquake Information Center at Northern Arizona University (Flagstaff), the Southern Arizona Seismic Observatory at the University of Arizona (Tucson), and the Department of Geology at Arizona State University (Tempe).

Governor Fife Symington has supported earthquake safety and preparedness in Arizona through Executive Order 93-3, in which he established the Arizona Council for Earthquake Safety to assist in determination of policy and coordination of government programs and activities with those in the private sector.

# Just Released

The Arizona Geological Survey released nine new publications, described below, since February 1994. Please use the publication number to identify those you want to purchase. Please mail publication orders to AZGS Publications, 845 North Park Ave., #100, Tucson, AZ 85719-4816. Orders are shipped by UPS, which requires a street address for delivery. All orders must be prepaid by check or money order payable in U.S. dollars to the Arizona Geological Survey. Add these shipping and handling charges to your total order, please:

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Other countries, request price quotation.

***AZWELL: a digital database of the Arizona Geological Survey well-cuttings repository:*** T.G. McGarvin and R.A. Trapp, Digital Information Series 2 (Pub. number DI-2), 4 p., 3.5" floppy disk. $6.00

This database contains the names and locations of 4,148 wells, mostly water wells, that were drilled in or near Arizona, along with sample descriptions and other data on file at the AZGS. The database is available in three formats: dBASE IV, FileMaker Pro v.1.0, and ASCII. The dBASE IV format is compatible with many database programs running in a variety of hardware/software environments. The FileMaker Pro version provides a more intuitive interface for users of Windows or MacIntosh operating systems with FileMaker Pro software. The ASCII format is the simplest data interchange format. Unless specifically requested, the data will be provided on a DOS-compatible, high-density, 3.5" floppy disk. MacIntosh-formatted disks are also available.

***Bibliography of earthquake hazards in Arizona:*** Scott Beyer and P. A. Pearthree, Open-File Report 94-3 (Pub. number OFR 94-3), 44 p. $6.75

Refer to page 2 of this issue for description.

***Uranium distribution in sediments of the Safford and Duncan basins, southeast Arizona, and implications for indoor radon:*** R.C. Harris, Open-File Report 94-4 (Pub. number OFR 94-4), 11 p., 2 sheets, scale 1:100,000 and 1:24,000. $5.50

Uranium concentrations, measured primarily with a portable gamma-ray spectrometer, were in the normal range in most of the study area, but were locally anomalous. Elevated levels of uranium in rock and soil increase the likelihood that buildings constructed there will have elevated levels of indoor radon. This study was funded in part by the U.S. Environmental Protection Agency.

***Preliminary reconstruction of middle Tertiary extension in the Basin and Range of Arizona and adjacent areas:*** S.M. Richard, Open-File Report 94-5 (Pub. number OFR 94-5), 11 p., 1 sheet, scale 1:1,000,000. $3.50

This preliminary map shows the approximate position of pre-Tertiary rocks in the Arizona Basin and Range (relative to rocks of the Colorado Plateau) in early Oligocene time, prior to the episode of large-scale extension that occurred in late Oligocene through middle Miocene time. The pre-extension position of major porphyry copper systems is shown as well. The accompanying text describes the procedure used to make the reconstruction. The map will be useful to those analyzing Laramide deformation and possible controls on the distribution of Laramide porphyry copper deposits.

*see* ***JUST RELEASED,*** *page 4*

## Geologic Maps Wanted

In late 1994 AZGS geologists will begin preparation of detailed geologic maps in the Mesa $1^{o}$ x $2^{o}$ quadrangle. Work will begin in the western half of the quadrangle, which extends from the longitude of Tempe and Scottsdale on the west to the eastern end of Roosevelt Lake on the east, and from the latitude of Horseshoe Reservoir on the north to Coolidge and Florence on the south.

We request the assistance of any geologist who has done geologic mapping within this area, but has not published the map(s). May we use your maps to help complete the project? If so, please contact AZGS geologist Jon E. Spencer if you have bedrock maps, or Philip A. Pearthree if you have surficial maps. Your help will be appreciated.

If you would like, we will review your maps for possible inclusion in the AZGS Contributed Map Series to make them available to the public. Geologic maps that were contributed by E.B. Melchiorre, W.R. Dickinson, and R.F. Holm are announced on page 4 of this issue.

*JUST RELEASED, from page 3*

***Geology of the Enebro Mountain area, Greenlee County, Arizona:*** E.B. Melchiorre, Contributed Map 94-A (Pub. number CM 94-A), 1 sheet, scale 1:10,600. $2.00

Precambrian metamorphic and igneous rocks, Paleozoic sedimentary rocks, and Tertiary basalt and rhyolite crop out in the map area north of Morenci. The rocks have been cut by steeply dipping normal faults.

***Geologic map of Star Flat - Willow Springs area, Pinal County, Arizona:*** W.R. Dickinson, Contributed Map 94-B (Pub. number CM 94-B), 3 p., 1 sheet, scale 1:24,000. $1.50

Proterozoic granite and Tertiary sedimentary and volcanic rocks crop out within the map area northwest of Oracle in southeastern Pinal County. The mid-Tertiary San Manuel and Cloudburst formations rest on the low-angle Star Flat detachment fault and are tilted to the east.

***Geologic map of the Morman Lake Quadrangle, Coconino County, Arizona:*** R.F. Holm, Contributed Map 94-C (Pub. number CM 94-C), 25 p., 1 sheet, scale 1:24,000. $5.50

The map area, southeast of Flagstaff, is covered by volcanic rocks of late Cenozoic age, mainly basaltic flows between 3 and 6 million years old. Rock descriptions and major, trace, and some rare-earth-element data are included.

***Several flow events on the margin of the Algerian-Moroccan Sahara and their morphological consequences:*** Fernand Joly, translated by Julie Woodward, Contributed Report 93-C (Pub. number CR 93-C), 14 p. $2.75

This is one of only four eye-witness accounts of sheet flooding, an important but poorly understood process in desert regions such as Arizona. The original paper was published in French in the proceedings of the 1952 International Geological Congress. With the release of this translation, English-speaking geologists can benefit from Joly's fascinating observations.

***The Black Mustache uranium-vanadium mine, Apache County, Arizona, and the probable source of the ore shipments:*** W.L. Chenoweth, Contributed Report 94-A (Pub. number CR 94-A), 12 p. $2.00

Production from this mine was supposedly from the Salt Wash Member of the Morrison Formation. The author concludes that the ore came from a different source.

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## Now Available from the AZGS

***Advances in geology of the porphyry copper deposits:*** S.R. Titley, editor, 1982, (Pub. number NP-8). $40.00 plus shipping and handling charges (See page 3.)

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