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ARIZONA
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INFORMATION TO
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OUR MISSION

To provide unbiased earth-science information to the public, businesses, and other governmental agencies to facilitate development of relevant policies and courses of action for prudently managing and using Arizona's land, water, mineral, and energy resources.

OUR FUNCTIONS

- **Geologic publications**
- **Computerized databases**
- **Geologic library and data files**
- **Well cuttings and core repository**
- **Geologic mapping and characterization**
- **Investigations of geologic hazards and limitations**
- **Mineral and energy resource investigations**
- **Regulation of oil, gas, helium and geothermal resources (by the Oil and Gas Conservation Commission)**

A.R.S. § 27-152

Kobe Earthquake

Larry D. Fellows
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On January 17, 1995, almost a year to the day since California's Northridge earthquake, a major quake (magnitude 7.2) occurred in Kobe, Japan. More than 5,200 people were killed, almost 27,000 were injured, and 107,000 homes and buildings were damaged or destroyed. Damage is estimated to exceed \$100 billion. Throughout recorded history, 21 quakes have caused **50,000 or more** deaths (Table 1, page 2). The Kobe quake was one of 32 that have caused 5,000 or more deaths **in this century**.

The Kobe tremor clearly illustrated three major needs relative to earthquake preparedness and mitigation. First of all, earthquakes strike without warning. Research to find ways to predict them has been unsuccessful. Until prediction is possible, if it ever is, the number of people killed will be determined by the population density, time of day the quake occurs, geologic conditions in the area of ground shaking, and ability of buildings and other

structures to withstand ground shaking. Second, some buildings and other structures in Kobe that were believed to be capable of withstanding a quake of such magnitude were not. This quake provides an opportunity to assess designs that are needed to reduce death and injury from collapsing structures. Finally, governments of states and countries that have potential for damaging earthquakes must be prepared to respond promptly after a quake. Plans must be in place to rescue people trapped in buildings and other structures, get the injured to hospitals, put out fires, and provide medicine, water, food, and shelter to the injured and homeless.

A quake as large as the Kobe quake has not occurred in Arizona since records have been kept. Based on knowledge of "young" faults in Arizona, however, a number of major quakes have occurred here within the last 50,000 years. Studies indicate that recurrence intervals between those quakes are fairly long. The earthquake risk in most of Arizona is much less than that of southern California,

the Reno-Carson City, Nevada area, and the Salt Lake City and Wasatch Front areas in Utah.

The Yuma area has the greatest earthquake risk in Arizona because it is close to the San Andreas fault system, which extends through southeastern California. Numerous small to moderate tremors have been recorded north of Grand Canyon National Park Headquarters, near Flagstaff, and along the Big Chino fault north of Prescott. The large quake (magnitude 7.2) that occurred in 1887 in northern Sonora, Mexico, 30 miles southeast of Douglas, Arizona, caused damage throughout southeastern Arizona.

The Northridge quake of 1994 (magnitude 6.7) and the Landers quake of 1992 (magnitude 7.4) focused renewed attention on the potential for large earthquakes in southern California. In the past, earthquake-hazard assessment there concentrated mainly on the San Andreas and related faults, which pass **outside** of the Los Angeles basin. Almost 100

Earthquake (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. Please contact the AZGS for information about being placed on the mailing list.

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active faults are known, however, to be **beneath** the Los Angeles basin. James F. Dolan, and others, in the 13 January 1995 issue of *Science*, identified six major fault systems beneath the Los Angeles basin that are capable of generating quakes of magnitude 7.2 to 7.6. They concluded that too few earthquakes have occurred along those systems to account for observed strain accumulation and, therefore, the area is in a centuries-long quiescent period. The last 7.2 to 7.6 magnitude quake occurred 210 years ago. In short, they believe that the area is overdue for a major quake or a series of moderate ones.

Arizona could be impacted when a major quake strikes southern California. Many food products are trucked from southern California to wholesale and retail grocery companies and convenience stores in Arizona. Arizona is especially dependent on California for refined petroleum products such as gasoline and diesel fuel. In addition, Arizonans may be called on to assist their neighbors after a damaging quake.

Arizona's earthquake preparedness and mitigation program is in the Department of Emergency and Military Affairs' Division of Emergency Management (5636 E. McDowell

Road, Phoenix, AZ 85008). Michael P. Austin is director of the Division and Linda D. Mason is the Earthquake Program manager. The Earthquake Program distributes a free brochure entitled "*Arizona Earthquakes: Are we at risk?*"

Governor Fife Symington, through Executive Order 93-3, established the Arizona Council on Earthquake Safety (ACES) to increase earthquake awareness, and to coordinate the earthquake safety and related activities of governmental agencies and the private sector. ACES provides guidance to the Earthquake Program.

The Arizona Geological Survey (AZGS), an active member of ACES, provides information

about historical earthquakes and the locations and character of young faults to the Earthquake Program and other governmental agencies. The AZGS has published a catalog of earthquakes felt in Arizona from 1776-1980 (Bulletin 193), a report on the 1887 Sonoran earthquake, the strongest felt in southeastern Arizona (Special Paper 3), and a map showing young faults (Map 22). These and a number of other reports and maps may be purchased from the AZGS. Many of these reports were prepared by, or under the direction of, Dr. Philip A. Pearthree, our earthquake specialist, who can also refer those who are interested to other sources of information about earthquakes and faults.



Table 1. Most destructive known earthquakes. (Information from the U.S. Geological Survey National Earthquake Information Center)

Year	Location	Deaths	Magnitude
856	Damghan, Iran	200,000	
893	Aradabil, Iran	150,000	
1138	Aleppo, Syria	230,000	
1268	Sicilia, Asia Minor	60,000	
1290	Chihli, China	100,000	
1556	Shanshi, China	830,000	
1667	Shemakha, Caucasia	80,000	
1693	Sicily, Italy	60,000	
1727	Tabriz, Iran	77,000	
1737	Calcutta, India	300,000	
1755	Lisbon, Portugal	70,000	8.7
1783	Calabria, Italy	50,000	
1908	Messina, Italy	70,000-100,000	7.5
1920	Gansu, China	200,000	8.6
1923	Kwanto, Japan	143,000	8.3
1927	Xining, China	200,000	8.3
1932	Gansu, China	70,000	7.6
1935	Quetta, Pakistan	30,000-60,000	7.5
1970	Peru	66,000	7.8
1976	Tangshan, China	255,000-655,000	
1990	Iran	50,000	7.7

New Publications

The Arizona Geological Survey released seven reports and maps, described below, since December 1994.

Geologic map and cross sections of the Big Horn and Belmont Mountains, west-central Arizona:

J.A. Stimac, S.M. Richard, S.J. Reynolds, R.C. Capps, C.P. Kortemeier, M.J. Grubensky, G.B. Allen, Floyd Gray, and R.J. Miller, 1994, Open-File Report 94-15 (Pub. number OFR 94-15), 16 p., 3 sheets, scale 1:50,000. \$6.00

This map covers nearly 400 square miles of Tertiary volcanic rocks and Tertiary, Cretaceous, and Proterozoic crystalline rocks that are cut by numerous, largely northwest-striking normal faults. The complex structural geology that results from the faulting is depicted on the cross sections.

Map showing names and outlines of physiographic areas in Arizona used by the Arizona Geological Survey:

R.A. Trapp and S.J. Reynolds, 1995, Open-File Report 95-2 (Pub. number OFR 95-2), 2 sheets, scale 1:1,000,000. \$2.50 each sheet; both sheets, \$5.00

The authors subdivided the State into 555 physiographic areas. The primary criteria for selection of the area boundaries are geology

and topography. References in AZGEOBIB, the geologic bibliography, have been key-worded to these areas. Bibliographies on any of the depicted areas can be produced by the Arizona Geological Survey. Both sheets depict county boundaries and the Transition Zone. Sheet A depicts the physiographic areas on a base map that shows highways, cities, and political boundaries. Sheet B depicts the physiographic areas on a base map that shows Township and Range divisions.

Trace of main displacement surface (bedrock/basin-fill contact) of Pirate fault zone, west flank of Santa Catalina Mountains, Pima and Pinal Counties, Arizona:

W.R. Dickinson, 1994, Contributed Map 94-G (Pub. number CM 94-G), 9 p., 1 sheet, scale 1:24,000. \$3.00

West-side-down normal movement on the Pirate fault is responsible for the impressive mountain front on the west side of the Santa Catalina Mountains and for drooping the valley between the Santa Catalina and Tortolita Mountains. This map shows the trace of the fault and locations where its dip can be observed.

Geochemical analysis of the 1-Alpine Federal well:

Humble Geochemical Services, Humble, Texas, 1994, Contributed Report 95-A (Pub. number CR 95-A), 48 p. \$8.00

This final report includes TOC, Rock-Eval, vitrinite reflectance, thermal alteration index, and thermal-extract-pyrolysis/gas-chromatography analyses. The well is in southern Apache County, Arizona.

Geology and production history of the Mitchell Butte Uranium-Vanadium mine, Navajo County, Arizona:

William L. Chenoweth, 1995, Contributed Report 95-B (Pub. number CR 95-B), 10 p. \$2.00

Location, geology, and mining, Sam Charlie No. 1 Uranium-Vanadium prospect, Navajo County, Arizona:

William L. Chenoweth, 1995, Contributed Report 95-C (Pub. number CR 95-C), 8 p. \$1.75

Proceedings of the Fossils of Arizona Symposium, Volume II:

Mesa Southwest Museum and Southwest Paleontological Society, 1994, Pub. number NP-10, 140 p. \$12.00

The symposium, held in November 1994, included ten papers on fossils. Copies of Volume I, from the 1993 Symposium, are still available for \$18.00.

How to Order Them

You may purchase publications by mail or in person from the Arizona Geological Survey (AZGS) office. Please send mail orders to AZGS Publications, 845 N. Park Ave., Ste. 100, Tucson, AZ 85719-4896. Orders are shipped by UPS, which requires a street address for delivery. All mail orders must be prepaid by check or money order payable in U.S. dollars to the Arizona Geological Survey. Do not send cash. Add these shipping and handling charges to your total order, please:

Shipping & Handling CHARGES

In the United States:
Less than \$1.01, add \$1.00
\$ 1.01- 10.00, add 3.00
10.01- 20.00, add 4.50
20.01- 30.00, add 5.75
30.01- 40.00, add 6.50
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 the cost of postage, insurance, mailing materials, and handling.

If you purchase items at the AZGS office, please keep in mind that we need up to two days for photocopying and (or) reproducing reports and maps in the Open-File Report, Contributed Map, and Contributed Report Series.

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DRILLING PERMIT ISSUED

The Arizona Oil and Gas Conservation Commission issued a permit to Ridgeway Arizona Oil Corporation to drill a 2,500-foot well, the #3-1 State, in section 3, T. 11 N., R. 29 E., Apache County, Arizona. The well location is 7 miles southeast of St. Johns and 4 miles south of Ridgeway's Plateau Cattle Company #1 well. The latter, drilled in August 1994 and described in the Fall and Winter 1994 issues of *Arizona Geology*, encountered carbon dioxide and helium.

Drilling is expected to begin in March or April to determine whether carbon dioxide and (or) helium are present in sufficient quantities to be commercial. For additional information, please contact Steven L. Rauzi, Oil and Gas Program Administrator.

NEW LIST OF PUBLICATIONS

The Arizona Geological Survey has released a new list of publications that are available for purchase. This list, which supersedes all other lists, includes more than 440 reports and maps. A copy may be obtained from the Publication Sales Manager.

BACK ISSUES AVAILABLE

Sets of back issues of *Fieldnotes* and *Arizona Geology* (March 1971 to Summer 1993 issues) will be available **until May 1**. They are free if you pick them up at our office. The sets are not complete, because some issues are out-of-print. Please call first to determine shipping costs, if you need them mailed.

GEOLOGIC MAPPING AWARD

The Arizona Geological Survey (AZGS) has been awarded \$55,000 to do geologic mapping in the western half of the Mesa 1° x 2° Quadrangle during Fiscal Year 1995-96. The award is part of the National Cooperative Geologic Mapping Act of 1992, which includes a 50-50 matched-funding program between the U.S. Geological Survey (USGS) and state geological surveys throughout the Nation. The Association of American State Geologists (AASG), composed of the directors of state geological surveys, strongly supported passage of the National Geologic Mapping Act.

The AZGS has been a participant in cooperative geological mapping with the USGS every year since 1982.

**BILLS IN THE ARIZONA LEGISLATURE
(Status 10 March 1995)**

SB 1077: Modifies the requirement that applicants for technical registration (including geologists and engineers) must have worked under the direct supervision of a registered professional. The bill passed the full Senate and the House Commerce Committee.

HB 2013: Enables the Arizona Oil and Gas Conservation Commission (attached administratively to the Arizona Geological Survey) to forfeit a performance bond, if necessary, and use the money to properly plug and abandon an oil, gas, helium, or geothermal well. The bill passed the full House and the Senate Natural Resources, Agriculture, and Environment Committee.



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