

# Southern Arizona Earthquake Update

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The largest earthquake to affect southeastern Arizona in more than 25 years occurred on June 11, 1988 near Agua Prieta, just south of the Arizona-Sonora border (Figure 1). The earthquake, which had a magnitude of 4.0, occurred at 1:58 a.m. local time (08:58:35 Greenwich mean time) and was widely felt in Agua Prieta and Douglas, although there was no reported damage. The event had several small aftershocks, the largest of which occurred on June 19 with a magnitude of 3.1.

The epicenter of the earthquake was very close to the Pitaycachi fault in the San Bernardino Valley. This fault ruptured in 1887 in a major 7.2-magnitude earthquake, sometimes referred to as the great Sonoran earthquake.\* Bull and Pearthree (1988) studied the Quaternary history of the Pitaycachi fault and found a recurrence interval of at least 100,000 years between large earthquakes. Large

\*The magnitude of the 1887 earthquake is an estimate based on the length of the surface rupture and the amount of displacement along the Pitaycachi fault.

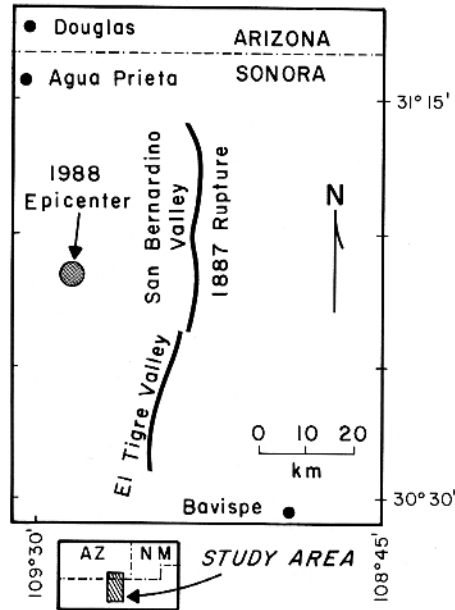


Figure 1. Location map of Pitaycachi fault region, showing epicenter of June 1988 earthquake. Solid line indicates surface rupture due to 1887 earthquake. Note discontinuity near northern part of El Tigre Valley.

earthquakes that have such recurrence intervals typically have aftershocks for 100 to 150 years, so the June seismicity probably represents aftershocks from the Sonoran earthquake.

The June 1988 event occurred near a major discontinuity in the surface trace of the 1887 earthquake. This is the same region where Natali and Sbar (1982) found a concentration of earthquake activity when they investigated the Pitaycachi region with an array of portable seismometers. It is not unusual to have a concentration of aftershocks at fault discontinuities; the stress appears to concentrate at "restraining" points, which may be bends or complexities in the fault zone. The June 1988 earthquake was actually the fourth earthquake to occur in the Pitaycachi region during the past 15 months. (Table 1 gives the dates and magnitudes of the other events.) In the southeastern Arizona-northern Sonora region, "normal" earthquake activity is about one earthquake with a magnitude greater than 3.0 per year. Although this is hardly active by California standards (where a 3.0-magni-

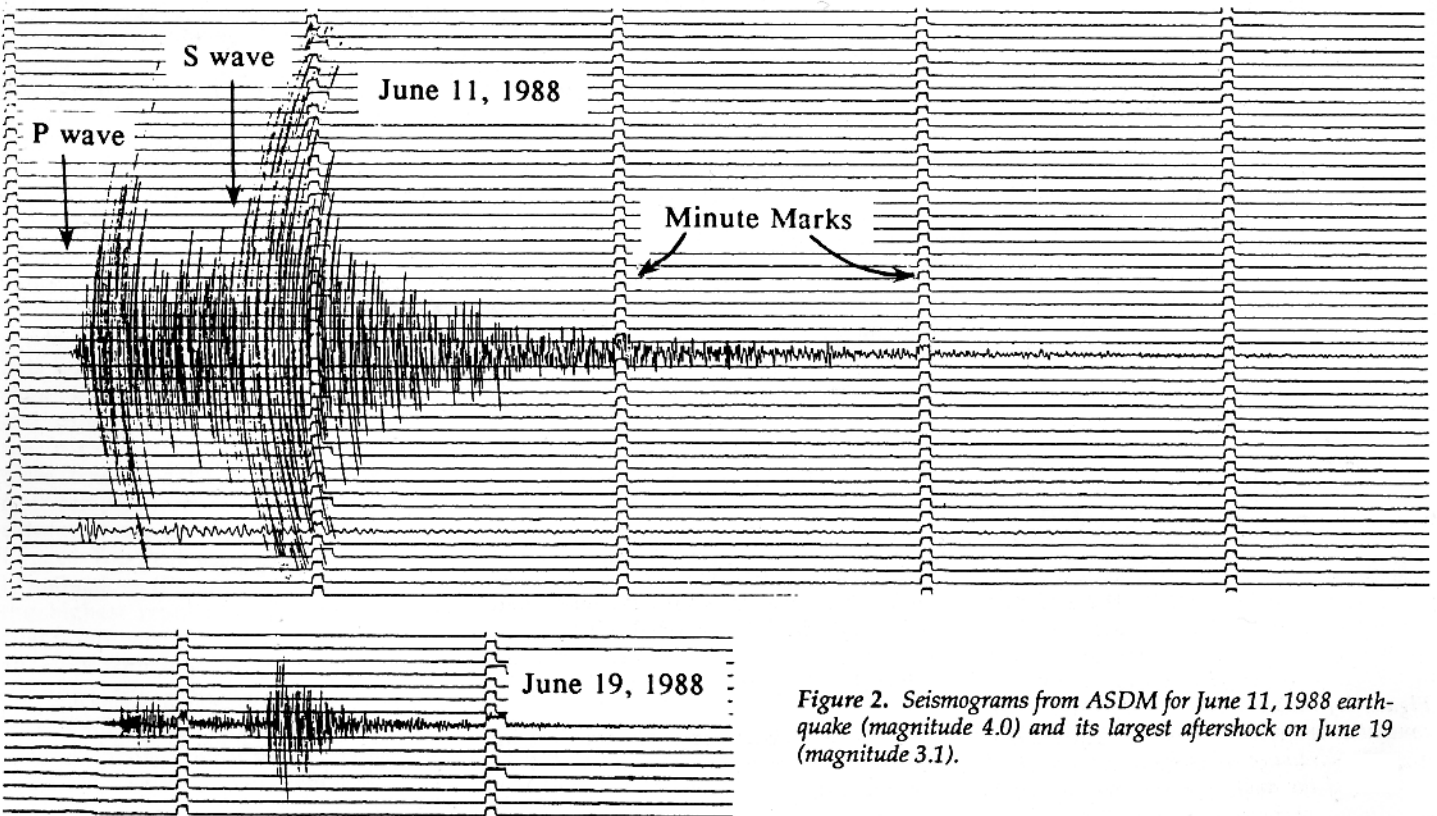


Figure 2. Seismograms from ASDM for June 11, 1988 earthquake (magnitude 4.0) and its largest aftershock on June 19 (magnitude 3.1).

tude earthquake is expected every 28 hours), it is indicative of the Quaternary fault history of the region. Pearthree (1986) identified about a dozen faults in the area that have probably experienced significant Quaternary earthquakes with magnitudes greater than 6.0.

The seismogram from a seismic station at the Arizona-Sonora Desert Museum (ASDM) for the June 1988 earthquake is shown in Figure 2. The first arrival, the P wave, is complicated; ground shaking began gradually and built up, indicating that the earthquake was preceded by a minor foreshock. The large arrival 30 seconds after the P wave is the S wave. By using the differential arrival times of P and S waves recorded at ASDM, the University of Arizona seismic station (TUC), and an array of seismometers operated by New Mexico Institute of Mining and Technology in Socorro, New Mexico, we can locate the event  $\pm 7$  kilometers in the east-west direction and  $\pm 4$  kilometers in the north-south direction. The magnitude of the event is determined by the length of time it takes the ground shaking to decay to the background level. Figure

2, which shows both the main event of June 11 and the aftershock of June 19, also indicates that the duration of shaking was more than  $4\frac{1}{2}$  minutes for the former and about 2 minutes for the latter.

On December 31, 1988 at 7:33:32 a.m. local time, a 3.2-magnitude earthquake

*Table 1. Recent seismicity in Pitaycachi area.*

Date	Longitude	Latitude	Magnitude
3-14-87	109° 25.8' W	30° 50.6' N	3.1
12-19-87	109° 29.0' W	30° 58.1' N	3.2
4-10-88	109° 26.8' W	30° 58.1' N	3.1
6-11-88	109° 25.5' W	30° 55.4' N	4.0
12-31-88	109° 25.8' W	30° 45.6' N	3.2

occurred 6 kilometers southwest of the June event. Considering the seismic quiescence in this area during the last quarter century, it is somewhat surprising that two 3- to 4-magnitude events occurred within the span of 6 months.

Like the earthquakes earlier in the year, the December quake was located near the south-central portion of the 1887 fault trace.

Although overall earthquake activity in southeastern Arizona is low, the region around the Pitaycachi fault remains active. It is unlikely that the region will produce a large event that could be felt in Tucson or Nogales in the near future, but it is quite likely that Douglas and Agua Prieta will feel more moderate-sized events.

#### References

- Bull, W.B., and Pearthree, P.A., 1988, Frequency and size of Quaternary surface ruptures of the Pitaycachi fault, northeastern Sonora, Mexico: Bulletin of the Seismological Society of America, v. 78, p. 956-978.
- Natali, S.G., and Sbar, M.L., 1982, Seismicity in the epicentral region of the 1887 northeastern Sonoran earthquake, Mexico: Bulletin of the Seismological Society of America, v. 72, p. 181-196.
- Pearthree, P.A., 1986, Late Quaternary faulting and seismic hazard in southeastern Arizona and adjacent portions of New Mexico and Sonora, Mexico: Arizona Bureau of Geology and Mineral Technology Open-File Report 86-8, 22 p.

## STAFF NOTES

Thomas G. McGarvin presented a workshop titled "Arizona's Auriferous Occurrences" at the annual convention of the Arizona Science Teachers Association on October 21. On October 29, he presented two workshops as part of the "4th R" educational program for teachers, sponsored by the Tucson Association of Museums and the Smithsonian Institution. The workshops were titled "Geology Unearthed" and "Rock Recipes." McGarvin also led four Saturday field trips on October 15, November 5 and 19, and December 3 for Tucson-area educators to examine and discuss the geologic setting of the western, northern, and eastern Tucson region.

Philip A. Pearthree presented two papers at a meeting of the Arid West Committee of the Association of State Floodplain Managers (cosponsored by the Arizona Floodplain Management Association), which was held in Las Vegas on October 19-21. The purpose of this meeting was to focus attention on floodplain-management issues in the arid and semiarid portions of the western United States. One paper, which was coauthored by Marie S. Pearthree, discussed the use of geomorphology and hydrology to delineate areas of potential alluvial-fan flooding in the Scottsdale area. A second paper summarized occurrences of debris flows in southeastern Arizona.

Stephen J. Reynolds has been reelected Vice President for Programs by the Arizona Geological Society. On November 1, he presented a talk to the society titled "Advances in Arizona Geology—A Cook's Tour of the New Geologic Map of Arizona." He also discussed the new geologic map on the programs "Arizona Illustrated" and "Reflexiones" on KUAT-TV (Channel 6, PBS affiliate), which aired on November 7 and November 27, respectively. On November 4-6, Reynolds served as coleader of a Geological Society of America field trip, which was associated with the national meeting held in Denver, to examine the structural geology of southeastern Arizona. On December 1, he presented a talk, "Mesozoic Evolution of Western Arizona," to participants in the University of Arizona Department of Geosciences Colloquium series. On December 2, he gave a lecture to faculty and graduate students at the Massachusetts Institute of Technology (MIT) and Harvard University. Reynolds, an invited speaker whose expenses were paid by MIT, discussed "Fluids in Detachment Faults — Metasomatism, Mineralization, and Structural Aspects."

Denise M. Siewert joined the Arizona Geological Survey on December 5 as a clerk-typist. She formerly worked for Career and Placement Services at the

University of Arizona. Born in Toledo, Ohio, she has lived in Tucson since 1961 and is working on an Associate in Applied Science - General Secretary degree at Pima Community College.

John W. Welty opened this year's University of Arizona Department of Geosciences Colloquium series with a presentation on August 25 titled "Geologic and Geotechnical Characteristics of the Arizona Superconducting Super Collider (SSC) Site." He also accompanied Governor Mofford and 18 other distinguished Arizonans to Washington, D.C. in early October to brief Secretary of Energy John Herrington on the attributes of the Arizona SSC site. At this briefing, the Governor unveiled a three-dimensional 1:18,000-scale model of the Arizona site; this model was presented to the people of Arizona at a public unveiling at the State Capitol in late October. In November, Welty presented an invited paper at the 100th annual meeting of the Geological Society of America (GSA) in Denver. The paper, "Superconducting Super Collider (SSC) Site Selection in Arizona," was given at a symposium titled "The Role of Geology in the Superconducting Super Collider Site-Selection Process." An abstract for the talk was printed in GSA Abstracts with Programs.