The 1887 Sonoran Earthquake: It Wasn’t Our Fault

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On May 3, 1887 Arizona and the Southwest experienced a major earthquake that had an estimated magnitude of 7.2 on the Richter scale (DuBois and Smith, 1980). The epicenter was in Sonora, Mexico approximately 40 miles south of Douglas, Arizona. The earthquake caused several dozen deaths, damaged buildings as far away as Phoenix, generated rockfalls and fires triggered by rockfalls in the mountains, and caused panic among the population. This year is the 100th anniversary of the only earthquake that caused considerable damage in Arizona in historic times.

Although earth scientists know much more now regarding the mechanisms of earthquakes than they did 100 years ago, reliable earthquake prediction is still in its infancy. It is known that the crust and uppermost mantle of the earth is divided into approximately a dozen major sections or “plates” that are slowly moving. Rates of relative movement range up to several inches per year. It is along the plate boundaries that the most earthquakes occur. The San Andreas fault of California is a plate boundary along which the Pacific plate is moving northwestward with respect to the adjacent North American plate. Because of friction along plate boundaries, plates do not smoothly slip past each other. As a consequence, resistance to movement allows stress to accumulate. When stress builds to the point at which it overcomes the resisting forces, energy is released causing ground motion, or an earthquake.

Although southeastern Arizona is several hundred miles from the San Andreas fault system, it is not immune to earthquakes. No region can be considered completely earthquake free; in fact, worldwide there are approximately 1 million detectable earthquakes annually (Gilluly and others, 1968). The majority of these are small shocks that cause no damage. The large, dangerous earthquakes occur less frequently, on the average of only several per year, and are usually concentrated along plate boundaries. By the time the surface waves of these large events reach southeastern Arizona, the energy has dissipated so that little or no motion is felt except by sensitive recording devices.

The 1887 event was, however, close enough and strong enough to cause major damage and loss of life in the southern portion of the State. The earthquake occurred along a south-trending fault approximately 30 miles in length located south of Douglas, Arizona (Figure 1). This surface rupture, named the Pitaycachi (pronounced Pi’i’-ka-che) fault, is one of several surface faults in the region that are thought to have been active during the last 100,000 years (Pearthree, 1986). These faults are located along the margins of south-trending ranges in the southeastern Arizona—southwestern New Mexico border region and extend into Sonora, Mexico.

It is estimated that the 1887 Sonoran earthquake released twice as much energy as any of the other earthquakes recognized in this region (Pearthree, 1986). Firsthand accounts reported that two violent shocks were preceded by low rumbling noises. This rumbling sound was reported in Tucson and as far away as Phoenix (Figure 2). Estimates of the duration of ground motion vary from a few seconds to approximately 10 minutes, with 1 to 3 minutes being the time most frequently reported. People throughout the region ran into the streets, some fainted, and others were thrown to the ground (DuBois and Smith, 1980). Numerous rockfalls were reported in the mountain ranges of southeastern Arizona and northern Sonora. Sparks from the crashing boulders ignited dry brush and grass, and fires quickly spread to the forests. Nearly all the valleys experienced changes in water conditions. Wells that had been excellent

Figure 1. Aerial view, looking northward, of 1887 scarp along Pitaycachi fault, Sonora, Mexico. The fault extends from about 8 kilometers south of the Arizona border for 50 kilometers to and beyond Colonia Morales in the San Bernardino Valley. Photo by Peter Kresan.
frightened and run

Generally deal with the manner in which the earthquake is felt by persons; the higher

earthquake. It is determined from the logarithm of the amplitude of earthquake waves recorded by seismographs. Magnitude is expressed on the Richter scale in whole numbers and decimal fractions (e.g., 7.2, the magnitude of the 1987 earthquake). Theoretically this scale has no upper limit; however, the largest earthquake ever recorded, in Chile in 1960, had a magnitude of 9.5 (DuBois, 1979).

Intensity is an arbitrary measure of the observable effects of an earthquake on humans and structures at a specific site. It varies from place to place depending on the strength of the earthquake (magnitude), the distance from the epicenter, and the local geology. The intensity scale currently used in the United States is the Modified Mercalli (MM) Intensity Scale. This scale, composed of 12 levels of intensity that range from imperceptible shaking (I) to catastrophic destruction ( XII), is designated by Roman numerals, as shown in the map above. The lower numbers of the MM intensity scale generally deal with the manner in which the earthquake is felt by persons; the higher numbers are based on observed structural damage. For instance, the MM rating of 3, recorded in Yuma during the 1887 earthquake, is based on the following MM characteristics: "Felt noticeably indoors; not usually recognized as earthquake." The rating of VI, recorded in Phoenix, is based on these observations: "Felt by all, many frightened and ran outdoors; falling plaster, moving furniture; damage slight." Tucson was assigned an MM intensity level of VII during the 1887 earthquake: "Everybody runs outdoors; damage to buildings varies depending on quality of construction." At the epicenter, which was assigned an intensity rating of X, observers reported the following: "Few structures remain standing; bridges destroyed; fissures in ground; pipes broken; landslides; rails bent."

The Arizona Bureau of Geology and Mineral Technology has several publications on seismicity and recent faulting in Arizona. Special Paper 3 (DuBois and Smith, 1980) focuses on the 1887 earthquake. It describes the characteristics of the Pitaycachi fault, quotes historical accounts from newspapers and other writings of that period, and analyzes the intensity patterns of the earthquake and its significance in terms of current seismic hazards in Arizona. Bulletin 193 (DuBois and others, 1982) is a compilation of data on the magnitude, source, distribution, and intensity of earth movements in Arizona from 1776 to 1980. Map 22 (Scarborough and others, 1986) identifies the youngest faults, folds, and volcanic rocks in Arizona. Open-File Report 86-B (Pearthree, 1996) analyzes the scarp morphology and surface displacement of late Quaternary faults, identifies the locations of Holocene and late Pleistocene faulting events, and assesses the seismic hazards in southeastern Arizona, southwestern New Mexico, and northeastern Sonora, Mexico. Two earlier issues of Fieldnotes (Summer, 1976; DuBois, 1979) provide general information about earthquakes such as when they occur, how they are measured, and if they can be predicted. For information on ordering these or other Bureau publications, contact the Bureau offices at 845 N. Park Ave., Tucson, AZ 85711, or call (602) 621-7906.

Selected References


