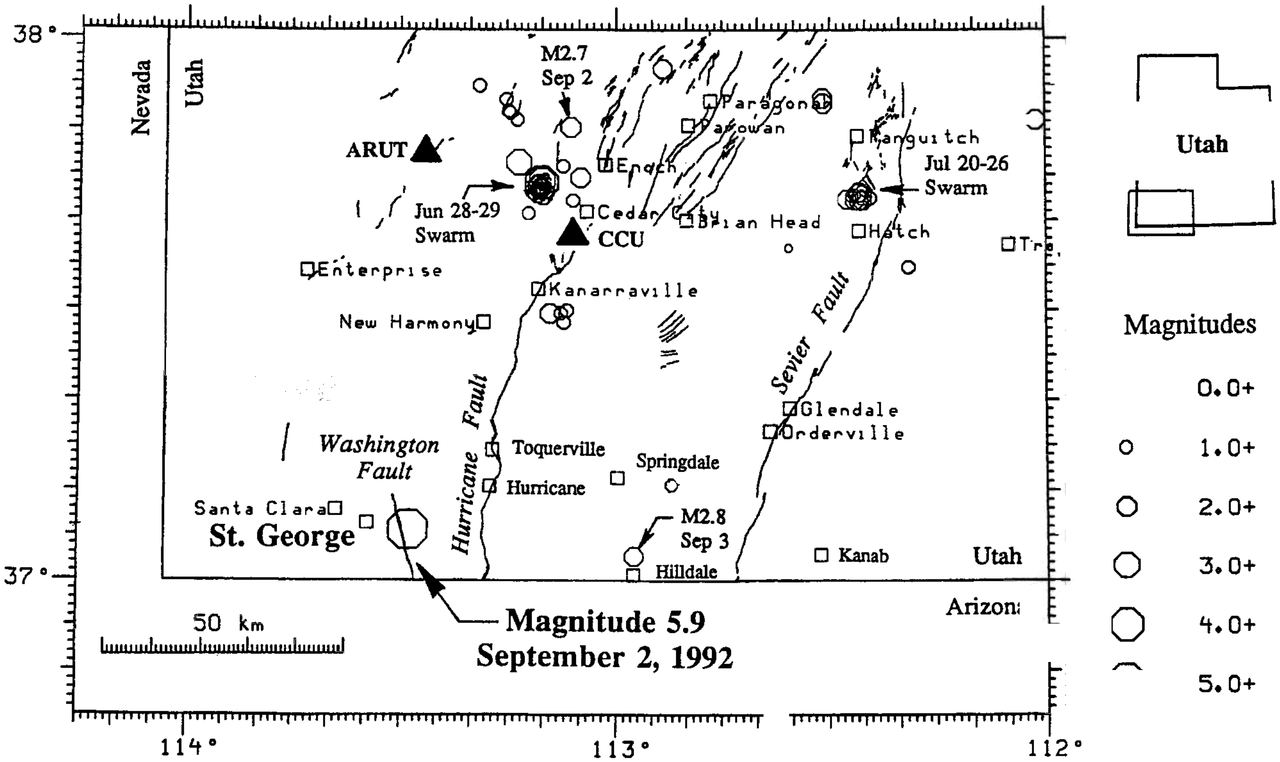
EERI Special Earthquake Report

St. George, Utah, September 2, 1992



Map shows epicenters (octagons) of earthquake in southwestern Utah, June 1 through September 5, 1992. Earthquakes of special interest, including the magnitude 5.9 earthquake on September 2, are labeled. Also shown are the locations of geologically young faults (after a compilation by S. Hecker), cities and towns (squares), and nearby seismographs (triangles labeled ARUT and CCU).

Overview

A damaging earthquake of M_L 5.9 (preliminary) occurred on September 2 in southwestern Utah, 9km ESE of the city of St. George. The shock was the largest in the Utah region since 1975 and the largest in the St. George area since 1902. No deaths or serious injuries were reported. The earthquake caused structural damage in at least three localities within about 50 km of the epicenter, produced liquefaction along the nearby Virgin River, and triggered a massive, destructive landslide 45km to the ENE in the town of Springdale. No surface faulting has yet been found. Although historical earthquakes have not exceeded magnitude 6.5 in southwestern Utah, late Quaternary geology and paleoseismology indicate that this region has the potential for earthquakes in the magnitude 7 to 7.5 range.

Preliminary Seismological Information

The earthquake occurred at 4:26 a.m. local time (MDT) on September 2 with an epicenter at 37.09°N, 113.47°W. A focal depth of 15km (±2km) has been estimated by T.C. Wallace, University of Arizona, based on teleseismic recording. Estimates of size include M_L = 5.9 (Univ. of Utah), M_W = 5.7 (T.C. Wallace, Univ. of Arizona), and m_b = 5.5 (USGS). Preliminary focal mechanisms indicate that the main shock was caused by dominantly normal faulting on a northerly-striking fault of moderate dip, possibly a west-dipping, subsurface projection of the Hurricane Fault.

Southwestern Utah lies within the Intermountain Seismic Belt. Background seismicity in recent months, prior to the September earthquake, included earthquake swarms in June and July. A swarm on June 28-29 ($M_L \leq 4.1$) began within an hour of the M_S 7.5 Landers, California earthquake. Small earthquakes have occurred episodically in the general area of the September 2 earthquake; five prior shocks of magnitude 2.0 to 3.1 had occurred within 25km of its epicenter since January 1990.

The September 2 main shock was not preceded by any immediate foreshocks ($M_L \geq 2.0$) and has been followed by remarkably few aftershocks. A magnitude 2.7 aftershock on September 10, eight days after the main shock, is the only aftershock larger than magnitude 2.0 that has originated in the epicentral area as of this writing (13 days after the main shock). Smaller microaftershocks have been recorded with portable seismographs. The absence of sizable aftershocks is clearly unusual for a main shock of magnitude 5.9, based on worldwide seismological experience. Using average parameters for California aftershock sequences, one would expect a main shock of this size to be followed by about 15 aftershocks of magnitude 3.0 or larger during the first 24 hours. Newspaper reports following the last earthquake of comparable size in the St. George region, the 1902 Pine Valley, Utah earthquake of estimated magnitude 6.0, indicate that numerous aftershocks were felt for at least 2½ weeks after that main shock. The implications of weak aftershock behavior, such as shown by the recent St. George earthquake, are uncertain at present. There appears to be no evidence that such behavior is a short-term precursor to a larger earthquake.

Contributed by Walter J. Arabasz, James C. Pechmann, and Susan J. Nava of the University of Utah, and Terry C. Wallace of the University of Arizona.

Geologic Effects

Contributed by Gary Christenson, Utah Geological Survey

Geologic effects of the earthquake, other than ground shaking, included rock falls, liquefaction, and landslides. Rock falls were common because the earthquake occurred in an area of steep cliffs and canyons. Local roads were temporarily closed as rocks were cleared, and rock fall in St. George damaged a car. Otherwise, little rock fall damage was reported, principally because the areas where rock falls were most common are remote and sparsely populated.

Liquefaction occurred near the epicenter along the Virgin River. Numerous small sand blows were found along the channel, and ground cracks indicating lateral spreading were common along channel banks. No damage to structures has yet been documented from liquefaction.

The most damaging geologic effect was a large landslide in Springdale (45km east of the epicenter) which temporarily closed State Highway 9, the entrance to Zion National Park. The main scarp is about 12m high, and the volume of material has been estimated to be about 20 million cubic meters. The landslide, which is believed to be one of the largest in the world caused by a M_L 5.9 earthquake, is much further from the epicenter than would be expected for a landslide of this type. Although movement was initiated by the earthquake, the landslide moved slowly and significant movement continued for many hours after the earthquake. The landslide destroyed three homes, disrupted utilities along Highway 9, and potentially threatens several businesses, the highway, and a condominium complex.

The two major potentially active faults near the epicenter are the Hurricane and Washington faults. Both were searched for evidence of surface rupture, but no scarps, ground cracks, or obvious surface deformation have yet been found. Of these two faults, the focal mechanism indicates that the earthquake was more likely on the Hurricane Fault. Paleoseismic data, chiefly late Quaternary slip rates, indicate that the Hurricane fault is one of the most active faults in southern Utah.

Effects on Buildings

Contributed by Larry Reaveley, Reaveley Engineers & Associates

The earthquake ground motion in St. George was very intense according to many people who experienced it. The individuals who were there and are experienced in building design expected to find considerable structural and nonstructural damage. The magnitude and location of the earthquake should have produced ground shaking that would cause significant nonstructural damage and structural damage to buildings not constructed in compliance with earthquake codes. Detailed observations of many buildings failed to verify the expected damage.

The only buildings structurally damaged were constructed utilizing massive stone walls or adobe bricks. There were no reports or observations of collapsed elements. Minor hairline cracks were observed in unreinforced concrete masonry partition walls. There were a few cases where light ceiling systems were damaged. Ceiling tile and gridwork were dislodged in grocery stores and gymnasiums. There were relatively few items dislodged from shelves. There were no reports of any water heaters overturning.

These observations raise the question of why there was so little damage. There were no instruments in the epicentral area, therefore no strong motion records exist. However, it appears to this observer that the duration may have been very short and the vertical motion may have been much greater than the horizontal motion. Similar motions were created following the 1983 Borah Peak Earthquake. Perhaps the ground motion created by normal faults in the intermountain west is different from other mechanisms.