The M4.1 Bombay Beach Earthquake Swarm of 13 November 2001

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Southern California Seismic Network/TriNet: cooperative project of Caltech and USGS

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A sequence of more than 70 small earthquakes has occurred near the southern end of the San Andreas fault, under the Salton Sea today (11/13/2001). Only the largest event, a M4.1 earthquake that occurred at 12:43 pm (local time), was reported being felt. The quakes are all tightly clustered under the Salton Sea, about 3 miles southeast of Bombay Beach, near the junction between the San Andreas fault and the northern end of the Brawley Seismic Zone. The largest ones have fault movement (focal mechanisms) consistent with the strike of the San Andreas.

The sequence this morning included seven earthquakes of M3.0-3.4 and one earthquake of M4.1. The sequence started gradually with a M1.7 earthquake at 5:43 a.m. (local time), which was followed by a M3.4 at 8:45 a.m. This early part of the sequence, before the largest event, was characterized by several earthquakes in the M2-3 range and very few smaller events. Later, the M4.1 earthquake occurred at 12:43 and was followed by a M3.2 within 3 minutes. During the next two hours, it was followed by at least 17 aftershocks of M1.6 to M3.2, with many more small events than had been recorded earlier. In seismologic terms, the ratio of large to small earthquakes, called b-value, was low during the first 4 hours and then increased after the occurrence of the M4.1.

We use seismic records to determine the orientation of the fault on which an earthquake occurs. All of the M3 and larger earthquakes in this sequence are consistent with slip on the San Andreas fault but could also be occurring on a fault perpendicular to the San Andreas. All the events are located about 4 km south of the mapped end of the San Andreas in the depth range of 3 to 5 km. Because the hypocenters form an alignment striking northeast, these earthquakes appear to be occurring on a small fault, perpendicular to the San Andreas (see attached Figure).

Three previous times in the last 30 years we have seen a M 3.0 earthquake in this part of the Salton Sea. However, those events showed focal mechanisms more consistent with the Brawley Seismic Zone. This is a region of seismicity that extends up the Imperial Valley from the Imperial fault towards the San Andreas. This morning’s sequence appears to be more closely associated with the San Andreas fault. In October 1999, following the Mw7.1 Hector Mine earthquake, numerous earthquakes were triggered to the south, between this location and the Salton Sea Wildlife Reserve.

There was a smaller swarm close to the same location in December of 1997. At that time, the largest event was a M3.7, and the focal mechanisms had a more northerly strike, consistent with the Brawley Seismic Zone. The most recent large sequence in the Brawley Seismic Zone was that of the M5.7 April 1981 Westmorland sequence that occurred about 20 to 30 km to the south. It showed a similar swarm like behavior with more than 1,000 earthquakes.

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