some suggestion in the layout of roads in Ejido Saltillo that the line of new surface breaks might once have been a natural boundary or barrier.

8. A Review of Geological Effects and Damage Distribution of the June 9, 1980 Mexicali Valley Earthquake

F. Suarez V., K.E. Sieh, W.E. Elders

The June 9, 1980 earthquake ($M_L = 6.1$) occurred on the Cerro Prieto fault located in the Mexicali Valley (Figure 8.1). A day and a half after the event, the area was inspected both from the air and on the ground.

The aim of the aerial reconnaissance was to obtain evidence of possible slippage of the Cerro Prieto fault as well as other phenomena related to the earthquake.

We did not observe any tectonic feature which can be related to the Cerro Prieto fault, no fresh scarps or fractures clearly indicating tectonic slip.

We found a lot of damage in the agricultural areas as well as in the small towns and villages located in the valley. The damage increases from the Cerro Prieto volcano (where scattered sandblows and fissures were observed) to the southeast and concentrates around the village of Pescaderos (Figure 8.1) and then decreases south from this point.

The ground reconnaissance started in the Cerro Prieto geothermal field where some fractures and sandblows were found just east of the Geothermal Electrical Plant (photo 1). A geologist from the Coordinadora Ejecutiva de Cerro Prieto finished a structural map of the area around the geothermal field and found three different sets of fractures. One set of fractures is oriented north-south, a second one has a general strike east-west and the third set of fractures has a northeast-southwest orientation. He believes that the northeast-southwest, and the east-west sets are tectonic features. We think that none of these fractures or cracks are tectonic; instead they could be features developed due to a liquefaction process.

The owner of a ranch near the Geothermal Plant told us that the shaking of the ground was from north to south and south to north. If he is right, we can infer that the zone of fractures is a result of a shaking perpendicular to the direction of the fractures and the liquefied layer below came spurting up through the fractures. This effect can be seen in photo No. 2, where a sandblow is emitting cold water and some yellow crust around the crater has formed indicating that some kind of gas was associated with the crater.

The largest fractures seen in this area were found near drains or irrigation canals. These fractures seem to be purely extensional features associated with the canals and also with the shallow liquefied layer. Perhaps, the digging of the canal involved removal of a significant portion of the overlying stiff silt of clay. The failure took place along the weakest part of the overlying stiff material (photo 3). We did not see any major damage to structures moving south of the geothermal field and passing the towns of Delta and Oaxaca. However, immediately upon leaving Oaxaca the road at the southeast of the town had many extensional transverse cracks (photo 4). Some of these cracks showed right lateral movement of about 2cm. Following this main road, we drove for about 5km looking for some evidence of the Cerro Prieto fault. Using seismic evidence alone, (Reyes 1979), this is a place where the fault can be traced, and therefore this should be the site to look for any tectonic features related to the fault; unfortunately, we could not find any of these features.

The general damage increased substantially from Olachea to Pescaderos, besides the damage in the agricultural areas (photo 5); the destruction in Pescaderos was very high. The damage here was definitely more severe than what we observed elsewhere; a quick view shows that 13 out of 39 adobe houses suffered major damage (including complete collapse) and this was also the case of two out of 19 concrete block houses (photos 6,7,8). It was also in this area where the railroad was warped and bridges were affected to the point that the rail traffic was interrupted for several days (photos 9,10).

According to Allen (personal communication) the Cerro Prieto fault can be seen on the surface south of Pescaderos. He describes a low scarp near to an old school within a cotton

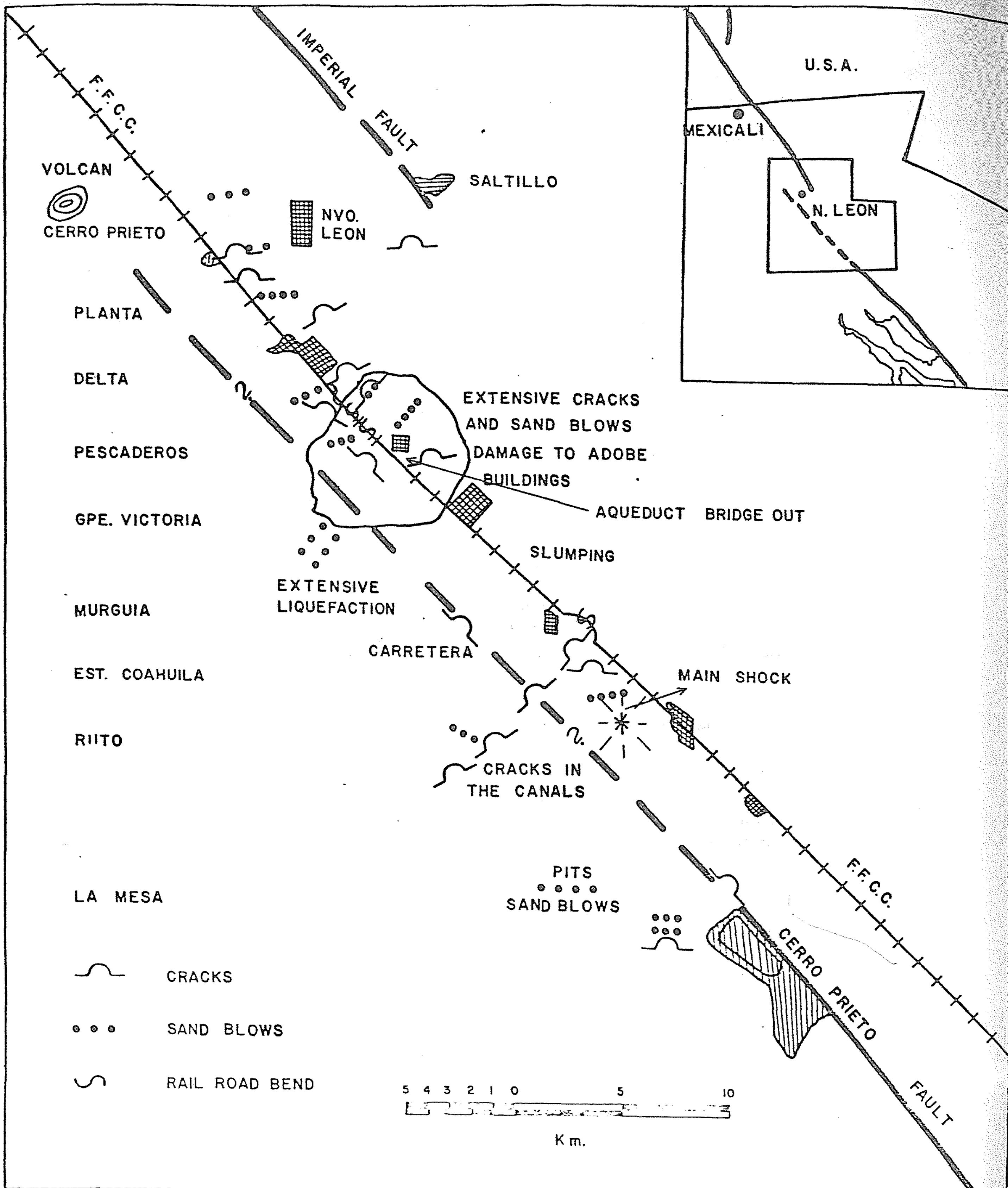

Figure 8.1 General map of the Mexicali Valley. Sites visited during the ground reconnaissance, and schematic illustration of damages and earthquake related features observed.

Photo No. 1 Sandblows located at the main entrance of the Cerro Prieto Geothermal plant. 48 hours after the earthquake, many of these structures were emitting water. The general orientation of the sandblows at this particular point was E-W.

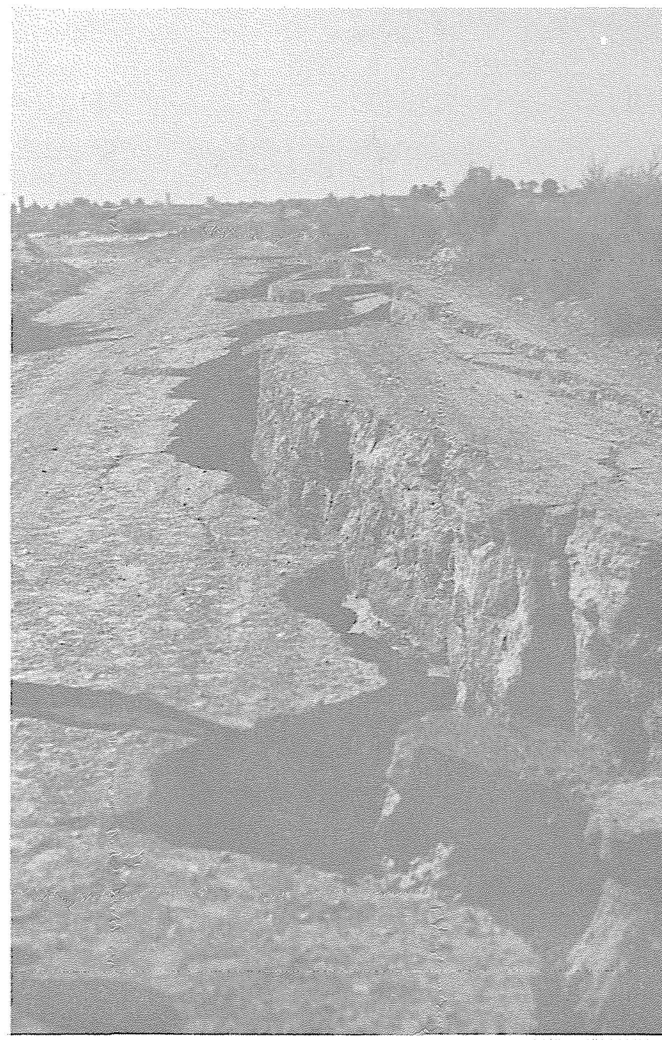

Photo No. 3 A large fracture (100m long) found 2km SE from the Cerro Prieto Geothermal plant, just west of irrigation canal located behind the bush on the right side of the picture.

Photo No. 2 A typical sandblow developed within a cultivated field after the earthquake. According to the owner of the ranch, some of the water that came up with the sand was hot and, in fact, killed his tomatoes.

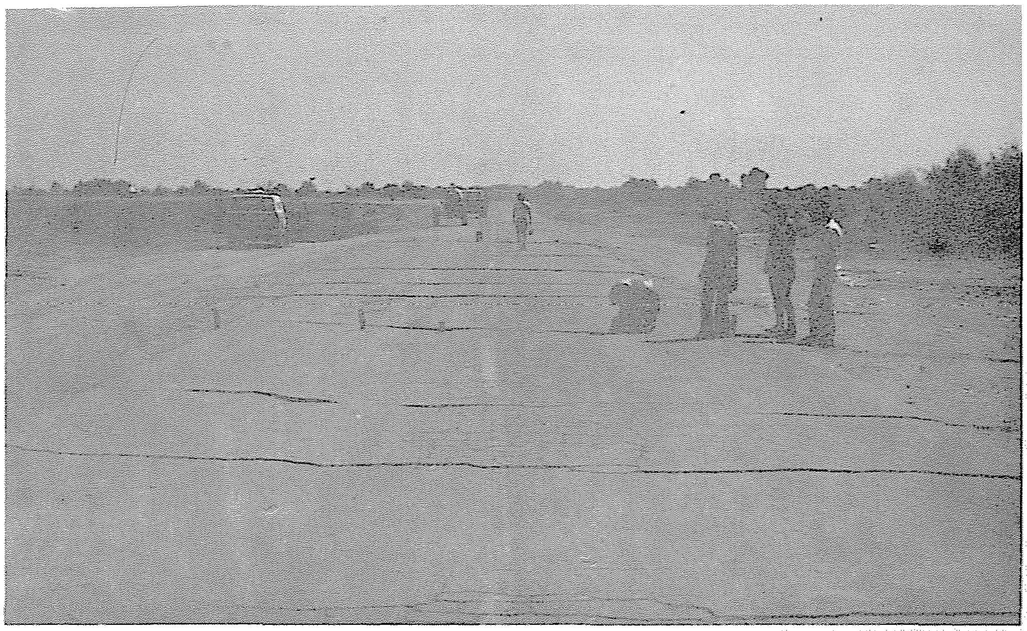

Photo No. 4 Transverse cracks found on the main highway at the southeast end of Oaxaca. Some of these cracks show a right lateral displacement of 2cm with a vertical component of about 5—7cm.

Photo No. 5 Several views of a drain located north of Pescaderos observe the collapse of these structures and all the fractures developed after the earthquake.

Photo No. 6 An adobe house in Pescaderos partially destroyed.

Photo No. 7 An adobe house in Pescaderos, complete collapse of the structure.

Photo No. 8 A totally destroyed concrete block house in Pescaderos Village.

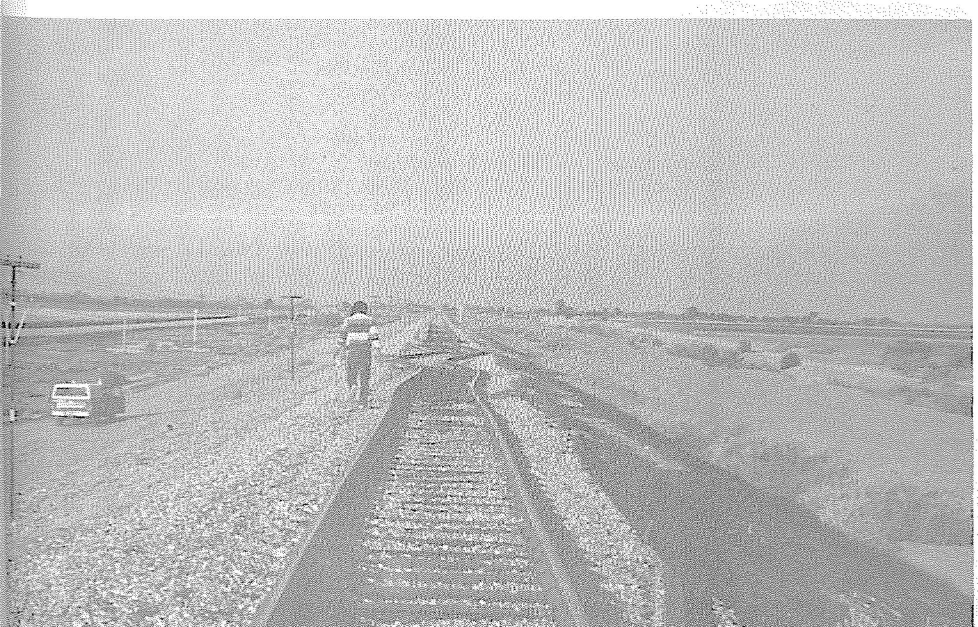

Photo No. 9 The rails were bent between Olachea and Pescaderos. This photo is courtesy of David Chavez, a CICESE seismologist.

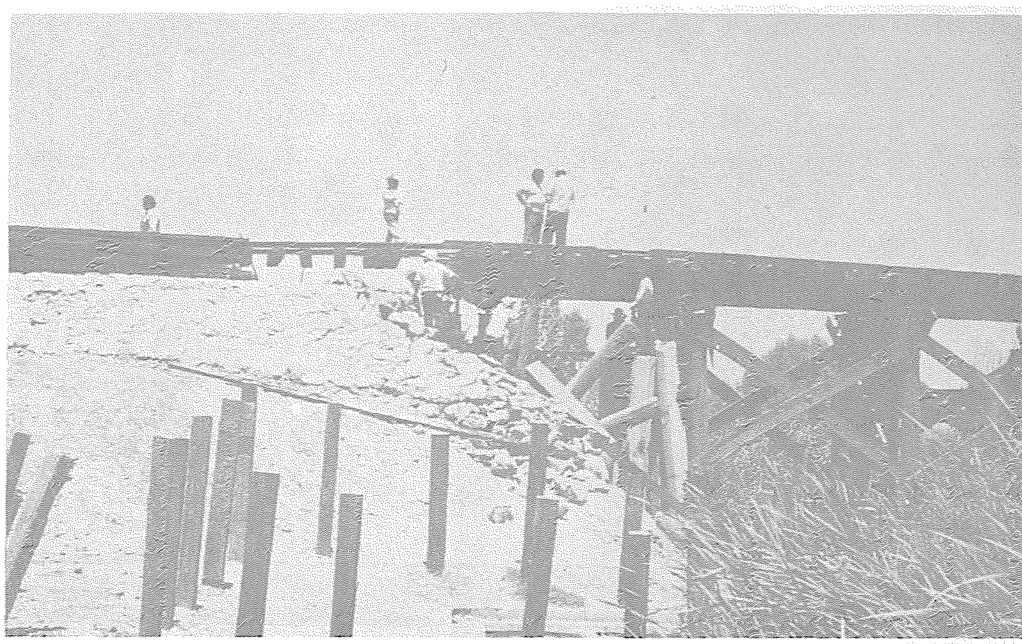

Photo No. 10 Damage in the railroad bridge. The abutments moved one meter with respec to the bridge structure.

Photo No. 11 Large slumpin at the northwest side of th Colorado bridge, 50m befor the toll-gate. On the opposit site, the bridge drops abou 10–20cm.

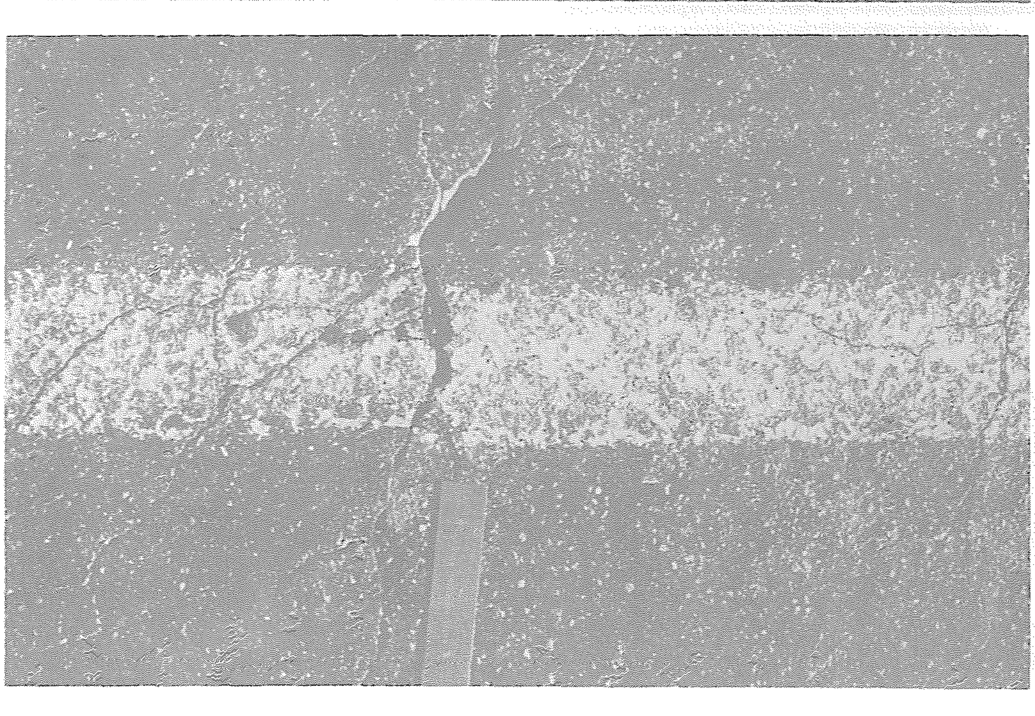

Photo No. 12 A fresh fractur found in the main highway jus east of Murguía railroad station The fracture shows a righ lateral displacement of 1–2cm The location coincides with the trace of the Cerro Prieto fault.

field which represents the superficial trace of the fault; however, we did not see any faulting or features which can be related to the fault. We observed damage in the canals, which were completely drained as well as many fractures in the bottom of the concrete-line canals, which apparently allowed the water to drain out.

The earthquake damage decreased south from Pescaderos and no severe damage was observed in the towns of Plan de Ayala, Coahuila and Mesa, this being the last site visited to the south. Perhaps the most notorious damage was observed at the south end of the Colorado Bridge. Here we found a drop of about 10-20cm and large slumping before the toll gate (photo 11).

Traveling to the north toward Mexicali we finished the survey just east of the Murguía railroad station. At 2.5km driving west of this section and from where the highway bends, we found cracks which were perpendicular to the roadway showing a right lateral motion of about 1cm (photo 12). Near this point, we found a dirt roadway crossing this highway. Perpendicular to the roadway we found a 6m wide zone of fracturing. One crack in the middle of this zone shows a right lateral motion of about 1cm. We also observed here cracks within the cultivated fields which are primarily slumping features. The shapes of these cracks are arcuate and oriented in various directions. One of these fractures found at the last site was oriented N37°W and showed a displacement of about 1cm in the right lateral sense. The importance of this feature is that its location is within a narrow zone which matches with the trace of the Cerro Prieto fault.

Taking into account the evidence described above we suggest a tectonic slip of about 1cm for the Mexicali Valley earthquake. However this has to be taken as a preliminary result. Through all our survey, we did not find any surficial manifestation of the Cerro Prieto fault. It is difficult to understand these results, especially if we compare this earthquake with others which have occurred in the same region. Three important cases are: the December 1934 Santa Clara earthquake, the May 1940 Imperial earthquake, and the October 1979 Mexicali earthquake. The first one is associated with the Cerro Prieto fault; the last two, with the Imperial fault. All three events produced surface indications of fault motion. At present this difference in behavior is not well understood and therefore it is necessary for further geological and geophysical research to clarify this point.

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