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Landslides triggered by the 15 August 2007 M8.0 Pisco, Peru earthquake

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The M_w 8.0 Pisco earthquake occurred along the seismically active western coast of Peru. The epicenter was located approximately 150 km south of Lima, and near Pisco, Alta, and Ica, three towns sustaining major damage to their buildings and infrastructure. Overall, at least 520 people were killed and over 1000 persons were injured in the earthquake. The event was recorded by several strong motion seismographs in the region with horizontal peak ground acceleration values as high as 0.50g being measured (Ica station, epicentral distance = 40 km). Soil liquefaction and consequent ground failure was the most significant geotechnical aspect of the event; however, landslides were also an important feature. This presentation on earthquake-induced landslides discusses the work of a joint United States-Peru geotechnical engineering research

team that performed a reconnaissance of the mesoseismal area several days after the event.

It is estimated that the earthquake triggered thousands of landslides, with a significant majority of these being disrupted landslides including rock falls, rock slides, soil falls, soil avalanches, and disrupted soil slides. Disrupted slope failures occurred in both natural and altered terrain (e.g. road cuts). Reports by the highway department indicate that rockfalls occurred over a vast region stretching as far as 700 km from the fault plane. Of the hundreds of landslides observed along Highway 024A, a major east-west roadway for the region, two were particularly noteworthy. The first was a massive ($\sim$ 20,000 m^3) rockfall located roughly 44 km from the fault plane which blocked the road for 3 days. This landslide involved blocky rock (Lower Cretaceous monzonites) with closely spaced, unfavorably oriented joints. In nearby natural terrain, these rocks were observed to weather to gentle slopes ($\sim$35 to 50 degrees) that remained stable in the earthquake. The second major landslide was a disrupted soil/rock slide located about 65 km from the fault plane. A significant quantity of slide debris completely covered the road surface, temporarily closing the highway. The slope consisted of sedimentary deposits of large (up to 1 m), subrounded igneous rocks in a silty sandy soil matrix. In contrast to many of the rockslides seen in the area, this disrupted soil/rock slide had a long run out distance, and ultimately spilled into the canyon below the road.

Perhaps the most spectacular landslide-related feature was a massive (at least 3 km^2) liquefaction-induced lateral spread of a marine terrace near the town of Canchamana. Horizontal displacement of the terrace appeared to be on the order of at least several meters. The near-surface marine terrace deposits were composed of an upper layer of non-liquefiable soil (weakly cemented sand), and a lower layer of liquefiable soil (silty sand). The thickness of the upper layer tapers from approximately 6 m on the east side to a thin veneer at the beach. Groundwater is in the range of several meters deep in the marine terrace and ground slopes were approximately 2%. The eastern boundary of the spread was defined by the interface between the marine terrace and the Pleistocene Canete Formation (conglomerate). The southern boundary appeared to be defined by the interface of the terrace with a Holocene alluvial sand deposit. The northern boundary was not firmly established, but appeared to be influenced by the presence of anthropogenic works at a bend in the Pan American highway. The lateral spread may have extended further to the north and this remains the topic of ongoing investigation.