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Liquefaction of Kawaihae Harbor and Other Effects of 2006 Hawai`i Earthquakes

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ABSTRACT

On October 15th, 2006, two earthquakes with magnitudes of M_w6.7 and M_w6.0 struck in close succession just off the Northwest coast of the Island of Hawai`i. The first of these, The Kiholo Bay event, produced a PGA of 1.03g in the nearby town of Waimea-Kamuela. Some of the worst damage occurred in Kawaihae Harbor, located only 24 km from the epicenter. Extensive liquefaction occurred in the dredged fill and in the natural calcareous deposits nearby, leading to lateral spreading and shifting of the pier-supported dock No.1. Numerous rock falls and landslides occurred, though only limited structural damage was noted on the Northern half of the Island of Hawai`i and the Eastern tip of Maui. This article summarizes the findings from a fact-finding reconnaissance by the authors two days after the earthquakes. Further details can be found in a more exhaustive report available at: http://www.eng.hawaii.edu/CE/news/news_earthquake.htm (Robertson et al., 2006).

KEY WORDS: Earthquake, liquefaction, Hawaii, dams, rock falls, structural damage

INTRODUCTION

Two earthquakes and numerous aftershocks struck the Northwest coast of the Island of Hawai`i (i.e. The Big Island) on October 15th, 2006. The Kiholo Bay earthquake, with a magnitude of M_w6.7, struck at 7.07 AM local time with epicenter location at 19.878°N, 155.935°W and focal depth of approximately 39 km (24 miles). It was followed by the Hawi earthquake, with a magnitude of M_w6.0, at 7.14 AM local time with epicenter location at 20.129°N, 155.983°W and focal depth of approximately 19 km (12 miles). The Hawi earthquake is considered a separate event and not an aftershock because of the distinct source location, although it was likely triggered by the larger Kiholo Bay earthquake (Figure 1). The effects of the earthquakes were felt on all islands in the State of Hawai`i. Figure 2 shows the USGS community Internet intensity map for the Kiholo Bay earthquake based on 2,900 individual reports received during the week following the earthquakes. It is likely that this map reflects the public response to both Kiholo Bay and Hawi earthquakes since the Hawi earthquake was initially perceived as an aftershock. The maximum Mercalli Intensity VIII was reported close to the Hawi epicenter, and personal communications with residents of the Hawi area indicate that its effects in their area were as severe as, or even worse than, those of the Kiholo Bay event. The shallower hypocenter location would likely have increased the local effects of this smaller magnitude event, while the effects at distant locations would have been less.

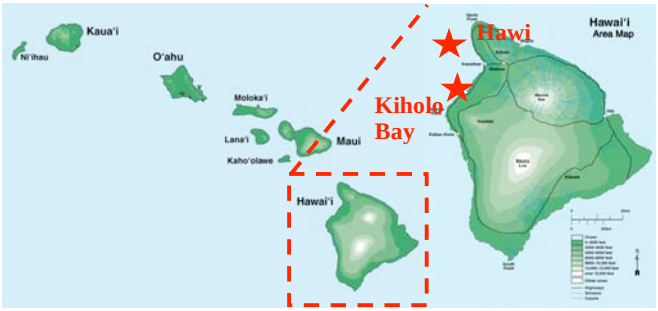

Figure 1. Locations of 2006 Hawai`i earthquakes

The Kiholo Bay earthquake was unusual for its location and depth. It is not associated with any well-known fault system but is probably related to tectonic flexing of the oceanic crust beneath the Big Island volcanic edifice as a result of continued island growth. Indeed, the most common type of earthquake in Hawai`i results from volcanic processes underneath the Kilauea, Mauna Loa and Hualalai volcanos. Magma intrusions into rift zones build up compressive stresses, which are occasionally released in the form of earthquakes. An example of such an event is the 1975 Kalapana M7.2 earthquake, which occurred underneath the flank of the active Kilauea volcano. Seismic activity decreases significantly with distance from the Big Island. Distant earthquakes attributable to intraplate seismicity from ocean crust faults, for example the Molokai fracture zone, also occur occasionally, although they are less frequent and their frequency-magnitude relationships are not well established. However, there is no doubt that seismic risks in Hawai`i are substantial, with probable PGAs exceeding 1.75g along the Southern part of the Big Island (50 year return period).