EFFECTS OF THE 1971 KAMCHATSKY PENINSULA EARTHQUAKE ON NORTHERN KAMCHATSKY BAY

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The 1971 Kamchatsky Peninsula earthquake (Mw 7.8) triggered a tsunami that was recorded on tide gauges 70 km away in the town of Ust-Kamchatsk, as well as in Hilo, HI, but with little reported local runup. At the north end of Kamchatsky Bay (Figure 1), we have identified sandy deposits attributed to the 1971 tsunami that overtop beach ridges 8-11 meters above sea-level (Figure 1). Ust-Kamchatsk is less than five kilometers to the west of these deposits, and written records from 1971 report little tsunami damage to structures near the beach, suggesting that the tsunami height was significantly lower near the town. Runup from deposits of the 1971 tsunami have been recorded on the open coast of Kamchatsky Peninsula (Martin et al. 2008), but the data for Kamchatsky Bay are sparse. We will try to determine if the tsunami height was actually smaller in coastal Ust-Kamchatsk by cataloguing and quantifying spatial variations in deposit runup values along Kamchatsky Bay. Then, by modeling tsunami runup from a variety of earthquake sources, we will determine if a submarine canyon in Kamchatsky Bay focuses tsunami runup to the east of Ust-Kamchatsk.

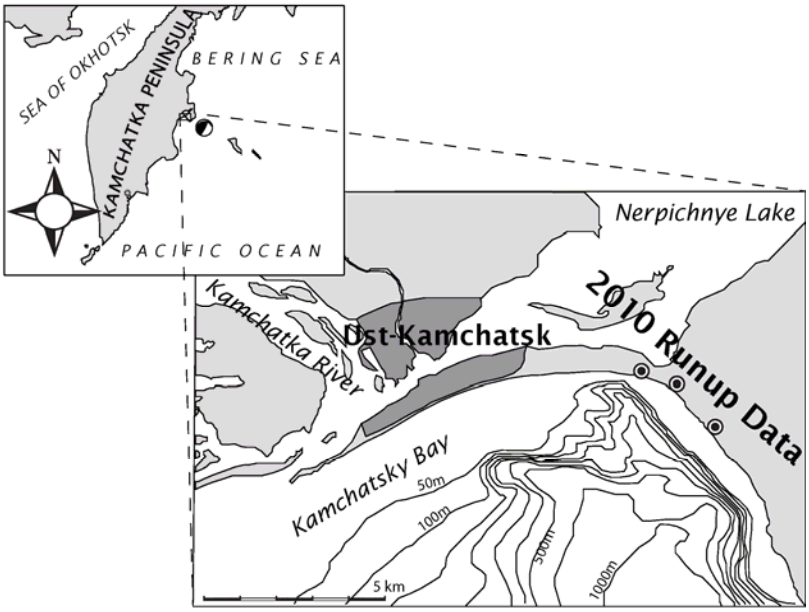

Figure 1: Map of Kamchatsky Bay. Gray areas are land. Contour lines show bathymetry, note the submarine canyon on the east side of the bay. The town of Ust-Kamchatsk is located on the west side of Dembi Spit. Three profiles measured in 2010 (circles) show where 1971 tsunami deposits were found, indicating overtopping of 8-11 m high beach ridges.

Along Kamchatsky Bay, the 1971 tsunami deposit is easily identifiable as a sand layer directly overlying a deposit of 1964 Shiveluch tephra. Ust-Kamchatsk, in the last century, has been damaged by larger tsunamis than 1971, but the lack of locally preserved marker tephra older than 1964 makes it difficult to distinguish other historical tsunami deposits from one another. Also, historical data for older earthquakes are less reliable or nonexistent. Therefore, the 1971 event is the prime candidate to model and compare to field data. However, one caveat of studying this relatively recent event is the possibility that the deposit has been reworked by human activity in areas closer to the town.

To model tsunamis, we use GeoClaw, which models depth averaged flows with adaptive refinement (Leveque et al. 2011, online). After specifying the sea-surface deformation due to a given earthquake, the model propagates the resulting wave over bathymetry and onto land (Figure 2), where we can determine the modeled runup. We will use measured runup in the field to compare to modeled runup in order to determine if the bathymetry in Kamchatsky Bay is a large control on runup. There is a submarine canyon on the east side of the bay (Figure 1), and we would like to see how this canyon in particular influences runup. By modeling similar sized earthquakes, but with different epicenter locations, we can determine whether or not the bathymetry consistently produces higher runup to the east of Ust-Kamchatsk, and whether the specific location of the 1971 rupture causes this behavior..

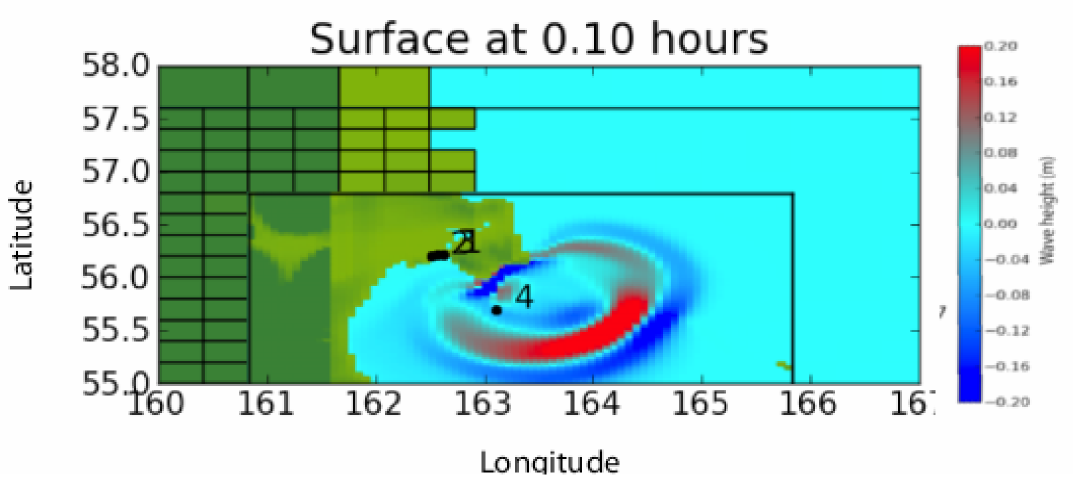

Figure 2: Preliminary model run of the 1971 tsunami in GeoClaw, showing waves propagating from the earthquake epicenter six minutes after the rupture. Earthquake source from Martin et al, 2008.

Preserved tsunami deposits have been vital in determining tsunami and earthquake recurrence intervals in Kamchatka because of the short and often incomplete written record in this region. (Pinegina, Bourgeois, 2001). A better understanding of the magnitude of the 1971 tsunami in addition to modeling tsunami runup in Ust-Kamchatsk will provide a broader picture of the tsunami hazards posed to communities in this region.

References

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