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The September 16, 2015 Illapel Tsunami – Sedimentology of tsunami deposits at the beaches of La Serena and Coquimbo

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On September 16, 2015, at 7:54 pm local time, an earthquake with Mw 8.3 occurred off the coast of Central Chile, 46 km west of the town of Illapel. Its hypocenter was located at a depth of 8.7 km in the transition zone from the Chilean flat slab to the central Chilean steep slab subduction geometry, and near the intersection of the Juan Fernandez Ridge with the South America plate. The quake caused a predominantly minor tsunami between Caldera (c. 27°S) and Los Vilos (c. 32°S). Only at Coquimbo and La Serena (c. 30°S) did the tsunami attain large wave heights on the order of 4.5 m leading to flooding and destruction of infrastructure. Maximum inundation distance was c. 700 m at Playa Changa, Coquimbo Bay. Minor flooding occurred along the northward adjacent beaches of La Serena reaching inundation distances of up to 150 m.

Tsunami deposits are usually the only observable evidence of past events. To understand how tsunami deposits form and are preserved, and how they can be identified in the geological record, it is of paramount importance to undertake detailed studies in the wake of actual events. Here we report initial field data of a sedimentological post-tsunami field survey undertaken in October 2015.

The most comprehensive and instructive sedimentological record of the September 16, 2015 tsunami is preserved at Playa Los Fuertes in La Serena. Along a 30 m long trench perpendicular to the coast we observed a laminated package of tsunami deposits of varying thickness. The deposits have an erosive basal unconformity with an amplitude of at least 10 cm. The preserved deposit thickness varies between 10 an 50 cm. The deposit consists of 7 layers of variable thickness, ranging between dark laminae a few millimeters thick and rich in heavy minerals, and lighter colored sand layers up to 15 cm thick. Grain size distributions are moderately well to well sorted and unimodal with modes between 1.3 and 2.0 Φ (medium sand). A c. 10 cm thick laminated layer in the central part of the vertical section includes mildly trough-shaped crossbeds indicating landward flow, a c. 5 cm thick layer 10 cm below the top in the interior part of the trench contains planar cross beds formed by outflow currents.

Water escape occur as small sand diapirs and volcanoes within the final deposit. Water escape through small volcanoes appears to have been coeval to formation of the overlying layer by traction deposition as sand issuing from the lower layer has been preserved as a thin plume deformed in the downcurrent, i.e. landward, direction in the newly forming upper layer. Other sectors of the sediment show sand diapirs intruding up to 15 cm into the overlying tsunami deposit.

The assemblage of laminae, layers and sedimentary structures indicates that the deposit records at least two events of tsunami inflow indicated by crossbeds and deformed sand volcano plumes, and one outflow event. Intervening layers without directional structures can not be assigned unequivocally to either inflow or outflow deposition.