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Preliminary report on the bedforms of the tsunami deposits from the 2011 off the Pacific coast of Tohoku Earthquake

Osamu Fujiwara^{1*}, YUKI SAWAI¹, Masanobu Shishikura¹, Yuichi Namegaya¹, Haruo Kimura¹, Kyoko Kagohara¹

¹Geological Survey of Japan, AIST

Tsunami from the 2011 great Tohoku earthquake formed tsunami deposits on throughout the Kujukuri coast, East Japan. Land survey performed immediately after the tsunami revealed various forms of tsunami deposits, such as the variation of thickness, grain size and bedforms of the deposits. These sedimentological data will contribute to understand the tsunami sedimentation process, and also improve our skill to identify the tsunami deposits from the storm deposits, which is indispensable knowledge in the paleo-tsunami researches.

Observation sites and tsunami: 1) Hasu-numa, San-mu City, Chiba Prefecture, where the tsunami partly washed over the coastal dunes with height of ~4-5 m and inundated inland ~1 km (1.8 m in height) from the coast line along the a paved road. 2) Katakai fishing port, Kujukuri Town, Chiba Prefecture, where the tsunami height was 3.77 m above sea level of 15:18 PM, March 12 and flooded from the quay to the vacant land and road.

Tsunami deposit in the Hasu-numa coast

The 2011 tsunami eroded the sandy coast and sand dunes, then transported the eroded materials mainly inland and formed tsunami deposit. The tsunami deposit was mainly distributed behind the dunes (with patchy distribution on the sea-side area of the dunes) and generally tapered landward direction. The maximum thickness is ~15cm. According to the observation along a road in coast-normal direction, the tsunami deposit was mainly composed of well sorted fine sand within ~600m from the coast-line, and then the more it was distributed inland the more it became muddy. Finally the trace of the tsunami was marked by debris (mainly plant fragments) concentrated lines near its inundation limit.

Bedforms characterizing the tsunami deposit is ripples with various size and shape. Many of them are current ripples with a wavelength ranging from several cm to 10cm, which suggest a uni-directional current. Flow-directions reconstructed from the ripples were mainly landward (tsunami run-up) within ~500m from the coastline, however, more inland area, seaward directed flow (tsunami back wash) was dominant. Thin film of mud (mud drape) resulted from the suspension fall out during the slack water condition (after the flooding) often covers the ripples.

Interference ripples showing honeycomb pattern characterized the slopes connecting the sidewalk and roadway. As interference ripples are formed by the interaction of two-directional current, they suggest that the flooded water on the sidewalk concentrated in the slopes from landward and seaward and collided each other there, and then was drained to the roadway.

Tsunami deposit at the Katakai fishing port

Tsunami deposit at this site was also characterized by fine-grained sand bed with current ripples, ranging from 8 to 12 cm in thickness. Probable source of the current ripples ornamenting the surface of the tsunami sand bed is tsunami backwash. The vertical section of the tsunami deposit was characterized by the fine alternation of sand sheets and mud drapes, and suggests the repeated occurrence of the tsunami flooding intercalating the slack water periods. At least four tsunami flooding (sand sheets) and three slack water periods (mud drapes) were recognized here.

Keywords: 2011 Tohoku Earthquake, Tsunami, Tsunami deposit, Kujukuri