Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

HCG35-09 Room:105 Time:May 27 11:30-11:45

Developing process-oriented studies of tsunami-induced erosion and deposition, and morphological changes: A brief review

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Tsunamis are capable of eroding huge amount of sediments, depositing them everywhere in the impacted areas and modifying the coastal morphology. Decrypting geological records of tsunamis as well as modeling their sedimentary processes is crucial for providing information for improved hazard assessment. In addition, geological and sedimentological researches may lead us to comprehensive understanding of the linkage of sedimentary process between land and sea (Goto et al., 2014), and clarifying long-term changes in coastal morphology and environments regarding the effects from infrequent large-scale tsunamis.

What information of the tsunami is reflected to its deposits depends on the local settings and dynamics of the tsunami waves. For example, eyewitness accounts suggested that the second wave of the 2011 Tohoku tsunami brought the massive marine sediments onto the head of Samenoura Bay, southern Sanriku Coast. The first wave, which had an equivalent height to the second wave, did not contributed to the formation of the tsunami deposit (Sugawara et al., 2014a). In this case, no information for the first wave can be extracted from the tsunami deposit.

Understandings (and sometimes insights as well) on the processes of the tsunami wave, flow and sediment transport are indispensable to derive interpretations of the deposits that is consistent with the tsunami behavior. Numerical modeling is capable of capturing part of the dynamics of tsunami sedimentation. Along with perspectives of local morphology and sedimentary environment, the modeling may provide aids to interpret the tsunami deposits and tsunami-induced morphological changes.

Our increasing knowledge on tsunami deposits is founded on the various kinds of massive datasets since the beginning of the research field, in particular after the 2004 Indian Ocean and the 2011 Tohoku Tsunamis. Numerical studies of tsunami sediment transport are also founded on the dataset, and these studies brought improved understandings on the tsunami sedimentation. In the case of the 2011 Tohoku Tsunami in Sendai Plain, geological data for the lack of marine signature from the onshore tsunami deposit and the characteristic deposition patterns were explained by the numerical modeling of tsunami transport of sandy sediments (Sugawara et al., 2014b). Tsunami deposits sometimes share their sedimentological characteristics with turbidites. Similarities in terms of a coupled hydrodynamic-transport process between onshore tsunami flooding and submarine self-accelerating turbidity current are found recently and they have been investigated using numerical approaches (Naruse et al., 2014).

Collaboration of observation and modeling are the key for integrated understanding of tsunami erosion, deposition and morphological change. Process-oriented researches may contribute to depict the dynamics of tsunami sedimentation and to make improved criteria to interpret tsunami deposits.

Keywords: Tsunami deposit, sediment transport, numerical modeling