Challenges of identifying the tsunami deposits using the sedimentary features

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Identification of the tsunami deposits from the other event such as storm deposits have been an issue of capital importance since the primary stage of paleotsunami researches. As shown by the previous studies, the greatest features of the tsunami deposits are 1) their long inundation distance beyond the inundation limit of the storm surges and 2) their taper shape body showing a thinning landward trend (e.g., Fujiwara, 2008; Goto et al., 2011). In the paleotsunami researches, however, it is difficult to detect these features due to the post depositional disturbance; spatial distribution of the tsunami deposits is generally discontinuous in the geological record. Limitation of the spatial extent of suitable area for paleotsunami survey complicates the problem. In order to solve this problem, it is necessary to obtain the peculiar sedimentary features to tsunami sedimentation process, and that is in size of the small outcrop or sediment cores.

The 2011 Tohoku-oki tsunami formed ripples and dunes with various size and shape on the coastal area. The morphologies of the current ripples and dunes reflect the speed and duration of the inundated tsunami flows as well as their direction (Fujiwara et al., 2012; Fujiwara and Tanigawa, in press). Then the analyses of the ripples and dunes in the event deposits may provide the diagnostic criteria for the tsunami deposits.

Multiply layered sand beds also characterize the tsunami deposits from the 2011 event in some places. Each sand layer shows a normal grading and is covered by a mud drape. Cross-cut section of these tsunami deposits looks like a ham-sandwich made with bread (graded sand sheets) and sliced ham (mud drape). Formative process of this structure is explained as follow. Tsunami run-up flow formed a graded sand sheet covering the ground surface. When the run-up flow slowed down and stagnated, fine suspended matters fell out and draped the sand sheet. When the return flow accelerated, the deposition of the sand sheet reactivated covering the mud drape. Suspension fallout from the ponded water remaining after the tsunami covered the sand sheet. Repeated occurrence of run-up and return flow formed the multiply layered tsunami sand bed. This structure is peculiar to tsunami that has a long wave period with several tens of minutes.

The tsunami deposits exhibiting the “ham-sandwich structure” has been reported from both the subaerial and subaqueous conditions. This structure was found from the tsunami deposits formed in the middle Holocene drowned valley along the southern Kanto coast (Fujiwara and Kamataki, 2007). Similar structure was reported from the volcano-genic tsunami deposit from the 7300 cal BP Akahoya eruption occurred off the southern Kyushu (Fujiwara et al., 2010). Depending on the preservation condition of the tsunami deposits, run-up and return flow deposits alternately overlap with each other. If the whole succession of the tsunami deposit is preserved, each sand sheet becomes thinner and finer as its position approaches the top of the tsunami deposit. This thinning and fining upward trend of the sand sheets shows a waning process of the tsunami wave train.

References
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