Tsunami sedimentology for disaster science
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Researches on paleotsunami deposits are typically focus on identification and dating of the tsunami event and estimation of its magnitude information, in order to assess the hazards and risks of large-scale tsunamiis. Perspective understandings of modern tsunami events and the relevant sedimentation processes, as well as our ability to extract useful information from the tsunami deposits, may be the basis to tackle the issues on the tsunami-risk assessments. Even in the modern cases, what we can obtain in the field is the final state of the tsunami event, because of the difficulties in in-situ, instrumental observation of tsunami sedimentation. Our understandings on the formation process of tsunami deposit is largely depends on interpretation of the deposits, regardless of the age of the tsunami event.

A lot of proxies have been proposed to identify paleotsunamis (e.g. Goff et al., 2012). General criteria is not yet established due to the diversity of the distribution and nature of the tsunami deposits. Recent researches have made it clearer that understandings on the sedimentation process may be indispensable to enhance our ability for identifying tsunami events from the deposits. For example, we may have a tendency to assume that tsunami deposits consist of more or less amounts of materials from the sea floor. It sometimes is a key criterion to discern the marine (i.e. tsunami) origin of the deposit. However, the findings from the 2011 Tohoku tsunami proved clearly that it is not always applicable; for example, quite minor contribution from materials from the sea floor, such as heavy minerals and diatoms, were found from the sediments deposited in the Sendai Plain (e.g. Szczuciński et al., 2012). A numerical modeling showed that whether the onshore tsunami deposit include marine materials or not is controlled by the combined effects of the local bathymetry, topography and the incoming waveform. It seems that an integrated understanding on the tsunami event, which may include geological and geomorphological backgrounds and local behavior of the tsunami waves and currents, is the basis to identify tsunami events.

With regard to field observation, we will be able to obtain the data effectively, if the locations with higher possibilities of tsunami sedimentation are estimated prior to the survey. For example, a preliminary numerical modeling of tsunami propagation near the Samenoura Bay, southern Sanriku Coast, showed a higher possibility of the generation of greater tractive force and resulting erosion and deposition. In fact, a sand layer with few tens of meters to one meter was deposited on the land, and the elevation of the sediments deposited in the bay head reached up to 20 m.

Both eyewitness accounts and numerical modeling suggested that the bay was struck by two waves with identical heights of 20 m, and the transportation and onshore deposition of marine sediments took place due to the second wave. It is notable the first wave, which was comparable to the first wave in terms of the height, had not moved the seafloor sediments onto the land. The example from the Samenoura Bay presented the importance to understand the sedimentation processes during the tsunami event, as well as to be aware of the limitations of information obtainable from tsunami deposits.

Now numerical modeling plays an important role to understand the perspective of the tsunami event. We can draw a picture of the temporary-variable, complex tsunami event, based on the integrated analysis and interpretation of the field data and numerical reconstruction. Both forward and inverse models of tsunami sediment transport have been validated using the massive dataset of the 2011 Tohoku tsunami. Enhanced application of the numerical modeling of tsunami sedimentation will facilitate our understanding on tsunami events, as well as the assessment of risks from future large-scale tsunamiis.

References