High-precision age estimation of tsunami deposits in Koyadori, Yamada Town, northeast Japan

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Radiocarbon dating is generally conducted for age estimation of tsunami deposits. Moreover, other dating methods were applied depending on sediments and regions (Sawai, 2012). However, we need to consider and assess accuracy of measured dates because contamination and disturbance affect accuracy and precision of them. In this study, we conducted radiocarbon dating using some kinds of materials for precise age estimation of tsunami deposits and discussed about appropriate samples for age estimation. Moreover, we measured excess 210Pb and 137Cs for age estimation of very young sediments. From these data, we obtained more accurate and precise age model for tsunami deposits at Koyadori than previous study (Ishimura and Miyauchi, 2015).

Keywords: tsunami deposits, radiocarbon dating, 210Pb, 137Cs, Sanriku Coast

Historical and paleo-tsunami events based on tsunami deposits during the last 4000 years along the Pacific Coast of Iwate Prefecture

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Iwate Prefecture is advancing examination for future tsunami hazard based on scientific knowledge such as historical records and tsunami deposits. We evaluated the correlations of large tsunami event during last 4,000 years along the Pacific Coast based on the result of tsunami deposit survey and data reported by previous studies.
According to the geological evidence, the event corresponded to 1611 Keicho Oushu (Sanriku) tsunami is recognized along the northern and middle coast of Iwate Prefecture. The event probably correlated with this tsunami is also distributed around the Hirota Peninsula. Because radiocarbon age of this event shows 14th Century to early 17th Century, it is possible to correlate with 1454 earthquake that tsunami might have occurred. We have judged this event is corresponded to 1611 Keicho tsunami because (1)only one event is recognized in this age, (2) 1611 Keicho tsunami were recorded major damages in ancient documents along the Iwate coast. Same event is known in the Sendai and Ishinomaki Plain. Tsunami event that occurred in 17th Century is also recognized along the southeastern coast of Hokkaido.
The event corresponded to 869 Jogan tsunami is recognized throughout the coast of Iwate Prefecture. At Noda lowland and the Hirota Peninsula, an event layer is deposited just below tephra layer that is identified as Baitoushan-Tomakomai tephra (B-Tm) that was deposited in early to middle 10th Century or Towada-a tephra (To-a) of AD915. The horizon of this sand is similar to the Jogan tsunami deposits reported in the Sendai Plane. Geological evidences of the tsunami event that occurred in 9th Century to 10th Century are known along the Pacific Coast from Hokkaido to Fukushima.
Six or seven simultaneous events during last 4,000 years are recognized throughout the coast of Iwate Prefecture, and their intervals are about 500-750 years. However, event ages in 2,000-4,000 yrBP of northern coast show a little difference to southern coast. The boundary of this gap is around the Funakoshi Bay.
On the other hand, several events are correlated only in the limited area. These events might suggest smaller tsunamis or events that generated from factor besides the earthquake (for example landslide of seafloor).
Our evaluation is based on many assumptions. For future tsunami hazard, we need further investigation and have to understand more earthquake phenomena around the Japan Trench and Kuril Trench.

Keywords: tsunami deposit, geochronology, historical tsunami, Jogan tsunami, Keicho Oushu (Sanriku) tsunami, Iwate Prefecture

Grain characteristic of Tsunami deposit in Hirota bay

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The study of onshore features for tsunami impact is well researched, but offshore is only a few researches. In this presentation we will show about characteristics of lithofacies and grain features about 2011 Tsunami deposit using Sub Bottom Profiler (SBP), Vibration Core Sampler (VCS) and Grainsize analyzer.

We took the columnar core at water depth from 8 to 30 m. The columnar cores were able to sectionalize into mainly two units by lithofacies, Unit1 (sand layer) and Unit2 (muddy layer) from the top. Yokoyama et al. (2014) estimated Unit1 were 2011 Tsunami deposit and Unit2 were normal sediment in this bay.

We estimate U1 distribution with thickness approximately 7-80 cm. Change of U1 thickness about east and west side were grow thick from coastal area to water depth 16-25 m, and grow thin from water depth 16-25 m to deeper side. East side drastic grow thin than the west side.

We making correlation chart using median diameter and sorting value of core sample and beach sand, and using for infer the origin of Tsunami deposit. U1 and U2 distribute clearly different area. U1 distribute during the U2 and beach sand, it means the possibility of U1 have originated as both. Most coastal side core sample shown the same value with Takatamatsubara beach sand. Sub unit of U1 shown sorting were almost same area, but grain size become smaller from bottom sub unit (U1a) to upper (U1b). U1c were located in U2 area, it shown the possibility of U1c have originated as U2. Combination of Lithofacies, Grain size analysis and correlation median size and sorting value have possibility about estimate flow mechanism and origin of Tsunami deposit.

Keywords: Tsunami deposit, Sanriku coast

Behavior of the 2011 Tohoku-oki tsunami using magnetic fabric

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Behavior of the 2011 Tohoku-oki tsunami was reconstructed using magnetic fabric. First, a plane bed was formed using experimental flume in order to verify the effectiveness of the magnetic fabric, and it is confirmed that the current direction estimated using magnetic fabric is the same direction of flow in the flume. Then, field survey and facies descriptions of the deposits were conducted in Odaka area, Minami-Soma city, Japan. The deposits were divided into three sedimentary units based on facies descriptions and magnetic fabric data. Unit 1 is of medium-grained sand including abundant mud clasts and is interpreted to inflow deposits. Unit 2 consists of parallel laminated medium-grained sand deposited under return flow of the tsunami. During the final and/or post tsunami period, organic silt (Unit 3) was accumulated from stagnant water caused by the tsunami.

Keywords: magnetic fabric, tsunami deposits, anisotropy of magnetic susceptibility, the 2011 Tohoku-oki tsunami

Tsunami deposits in Holocene sediments on Shita Plain, Shizuoka, central Japan

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Geological coring in Hamatome lowland of the northern Shita plain, central Japan, revealed occurrence of two event deposits which composed of single or multiple graded beds with sharp erosional bases and 10–60-cm-thickness and represent the higher-energy hydrodynamic event. Radiocarbon dates show that two event deposits were deposited from AD 780 to AD 1025, and after AD1025, respectively. The lower event deposit overlies back marsh clay and in turn is overlain by backshore and beach ridge deposits, indicating that higher-energy hydrodynamic event was accompanied with rapid transgression. The correspondence between geological and historical records, we concluded that lower event deposit was caused by AD 887 Ninna tsunami and that the transgression was associated with submarine landslide and/or erosion by tsunami. The upper event deposit may be caused by AD 1498 Meio tsunami.

Keywords: Shita plain, Holocene, tsunami deposits

Event deposits recorded in the coastal plain in Toyama and Ishikawa area

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Tsunami deposit was investigated in Noto Peninsula and coastal area of Toyama Bay. The coarse sand layers which includes rounded gravel were admitted from the coastal terrace sediment. The age of these events indicates 19th century, 9-11th century and 1800-2000 calBP.Boring exploration was performed at Suzu, Himi, Imizu, Uozu and Kurobe city. An event sediment was authorized from a core sample in each spot and age was presumed. As a result event sediments common to each spot on Toyama-wan coast were 4 horizons of about 7900-7800 calBP, about 5000- 4800 calBP, about 2500-2000 calBP and about 800-700 calBP. Judged from an altitude of beach ridge and the distance from the coast, these event sediments have a high possibility by the tsunami wave.

Keywords: toyama and ishikawa area, Tsunami sediment

Using onshore sediment cores to reconstruct the ages of oceanic intraplate earthquakes in Beppu Bay

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Historical written records document the devastation of the coasts of Beppu Bay, eastern Kyushu, Japan, by a tsunami associated with an oceanic intraplate earthquake in AD 1596 (*M*=6.9, Hatori, 1985). Results of acoustic and coring surveys conducted in the bay (e.g., Shimazaki et al., 2000; Ooita Prefecture, 2002), show that east part of the Beppu Bay–Hijiu active faults has been active five times since the deposition of the K-Ah tephra (7170–7300 cal. yr BP, Smith et al., 2013). However, the accurate timing of these fault ruptures is yet to be determined. It is also not known whether each prehistorical earthquake triggered a tsunami or not. The aim of this study is to establish a detailed chronology of tsunamigenic earthquakes that occurred in Beppu Bay in prehistorical ages using data from onshore sediment cores obtained from a coastal marsh located on the south coast of the bay. In order to identify prehistorical tsunami deposits, sediment cores were analyzed for grain size, diatom and geochemistry (using an ITRAX core scanner) combined with the observation of sedimentary facies. Radiocarbon analysis of plant material taken from the organic-rich mud immediately above and below the assumed prehistorical tsunami deposits was also undertaken.

At site OEJa-02 (170 m from the shoreline), the sedimentary sequence between 2.0–7.8 m depth is mainly composed of organic-rich mud. Plant material obtained from the uppermost (2.15–2.17 m depth) and lowermost (7.79–7.80 m depth) parts of this section returned ages of 2760–2860 cal. yr BP and 7670–7790 cal. yr BP, respectively. Two tephra layers at 4.30–4.33 m and 5.30–6.50 m depth were identified as the Danbaru scoria (DS) and the Kikai-Akahoya tephra (K-Ah), respectively, based on refraction indexes of volcanic glass. Three sand layers were observed in the sedimentary sequence. Two are thin sand units above the 5700-year-old DS and which are dated to 3330–3450 cal. yr BP and 4400–4530 cal. yr BP, while there is another 6500-year-old sand layer between the DS and K-Ah tephras. Immediately beneath the K-Ah layer, there is a 4 cm thick graded unit composed of pebbles to coarse sand. All sand units exhibit sharp upper and lower contacts with the surrounding muds, suggesting that they were deposited by a sudden event. They are characterized by higher magnetic susceptibility associated with higher counts of titanium (Ti) and iron (Fe), as well as silicon (Si), potassium (K), calcium (Ca), vanadium (V), chromium (Cr), manganese (Mn), strontium (Sr), and barium (Ba) than in the overlying and underlying organic-rich muds. Principal component analysis of the ITRAX results suggests that the sand grains were transported from different environments. Moreover, as the marine benthic diatom *Rhaphoneis* sp. occurred in the sand layers, but not in the surrounding muds, the sand units appear to have, at least partly, a marine source.

The sedimentary record since the K-Ah tephra includes at least three probable prehistorical tsunami deposits from 3300–3450, 4400–4530, and 6500 years ago. Based on the submarine cores obtained from Beppu Bay, the last five fault ruptures are estimated to have occurred 1700–2200, 3600–4600, 5300–6000, and 5800–7300 years ago in addition to the AD 1596 earthquake (Headquarters for Earthquake Research Promotion, 2005). Bearing in mind that the record preserved in the sediment cores at our study site does not include the last 2760–2860 years, the number of past tsunami deposits reported here show some agreement with the results of the offshore seabed research (e.g., Ooita Prefecture, 2002; Headquarters for Earthquake Research Promotion, 2005).

Keywords: Tsunami deposit, Submarine active fault, Beppu Bay, Radiocarbon dating, Diatom, Geochemistry

Exploring Coastal Wetlands of the southern Kyushu (Japan) with Consideration of their Preservation Potential for Tsunami Deposits

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This research project is based on tsunami geology. Specifically, it addresses making ertinent inventories of coastal wetlands in the southern Kyushu (Japan) that faces the East China Sea, with the Ryukyu trench (an active fault of great extent) being situated farther south. Thus the present research is aimed at assistin in the assessment of recurrent intervals (or such related matters) of great earthquakes that may be generated by the rupture along the Ryukyu trench. The important consideration herein is as follows: A targeted wetland should e such that it is sensibly away from the shoreline and is protected by a natural beach ridge or so, permitting the deposition of peaty or clayey sediment under normal calm conditions, over a prolonged period of time (say several thousand years or more). Moreover, such a targeted wetland should, ideally, have been exposed to rare event (run-up of tsunami flows or so), leaving evidences that would be identifiable from a scientific means.
With the above-mentioned in mind, the examination of the field information available led the author to select a total of eleven coastal wetlands as sort of geo-archives (ten wetlands along the 130-km-long coastline of the Satsuma peninsula; one wetland on the 25-km-long coastline of the Koshikijima island). In all of the eleven wetlands, we retrieved a total of fourteen continuous sediment cores and subjected a number of (plant) specimens to the C-14 dating methodology. The results together confirmed that the retrieved sediment cores covered a span of recent six thousand years or longer. It is of particular interest herein to state that at the Nakayama wetland in the Koshikijima island, we found a few event layers being intercalated in a thick deposit of peat. The peat extends directly from the ground surface (elevation 3.3m) down to a depth of 9 m and is underlain by a marine deposit 4 meters or so thick. Each event layer consisted of an assembly of platy gravel of slate. Note herein that on the beach a great many number of platy slate gravel can be seen scattered. It is thus concluded that a sizable amount of the platy slate gravel were transported landwards by seawater flows over the beach, and were eventually deposited on to the peaty soil surface in the wetland. It is too premature, however, to judge the type and nature (tsunami or storm wave) of the responsible fluid forcing. Yet it is important to note that the occurrence of the events concentrated in the period between 2500 years B.P. and 3500 years B.P. In order to clarify the geological meaning of the particular time period, one should take a close look at the sequence of formation of the wetland. A tentative inference is as follows: Initially, there was a concave coastal planform toward the ocean; Alongshore sediment transport then facilitated the development of spit-like sedimentary features, eventually becoming a bay-mouth barrier; Then, the water body behind the barrier was gradually buried with terrigenous sediment, forming a peaty wet land. It is a subject for future studies to perform a detailed survey of cross-shore profiles through each of the selected wetlands, enabling one to assess the power of fluid forcing enough to transport a variety of sediment including platy gravel.

Keywords: southern Kyushu, Tsunami Deposits

Modeling of grain size distribution of tsunami sand deposits in V-shaped valley of Numanohama during the 2011 Tohoku tsunami

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We propose a numerical method of tsunami sediment transportation that can simulate grain size distribution of deposited sand. In the numerical model, the sediment transportation is computed in the suspended load layer and bed load layer (Takahashi et al., 2000; Gusman et al., 2012, EPS). We introduce two sub layers in the bed load layer, which are the active layer and the parent layer. These sub layers contain grain size distribution information. The coefficients for the suspended transport (alpha) and bed load transport (beta) for grain sizes of 0.166, 0.267, and 0.394 mm are obtained by a hydraulic experiment conducted by Takahashi et al. (2011, Coastal Engineering). In this study, the coefficients for grain sizes outside the above range (0.166 –0.394 mm) are extrapolated and for those within the range are interpolated. We simulated sediment transportation of multiple grain sizes ranged from 0.063 (4 phi) to 5.657 mm (-2.5 phi) with an interval of 0.5 phi.
We apply the model to simulate the sedimentation process during the 2011 Tohoku earthquake in Numanohama, Iwate prefecture, Japan. Samples of tsunami sediment deposits in Numanohama coast have been collected after the 2011 Tohoku earthquake (Goto et al., 2015, Marine Geology). The grain size distributions at 15 sample points along a 500 m transect from the beach are used to validate the tsunami sediment transport model.
For the tsunami source model, we use the one estimated by Satake et al. (2013, BSSA). This source model can well reproduce the observed tsunami run-ups that are ranged from 16 –34 m along the steep valley in Numanohama. For the sediment source, the parent layer (sediment source) is unlimited anywhere in the modeling domain and the grain size distribution of the parent layer is assumed to be the same as that found at the beach. The 200 m long and 50 m wide beach in Numanohama is dominated by rounded sand particles with d_{50} (the grain size at which the sample are 50% finer than) of 1 mm and located in front of coastal marsh.
The shapes of the simulated grain size distributions at many sample points located within 300 m from the shoreline are similar to the observations with the difference between observation and simulation peak of grain size of less than 1 phi (Goto et al., 2015, Marine Geology). The thicknesses of the observed sand deposits are also compared with the simulated ones. The simulated sand thickness distribution is consistent with the observation. The model is also capable of showing the sediment transport process of how the grain size distribution of the sand deposit changes over time. This kind of simulation result may be compared with the observed vertical change of grain size distribution.

Keywords: Simulation of grain size distribution of tsunami sand deposits, Tsunami sediment transportation process, The 2011 Tohoku tsunami sand deposits, Spatial distribution of deposit thickness, Suspended load and bed load transports, Coastal morphology change

Applications of ITRAX XRF core scanning and PCA in palaeotsunami research

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Following the devastating 2011 Tohoku-oki tsunami in Japan, much research has been carried out to identify its precursors and any other events that have impacted the country. While it is important to gain a better understanding of recurrence intervals, identifying the limit of inundation of these events is crucial in order to be able to estimate their magnitude and thereby improve hazard mitigation measures for the future. However, researchers generally rely on the presence of anomalous coarse layers (mostly sand) to identify tsunami deposits. Estimating the limit of inundation beyond the extent of the sand has proven more difficult and can be very time consuming with commonly used methods, such as grain size and microfossil analyses and/or even conventional geochemical techniques.

Here we present the results of a study, where we used an ITRAX XRF core scanner, a rapid and non-destructive technique, which provides continuous high resolution elemental profiles, magnetic susceptibility, as well as an optical and a radiographic image. Sedimentary sequences collected along a shore-perpendicular transect on the Sendai Plain, include the 869 AD Jogan sandy tsunami deposit within paddy field soil, which is overlain by the Towada-a tephra, as well as possible older tsunami and flood deposits in the lower part of the cores. Further inland, the Jogan deposit becomes discontinuous and is replaced by mud, as also reported for the 2011 Tohoku-oki tsunami deposit on the Sendai Plain. The X-radiographic image allows the identification of thin mud units within the paddy field soil, which were not clearly visible to the naked eye. Analysis with the ITRAX core scanner reveals subtle geochemical differences between the mud unit attributed to the Jogan tsunami, the paddy soil and other mud units. ITRAX data were also processed by principal component analysis (PCA), allowing the distinction of various units and their possible origin, despite the semi-quantitative nature of the elemental data. In this study we could distinguish the marine-sourced units from their terrestrial counterparts, based on their geochemical characteristics.

This study shows that high resolution geochemistry using core scanners can provide a means to identify the limit of inundation of palaeotsunamis beyond the extent of the visible sand deposits, even when units are not clearly visible to the naked eye. These data can be used to draw more accurate palaeotsunami inundation maps, thereby improving hazard management measures for the future.

Keywords: tsunami, geochemistry, ITRAX XRF core scanning, PCA, mud, inundation limit

A preliminary report on a flume experiment of Tsunami-generated turbidity currents and sediment transport

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Tsunami-generated turbidity currents occurred associated with the great earthquake, Mw9.0, 2011 Tohokuoki-oki event off shore Japan (Arai et al., 2013). After the earthquake and the tsunami, “turbidity currents” were recorded by the ocean-bottom pressure recorders and seismometers, and freshly emplaced turbidites were collected from a wide area of seafloor off the Tohoku coast. These records showed the tsunami entrained the large amount of sediment in the coastal region to yield the turbidity currents. These turbidity currents transport a large amount of sediment into the deep seafloor, thus are important to evaluate the tsunami-related sediment transport and the effect on ecological environment on the seafloor. There have been, however, very few experimental studies about tsunami-generated turbidity currents (e.g., Niitani et al., 2013). This is the preliminary report on a flume experiment on the tsunami-generated turbidity currents and their sediment transport.

The experiment was conducted using 7.2 m long, 1.2 m deep, and 0.3 m wide flume in Osaka Institute of Technology. We made two terrain models, one referred the profile of Kumano-Nada region which has a steeper slope, and the other referred the profile of Tokachi-oki region which has a shallower slope. The models were made of very coarse sand and granule, and mantled by fine to very fine sand about 5 cm in thickness. The horizontal and vertical ratio of the profiles is 1:100. We generated “tsunami” by the acrylic plate, in the way as same as that of Niitani et al. (2013), and repeated “tsunami” 10 times for each profile.

As the results, turbidity currents occurred in both cases. The amount of entrainment of sediment by the “tsunami” was larger in the steeper “Kumano-nada” model, and the velocity of the turbidity currents was larger for and total amount of sediment transport was larger for the steeper model. The relict bedforms, however, showed more wave-dominated features in the case of steeper “Kumano-nada” model.

References cited

Arai, K., Naruse, H., Miura, R, Kawamura, K., Hino, R., Ito, Y., Inazu, D., Yokokawa, M., Izumi, N., Murayama M. and Kasaya, T., 2013, Tsunami-generated turbidity current of the 2011 Tohoku-Oki earthquake, Geology, 41, 1195-1198, doi: 10.1130/G34777.1.

Niitani, S., Masuda, F., and Naruse, H., 2013, Tsunami-induced gravity currentsgenerated in an experimental flume. Journal of Sedimentary Society of Japan, 72, 109-113. (in Japanese with English abstract)

Keywords: Tsunami, Turbidity currents, Sediment transport, Flume experiment

The potential and challenge of laboratory experiments on tsunami deposits

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Field surveys have been played an very important role in researches on tsunami deposits. The observed ancient tsunami deposits can be the strongest evidence for the existence of mega tsunamis in the survey field. For this reason, the field survey is the most basic and necessary method to investigate tsunami deposits.
On the other hand, the interpretation of tsunami deposits observed in the field faces with considerable difficulty because the formation of tsunami deposit affected by the magnitude of the tsunami, local topography, bed materials and environmental after the tsunami. Therefore, the comparison between hydrological characteristic of tsunami and depositional characteristic of the resulting tsunami deposits is not a easy task.
In this presentation, we are going to discuss the potential and challenge of laboratory experiments by taking the large scale experiments conducted by CRIEPI as an example. We will also discuss what kind of information is needed for field surveys, laboratory experiments and numerical simulations to develop our knowledge on tsunami deposits.

Keywords: Tsunami deposit, laboratory experiment, sedimentary structure

Numerical modeling of tsunami deposits: recent advances and future research

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This presentation reviews recent research on numerical modeling of tsunami sediment transport and discusses future research directions.
From the viewpoint of disaster science, recurrence intervals and magnitudes of paleotsunami events is a primary reason for studying tsunami deposits. Tsunami numerical modeling has been an important part of the research field since the 1990s. Numerical modeling provides supporting information for interpreting tsunami deposits and can help reconstruct inundation area and wave source. The 2011 Tohoku-oki earthquake tsunami provided an opportunity to improve coupled tsunami hydrodynamic and sediment transport models because of the quantity and quality of pre- and post-tsunami field data and real-time observations. For example, recent case studies of Oppa and Hirota Bays on the Sanriku Coast [1][2] and the coastal plain of Sendai Bay [3] demonstrated that changes in the coastal geomorphology, volumes of erosion and deposition, and distribution of the onshore tsunami deposit can be reproduced when the model inputs and boundary conditions, such as wave source, bathymetry and topography sediment source, and grain size are well constrained. Numerical modeling of tsunami sediment transport will benefit planning pre-tsunami countermeasures and post-tsunami recovery, improved estimation of tsunami inundation area and wave source, and assessing suitable sites for geological surveys of paleotsunami deposits.
A dearth of geological data and uncertainties in pre-existing geomorphology and other conditions are very common in paleotsunami research. In such circumstance, unequivocal estimation of tsunami inundation area and wave source is quite difficult. Hybrid modeling [4][5], which combines forward and inverse models of tsunami sediment transport and deposition, is a possible way to solve this problem. Flow parameters, such as flow velocity and shear velocity, are estimated based on the inverse modeling of tsunami deposit. Estimated flow parameters are used as boundary conditions of the forward modeling, which determines tsunami inundation area and wave source. In addition, forward modeling is used to assess whether the assumptions of the inverse model are satisfied. Although substantial investigation will be required, hybrid modeling can be a promising approach to extract more information from tsunami deposits.
The role of tsunamis in coastal geomorphology and stratigraphy, and the formation process of tsunami deposits are important topics for tsunami sedimentology. Few numerical studies [6][7] have investigated internal structures of tsunami deposits, for example sedimentary units and lamina, and horizontal and vertical variations of grain size. Tsunami deposits simulated by the forward modeling are not often compared with the observed deposits, in terms of structures. If numerical models acquire the ability to resolve the sedimentary structure of deposits, we can compare models not only to the commonly observed parameters such as deposit thickness and bulk grain size of deposit, but also can constrain the processes of tsunami sedimentation. A new model, the “stratum simulator” can be coupled with numerical models of tsunamis and other phenomena that create event layers. Such models may benefit improved identification of event deposits and interpretation of sedimentary records.

[1] Imai et al., 2015, JSCE B2 71, I_247_I-252.
[2] Yamashita et al., 2015, JSCE B2 71, I_499_I-504.
[3] Sugawara et al., 2014a, Marine Geology 358, 18-37.

[4] Jaffe et al., 2012, Sedimentary Geology 282, 90-109.
[5] Sugawara et al., 2014b, Marine Geology 352, 295-320.
[6] Apotsos et al., 2011, Journal of Geophysical Research 116, F01006.
[7] Li et al., 2012, Natural Hazards 64, 1549-1574.

Keywords: tsunami, sediment transport model, simulation, deposit, coastal geomorphology

