Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS25-01 Room:106 Time:May 24 09:00-09:15

Characteristics of tsunami origin sediments sampled from Hirota and Toni bay around the Sanriku coast, Japan.

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The recent 2011 Tohoku tsunami strongly affected the coastal area of the Pacific coast of Tohoku. Tokai University and JAMSTEC team investigated the Tohoku coastal area as a part of Tohoku Ecosystem-Associated Marine Sciences (TEAMS). We got the knowledge of distribution of rabble, bottom sediment environment and tsunami information in the local area.

We researched using acoustic equipments (Multi beam echo sounder, Sub bottom profiler and Side scan sonar), bottom sampler and ROV. And, we have interviewed about situation of damage at the local area.

Characteristics of submarine topography

Toni and Okirai bay have the scattered irregularity bottom surface (Okirai 15-20 m and Toni 17-25 m). This irregularity bottom surface relative height is 20-100 cm at Okirai. Rabble was seen in the coast side from this irregularity bottom surface. And, from SBP data, a record to scraping underlying layer was seen. We were able to estimate that submarine topographic signature (erosion surface) made by undertow at Tsunami event.

Surface sediments

SBP data was seen signature reflecting (20-50cm down from seabed), and able to estimate the reflecting surface to depth of approximately 40 m at Hirota bay. In the Toni and Okirai bay, SBP data was seen signature reflecting (20-100cm down from seabed), and able to estimate the reflecting to depth of approximately 50 m. These reflecting characters have large lateral change in each bay.

Columnar core

Almost each core, first layer (approximately 0-10 cm) of core was seen grading structure (middle to coarse) of sand sediment, but second layer (from 10 cm underlying layer) was different facies from center area to side area of each bay. Especially at the center area of axial, bottom part of second layer (contain woodchip and shell piece) was scraping underlying layer. Thus, we were able to estimate upper zone from second layer was tsunami origin sediment.

The longest 2 m core at Hirota bay was divided into two more parts under the second layer, such as, 3rd layer with fine sand to massive silt sediment zone, and 4th layer (140-200 cm) with middle to coarse sand sediment zone. So, we think that underlying layer sediment (from 130 cm underlying layer) has possibility of palaeo tsunami origin sediment.

Keywords: Tsunami origin sediment, Sanriku coast

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Influence of the 2011 Tohoku tsunami to the surface sediments on the Sendai shelf

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Huge tsunami by the 2011 off the Pacific Coast of Tohoku Earthquake inundated coastal areas of the northeastern Japan. Because friction velocity at sea floor by the tsunami wave became larger at shelf, the tsunami might agitate and resuspend the shelf sediments in the Sendai Bay. However, we have only a little knowledge on characteristics of the shallow marine tsunami-related deposit. To understand the tsunami influence on sea-bottom environments, we conducted two surveys to collect the surface sediments of the Sendai shelf in summer 2012. Comparison with the pre-earthquake surface sediment dataset suggested that bottom sediment changes occurred at least several locations on the shelf. Mud deposition was most characteristic change at the northern and southern mid shelf. Resuspension and redeposition of shelf mud might occur on the shelf. Occurrence of muddy turbidite on the outer shelf suggested that a part of resuspended mud might be transported as turbidity currents toward offshore. Generation of the turbidity currents might play an important role on the long-distance transport from shelf to slope. On the other hand, no clear change on bottom sediment grain size and sedimentary structure found on the sandy shelf located central-southern mid shelf. Although the detailed comparison should be necessary, no large and long-distance transport might occur on the sandy mid shelf.

Keywords: tsunami, surface sediment, Sendai Bay, shelf, 2011 Tohoku earthquake tsunami

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Origin of submarine event deposits by the 2011 Tohoku earthquake and tsunami: from benthic foraminiferal assemblages

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Tsunami by the 2011 off the Pacific Coast of Tohoku Earthquake brought significant damage along the northeastern Japan coast. We conducted a marine survey cruise (KT-11-17) to clarify the influence of earthquake/tsunami to sea bottom environments, off Sanriku, northeastern Japan, July-August, 2011. As the results, we found the 2011 earthquake- and/or tsunami-induced turbidites at 13 sites from outer shelf to trench slope off Sanriku. At two sites from slope (893 m and 1446 m in water depth), the turbidites have sharp erosional bases, and upward-fining graded structures started from very fine sand-coarse silt.

The surface layer of the turbidite mud at the shallower site (893 m) includes the major foraminiferal species in the outer shelf (*Uvigerinella glabra* and *Elphidium clavatum*). The possibility of inflow from outer shelf to the site by earthquake- and/or tsunami-induced turbidity currents is inferred from the benthic foraminiferal assemblages. The Basal sands of the turbidite at the deeper site (1446 m) include abundant *Takayanagia delicata*; and the turbidite mud include abundant *Stainforthia apertura*. Both species are reported by previous studies on living benthic foraminifera off Sendai as dominant species in water depth 550 m - 900 m. It is suggested that the sediment was transported from several-hundred meters shallower water depth than the site.

Keywords: event deposit, earthquake, tsunami, turbidite, marine sediment, foraminifera

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MIS25-04 Room:106 Time:May 24 09:45-10:00

High contribution ratio of tsunami deposits for alluvium in the Masaki coast, northern Japan

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Several tsunami deposits were recognized in the alluvium in the Masaki coast, Iwate prefecture, northern Japan. These tsunami deposits showed a high contribution rate for alluvium.

Keywords: tsunami deposits, alluvium

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MIS25-05 Room:106 Time:May 24 10:00-10:15

Magnetic anisotropies for tsunami deposits: Application to the 3.11

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Tsunami deposits consist of well-sorted fine sand intercalating with non-marine black organic mud. It is difficult to reveal a transport direction of the deposit if the deposit showed no sedimentary fabrics,such as ripples. The proxy of anisotropy of magnetic susceptibility (AMS) appears to be a promising tool for the study of flow fabrics in recent-tsunami deposits such as Sumatra tsunami (Wassmer et al. 2010). The AMS fabric might allow us to reconstruct transport directions of unconsolidated tsunami sediments during emplacement because AMS provides a cryptic alignment of ferromagnetic and paramagnetic minerals. Such cryptic minerals, such as magnetite or phyllosilicate minerals, would behave as a different emplacement mode in a different hydrodynamic condition. In the AMS fabrics of volcanic rocks, there are large discrepancies between the magnetic lineation and the framework-forming silicate linear fabric. This suggests that the uncorroborated use of bulk AMS to detect flow fabric in tsunami deposits has risks. In this article, we show that the anisotropy of anhysteretic remanent magnetization (AARM) may resolve the difficulties. The combination of inundation eye-witness, SEM, AMS, and AARM confirms the flow pattern of recent- and paleo-tsunami deposits from the geoslicer sampleing at Rikuzen-Takata city, Japan during 2011, 11th March Tohoku tsunami. We determined if the sandy deposits are of tsunami from these magnetic anisotropies.

Keywords: tsunami deposits, paleomagnetism, anisotropy of magnetic susceptibility, anisotropy of anhysteretic remanent magnetization

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MIS25-06 Room:106 Time:May 24 10:15-10:30

Sedimentary features of the 2011 Tohoku-Oki tsunami on coastal lowland behind a lagoon in Matsukawaura, Fukushima

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In this paper we describe the sedimentary characteristics of the 2011 Tohoku ? Oki tsunami deposit in Matsukawaura, Fukushima Perfecture, Japan. Matsukawaura is paddy field lowland with a 1.5 km wide of semi-enclosed lagoon. This study area provides opportunity to examine the effects of lagoon for tsunami deposition on the coastal lowland behind a lagoon. Total of eleven sites along a transect were examined and sampled for thickness, and sedimentary analysis (grain size, mineralogy and foraminifera analysis). Thickness of the deposits is ranging from 8 to 26 cm and showing a fining landward trend. The deposits are mainly composed of well sorted to poorly sorted of coarse to very fine sand which covered by mud layer. Medium to fine sand dominated the deposits and is nearly similar with lagoon grain size. The foraminiferal assemblages in the tsunami deposit dominated by lagoonal ? intertidal species (Elphidium Matsukawauraense, Ammonia tepida, and Rotalia beccarri). The mineral composition of the tsunami and lagoon deposits was almost similar, with only the percentage of each mineral differing between types of deposits. Based on the sedimentary structure, settling out of sediment from suspension was the dominant process of deposition. Our observations and analyses suggest that lagoon was the main source of the deposits. Our results indicating that the depositional characteristics of the 2011 Tohoku-Oki tsunami appeared to have been affected mainly by local effect. The findings of our study are of considerable importance in interpreting paleotsunamis in coastal lowland behind lagoon.

Keywords: the 2011 Tohoku-Oki tsunami deposit, Matsukawaura, Lagoon, Grain size, Mineralogy, Foraminifera

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS25-07 Room:106 Time:May 24 10:30-10:45

Measurement of precise grain size and morphological characteristics of tsunami sand particles

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Morphological characteristics such as circularity, convexity, aspect ratio, intensity, particle size of the 2011 Tohoku-oki tsunami deposits are measured by a grain image analyzer (Morphologi G3S, Malvern). The tsunami deposits, beach sand, coastal dune sand, and basal layer (aeolian sand) beneath the tsunami deposit were collected from Misawa coast, northern Tohoku just after the tsunami inundation. We could analyze the particle size with 1/32-phi-precision by using the machine and it shows that the tsunami deposit is slightly but significantly finer than the coastal dune sand. It was also confirmed that the basal layers contain a significant amount of silt and clay fractions, whereas the tsunami deposit is poor in mud contents (<1%). Circularity and aspect ratio of the tsunami sand particles are similar to those of the coastal dune sand, but dissimilar to those of basal layers. Precise measurement of particle characteristics of sandy and muddy tsunami sediments will be useful not only to identify the possible source of tsunami sediment but also to identify thin sandy layers or sandy patches of paleo-tsunami origin in soil.

Keywords: Tsunami deposit, Precise grain size analysis, Morphological characteristics, Morphologi G3S, 2011 Tohoku-oki tsunami deposits

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(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS25-08 Room:106 Time:May 24 11:00-11:15

Paleo-tsunami records in Tonankai area and future issues of paleoseismological studies along the Nankai Trough

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It became widely understood after the 2011 Tohoku Earthquake that geological records of thousands of years are needed to know possible largest magnitude of earthquakes and tsunamis in a region. Though the Nankai Trough has been the focus of many paleoseismological studies, it becomes more important to understand diversity of earthquake magnitude and recurrence intervals within longer time scales.

To reveal tsunami history of thousands of years, we conducted hand coring and drilling survey at 27 study points. These coring exposed at least 9 paleo-tsunami layers in the sedimentary succession deposited between 4500 yrBP and 500 yrBP. All of the paleo-tsunami layers contain bioclasts of marine and brackish water organisms such as gastropod, bivalve, calcareous algae and foraminifera. In most cases, these layers are few centimeters thick and have sharp basal contacts. Soft x-ray imaging shows that some of the sand layers includes rip-up clasts and are composed of two or more sub-layers of paired sand and silt. Radiocarbon ages of selected materials indicate that the younger three layers were deposited by the historical tsunamis in AD 684, 1096 and 1498 respectively. These layers were deposited by past tsunamis which provably occurred in the Tonankai and/or Tokai areas. Historical documents tell that the 1854 Ansei Tokai Earthquake Tsunami inundated the study site and left sands on ground surface. On the other hand, wave heights of the AD 1946 Showa-Nankai earthquake tsunami occurred in the Nankai area and the AD 1960 Chilean tsunami were 1.0 m and 1.5 m respectively, and lower than the barrier spit that separates the study site from the sea.

There is no historical documents of the AD 684 earthquake tsunami in Tonankai area, but our result supports archaeological studies, which suggest that the rupture of the earthquake extended to the Tonankai area. We do not see traces of the AD 887 and 1361 earthquake tsunamis that are thought to have occurred in the Nankai area.

Interregional correlations of geological records based on detailed dating results will become increasingly important to know the lateral extent of past rupture zones. In addition, examinations of uplift/subsidence occurred simultaneously with tsunami sand deposition by paleontological and geochemical analysis will provide more precise information about diversity of vertical crustal deformation along the Nankai Trough.

Keywords: tsunami deposit, Nankai Trough, Tonankai area

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(May 19-24 2013 at Makuhari, Chiba, Japan)

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Estimation and sensitivity of fault parameters from distribution of tsunami deposit

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Comparisons of distribution of tsunami deposit with computed tsunami inundation is a useful method to estimate fault parameters. Sawai et al. (2012, GRL) assumed 14 different fault models of the AD 869 Jogan earthquake, and compared the computed tsunami inundation areas with distribution of tsunami deposit in Ishinomaki and Sendai plains, and Odaka lowland. The 14 fault models include outer-rise normal-fault earthquake associated with the 1933 Showa Sanriku earthquake, tsunami earthquake on shallow plate interface near the Japan trench such as the 1896 Meiji Sanriku earthquake, active-fault earthquake in Sendai bay, and interplate earthquakes with various fault depths, widths, lengths, and slip amounts. They showed that an interplate earthquake of 200 km long and 100 km wide with 7 m slip can produce tsunami inundation to cover the distribution of the tsunami deposit.

Nanayama et al. (2003, Nature) surveyed tsunami deposit along the Pacific coast of Hokkaido, and concluded that unusual tsunamis occurred along the Kuril trench with an average interval of about 500 years. The most recent tsunami is dated in the 17th century. Satake et al. (2008, EPS) assumed the fault models including ”Giant fault model” with depth range of 0 km to 85 km, tsunami earthquake, and interplate earthquakes. They showed that an interplate earthquake of 300 km long and 100 km wide, and slip of 5 m and 10 m in the north and the south, respectively (Mw8.5), can produce tsunami inundation to cover the distribution of the tsunami deposit.

Sensitivity analyses of computed tsunami inundation to fault lengths and slip amounts are also helpful to estimate these fault parameters. We examined the sensitivity to fault lengths and slip amounts of the AD 869 Jogan earthquake. We assumed various interplate fault models with four different lengths (100, 200, 300, 400 km), three uniform slip amounts (6, 9, 12 m), and two top depths (15, 31 km). Fault width is fixed at 100 km (Uniform Slip Models). We also assumed variable slip models using slip distribution of the 2011 Tohoku earthquake (Satake et al., 2013, BSSA) (Variable Slip Models). Tsunami inundation distances were computed on the 869 topography in Ishinomaki and Sendai plains in Miyagi prefecture (Sawai et al., 2012, GRL) and Odaka (Sawai et al., 2012, GRL) and Ukedo (Imaizumi et al., 2010, internal report) in Fukushima prefecture, and compared with maximum transportation distances of sandy tsunami deposit on 10 transects.

As a result of Uniform Slip Models, the fault model of the 869 earthquake requires the fault length of at least 200 km and the slip amount of at least 9 m to completely inundate up to the tsunami deposit on the 10 transects. For Variable Slip Models, we found that fault length of more than 200 km is also needed. However, when fault length exceeds 200 km with slip amounts of more than 9 m in Uniform Slip Models, or when fault length exceeds 200 km in Variable Slip Models, the computed inundation distance increases very little. This indicates the following two points. One is that we cannot judge whether the fault length is 200 km or more, and field studies of tsunami deposit are necessary on the northern part or the southern part. The other is that inundation distance does not simply increase with fault parameter but saturates due to topography. The computed tsunami inundation areas show that the margin between the calculated inundation limit and upland, which is defined as altitude more than 10 m (T.P.), is small and it is difficult for tsunami to inundate for a longer distance except for two transects in Sendai plain.

Geological studies after the 2011 Tohoku earthquake (e.g. Goto et al., 2011, Marine Geology; Abe et al., 2012; Sedimentary Geology; Sawai et al., 2012, GRL) reported that the tsunami inundated more extensive than the tsunami deposit. However, it is difficult to apply a simple relationship to estimate the accurate magnitude of the 869 earthquake, because of the saturation problem.

Keywords: tsunami deposit, fault model, the AD 869 Jogan earthquake, tsunami computation, inundation distance

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS25-10 Room:106 Time:May 24 11:30-11:45

Paleotsunami investigations in the Primorye region, Russia, for assessing tsunami hazards around the Sea of Japan

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Information from tsunami deposits is most important for assessing tsunami and earthquake hazards in areas where recurrence interval and size distribution of historical and pre-historical tsunamis are not known or poorly recorded. Northern coast of the Sea of Japan is one of these areas. Recent earthquakes such as the 1983 Nihonkai-chubu Earthquake and the 1993 Hokkaido Nansei-oki Earthquake provided severe damage along the coastal communities, where we have no knowledge about the past events. The 1983 and 1993 tsunami inundated not only in the Japanese coast but also in the Primorye region, Russia, along the other side of the Sea of Japan and caused some damage there. We carried out reconnaissance along the Primorye coast to find the historical and pre-historical tsunami evidences, as there are many natural lowlands facing sandy beach that are suitable for tsunami deposit reservation. The surveys were done in summer of 2010, 2011 and 2012 as a joint research project with Hokkaido University and the Russian Academy of Science. As a result, we could find candidate tsunami deposits in some sites. The deposits are continuous sandy layers buried in the peat. Some of them are probably correlated to be 1940, 1983 or 1993 tsunami. Tsunami heights of them are recorded to be more than 4 m. We also found possible pre-historical tsunami deposits beneath the B-Tm tephra (ca. 1000 AD) at Kit Bay.

Keywords: tsunami, paleo-tsunami, tsunami deposit, Sea of Japan, Primorye

Japan Geoscience Union Meeting 2013
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MIS25-11 Room:106 Time:May 24 11:45-12:00

Late Holocene record of tsunami events from coastal wetlands, Okushiri Island, off south-western Hokkaido

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The 1993 off the southwest coast of Hokkaido Earthquake provided a cause of the tsunami that damaged on the Coast of Okushiri Island. Many offshore active faults are distributed along the eastern margin of the Japan Sea and some of them triggered large earthquakes. In the historical record at Hokkaido, the oldest tsunami hazard around the west coast of Hokkaido was induced by the volcanic avalanche of Oshima-Oshima in 1741AD. Hitherto known events in the sedimentary records are resulting from the investigation of submarine turbidite (Ikehara, 2000) and tsunami deposits on Holocene marine terrace (Kawakami et al., 2012; Hirakawa et al., 2012). The shallow CCD in the Japan Sea and slow sedimentation rate of terrace deposition have been complicated correct estimation the event occurrence age. We investigated event deposits formed by tsunami to reveal occurrence age, in coastal lowlands in the Okushiri Island.

Surface deposits were extracted at two coastal lowlands (Hatsumatumae and Wasabiyachi-gawa) located behind the dunes over 10 m high in the south coast of Okushiri Island. The sediment of the lowland consists of peat and peat mud. Several sand beds are intercalated in the normal peaty sediment. There are three event layers in Hatsumatumae lowland and five layers in Wasabiyachi-gawa lowland. The event layers indicate some typical features of formed by tsunami running over a coastal sand dune (Takashimizu, 2012). The features are decreasing bed thickness toward inland, massive or faint parallel lamina, erosional contact at the base and including rip-up clast. Therefore, we interpreted the event sand bed as tsunamiite. The ages estimated from 14C, of five events occurred are 11-13 centuries, 6-7 centuries, about 2,300 cal yBP, 2,600 or 2,700 cal yBP and 3,100 to 3,300 cal yBP, respectively. These tsunami events corresponded to the events deposits in the event on the Holocene marine terrace.The past tsunami events that we found occurred every about 300 through 1000 years. The calculated mean interval is approximately 650 years.

The event ages from the sedimentary record in the isolated island inside of the tectonic belt of the eastern margin of the Japan sea are important for collerations of another tsunami events in the nearby earthquake source area.

Keywords: tsunami deposit, eastern margin of Japan sea, coastal lowland, correlation

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(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS25-12 Room:106 Time:May 24 12:00-12:15

Geological study on tsunami deposits in the Pacific coast of Aomori, northern Japan

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We studied paleotsunami deposits in the Pacific coast of Aomori Prefecture. The study area is facing to northern edge of the Japan Trench, where the 2011 Tohoku earthquake raised concerns about future large earthquake (Simons et al., 2011). However, there are few historical and geological records to evaluate long-term earthquake history around north of the Japan Trench. We found unusual sand sheets interbedded with fluvial mud and peat, beneath coastal lowlands in Higashidori, Rokkasho and Misawa. Some sand sheets contain brackish-marine as well as freshwater diatoms, such as Fragilariaceae spp. (e.g. Staurosira spp. and Staurosirella spp.). The diatom assemblages of sand sheets indicate that they were transported from seashore.

In Higashidori site, five sand sheets were found between 1.5 and 3.5 m in elevation. Three of them are 3-10 cm thick, quartz-rich and wide-spread. They show normal grading and sharp contacts with underling peat. 14C date of plant microfossils just above and below the sand sheets show that they deposited after 1500 AD, ca. 4,500 cal BP, ca. 5,000, ca. 5,300 cal BP and ca. 5,800 cal BP.

Keywords: tsunami deposit, diatom, Aomori, Japan Trench, Kuril Trench

Japan Geoscience Union Meeting 2013
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MIS25-13 Room:106 Time:May 24 12:15-12:30

Coastal paleo-environment changes and tsunami deposits from Kanto earthquakes in Ena bay, during the past 4000 years

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Interplate earthquakes and subsequent tsunamis often leave geological evidence such as tsunami deposits in coastal regions, therefore studies of coastal paleo-environment changes and tsunami deposits from paleo-earthquake by microfossil analysis are important for long-term earthquake forecast because these data provide information on earthquake occurrence time and environmental changes during co-seismic and inter-seismic periods.

The average recurrence interval of the great interplate earthquakes along the Sagami Trough, Taisho-type Kanto earthquake, is estimated to be 200-400 years. However, earthquake histories prior to the 1703 Genroku Kanto earthquake have not been revealed from historical literature although some candidates were proposed. Miura Peninsula has been uplifted during the previous Kanto earthquakes and attacked by the tsunamis (Hatori et al., 1973). Shimazaki et al. (2011) conducted Geo-slicer surveys in Koajiro Bay of Miura Peninsula and suggested that the 1293 earthquake causing destructive damage in and around Kamakura was the Kanto earthquake prior to the 1703 Genroku earthquake. On the other hand, Kaneko (2012) reported the possibility that the tsunami accompanied by the Kanto earthquake in 1495AD might strike Ito on the east coast of Izu Peninsula from archeological and historical records. However, geological evidences and historical records of Kanto earthquake are still not enough to reveal the recurrence interval. Also, there are hardly natural coastal wetlands that would preserve tsunami deposits, because the natural environments were collapsed by revetments in Kanto.

The object of this study is to reveal the histories of Kanto earthquakes through identification of tsunami deposits and a reconstruction of paleo-sea depth changes using diatom, grain size and C/N analysis in Ena bay. Ena bay is a small bay on the south coast of Miura Peninsula and salt marsh is formed innermost of the bay. In May and November, 2009, and February, 2011, we conducted 3 m length handy Geo-slicer surveys at Ena bay. We have basically analyzed 5 cores (ENA-C, ENA-E, ENA-F, ENA-I and ENA-2a) and some modern surface sediment samples collected in the bay.

As a result, three (in ENA-C), four (in ENA-E and ENA-I), five(in ENA-F) or six (in ENA-2a) coarse layers including shell fragments and gravels are recognized. Each of these event deposits have sharp lower contact indicating that they accompanied with a strong current. Rarity and poor preservation of diatoms are recognized from these event deposits, indicating long-distance transport by a high-energy flow. On the other hand, changes in diatom assemblage show an increase or a decrease of relative abundance of marine species, suggesting a paleo-sea depth changes. Namely, marine benthic species gradually decrease prior to the deposition of tsunami deposits indicating coastal subsidence, and benthic species increase above tsunami deposits indicating coastal uplift. It is revealed that Miura Peninsula uplifted about 1.4 m at the time of the 1923 Kanto earthquake and now subsides with a rate of about 3.7 mm/year from tide gauge record at Aburatsubo. The diatom analysis suggests that environmental changes corresponding to these co-seismic and inter-seismic crustal movements. Based on the sedimentological features and environmental changes, we conclude that the event deposits, named as T1, T2, T3, T4, T5 and T6 unit from the top to the bottom, are transported by tsunami from the previous Kanto earthquakes. The T1 unit is the tsunami deposit from the 1923 Taisho Kanto earthquake based on Pb-210 dating. Radiocarbon ages indicate that the T2, T3, T4, T5 and T6 unit deposited about 2000, 3000, 3300, 3700, and 4000 cal. BP, respectively. These dates are consistent with records of previous Kanto earthquakes inferred from marine terraces in Boso Peninsula (Shishikura, 2003). In addition, it is revealed that geological records during 1000-2000 cal. BP are hardly remained in Ena bay.

Keywords: Kanto earthquake, Tsunami deposit, Diatom analysis, Paleosea depth, Ena bay

Japan Geoscience Union Meeting 2013
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Tsunami deposit survey at Zaimokuza, Kamakura City, Japan (a progress report)

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The Kanagawa Prefectural Government has been conducting its first Tsunami deposit survey on the shore of its territory since 2011. Here we will give an interim report on our research at Kamakura, where has been attacked by several tsunamis as known from historical literatures.

The survey was held in Zaimokuza area, which is known as a port developed behind the beach ridge in the Middle age. We excavated ten boreholes in four localities in the area. The depths are 5-6 meters. The general stratigraphy obtained from the investigation is summarized as follows in ascending order.

The lowermost stratum obtained in our investigation is silty fine sand (Unit A). This layer is highly water-bearing, bluish gray colored and massive sand containing molluscas that represent sublittoral environment such as Macoma sectior, Veremolpa micra or Rhinoclavis kochi. The facies and the Mollusca assemblage implies this layer is formed in more closed bay than the present bay.

Unit A is overlain by a series of sediments that include river gravels, sand, and silty sand (Unit B). The gravels are rounded but not flat and composed of mudstone and kawarake or ancient earthenware. The mudstone was widely quarried around edge of the ancient Kamakura to spread the habitable area to hillside and fill the low ground. This series of deposit is interpreted as deposit of a wetland, which is documented and mapped in ancient literatures. The uppermost layer is landfill formed in the modern age, approximately 1910s.

The deposit of historical wetland created in the calm environment was expected as the host of event deposits that include tsunami deposit; however, we recognized it is highly affected by current of river. This means that the area is not ideal for tsunami deposit research. However we are still due to evaluate each layer, since deposit processes of some layers are not certain. We will also give some data in the session to deepen discussions on geology of this area.

Keywords: Kamakura, Zaimokuza, topographic development, Tsunami, wetland

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS25-15 Room:106 Time:May 24 14:15-14:30

Preliminary study for evidence of tsunami deposits from Holocene sediments in the southern of the Izu Peninsula

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This study conducted stratigraphic and paleoenviromental research on Holocene deposits based on a new outcrop and sediment cores in the lowland of the southern of the Izu Peninsula, central Japan, examining the evidence for tsunamis during the past few thousand years. Until now, we did not identified any evidences for mega-tsunamis.

Keywords: tsunami deposits, Holocene, southern of the Izu Peninsula

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(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS25-16 Room:106 Time:May 24 14:30-14:45

Tsunami deposits from Shimizu Plain, Shizuoka Prefecture

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This study reconstructed the Holocene sedimentary environment and researched the distribution of possible tsunami deposits in Shimizu Plain, Shizuoka Prefecture from 11 sediment cores.

Based on the sediment and molluscan fossil records, the Holocene sediments are divided into four facies: lower sand (LS), middle mud (MM), upper sand (US) and uppermost sand (UMS) layers. Except for UMS, these sand and mud layers are interpreted as delta front and prodelta deposits in bay, respectively. UMS is interpreted as fluvial and dune sediments.

Transition from LS to MM occurred at 9500-8600 yr BP which corresponds to period of eustatic sea-level rise with 10-20 m. While transition from MM to US or UMS occurred after 4000 yr BP which Elevation and 14C dating of the upper limit of the marine deposits show that the total coseismic uplift has exceeded 20 m total interseismic subsidence during the last 8800 years.

Based on elevation and 14C age of marine deposits, coseismic uplift of AD 1854 Ansei-Tokai earthquake is estimated to be at least 1.5 m. This value confirms the coseismic uplift value in historical document.

Six event deposits were identified in sediments after 6000 yr BP when sea level reached and maintained its present elevation. These deposition ages are estimated to be about 200, 550, 1300, 3400, 4300 and 5600 yr BP. The youngest event deposit seems to be flood deposit. It is likely that the event deposit at 550 yr BP was caused by tsunami associated with AD 1498 Meio earthquake. The event deposit at 1300 yr BP may be formed by tsunami of either AD 684 Hakuho or AD 887 Ninna earthquakes. There is possibility that event deposit at 3400 yr BP correlates with any tsunami deposits reported from Shizuoka Plain (3500 yr BP), in Lake Hamana (3300 yr BP) and coastal plain around the lake (3400 yr BP). Since the event deposits at 4300 and 5600 yr BP contain rip-up clasts, they are probable tsunami deposits.

Keywords: Shimizu Plain, tsunami deposits, Holocene, sedimentary environment

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MIS25-17 Room:106 Time:May 24 14:45-15:00

Tsunami deposits at the Iwafune lagoon and the Kamo lake, Niigata Prefecture

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Tsunami damage has occurred in the past, in the Sea of Japan, it is necessary to understand the history of the tsunami. We studied tsunami deposits in the Iwafune lagoon of Murakami city, and the Kamo lake of Sado city, Niigata Prefecture. The Kamo lake is a lagoon that is separated by sandbank about 2 ~ 3m elevation. The Iwafune lagoon developed behind the coastal dunes. We made the core drilling at three sites each of the Iwafune lagoon and Kamo lake. We certified sediment facies observed events, and a grain size analysis. Results of core observation, and brackish waters since about 9000 years ago, the sedimentary environment of Kamo lake, coastal sandbar was established about 7000 years ago. In Iwafune lagoon, the depositional environment of the bay has been continued until about 3000 years ago. Sand layer that extends to the inner bay environment of both regions, it may be caused by event deposits such as the tsunami event. Grain size, From consideration of the facies-change and grain size etc., these deposits are brought by the tsunami. The depositional age of 5 to 8 events in the lagoon sediment of the Iwafune and Kamo lake are matched. Certification of tsunami deposits, it is necessary to consider in more detail. Event deposits in the Iwafune lagoon and Kamo shows the history of the tsunami that occurred in northern waters in the Sea of Japan about 9000 years.

Keywords: tsunami deposits, Japan sea, Niigata, Kamo lake, Iwafune lagoon

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(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS25-18 Room:106 Time:May 24 15:00-15:15

The distribution of benthonic foraminifera in paleo-tsunamis sediments on Ishigaki islands

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In the last 250 years, the Ryukyu subduction zone had no known thrust earthquakes with Mw $>$ 8.0. Because of the lack of large thrust earthquakes, a common idea that the Ryukryu trench is unlocked was commonly accepted. However, a large tsunami struck Ishigaki and Miyako islands with the wave height of up to 30-35 m in 1771.The source of this earthquake was suggested to be a tsunami earthquake with Mw=8.0 that occurred near the trench axis (Nakamura, 2009). In addition, slow-slip events at depths of 30km (Heki and Kataoka, 2009) and very-low frequency earthquakes at shallow depths near the trench axis (Ando et al., 2012) have been identified in the western Ryukyu trench. These findings suggest that the Ryukyu subduction zone should be locked and has the potential to generate large thrust earthquakes.

In order to estimate the size and recurrence intervals of paleotsunamis along the western Ryukyu trench, the excavation surveys of the deposits at 6 sites in Ishigaki Island was undertaken on November 2011, October 2012 and February 2013. The excavated sites are located on the lower Holocene marine terraces and implemented using a geoslicer or backhoes. According to the results of stratigraphy and C14 dating data, two tsunami events (1771 and one between 8 C. and 11C.) in this island were identified. Furthermore, comparing with shallow beach sand, the deep ocean benthonic foraminifera were found in the tsunami deposits and the value of deep/shallow species ratio were much higher than the sediments without tsunami events. Based on these results, through the analysis of benthonic foraminifera in the deposits could gain information on sediment source and depositional style. In addition, it also could provide more reliable evidence for the tsunami identification.

Keywords: tsunami deposits, benthonic foraminifera, Ryukyu trench, 1771