Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

MIS25-P01 Room:Convention Hall Time:May 20 15:30-17:00

Beach deposits inferred as being formed by the 2011 Tohoku Tsunami at the Sendai Coast

SHIRAI, Masaaki[1*], HAYASHIZAKI, Ryo[1], UTSUGAWA, Takako[1], Yasutoki Mukaiyama[1], MURAGISHI, Jun[1]

[1]Tokyo Metropolitan University

Tsunami deposits are important evidence for analysis of paleo-earthquake and paleo-tsunami. Generally tsunami deposits are recognized as sand layers intercalated in muddy sediments in estuary, coastal swamp, and so on. Whereas, it is difficult to distinguish sandy tsunami deposit from sandy beach deposit. We carried out field survey of tsunami deposit on beach formed by the 2011 off the Pacific Coast of Tohoku Earthquake tsunami (2011 Tohoku Tsunami) on 3 May, 2011 nearby the Sendai Airport.

On the foreshore environment, 10 cm thick mafic minerals concentrated layer and water escape structures (pipes) above the layer were observed. Because these structures means continuous erosion and subsequent rapid accumulation of sand grains and water, which is not common on beach environment, the deposit may have been formed by 2011 Tohoku Tsunami. Water escape structures were formed also in surface sand on coastal dune. Because coastal dune sand is transported and deposited by wind, water escape structure exist in unusual conditions. These sand layers should have been formed by2011 Tohoku Tsunami. Further analyses are planned for elucidate origin of these deposits.

Keywords: 2011 Tohoku Tsunami, tsunami deposit, beach, water-escape structure

Japan Geoscience Union Meeting 2012
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MIS25-P02 Room:Convention Hall Time:May 20 15:30-17:00

Backshore deposits inferred as being formed by the 2011 off the Pacific Coast of Tohoku Earthquake Tsunami at the Tsuris

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Tsunami deposits are important evidences of paleo-tsunami and paleo-earthquake. However, studied on tsunami deposits around the shoreline have not been reported frequently, because it is believed that tsunamis generally erode coastal topographies. We investigated beach deposits at the Turishihama Beach, Shinchi Town, Fukushima Prefecture on July 17, 2011. We found the deposits, which are inferred as being formed by the 2011 off the Pacific Coast of Tohoku Earthquake Tsunami (2011 Tohoku Tsunami).

Survey at the Turishihama Beach had been carried out before the 2011 Tohoku tsunami on October 17, 2010. Comparing to before the 2011 Tohoku tsunami, backshore was thicker and flatter; the gradient of foreshore was higher. On the backshore, a 50 cm pit was excavated and backshore deposits were observed. The deposits composed granule to medium sand. A wedge shaped granule layer between 33 to 40 cm depths from the surface showed landward dipping (N45W, S12) on its top. The granule layer was overlain high-angle landward dipping sand-granule cross laminae layer. Although land shape of berm dips landward, its gradient is shallow than 10 degrees. Therefore, observed granule wedge and overlying sand-granule layers may have been formed unusual backshore environment, that is the 2011 Tohoku tsunami run-up. Further analyses are planned for elucidate depositional process and origin of these deposits.

Keywords: The 2011 off the Pacific Coast of Tohoku Earthquake, tsunami deposits, backshore

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MIS25-P03 Room:Convention Hall Time:May 20 15:30-17:00

Possible onshore-dominated source of tsunami deposits of the 2011 Tohoku tsunami: a case study from northern Fukushima

SULASTYA PUTRA, Purna[1*], Yuichi Nishimura[1], Yugo Nakamura[1], Eko Yulianto[2]

[1]Institute of Seismology and Volcanology, Hokkaido University, [2]Research Center for Geotechnology, Indonesian Institute of Sciences

We surveyed the tsunami deposits of 2011 Tohoku tsunami at Matsukawaura and Yunuki, two lowlands in northern Fukushima. The presence of a lagoon at Matsukawaura and river at Yunuki makes these locations are the best location to study the source of tsunami deposits. Matsukawaura is a flat area, and it was a paddy field before inundated by tsunami. At Matsukawaura we surveyed and sampled every 200 m along 2 km transect. Our first point is just behind the lagoon. The inundation distance was around 3.8 km, and our last point was about 300 m before inundation limit. The tsunami height was around 9 m. The tsunami deposits here composed of sand and mud layers. The mud is black and along the transect the mud is distributed in the upper part of the tsunami deposits; however it is sometimes intercalated between the sand. The thickness of the mud is from 1 to 10 cm, and the thickness of the sand is from 3 to 10 cm. Sometimes, within the sand, rip-up clasts are present.

Yunuki is a flat (1.5 x 5 km2) valley located around 7 km south of Matsukawaura. The inundation distance was about 4.5 km, with tsunami height about 10 m. At Yunuki, we surveyed the tsunami deposits along 4.1 km transect (longitudinal transect). We also surveyed the tsunami deposits crossing the river (transversal transect). Total 26 points for longitudinal transect and 11 points for transversal points were observed and sampled. In general the tsunami deposits are composed of sand layer covered by mud. The sand sometimes laminated. This laminated sand deposited above the massive or graded bedding sand.

To understand the main source of these tsunami deposits, we perform foraminifera and mineral composition analysis of beach, dune, lagoon, and tsunami deposits. Examples of foraminifera found within the tsunami deposits are genus of Elphidium, Haynesina, Rotalia. Some species of Elphidium, Haynesina are typical of lagoon spesies.

Based on the percentages of foraminifera, shell fragments and mineral composition, the possible main source for tsunami deposits at Matsukawaura were dune (30%) and lagoon (35%), meanwhile at Yunuki the possible main source was the dune (70%). This novelty result is very important because we always thinking that tsunami deposits mostly sourced from offshore area, and now we understand that tsunami deposits can also mostly sourced from onshore area.

Keywords: tsunami deposits, onshore source, Yunuki and Matsukawaura, foraminifera, tsunami Tohoku 2011

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(May 20-25 2012 at Makuhari, Chiba, Japan)

MIS25-P04 Room:Convention Hall Time:May 20 15:30-17:00

Relationship between tsunami inundation and sand distribution due to the 2011 Tohoku Earthquake tsunami

SHIGENO, Kiyoyuki[1*], Shota Arai[1], NANAYAMA, Futoshi[2], ITO, Takashi[1]

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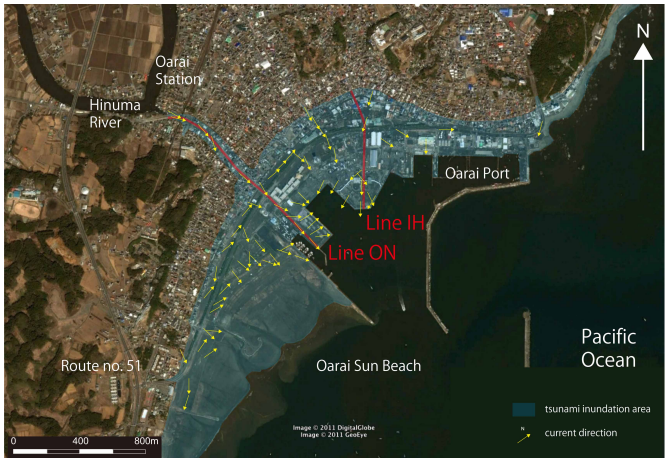
The great earthquake off the Pacific coast of Tohoku was a magnitude Mw 9.0 undersea megathrust earthquake off the coast of Japan that occurred on 11 March 2011. The earthquake triggered powerful tsunami waves that reached heights of up to 40.5 m in Miyako, and which, in the Sendai area, travelled up to 10 km inland. There were three invasions and maximum height was 4.2m at Oarai, Ibaraki Prefecture, and then tsunami came out serious damage for Oarai port and downtown areas. Just after the tsunami, we went there and described tsunami inundation and tsunami sedimentation. In our presentation, we report the relationship between tsunami inundation area and sand distribution due to the 2011 tsunami in this area.

Keywords: 2011 Tohoku Earthquake, tsunami inundation area, sand distribution, Oarai, Ibaraki Prefecture, Oarai Port, Tsunami deposit



Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

MIS25-P05 Room:Convention Hall Time:May 20 15:30-17:00

Tsunami sandy sediments of the coastal forest reserve in Asahi city, Chiba Prefecture, central Japan

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3.11 gigantic tsunami hit Pacific coast of NE Japan and human damage was extended to Chiba Prefecture. Sandy tsunami sediments were distributed in the forest reserve at Yasashigaura coast 3 km west of Asahi city downtown, Chiba Prefecture. The mud drape covering current ripple was discovered there. This mud drape covering current ripple indicates that the stagnant water situation occurred when the gigantic tsunami hit and when tsunami water overflowed artificial bank 5.4 m high into the forest reserve.

The grain size analysis of rippled sandy tsunami sediments collected from the forest reserve indicates that grains less than 0.25 mm occupy 93%, and the threshold velocity attains 25.2 to 29.9 cm/s. The current producing current ripple was concluded to be due to outflow of tsunami, because the direction suggested by all fallen pine trees was different from that of rippled sediments; all pine trees were fell down by hitting of inflow.

In this paper, inflow and outflow of tsunami water flow in the forest reserve will be discussed based on the rippled sediments and fallen trees and grasses. In conclusion, referring to DVD recorded at the near-by light house, it proves that sandy tsunami sediments were produced by 1st and 4th hits of tsunami.

Keywords: inflow, outflow, sandy tsunami sediment, ripple, mud drape, land form

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

MIS25-P06 Room:Convention Hall Time:May 20 15:30-17:00

Behavior of the 2011 Tohoku Tsunami inundated in Taro area (Miyako City) inferred from the distribution of flow traces

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[1]Soil Engineering Corporation

An outsized tsunami generated by the 2011 off the Pacific coast of Tohoku Earthquake swept the wide area along the Pacific coast of the Japan Islands. Taro area in Miyako city (Iwate prefecture) is one of severely damaged cities. This area is located near the rupture zone of this earthquake and situated in the inner part of a narrow bay along the Sanriku Coast. The area has been repeatedly destroyed by tsunamis such as the 1986 Meiji Sanriku Tsunami and the 1933 Showa Sanriku Tsunami. Hence, various mitigation measures against tsunamis were taken in the area. For example, roads in Taro area were planned to be easy to escape from tsunamis; the large embankments of 10 m high and 2.4 km long were built, surrounding the central part of the area. Nevertheless, the 2011 tsunami completely destroyed the area again.

Based on huge damages of the 2011 tsunami, disaster prevention plan against tsunamis are reconsidered in Miyako city. The field survey along the Sanriku Coast, which was immediately conducted after the tsunami, shows basic information on the 2011 tsunami in Taro area: run-up height and inundated area. However, behavior of the tsunamis inundated into the area, however, is still unclear. Therefore, we report the tsunami behavior based on tsunami traces collected by a field survey in Taro area.

We take notice tsunami traces left on artificial objects. In urbanized area, tsunami traces such as tsunami deposits are rare, whereas those left on artificial objects such as concrete structures or asphalt-paved roads are abundant. Some of these traces record directions or orientations of tsunami flows and become clues to clarify behavior of the tsunami.

Our field survey was conducted in November, 2011 (about 8 months after the 2011 tsunami). In this survey, about 300 points of tsunami traces were observed and flow directions or orientations left in them were measured mainly on the embankments and the roads. These traces are categorized into two types of flow traces. One type of traces is linear scrape on flat surfaces of concrete structures or asphalt-paved roads. This type is left by some objects dragged by the tsunami such as ships, building materials, or gravels. Directions of the scrapes indicate those of tsunami flows. Another type is bending of poles such as street lights or utility poles. This type is formed by some objects that are moved by tsunami flows, and hit and bend poles. Bending directions of the poles reflect those of tsunami flows.

Distribution of flow traces of the 2011 tsunami in Taro area are interpreted assuming that these traces were left by the strongest rup-up and backwash currents in the tsunami. Representation of behavior of the tsunami is summarized as multi-directional run-up currents shifted by landform and the embankments and backwash currents showing nearly direct routes to the sea.

Keywords: tsunami, 2011 Tohoku Earthquake, flow trace, Taro, Miyako

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MIS25-P07 Room:Convention Hall Time:May 20 15:30-17:00

Transportation and deposition of tsunami boulders and an onshore gravelly tsunami deposit

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Tsunami deposits in stratum give helpful information for disaster prevention such as inundation area of paleotsunamis and recurrence intervals. To identify tsunami deposits in strata, it is necessary to show as many criteria as possible. Whereas most of the recent tsunami deposits that have been reported so far are composed of sand, gravelly tsunami deposits are rarely reported. While, gravely paleotsunami deposits are often identified in the stratum. Description of the various grain sizes will clarify the diversity of tsunami deposits, and provide criteria to identify tsunami deposits in strata.

This paper reports relationship between tsunami behaviors and characteristics of onshore gravelly tsunami deposits at Settai, Taro-cho, Miyako City, Iwate prefecture, Japan that were inundated by the 2011 Tohoku-oki tsunami. In this region, the highest point of inundation height was 28.1 m and the inundation distance reached to 1.8 km from shore. As a result, lowlands that had been used to paddy fields were covered by tsunami deposits. Moreover, many boulders such as bits of concrete, tetrapod and rock were transported from shore. The deposition of the boulders and tsunami deposits in Settai is one of the rare cases in the sense that wide range of sedimentary grains are left concurrently by a tsunami. Because the methods to estimate the current velocity from transported boulders have already been established, the boulders and tsunami deposits can be a research object to examine relationship tsunami behaviors and characteristics of the deposits.

Boulders are concentrated in some areas rather than scattered in the lowland. Changes in current velocity and current direction due to geographical factors probably affect the characteristic distribution of the boulders. The obtained data show a sharp decline in thickness and gravel size of the gravelly tsunami deposits where many of the boulders are stopped. This indicates that many of the sand and gravel were deposited as the current velocity diminished and the boulders were stopped. The current velocity estimated from larger boulders is 8.0 m/s or more. In the future, the more studies that weigh the boulder and tsunami deposit can be expected to estimate the current velocity of past tsunami from paleotsunami deposits.

Keywords: 2011 Tohoku-oki tsunami, gravelly tsunami deposit, boulder, current velocity

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

MIS25-P08 Room:Convention Hall Time:May 20 15:30-17:00

Tsunami deposits by the 2011 Tohoku Earthquake -observation from the estuary of kuji, natsui river and fudai beach-

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[1]Division of Human Environmental Science | Faculty of Human Development, Kobe University

I Study of tsunami deposits in Kuji, Iwate Prefecture and Fudai beach.
The estuary in Kuji,I observed tsunami deposits,and got the sample.
Layer thickness was about 30cm,the bottom had various size Gravel and sand substrate,poor selection.13-24cm layer had fine grained upqaward,0-13cm layer had massive sand layer and observed a lot of piece of mica.
Results of observation of benthic foraminifera,live in shallower than 20-33m
were rich.
Sandbar at the estuary was eroded,and lagoon had been reduced.
Also in Fudai,sandbar was eroded and lost.

Keywords: Tsunami deposit, The 2011 Tohoku Earthquake, Tsunami, Kuji river, Natsui river, Fudai beach

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

MIS25-P09 Room:Convention Hall Time:May 20 15:30-17:00

Facies and chemical analysis of the 2011 Tohoku earthquake tsunami deposit for identification of paleotsunami deposit

SASAKI, Toshinori[1*], YOSHII, Takumi[1], ITO, Yuki[1], UETA, Keiichi[1], AOYAGI, Yasuhira[1], MATSUYAMA, Masafumi[1], Satoshi Kanaguri[2], Makoto Yanagida[2], OKUZAWA, Koichi[3], Masakazu Watanabe[3], Takahiro Iida[3]

[1]CRIEPI, [2]Hanshin Consultants, [3]Ceres

The 2011 Tohoku earthquake accompanied gigantic tsunami that caused severe damage along the Pacific coast of Hokkaido, Tohoku and Kanto districts.

We have conducted facies and chemical analysis of the tsunami deposit for identifying paleotsunami deposits at the Sanriku-cho, Ofunato city. We carried out the observation of these deposits by pit and boring survey in the field, and grain size analysis, EC, ion analysis, stable isotope analysis in the laboratory.

We will present a detailed result and conclusion at the poster.

Keywords: The 2011 Tohoku earthquake, Tsunami, Tsumani deposit, Facies, Chemical analysis, Paleotsunami deposit

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

MIS25-P10 Room:Convention Hall Time:May 20 15:30-17:00

Microtopography formed by the 2011 Tohoku earthquake tsunami and facies of tsunami deposit at Yoshihama, Iwate

SASAKI, Toshinori[1*], Makoto Yanagida[2], UETA, Keiichi[1]

[1]CRIEPI, [2]Hanshin Consultants

The 2011 Tohoku earthquake accompanied gigantic tsunami that caused severe damage along the Pacific coast of Hokkaido, Tohoku and Kanto districts.

We have conducted microtopography and facies analysis of the 2011 Tohoku earthquake tsunami deposit at the Sanriku-cho, Ofunato city. We carried out the observation of topography using detailed DEM after the earthquake, and facies analysis in the field. Distribution of tsunami deposit have crevasse splay like topography. There are a lot of dunes in this distribution area.

We will present a detailed result and conclusion at the poster.

Keywords: The 2011 Tohoku earthquake, Tsunami, Tsumani deposit, Microtopography, Facies analysis

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

MIS25-P11 Room:Convention Hall Time:May 20 15:30-17:00

Two types of Tsunami deposits in Kujukuri Coast at the 2011 Tohoku Earthquake

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Tsunami caused by the 2011 Tohoku Earthquake brought terrible damage to Pacific Ocean side of Boso Peninsula, eastern part of Japan. This report described Tsunami deposits in Kujukuri Coast at the earthquake. Kujukuri Coast is sand beach, 60km long, along the northeastern part of Boso Peninsula. Recently, a supply of sand decreases and a man-made change is remarkable in the coast. The height of tsunami was approximately 2.5m (at Choshi) and raised northeastward remarkably. A coastal Tsunami deposits varied depending on the height of the tsunami and the existence of the artificial component and the width of sand beach.

Keywords: Tsunami deposits, Kujukuri Coast, 2011 Tohoku Earthquake

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

MIS25-P12 Room:Convention Hall Time:May 20 15:30-17:00

An application of facies analysis and tsunami deposit investigation using X-ray CT images of the boring cores

TATEISHI, Ryo[1*], SASAKI Toshinori[2], SHIMADA Koji[1], IWAMORI Akiyuki[3], HARADA Hiroaki[3], MORI Toshio[4], UETA Keiichi[2], SUGIMORI Tatsuji[5], YAMANE Hiroshi[5], KITADA Naoko[6], ECHIGO Tomoo[6]

[1]JAEA, Monju, [2]CRIEPI, [3]The Kansai Electric Power Co. Inc, [4]The Japan Atomic Power Co., [5]Dia Consultants, [6]GRI

Introduction: As a part of tsunami deposit investigation (Shimada *et al.*, 2012, this session), the boring survey was carried out in the lake Kugushi, central Japan. Four boring points (KG11-1 to KG11-4, from north to south) were set along N-S direction and another one (KG11-5) was placed in SW part of the lake. We discuss the transition of sedimental environment after the Heian Period within 1m thicknesses of the cores and the existence of the evidence for the large tsunami generated by the Tensho earthquake, occurred at AD 1586.

Regional settings and methods: The Mikata-goko area is located in subsidence side of the Mikata fault (N-S strike, E dip). The blackish lake Kugushi has N-S major axis and connects to Wakasa bay by the river cutting beach ridge in northern part of the lake. Main source of sediment supply into the lake was the old-Kiyama river along the Mikata fault before the Kanbun earthquake, occurred at AD 1662. The old-Kiyama river was closed due to uplift by the earthquake, and the main source was altered to an artificial canal through another lake. The old-Kiyama river delta remains in southern part of the lake Kugushi.

Facies analysis based on observation of the cores by eyes and X-ray CT images, and 14C dating was operated.

Results: As a result of the facies analysis, the bed is classified into three groups, III, II and I from lower to upper. The bed III, which mainly consists of organic fine silt, shows uniform grain size distribution in macro scale, but contains thin units typically composed of a pair of an erosion surface with clastic mud overlied by graded silt. The bed II mainly consists of highly bioturbated organic coarse silt and contains granule-sized clast. The bed I mainly consists of organic-rich fine silt and contains shell fragments.

Mean sedimentation rate are 0.5m/ka (KG11-1 and KG11-5) and 0.8m/ka (KG11-2, KG11-3 and KG11-4), based on the obtained 14C ages.

Sedimental environment: The bed III is interpreted to represent the deposits of quiet lake. The coarse-grained units are interpreted as the deposits of minor river flood. The bed II is interpreted to represent the deposits of prodelta. Upward coarsening from the bed III to the bed II and high sedimentation rate (see below) suggest progradation of the old-Kiyama river delta. Dominance of bioturbation suggests activation of the bioactivity as a result of shallowing of the lake. The bed I is interpreted to represent the deposits of quiet lake.

The sedimentation rate of the bed II are about 0.4m/ka (KG11-1), 1.6m/ka (KG11-2 and KG11-3) and 0.8m/ka (KG11-4 and KG11-5). These differences probably depend on influence range of the old-Kiyama river flow. The assumed sedimentation rate of the bed I is low in each core (about 0.1m/ka to 0.4m/ka).

The acceleration of the sedimentation rate through the bed III and the bed II, is thought to be artificial effects in the Heian Period. The 14C ages around the boundary are Cal AD 540-620 (KG11-1), Cal AD 780-980 (KG11-2), Cal AD 890-1020 (KG11-3) and Cal AD 890-990 (KG11-5). The deceleration of the sedimentation rate through the bed II and the bed I, is thought to be decrease of the sediment supply by the uplift of the old-Kiyama river. The 14C ages around the boundary are Cal AD 1150-1260 (KG11-1), Cal AD 900-1030 (KG11-2), Cal AD 1290-1410 (KG11-4) and Cal AD 1700-1920 (KG11-5).

The Tensho earthquake: Some historical records mentioned the large tsunami attacked the Wakasa Bay area at the Tensho earthquake. If it was true, the evidence should remain beneath the boundary of the bed II and the bed I. But, no clear erosion surface or coarse-grained deposits can be detected by analysis of high-resolution X-ray CT images (0.5mm pitch: correspond to 0.5~1.0yr) at the horizon. Thus, the evidence of large tsunami as mentioned in the historical records is not recognized.

Keywords: lake deposit, boring core, X-ray CT image, tsunami deposit, infrequent gigantic tsunami

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

MIS25-P13 Room:Convention Hall Time:May 20 15:30-17:00

An evaluation flowchart for detection of infrequent gigantic tsunami and the case study in the Wakasa Bay area

SHIMADA, Koji[1*], TATEISHI Ryo[1], IWAMORI Akiyuki[2], HARADA Hiroaki[2], MORI Toshio[3], UETA Keiichi[4], SASAKI Toshinori[4], KITADA Naoko[5], ECHIGO Tomoo[5], SUGIMORI Tatsuji[6], YAMANE Hiroshi[6]

[1]JAEA, Monju, [2]The Kansai Electric Power Co. Inc, [3]The Japan Atomic Power Co., [4]CRIEPI, [5]GRI, [6]Dia Consultants

Introduction : We propose an evaluation flowchart for detection of infrequent gigantic tsunami, which rapidly provides accurate and practical solutions applicable to the coastal important installations. We have investigated the tsunami deposit at the coast of the Wakasa Bay in the Sea of Japan, after the 2011 Off the Pacific Coast of Tohoku earthquake. The X-ray CT images of unconsolidated lagoon sediments captured during our case study is effective in facies analysis and enabled us to develop the evaluation flowchart. The objective of the flowchart is gigantic tsunami because tiny ones affect no damage on the coastal important installations. ***Philosophy of detection of infrequent gigantic tsunami*** : No tsunami deposit has been reported in the Wakasa Bay area. A lack of subduction zone along the coast of the Sea of Japan seems to result in the infrequency of gigantic tsunami generated by mega-earthquakes. Thus, investigation method for tsunami deposits supported by a comparison with descriptions in historical materials such as the way along the Pacific coast may overlook indications of infrequent gigantic tsunami in the study area. The purpose of our investigation is accumulation of information regarding traces of infrequent gigantic tsunami. Objective strata are Holocene and partly Upper Pleistcene. We aim to detect sand layers contained within fine-grained sediments. Sand layers showing synchronous and regional characteristics (Umitsu, 1999) can be used as a common marker (hereafter, a marker sand layer) to be examined whether it is a tsunami deposit which makes a subject of us in view of a possibility of infrequent gigantic tsunami. ***Selection of the boring point*** : We selected 9 points composed of 5 points in the lake Kugushi and 2 points on neighboring land, each 1 point in the lake Suga and the Nakayama marsh in consideration of continuous sedimentation of fine-grained materials, distribution of beach sand, distance from shoreline, elevation, and path of tsunami. Representativeness of the area in the Wakasa Bay was checked by the commonness of the recent tsunami height and propagation of simulated tsunami. ***Sampling*** : Soft sediments of bottom of lakes and the marsh were successively sampled using boring machine with advanced thin-wall sampler. ***Analyses*** : Observation of half-cut cores, and measurements of magnetic susceptibility (using U-channel), wet and dry weight, and color were carried out. Dating (14C) by AMS method and tephra analysis were also carried out. These systematic analyses assist objective judgment on the absence or existence of the marker sand layer. ***The judgment*** : Sediments are composed of silt in the lake Kugushi and the lake Suga, or organic materials in the Nakayama marsh (upper 2 m portion of each core). There is no marker sand layer at least after Cal AD 240-400 (2 sigma) based on the analyses. We judged that gigantic tsunami accompanied by deposition of marker sand layers did not occur during the period of sedimentation. The result is concordant with the result of interview survey regarding historical tsunami record to priests of Shinto-shrines in the coast of the Wakasa Bay area, who said there had been no record of tsunami since the Heian-period. ***Additional examinations*** : The X-ray CT analysis of the upper most sections (ca. 1 m depth) of lake sediments clearly shows weak sedimentary structures or trace fossils that are mostly undetectable by naked eye. Despite such capability, no marker sand layer was detected. Detailed discussion can be seen in Tateishi et al. (2012, this session). Although there are no marker sand layers, we further examined nanofossils and diatoms for detection the inflow of seawater into these lakes. Predominance marine nanofossils in specific horizon have not been observed. Much inflow of seawater during short term by gigantic tsunami did not happen. Nanofossil analysis should be indispensable in our flowchart if the marker sand layer was detected.

Keywords: infrequent gigantic tsunami, tsunami deposit, evaluation flowchart, boring core

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

MIS25-P14 Room:Convention Hall Time:May 20 15:30-17:00

Classification of the survey contents in the syudy of tsunami deposits in Japan

KAMATAKI, Takanobu[1*], UCHIDA, Jun-ichi[2], GOTO, Kazuhisa[3], NISHIMURA, Yuichi[4], SUGAWARA, Daisuke[5], FUJINO, Shigehiro[6], Hideharu Sugino[2], Kohei Abe[7]

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Japanese text only

Keywords: tsunami deposits, Japan

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The 2000 years ago tsunami event in the Kamoda-oike pond, eastern end of Shikoku Island

MATSUOKA, Hiromi[1*], OKAMURA, Makoto[1], Toshiyuki Tamura[2]

[1]Kochi Univ., [2]Nita Consultant Co., Ltd

Nankai earthquakes are plate boundary earthquake associated with the Nankai Subduction Zone that have been recorded in historical documents a total of nine times since the Tenmu Nankai earthquake in A.D. 684. In order to reveal pre-historical evidence of Nankai earthquakes, we investigated core sediments from ponds and lakes on the coast of southwestern Japanese Islands along the Nankai Trough.

We collected eight vibrocore samples from the Kamoda-oike pond which located in eastern end of Shikoku Island. Stratigraphical study and radiocarbon dating of these samples revealed that Kamoda-oike pond recorded only one tsunami event in 2000-2300 years ago during last 3500 yeares.

Keywords: Nankai earthquake, tsunami sediment

Keywords: tsunami sediment, Nankai earthquake

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The 17th century tsunami age in Hokkaido estimated from the core bored at Lake Harutori-ko, eastern Hokkaido

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Eastern Hokkaido is a severe Earthquakes and Tsunamis district occurred at Kuril trench in Pacific Ocean. The intervals of the huge earthquakes are estimated about 300˜500 years and the last event occurred in 17th century. But there is no precise tsunami age because the documents of them are only after 19th centuries. At the same time, Tohoku area had hit the huge earthquake named *Keicho Sanriku* Earthquake (1611). Some hypothesis says the 17th century tsunami in Hokkaido corresponds to *Keicho Sanriku* Earthquake. So it is important to estimate the tsunami age.

We analyzed the core sample and thin section from Lake Harutori-ko located in southeast of Kushiro city, eastern Hokkaido. There are 17th century tsunami deposits, lamina and tephra (Ta-b: 1667) in order into 16.5 cm long thin section. We observed thin section in microscope of 1000 magnifications to identify diatoms, which is important component of limnological lamina.

On the microscopic observation of the sedimentary and microfossil assemblages, about 30 laminae with light and dark layers were observed. 75 species belonging to 40 genera are identified in this sediment. In addition to them, plant opal, silicoflagellate and chrysophycean cysts are observed. Diatom assemblages are cyclically changed in related to the laminated structures. Those changes presumed that laminated structures might be formed by seasonal lake environmental changes. Therefore we could decide the detail dating of the 17th century tsunami by counting of the laminae.

Keywords: Tsunami deposit, Diatom, Lamina, Eastern Hokkaido

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Correlation of paleo-tsunami layers based on grain size and sediment composition, eastern Hokkaido

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Geological study of tsunami deposits is the most reliable method to reconstruct properties of paleo-tsunamis along the Kuril trench because there are no historical records on earthquakes before the 19th century in eastern Hokkaido. Correlation of event layers is needed to discuss the scale and behavior of paleo-tsunami. In general, the correlation of a tsunami layer is based on its thickness, depositional structures, marker tephras, and radiometric ages. Thickness and depositional structures are, however, affected by micro-topography. Thus, the tsunami deposits extend over a distance of hundreds meters are difficult to correlate. On the Pacific coast of eastern Hokkaido, only few marker tephras are available and are insufficient for chronology before the 17th century. In spite of recent developments of radiocarbon dating, the error of measurement often exceeds several centuries. In many cases, no dating samples are available. The present study attempts to correlate tsunami layers on the basis of the particle size distribution with a precision of 1/16 phi, component materials, diatom assemblage, and chemical composition of volcanic glass and orthopyroxene. Particle size distribution was measured with Camsizer (Retsch Inc.).

Field surveys were done on five peat lands in eastern Hokkaido; Urahoro, Kinashibetsu, Onbetsu, Akkeshi, and Nemuro. Deposits were excavated using the Geoslicer (100 and 150 cm length). The tsunami sand samples were taken from every two cm and from every sub-unit.

Between Tarumae-c tephra (Ta-c, ca. 2700 yBP) and Komagatake-c2 tephra (Ko-c2, AD 1694), eight sandy layers were identified at Urahoro (U1 - U8), two layers at Kinashibetsu (K1 and K2), four layers at Onbetsu (O1 - O4), two layers at Akkeshi (A1 and A2), and seven layers at Nemuro (N1 - N7). These layers were recognized as paleo-tsunami deposits, because they contained marine and blackish diatoms and well-rounded sand grains. Their grain size distribution and mineral composition are similar to those of recent beach and coastal dune sediments. Most tsunami layers can be correlated along one transect on the basis of precise grain size distribution and mineral composition. Their variation between layers is greater than that between sites. However, sand samples collected from inland sites contain more fine grains and light minerals than samples from coastal sites. Additionally, the U1 layer in Urahoro is distinguished from others by the appearance of much orthopyroxene. The variation of mineral composition implies difference of the coastal environment, likely difference of season.

Correlation of tsunami layers suggests that U1, U2, U5, and U8 are distributed more widely than other tsunami layers in Urahoro. Likewise, widely distributed layers are O3, O1, and O2 in Onbetsu, and N2, N1, N4, and N7 in Nemuro, in that order.

At present we cannot correlate tsunami layers across five regions. However, the tsunami layers in Kinashibetsu, Onbetsu, and Akkeshi are likely correlated with thick tsunami deposits in Urahoro and Nemuro on the basis of the stratigraphic relationships between the sand layers and marker tephras.

In Nemuro area, upper sand layers contain more marine and brackish diatoms. In Kinashibetsu, Onbetsu, and Akkeshi, thickness of upper sand layers are greater than those of lower layers. These areas likely show decreasing resistance to tsunami attack.

Keywords: Tsunami deposit, Correlation, Grain size, Mineral composition, Pacific coast of Hokkaido

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Daitom fossil assemblages of a Tsunami deposit found at the Ota-gawa lowland, western Shizuoka Pref., central Japan

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Holocene outcrop including a tsunami deposit was found at the Ota-gwa lowland ˜3.5 km inland from the present coastline (Fujiwara *et al.*, this meeting). We performed fossil diatom analyses on a part of deposits including the sand layer and discuss environmental changes around the study area. Fossil diatom assemblages are different between the above and beneath the tsunami deposit and indicate that environmental changes occurred associated with the earthquake.

Goelogy of this outcrop consist of peat layer, mud layer, sand layer (Tsunami deposit) and silt layer in ascending order. Their thicknesses are approximately 10 cm, 10 cm, 70 cm and more than 60 cm resepectively. The sand layer was recognized over 150 m in N-S direction horizontally. The sand layer includes several sandy layers showing fining upward. It indicates that tsunami waves attacked this area repeatedly. Aoshima *et al.* (this meeting) reports that gravel components, roundness and mineral composition of this layer are resemble those of sediments around the Tenryu river and the Enshu-nada coast. Radiocarbon ages from this layer suggest that this layer was formed at 4^{th} to 7^{th} century (Fujiwara *et al.*, this meeting).

As the results of the analyses, fossil diatom assemblages show harmonic changes with the core stratigraphy. The peat layer shows dominance of fresh water species, for example *Pinnularia spp.*, *Eunotia* spp. and *Cymbella* spp. making up 10-30 % respectively. They indicates that the peat layer was formed at the fresh water marsh. In contrast, main component species of the mud layer are brackish to marine species such as *Cocconeis scutellum*, *Tryblionella granulate* and *Tryblionella lanceolata*. This feature indicates that mud layer deposited at a tidal flat. The sand layer is characterized by the mixture of fresh, fresh-brackish and brackish-marine species. Especially, *Achnanthes hauckiana*, *Rhopalodia gibberula*, and *Cocconeis placentula* increased than the underlying sediments. The silt layer coved the tsunami deposit shows the abundance of fresh and fresh-brackish species such as *Rhoicosphenia abbreviata* indicating the middle to lower part of river. The upper of the silt layer is characterized by the dominance of *Pseudopodosira kosugii* indicating the marine limit during the Holocene (Sato *et al.*, 1996).

The environmental change from fresh marsh to tidal flat between the peat layer and the mud layer indicates a relative sea-level rising. After deposition of the tsunami deposit, an environmental change from the tidal flat to the riverine estuary occurred rapidly. Radiocarbon ages suggest that this environmental change was triggered by geomorphological change due to the tsunami flows, for example mass transportation. The characteristics of the fossil diatom assemblages of the tsunami deposit indicate exotic water and sediments were transported from inland by tsunami currents flowing seaward.

Reference

Aoshima *et al.*, this meeting, Rock type and mineral compositions of the tsunami deposit from the Otagawa lowland, western Shisuoka Prefecture

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Keywords: Tsunami deposit, Ota-gawa lowland, diatom fossil assemblages, Holocene

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Researches of tsunami deposits from Holocene bay deposits in the Shimizu Plain, Shizuoka Prefecture

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In order to clarify the frequency of tsunami during the last few millennia, this study researches stratigraphic distribution of tsunami deposits from four sediment cores from Holocene bay deposits in the Shimizu Plain, Shizuoka Prefecture. As a result, three graded sand beds are detected from mud layers between -5 m and 0 m altitude. These beds contain molluscan shells which are not found from the underlying and overlying deposits. These indicate that these sand beds may be tsunami deposits.

Keywords: tsunami deposits, bay deposits, Holocene, Shimizu Plain

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Rock type and mineral compositions of the tsunami deposit from the Otagawa lowland, western Shizuoka Prefecture

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Introduction:

Composition of mineral and rock type in the sand beds is an important criteria to identify the source area of the sediments. Roundness of grains reflects the transport and depositional process and is a useful indicator to distinguish the river and marine sediments. Here we adapt these criteria to the tsunami deposit reported by Fujiwara et al. (this meeting) from the Ota-gawa lowland, on the Enshu-nada coast, near the Nankai trough and discuss the source of the deposit.

The tsunami deposit:

The tsunami deposit, ˜70 cm in thickness, was found at the excavation site of river improvements ˜3.5 km inland from the present coastline. It consists of stratified and laminated sand beds with some sub-rounded pebbles and granules and can be traced over 200 m in the coast-normal direction. The tsunami deposit covers tidal flat mud with an erosion surface and is gradually overlain by brackish silt beds (Sato et al., this meeting). Fossil shells of brackish-marine species such as (Cyclina sinensis, Corbicula japonica) are also included in the tsunami deposit. Estimated age of the tsunami deposit ranges from the late of forth century to the end of seventh century (Fujiwara et al., this meeting).

Composition and roundness of gravel:

The composition of gravel was examined using 149 pieces of gravel. Accompanied with abundant gravels of sandstone and mudstone (˜90%), granite and crystalline schist (˜3%) characterize the tsunami deposit. Granite and crystalline schist are not distributed in the drainage of the Ota river (Shimanto belt), but in the drainage of the Tenryu river (Sanbagawa belt or the Ryoke belt). Beach deposits of the Enshu-nada coast are mainly supplied from the Tenryu river and then include ˜ 9% of granite and crystalline schist grains.

We calculated the values of roundness using Krumbein (1941)'s method for the gravels from the tsunami deposit, beach deposits on the Enshu-nada coast and river floor deposits of the Ota river near the study site. The values in the tsunami deposit are 0.72 for sandstone gravels (N=46) and 0.66 for mudstone gravels (N=45). Diameter of gravels ranges from 9.5 to 26.5mm. Values in the beach deposits are 0.70 for sandstone gravels and 0.62 for the mudstone gravels and similar to the values from the tsunami deposit. On the contrary, values of river floor deposits are 0.49 for the sandstone gravels and 0.44 for the mudstone and are clearly different from that of the tsunami deposit. According to the observation in the field, gravel content in the tsunami deposit (numbers of the gravels in the deposits of 1 kg) shows a landward decreasing trend.

Mineral composition of sand bed:

Mineral composition of the sand bed was examined using 266 sand grains (0.18mm-0.71mm in diameter) obtained from the lower part of the tsunami deposit (within 40 cm from the bottom surface). Component of sand grains is lithic fragment (38%), quartz (28%), feldspar (25%), and mica (4%). Occurrence of garnet (1%) characterizes the sand beds. This mineral composition in the sand beds is similar to that of dunes on the Enshu-nada coast and the river floor deposits of Tenryu river (Yosii and Sato, 2010). Garnet is an index mineral of the sediments derived from the Tenryu river, which has the outcrops of granitic rocks in its drainage (Aoshima, 2011).

Our data strongly suggest that the tsunami deposit was mainly transported from the Enshu-nada coast by tsunami run up.

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Keywords: Ota-gawa lowland, the tsunami deposit, the Tenryu river, the Enshunada coast, roundness, garnet

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Geomorphic Changes due to 2004 tsunami-Kirinda Fishery Harbor, Sri Lanka

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Tsunami can erode and bring in large volume of sand and other sea bed material into the land area behind the beach. The seabed became shallower near the coast at most locations, suggesting deposition of inner shelf or deep-sea sediments in the shallow areas. A variable amount offshore material was incorporated into the deposit even though the amount and depth of erosion offshore were not quantified. Relative to the onshore study of tsunami deposition, the impact of the tsunami on the offshore bathymetry is poorly understood, due to the scarcity of pre- and post-tsunami bathymetric data, which are useful for analysing tsunami erosion and deposition offshore. Numerical sediment transport model is a better approach for understanding the offshore process of the bathymetric change by the tsunami. Even though, various models have been proposed to understand the sedimentary process of the onshore and offshore sediment transport, most of the model yet to be validated using bathymetric data immediately before and after the tsunami. The bathymetric data at nearshore zone measured by JICA on November 2004 and February 2005 at Kirinda harbor (81.3375E, 6.2181N), Sri Lanka, was recoded the bathymetric change by the 2004 Indian Ocean Tsunami. This study is assessing the onshore and offshore geomorphic changes due to tsunami in Kirinda, while testing the validity of the sediment transport model using recorded bathymetry data. Nested grid system which includes six domains with different resolution is used to simulate the tsunami propagation and inundation as well as the bed level change. First of all, bed level change in smallest domain is obtained and compare with the measured data in order to validate the sediment transport model. The model calculated erosion and deposition ratio for the Kirinda harbor after the tsunami wave is 0.61, whereas the ratio was given as 0.52 for the measured data. Furthermore, high sedimentation occurred in the bay areas because of the diffracted tsunami inflow into the bays and erosion had been noted at the headlands, as well as at the artificial coastal structures such as breakwaters. The model predicted results overall are compatible with the measured data, although the model could not perfectly demonstrated the local effects. By applying the sediment transport model for the larger domains, it is found out that about 1 m layer of sediment is eroded at 50-100 m depth by tsunami flow and deposited on the nearshore area.

Keywords: sediment transport model, geomorphic changes, tsunami