Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS33-P01 Room:Convention Hall Time:May 26 18:15-19:30

Extensive fault rupture reached Japan trench is landslide

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Analysis on topographical change caused by the 2011 off the. Pacific coast of Tohoku Earthquake was carried out by using anaglyph images based on multi-narrow beam data collected by JAMSTEC and Japan Coast Guard. Apparent and distinctive change is not widely observed in spite of the large earthquake mainly because of rather coarse DEM grid (150 m), except along the seafloor of Japan trench between N 38.0 and N 38.2 where JAMSTEC claims based on topographical and structural changes after the earthquake that displacement over 50 m of the earthquake source fault reached the trench axis. However, detailed observation on anaglyph images reveals that such changes were caused by re-activation of pre-existing landslides located along the toe of a gigantic slope failure located near the epicenter. Mounds appeared along the trench axis probably rotating mass of landslide.

Keywords: Japan trench, submarine landslide, submarine active fault, 2011 Earthquake

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Seabed topography and subbottom images from 200 m to 3,000 m in water depth, off Miyagi and Iwate prefectures

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The 2011 Tohoku earthquake of Mw 9.1 occurred on March 11, 2011 at ˜24 km in depth and ˜130 km southeast from Ojika Peninsula. We have detected the recent dislocation and crustal movement due to the Tohoku earthquake using seafloor topography investigation, earthquake exploration and ocean GPS system and so on (e.g., Sato et al., 2011). The dislocation and movements should be recorded into sediment layers. We need to disclose recent tectonic activities in this area, but there are only a few study examples being geologic structural studies in the sediment layers (e.g., Nitta et al., 2013; AGU abstract).

We analyzed in detail recent deformation structures around Tohoku area using mainly a subbottom profiler (following SBP) system. The ?SBP provided sediment structures within ˜100 m below seafloor around off Miyagi and off Iwate. The water depths were from 200 m to 3,000 m. Total SBP survey lines in this study was 101 lines. For the analyses, we also used multi-narrow-beam (MBES) data to describe deformational seabed topography and single channel seismic data to describe large-scale deformational structures within ˜1000 m below seafloor.

As a result, we disclosed below three points.

?1) From the MBES data, the many lineaments were observed in the south area from 38:45N. This is regarded as a creep deformation.

2) From the SBP data analysis, we observed deformational structures having the cover layers of various thickness. The relative active deformational structures having thin cover layers are located mainly in the south area of 38:05N being SE bulge.

?3) From the MCS data, we detected subsidence and uplifted areas. The uplifted areas correspond to the topography. In addition, we observed several faults of 600 m long.

Based on the above-mentioned result, we concluded our study results as follows.

?1) Based on a geographic characteristics using the MBES and SBP data, we divided into three deformational domains (Domain A, B, C).?

2) Domain A is located ˜50 km SE from Ojika Peninsula. It is ˜300 km2. Judging from the cover layer thickness, We assume that Domain A is continuously in active and also in active now.?

3) Domain B is located on the east of Domain A. It is distributed in ˜500 km2. This domain is similar to Domain A. A fold belt exists between Domain A and B. This implies that Domain A moves faster speed than Domain B.?

4) Domain C is located on the north of Domain B and is distributed in more than ˜900 km2. Judging from the deformational structures and thickness of the cover layers, this area is in active now, but it was stopped at a previous preriod.?

5) According to Arai et al. (2013), there are a long-term subsidence area due to tectonic erosion at the east edge of Domain B. We assume that Domain B moves with the subsidence. Domain A would move to downslope with Domain B movement.

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Stratigraphy of seismo-turbidite assisted by paleomagnetic secular variation in 2011 Tohoku-oki earthquake rupture zone

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Turbidite sequences trapped in the lower slope terrace at 4000-6000 m water depth were collected for 300 kilometers along the Japan Trench in order to reconstruct earthquake occurrences of the Tohoku region Northern Japan. The major lithology obtained in the cores is diatomaceous hemipelagic clay interbedded with turbidite layers. Hr-FP tephra patches/layers derived from the Honshu arc during 500-600 years A.D. (Usami et al., 2014) were identified in the cores. We measured NRMs in 23 of the cores so far. The magnetizations are generally stable to A.F. demagnetizations. The variation of declination shows a systematic shift within 60 degrees. A comparison of the data to references, which are archeomagnetic and sediment paleomagnetic data during the past 3000 years, show a good agreement of the data to the references. The secular variations of the cores hopefully will contribute to date the seismo-turbidite stratigraphy.

Keywords: The 2011 off the Pacific coast of Tohoku Earthquake, Japan Trench, turbidite, paleomagnetic secular variation

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Possibility for the occurrence of tsunami-generated turbidity currents: Insights from the 2011 Tohoku-Oki Earthquake

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In this study, characteristics of the turbidites and turbidity currents associated with the 2011 Tohoku-Oki Earthquake and Tsunami were investigated. As a result, this study proposes a hypothesis suggesting that the large-scale tsunami can generate turbidity currents in deep sea. This hypothesis was verified by the numerical experiments of tsunamis and turbidity currents. The result of this research indicates that understanding of the initiation mechanism and behavior of the tsunami-generated turbidity currents are important to reconstruct paleo-events and paleo-environment change such as surface disturbance associated with earthquakes and tsunamis events.

The 2011 Tohoku-Oki Earthquake and Tsunami occurred at 5:46 (UTC) on March 11, 2011 off Tohoku region, Japan. At about 3 hours after the main shock of the Tohoku-Oki Earthquake, the sensors on the seafloor recorded that the anomalous event occurred (Arai et al., 2013). Subsurface sediment cores were collected at 16 sites over range of water depth 170-2000 m, and event deposits (newly emplaced sediment layers) were observed identified obviously at the top of 14 core samples. Sedimentological analysis of these layers implies that the event deposits can be interpreted as turbidites, and it is suggested that this anomalous event was affected by the turbidity current run from shallower regions.

Because of the absence of related submarine landslides in the shallow marine area, it is reasonable to consider that the turbidity current was developed from the tsunami itself (Arai et al., 2013). It is hypothesized that the suspension cloud was stirred up by the tsunami at shallower depths and it grew into the turbidity current via the self-accelerating process. Both the condition (flow velocity and distribution of event deposits) of turbidity currents and turbidites estimated from the observation and results of numerical simulations of the unsteady turbidity current were quite conformable to this hypothesis. The numerical experiments of turbidity currents suggested that the tsunami-generated turbidity currents can occur when seafloor sediment in shallow marine is eroded at least 1.4 cm in thickness (in case of the porosity 50%) by the tsunami. The numerical experiments of tsunamis (using iRIC-ELIMO) indicates that the Tohoku-Oki Tsunami can eroded substrate 1-2 cm in thickness off Miyagi Prefecture, suggesting that the tsunami erosion may exceed the requirement to develop the tsunami-generated turbidity currents. Thus, it is concluded that tsunamis that have a similar scale to the Tohoku-Oki Tsunami potentially produce turbidity currents.

Keywords: Tohoku-Oki earthquake, tsunami-generated turbidity current, event deposit

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A 100-year stratum record and a 2011 Tohoku-Oki event record in the Japan Trench

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Introduction

In this study, we described detailed sedimentary structures in the core samples which was collected from a shelf, shelf break, gentle slope and deep-sea fan off Hachinohe, a bottom of the canyon off Sanriku, and a gentle slope off Sendai after the Tohoku-Oki earthquake. We observed a sandy sediment layer due to the 2011 event at the surface layer. To estimate the depositional age in the sediment layer, we analyzed 210Pb and 137Cs being radionuclides.

A depositional age can be typically estimated using a profile of 210Pbex calculated from various radionuclide analyses. 137Cs was dispersed into the atmosphere and settled into sediments after the nuclear weapons testing, so that the presence of 137Cs means that the sediment was deposited within 60 years.

Based on these radionuclide analyses, we disclosed a disturbance on the seafloor and in the sediments by the 2011 event. Additionally, we revealed steady and calm sedimentation processes within about 100 years throughout the core sediments. Thus, we deciphered an abrupt [short-term sedimentation] being an event deposition and a steady and calm [long-term stratum records] being a background deposition within about 100 years in the Tohoku area.

Samples

The sediments off Hachinohe were collected using a multiple core system during the cruise KT-11-20 by R/V Tansei-Maru (JAMSTEC) in August 2011. The sediments off Sendai and off Sanriku were collected using a MBARI core on the ROV HyperDorphin during the cruise NT12-12 by R/V Natsushima (JAMSTEC) in May 2012. These sampling methods are possible to collect sediments at the seafloor without any disturbances.

Results

As a result we summarized the [short-term sedimentation] as below.

1. At the shelf and shelf break off Hachinohe, there are coarse sandy sediment layers. Based on the 210Pb profiles and sedimentary structures, we concluded this sandy layer rapidly deposited due to the 2011 tsunami. However, we could not observe any coarse-grained sediment layers at the gentle slope and deep-sea fan.
2. At the gentle slope off Sendai, we observed a sandy sediment layer of 4 cm thick that was formed by a current from west to east; from landward to seaward at the top. The base of the layer is unconformity. We concluded that this sediment layer would be the 2011 event deposit.
3. At the bottom of the canyon off Sanriku, there is a sand layer that was likely formed rapidly at the top based on 210Pb profiles.

We summarized [long-term stratum records] as below.

1. At the gentle slope and deep-sea fan off Hachinohe, the sediment is deposited and consolidated gradually with burial. We can not extract any paleocurrent directions because of probably heavy bioturbation.
2. At off Sendai, we detected a paleocurrent from northeast to southwest throughout the core sediments. This might be a predominant bottom current within ˜100 years in this area.
3. At off Sanriku, we extracted a paleocurrent from southeast to northwest. Based on 210Pb profiles, the depositional rates were 0.061 cm/yr (0.068˜0.072 g/cm2/yr) at 5˜13 cm below seafloor, 0.109˜0.166 cm/yr (0.045˜0.076 g/cm2/yr).

Concluding remarks

We observed a deep-sea [off Sanriku] 2011 event layer which was also ever reported off Sendai. This layer was only observed at the shelf area off Hachinohe. Thus, our study disclosed in detail depositional area of the 2011 event layer. The distribution, depositional processes and preservation processes of this layer should be a clue to understanding for the [deep-sea] paleoseismological study. We need more information for this new deep-sea science. The study continues.

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Temporal change of the 2011 Tohoku-oki earthquake- and tsunami-related event beds at off Sanriku forearc region

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Wide distribution of the 2011 Tohoku-oki earthquake- and tsunami-related submarine event deposits has been reported. Some event beds were formed by the repeated generation of turbidity currents with its interval of more than a few - a few tens days. These facts indicate the formation of the 2011 event deposits was occurred in wide range both in spatially and temporally. Large friction velocity of the tsunami waves might contribute to generate sediment resuspension and redeposition at shallow waters, and strong ground motion of the earthquake might affect the sediment remobilization in deep waters. Radiological measurements of the event deposits suggest the remobilization of surface sediments. However, we still do not know exact image what happened by the 2011 Tohoku-oki earthquake and its related tsunami in the entire off Sanriku region. To clarify the recurrence of the great earthquakes from marine sediment records, evaluation of preservation potential of the event deposits is essential. Repeated examination of sedimentary structures of the event deposits indicates that high sedimentation rate and low benthos activities are important factor for the preservation. A terrace at the lower slope and the Japan Trench floor, where has high sedimentation rates and low benthos activities, and sediments at which contains many fine-grained turbidites, is a potential area for the turbidite paleoseismology along the northern Japan Trench.

Keywords: event deposit, marine sediment, temporal change, 2011 Tohoku-oki earthquake and tsunami

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Effects of mass sedimentation event after the 2011 Tohoku earthquake on benthic organisms in the upper bathyal sediments

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We examined the effects of mass sedimentation events caused by the 2011 off the Pacific coast of Tohoku earthquake on abundances and vertical distributions of prokaryotes and metazoan meiofauna in sediments, using sediment cores collected from eight bathyal stations off Tohoku 1 and 2.5 years after the M9.0 earthquake. Event deposits of 1 to 7 cm thick were observed at the topmost part of the sediment cores at all sampling stations. At some stations, prokaryotic cell abundances were lower in the surface event-deposit layers compared to those in deeper sediments. These variations were explained by environmental parameters such as a sorting factor and mean grain size, suggesting that turbidite sedimentation affected prokaryotic cell abundances. Nematodes had anomalously higher subsurface abundances at the stations where subsurface peak prokaryotic cell numbers were observed. Although there are no corresponding data before the earthquake from the same sites, it is likely that the subsurface peaks in prokaryotic cell numbers and meiofaunal density resulted from the sedimentation events. The effects of sedimentation events on the organisms were observed 2.5 years after the earthquake, indicating that episodic sedimentation events on scales of several centimeters have a large effect on small organisms inhabiting sediments.

Keywords: Meiobenthos, Sedimentary microbe, the 2011 off the Pacific coast of Tohoku earthquake, Vertical distribution

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MIS33-P08 Room:Convention Hall Time:May 26 18:15-19:30

A secular variation of sub-bottom environment after the 3.11 Tohoku Earthquake and Tsunami disaster around Hirota-Bay

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On March 11, 2011, Tohoku Earthquake and Tsunami disaster were generated and the Tohoku district Pacific side suffered serious damage over a wide area. It intends that I clarify a change of sub-bottom environment and I predict it in the future at Hirota bay.

The sample which was gathered near the front of Kesen River in September, 2013 change from the gravel sediment to the mud sediment. As for this change, the influence of the typhoon and the heavy rain are thought about. The sediment from the mouth of Kesen River will be changed by the weather condition.

The strong reflector of SSS data which is distributed over the front of Kesen River is a tendency to decrease from 2013 through 2014. On the other hand, outer layer sediments which is distributed over the front of Kesen River change from the fine sediment to the corse sediment. And, a distribution range of the mud sediment spreads out in the east side of the Osabe fishing port. Thus, it is thought that the mud is carried to the offshore and the bay central part such as river water. Sub-bottom environment of the center part from Hirota bay will change to the mud sediment in the future.

Keywords: Tsunami, Sediment, Environmennt

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Characteristic of palaeoenvironment based on the diatom assembles of the core drilled from Hirota bay, Iwate, Japan

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Hirota bay located in Rikuzen takada off the coast is flowed Kesen river from southeastern . The recent 2011Tohoku tsunami strongly affected the coastal area of the Pacific coast of Tohoku. We will show about characteristic of diatom assembles of the columnar core sampled from Hirota bay.

Sakamoto et al(2014) estimated that sandy sediments from 0-71cm is 2011tsunami origin sediments (Unit1) , muddy sediments from 71-143cm is normal sediments in this bay (Unit2) on the 13HV3 core .Results of diatom analysis of the 13HV3 core are that brackish˜freshwater species from 0-71cm dominante but brackish-marine species from 75-143cm dominante .

On the 13HV8 core which sampled near the Kesen river , brackish˜freshwater species from 0-1cm dominate but brackish-marine species from 42-160cm dominate(Sagayama et al,2014).

Normal sediments on 13HV3 shows marine environment but normal sediments on 13HV8 shows brackish environment. It suggests that the difference of distance from river front and seawater environments (seawater/freshwater ratio) on sampling points.

Keywords: diatom, tsunami, deposit