Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

MIS33-01 Room:501 Time:April 30 09:00-09:15

Comparison of seabeds at <2000 m in water depth off Miyagi before and after the 2011 Tohoku-Oki earthquake

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The 2011 Tohoku-Oki earthquake of Mw 9.0 occurred on 11 March 2011. This earthquake excited large tsunamis, which were generated turbidity current as a tsunamigenic turbidity current (Arai et al., 2013). We do not know well how such turbidity currents will record in sediments in the future.

We investigated the impact of the tsunamigenic turbidity currents by seabed observations. Additionally, we discussed how the tsunami event will be preserved in deep-sea sediments.

We observed the video data of six dive surveys. The two dive surveys of 3K#483 and 2K#1220 have done on 5 September 2000 and on 19 September 2000 during the cruise NT00-09 by R/V NATSUSHIMA. A deep-sea camera survey of YKDT#100 has done on 21 June 2011 during the cruise YK11E-04 Leg 2 using R/V YOKOSUKA. The site P08 was dived on 25 September 2011 during the cruise by HAKUYO3000. OFOS-1 and -2 were dived on 18 March 2012 during the cruise SO219A by R/V SONNE. In addition, seabed sectional view ware made by PARASOUND in the cruise SO219A.

We observed the change of seabed before and after the Tohoku-Oki earthquake. We could see various alive benthic animals (e.g. sea anemones, sea pens and star fishes) on the muddy mounded seabed. There are no strong flow signals being a strong bottom current from the video observations. We found many dead bodies of benthic animals which were covered with bacterial mats by YKDT#100 and P08 videos. The size of bacterial mats was about 1 m in diameter. After one year from the earthquake, the size of bacterial mats had become small about 10 cm in the OFOS video data. Therefore, the bacterial mats ware made after earthquake by seabed disturbance, but bacterial mats would not record in sediment.

On the other hand, we found lines of evidence on the turbidity current which have the potential of preservation in sediments. We observed the bio-fragments scattered on seabed by YKDT#100 and OFOS videos. We measured these direction and we found majority of these faced the SW-NE. Thus, these indicate the direction of the strong flow (e.g. turbidity current) in recent. Our results support the direction of the turbidity current indicated by Arai et al.,(2013). The benthic animals as bio-fragments would record in sediments and would become evidence of tsunami/earthquake events.

Keywords: R/V SONNE, Tsunami deposit, biofragment, paleocurrent

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MIS33-02 Room:501 Time:April 30 09:15-09:30

Evidence of Tohoku-oki earthquake in the deep sea sediment

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A study on differences in bathymetric data between before and after 2011 Tohoku-Oki earthquake revealed a large coseismic displacement of the overriding plate, and a seafloor elevation in the Japan Trench axis (e.g. Fujiwara et al. 2012). Detail sub-seafloor structures around the axis obtained after the earthquake image offscraped trench and incoming sediments due to compression during coseismic slip in the plate interface close to the trench (Kodaira et al. 2012, Nakamura et al. 2013). Strasser et al. 2013 suggests that a large scale slump of the wedge toe significantly impacted the geometry and evolution of the plate boundary in the axis of Japan Trench based on data from sediment samples. Kawamura et al., 2012 and Tsuji et al., 2013 also point out that the coseismic displacement of the wedge. These recent researches indicat that remarkable co-seismic deformation and displacement occurred in the toe of slope near to the trench in the case of 2011 Tohoku earthquake. Thus geological evidences for the phenomenon should be recorded in the sediment around the trench axis. We have conducted research cruises to collect surface sediments in order to seek such features as evidences for 2011 and past Tohoku earthquakes. Piston cores were collected from the trench axis and the landward slope in Japan Trench by R/V ”Mirai” and R/V ”Sonne” in 2012. Intervals in the upper several ten-cm consisting of turbidite units which have been formed just after the earthquake were recovered from the trench axis. This discovery demonstrated that the trench axis is one of the feasible areas to reconstruct Tohoku earthquake history. As ensuring, the older turbidites were also recovered in the area. Contrarily debrite and inclined strata were recovered from the surface of landward slope near to the trench. Those lithologies could be evidences for the wedge displacement or slope failure induced by 2011 or past earthquakes. In the landward slope of Japan Trench, the elongated terrace developed in water depth of 4,000-6,000m is another interesting area to seek evidence related to Tohoku earthquakes. We collected sediment samples from the depth widely using R/V ”Natsushima”. Frequent thin turbidite occurrences were identified in the several cores. Ductile deformations, probably induced by slope failures, recognized in three cores. Those features could be regarded as evidences of past-other Tohoku earthquakes.Thus it is worth researching farther in these deep-sea areas of Japan trench to document the Tohoku earthquake record. Documentation spatiotemporal distribution of such geological evidences will improve our understanding of Tohoku earthquakes.

Keywords: 2011 Tohoku-oki earthquake, Japan Trench, deep sea sediment

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MIS33-03 Room:501 Time:April 30 09:30-09:45

Turbidites collected from the Japan Trench inner slope, during the NT13-19 cruise

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To understand the recurrence of large earthquakes along the Japan Trench, we collected 24 sediment cores from the Japan Trench inner slope, 37.5-40 N, 143.5-144.16 E, water depth 4000-6000 m, during the NT13-19 cruise. Many deep-sea turbidites were intercalated in the sediment cores. We examined the interval and structures of the turbidites using soft-X radiographs. In general, number of the turbidites in a core is high in the southern part off Sendai, but is low in the northern part off Miyako. Meanwhile, intercalated tephras such as Haruna-Ikaho (Hr-FP), Towada-Chuseri (To-Cu) and Towada-a (To-a) were identified in the 13 cores. Based on the eruption ages of the tephras, we estimated the averaged recurrence intervals of 100-500 years in average in almost cores. But there are cores that display different intervals over 1500-2000 years.

Keywords: earthquake, Japan Trench, turbidite, tephra

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MIS33-04 Room:501 Time:April 30 09:45-10:00

Tsunami-generated turbidite as a proxy for large-scale earthquakes

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We summarize the researches of tsunami-generated turbidites, and examine their possibility to be a proxy for ancient earthquakes. A tsunami-generated turbidity current is a kind of seismically triggered turbidites. Arai et al. (2013) reported the first real-time record of a turbidity current associated with a great tsunami. It was recognized after the Mw 9.0, 2011 Tohoku-Oki event offshore Japan. After the 2011 Tohoku-Oki earthquake and tsunami. An anomalous event on the seafloor consistent with a turbidity current was recorded by ocean-bottom pressure recorders and seismometers deployed off Sendai, Japan. Freshly emplaced turbidites were collected from a wide area of seafloor off the Tohoku coastal region. These measurements and sedimentary records to determine conditions of the modern tsunamigenic turbidity current. It can be anticipated that this discovery is a starting point for more detailed characterization of modern tsunamigenic turbidites, and for the identification of tsunamigenic turbidites in geologic records.

Keywords: Earthquake, turbidite, sediment gravity flow, tsunami

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MIS33-05 Room:501 Time:April 30 10:00-10:15

An abrupt seafloor water-temperature increase in the epicentral region of the 2011 Tohoku earthquake

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We report an abrupt seafloor water-temperature increase observed just after the 2011 Mw9 Tohoku earthquake. Ocean bottom pressure variations during the Tohoku earthquake were observed by a deployment of pressure gauges at eight stations in the epicentral region (Ito et al. 2013 Tectonophys.). The temperature sensors for pressure sensor compensation built into the pressure gauges recorded seawater temperature variations that are presented here.

The temperature data documented the following. Abrupt temperature increases were evident at two stations (TJT1 and GJT3: ocean depth of 3000-6000 m) where maximum slip occurred during the Tohoku earthquake. The temperature increases started less than 10 hours after the earthquake occurrence, reaching up to 0.1 ℃ above background temperature, and last for a few weeks. Comparable temperature increases were not evident at other stations farther landward, where the ocean depth is less than 2000 m. Prior to the Tohoku earthquake, there were no temperature changes related to other earthquakes at any of the stations. Thus the observed temperature increases are probably associated with the Tohoku earthquake, particularly in the region of maximum coseismic slip.

Geochemical analyses of the seawater sampled near the seafloor suggest that formation pore water was released in the region of maximum coseismic slip following the earthquake. The pore water was thought to originate at about 1 km below seafloor, based on analysis of methane (Kawagucci et al. 2012 Sci. Rep.), with a contribution from the mantle at deeper than 15 km below seafloor as suggested by helium isotope analysis (Sano et al. 2014 Nat. Comm.).

Here we suppose that the observed temperature anomaly is related to pore water release from greater than 1-km depth. In order to explain the timing of the temperature anomalies, required flow velocity of the released water is $>10^{-1}$ m/s. This is several orders of magnitude more than typical velocities of background fluid flow driven by dewatering of subduction zone sediments (10^{-9} m/s) (e.g., Screaton and Saffer 2005 EPSL). The high velocities ($>10^{-1}$ m/s) most likely reflect fluid flow due to enhanced permeability along fractures and fissures (Tsuji et al. 2013 EPSL) extending to depths of kilometers or more below seafloor, generated by the greatest slip of the Tohoku earthquake.

Keywords: Seafloor water temperature, 2011 Tohoku earthquake

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MIS33-06 Room:501 Time:April 30 10:15-10:30

A sedimentological and paleomagnetic study of deep-sea sediments collected from the Sagami trough

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Introduction

M7-8 class earthquakes occur repeatedly in the Kanto region, central Japan. We have studied earthquake history around the Kanto region using mainly distribution and geologic age of marine terraces so far (Shishikura, 2012). In contrast to the terrestrial study, we have discussed to identify any seismogenic events from deep-sea sediments (Ikehara, 2001). Recently, Noda et al. (2008) suggested that we could exclude mostly flood deposits by choosing the sampling site carefully. Thus, paleoseismology was developing by these previous studies.

In this study, we collected deep-sea sediments from west Sagami Bay. We described the sediments sedimentologically and paleomagnetically in detail. We discussed a sedimentary process and challenged to extract the earthquake history in the region from these data.

Studied specimens

We collected two cores from a gentle submarine slope (KT-12-35 PC01; 35:04.00N, 139:12.99E, water depth 991 m and KT-12-35 PC03; 34:58.30N,139:13.40E, water depth 1,235 m) using a piston corer during the cruise KT-12-35 of Tansei-maru in December 2012. Ikehara et al (2012) reported probable seismogenic turbidites nearby these coring sites.

Results and discussion

We described and measured the two cores PC01 and PC03 as follows.

1.Sample description using microscope: PC01 and PC03 were mainly olive black hemipelagic sediments including foraminifers and diatoms. Both core were observed several volcanic ash layers and sand layers.

2.X-ray CT analysis: Many sandy clay layers in the hemipelagic sediment layers were confirmed by the difference of CT value. These sandy layers would be event layers (e.g. seismogenic and/or flood events).

3.Physical properties: The porosities in PC01 and PC03 decrease from 72% to 58% and from 76% to 65% with increasing burial depth, respectively. The pososity decreases should result from burial consolidation.

4.Magnetic properties: We analyzed simply a paleocurrent direction using anisotropy of magnetic susceptibility and paleomagnetism. The paleocurrents were roughly judged from E to W in PC01 and PC03 throughout the cores.

5.Volcanic glass: Index properties of volcanic glasses was measured at two horizons at 11 cm and 95 cm below seafloor (hereafter cm-bsf) in PC03. We could identify the 1707 Fuji Houei eruption at 11 cm-bsf and the 838 Tentsujima Tenjyouzan eruption at 95 cm-bsf.

6.C14 dating: We measured C14 for age determination at two horizons at 136 cm-bsf in PC01 and 172 cm-bsf in PC03. We collected 30820±210BP and 2850±30BP, respectively. We could calculate the average sedimentation rates as 64 cm/kyr in PC03 and 4 cm/kyr in PC01, even though we could identify the geologic age only at one horizon in PC01.

Based on these results, we discuss the recurrence intervals of the event layers and its depositional processes.

Keywords: Sagami trough, Seismic deposit, XrayCT, Volcanic glass, C14 dating, Magnetic properties

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MIS33-07 Room:501 Time:April 30 10:30-10:45

DEVELOPMENT OF MULTI-PARAMETER BOREHOLE SYSTEM TO EVALUATE THE EXPECTED LARGE EARTHQUAKE ?N THE MARMARA SEA, TURKEY

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The Istanbul-Marmara region of northwestern Turkey with a population of more than 15 million faces a high probability of being exposed to an hazardous earthquake. The 1999 Izmit earthquake in Turkey is one of the best recorded in the world. For the first time, researchers from CNRS and Kandilli Observatory (Istanbul) observed that the earthquake was preceded by a preparatory phase that lasted 44 minutes before the rupture of the fault. This phase, which was characterized by a distinctive seismic signal, corresponds to slow slip at depth along the fault. Detecting it in other earthquakes might make it possible to predict some types of earthquakes several tens of minutes before fault rupture.

In an attempt to understand where and when large earthquakes will occur, and the physics of the source process prior to large earthquakes, we proposed to install multi-parameter borehole instruments in the western part of Marmara Sea in the frame of an EU project called MARSITE. This system and surrounding small-aperture surface array is planned to capable of recording small deformations and tiny seismic signals near the active seismic zone of the North Anatolian Fault passing through the Marmara Sea, which should enable us to address these issues.

The objective is to design and build a multi-parameter borehole system for observing slow deformation, low-frequency noise or tremors, and high frequency signals near the epicentral area of the expected Marmara earthquake. Furthermore, it is also aimed to identify the presence of repeating earthquakes and rupture nucleation, to measure continuously the evolution of the state of stress and stress transfer from east to west with high resolution data, and to estimate the near-surface geology effects masking the source related information. The proposed location of the borehole system is right on the Ganos Fault and in a low ambient noise environment in Gazikoy in the western end of the North Anatolian Fault in the Marmara Sea, where the Ganos Fault goes into the Marmara Sea. The proposed instrumentation will be consisted of broadband seismometer with very wide dynamic range, strainmeter, tiltmeter, hydrostatic pressuremeter and thermometer. These instruments will be installed in 150m deep borehole. Additionally, a surface microearthquake observation array, consisting of 8-10 seismometers around the borehole will be established to obtain continuous high resolution locations of micro-seismicity and to better understand the existing seismically active structures and their roles in local tectonic settings.

Keywords: Borehole system, repeating earthquakes, slow motion, microearthquake activity, rupture mucleation, MARSITE