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

HDS28-01 Room:104 Time:May 23 16:15-16:30

New perspective of submarine landslide

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Submarine landslide is motived for disaster prevention in recent. However, detailed slip monitoring at deep seafloor is much harder than the on-land situation. In most cases, even the tomographic change before and after the landslide event has not been estimated. And the basic conditions including soil mechanics and pore fluid pressure are not uncertain under deep sea water. The pore fluid pressure and seismic acceleration are believed as major trigger for slipping, and pore fluid pressure may concern with rain precipitation on landslide. Submarine sediment is saturated with water and the mechanism of pore fluid rise is uncertain in sub-seafloor. This presentation review the previous studies of surface sediment movement, ground deformation based on science-technology viewpoint, and shows new perspective of submarine landslide.

Keywords: Submarine landslide, Soil mechanics, Simulation

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HDS28-02 Room:104 Time:May 23 16:30-16:45

A hyposesis of the Senoumi submarine megaslide in Suruga Bay in Japan

Kyoji SASSA[1*], HE, Bin[2], STRASSER, Michael[3], MIYAGI, Toyohiko[4], FURUMURA, Takashi[5], SAKAI, Shinichi[6], SHINOHARA, Masanao[6], KONAGAI, Kazuo[7], OSTRIC, Maja[2], SETIAWAN, Hendy[2], TAKARA, Kaoru[2], NAGAI, Osamu[1], DANG Quang Khang[1], YANAGISAWA, Hideaki[4], YAMASHIKI, Yousuke[2]

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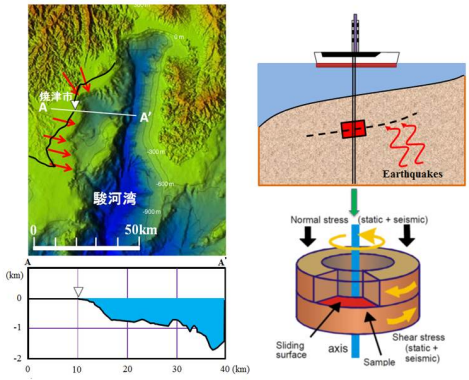
only in Japanese

Keywords: submarine landslide, IODP, undrained ring sher test, simulation



Japan Geoscience Union Meeting 2013
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HDS28-03 Room:104 Time:May 23 16:45-17:00

Submarine landslides in an active forearc basin (Eastern Nankai Trough area)

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Most of landslide analyses in offshore regions have been spotted in passive continental margins, where glacial-interglacial interaction could activate submarine landslides. These previous studies commonly focus on morphometric feature and distributional pattern of submarine landslide itself, and less on its structural and stratigraphical conditions. Understanding such geological knowledge on landslide regions would be helpful for geohazard assessment and resource development, especially in plate convergent zones. In this meeting, we present seismic and balanced cross sections of mass transport deposits in a Pleistocene forearc basin along the Eastern Nankai Trough to discuss tectono-stratigraphic impact on active-forearc landslides. This study was financially supported by METI and MH21 Research Consortium.

Keywords: submarine landslide, forearc basin, 3D seismic analysis, balanced cross section, Eastern Nankai Trough area

Japan Geoscience Union Meeting 2013
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HDS28-04 Room:104 Time:May 23 17:00-17:15

Submarine landslide identified in MD179 cores from shallow gas hydrate area of Joetsu basin, eastern margin of Japan Sea

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Gas hydrate is exposed on a sea floor and is hosted in a shallow depth of sediments in the Joetsu Basin, the eastern margin of the Japan Sea. Linear arrangement of pockmarks and mounds, 50 to 500 m in diameter and 10 to 50 m high and deep, respectively, are identified on both Joetsu knoll and Umitaka spur in the Joetsu Basin. Seismic profiles of these topographic highs reveal gas chimney structure, an effective conduit for the migration of deep-seated gases, develops below the pockmarks and mounds, and the depth of bottom simulating reflectance is estimated to be situated around 100-150m on the spur and knoll. Pockmarks and mounds should have been related to formation and dissociation of gas hydrate. Whereas Un-named ridge situated northeast of the Umitaka spur shows no such characteristic landforms (Matsumoto, 2009; Matsumoto et al., 2009).

Sediment cores are recovered from the Joetsu knoll, Umitaka spur and Un-named ridge during the cruise of R/V Marion Dufresne in 2010 to examine the occurrence and nature of gas hydrate and its surrounding sediments. Bioturbated layers interbedded with thinly laminated (TL) layers, both of which consists of silty clay, are the main constituents of the sediment cores. Blocks or fragments of gas hydrate, carbonate nodules and thin laminations of sand occur in some cores. The repeated bioturbated and TL layers are a diagnostic feature of the Quaternary sediments of the Japan Sea, and the TL layers substitute for marker beds with a help of tephras. Detailed observation of the TL layers makes it easy to recognize landslide horizons in the Japan Sea, in addition.

The recovered sediment is, although, mostly disturbed by tilted horizons, faults, slump folds and breccia except that from the Un-named ridge. The tilted horizons are the most common disturbance of sediments and faults follow them. Slump folds are almost limited to the MD179-3296 that is cored at a pockmark on the Umitaka spur. Detailed examination of TL layers clarified that the TL layers occur in order and a disturbance of sediment is limited in many cores. MD17-3317, which is targeted at a pockmark on the Joetsu knoll, is the most severely disturbed core and consists of breccia originated from repeated debris flow.

Timing and trigger of the submarine landslides are hardly clarified in most cases. Among them, breccia of MD179-3299 that occurs in the upper portion of TL2, the characteristic sediment of the last glacial maximum (LGM) in the Japan Sea, is interpreted as follows. Carbon isotopic analyses and an occurrence of a specific foraminifer strongly suggest a release of methane had occurred around that horizon. And this release of gas caused by the lowered sea level as much as 120 m during the LGM probably led the debris flow on the Umitaka spur.

The thick breccia of MD179-3317 and tilted horizon of MD179-3301 had been formed after the LGM when the global warming had rapidly progressed and sea level had been rising. The Clathrate Gun Hypothesis (Kennett et al., 2002) may be applied to this event. This hypothesis predicts that gas hydrate is unstable at the very time when the interstadial interval had started, and the dissociation of gas hydrate by the warming resulted slope failure such as slump, debris flow and turbidity current.

Seismic activity is another factor that should be considered, because the Joetsu basin is situated in the midst of tectonically active area of the eastern margin of Japan Sea. The Un-named ridge has no physiological sign of release of gas hydrate, and therefore the fault of MD179-3312 will be the case.

Acknowledgement

This work is financially supported by the MH21 project.

References

Kennett, J.P., et al., 2002. Am. Geophys. Union, 210p.
Matsumoto, R., 2009. J. Geogr., 118, 7-42.
Matsumoto, R., et al., 2009. J. Geogr., 118, 43-71.

Keywords: submarine landslide, gas hydrate, Joetsu Basin, Japan Sea, last glacial maximum

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HDS28-05 Room:104 Time:May 23 17:15-17:30

Mass-transport-dominated sedimentation in a foreland basin, Hidaka Trough

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Mass transport is an important process of sediment redistribution from shallow to deep sea basins. It is vital to understand this process for disaster prevention and protection of economic interests in coastal and offshore areas. We describe mass-transport-dominated sedimentation in an active foreland basin, the Hidaka Trough, which developed from collision between the northeastern Japan arc and the Kuril arc. The basin is deformed by east–west compression associated with large, frequent earthquakes. The trough is filled with thick sediments, ranging from coal-bearing Cretaceous terrestrial strata to modern diatomaceous hemipelagic mud and volcanic ash. Bottom-simulating reflectors and the distribution of mud volcanoes, pockmarks, and acoustic wipe-out zones on the seismic records suggest the presence of subsurface gases in the sediments. The basin features stacked mass transport deposits (MTDs), but no channel–levee systems have developed. The MTDs are relatively thin and are derived from three sides of the basin margin. Initiation of submarine slope failure in this area may be controlled by multiple factors that increase driving forces and decrease resistance of the slopes. The driving forces include oversteepening of the margin slope as a result of thrusting and folding, and additional downslope gravitational acceleration caused by cyclic shaking during earthquakes. Decreased resistance in the slopes may be caused by the accumulation of excess pore water pressure driven by a high sedimentation rate, gas hydrate dissociation accompanying changes in sea level or temperature, and liquefaction in coarse-grained beds during earthquakes.

Keywords: Mass transport, submarine landslide, foreland basin, active margin, gas hydrate

Japan Geoscience Union Meeting 2013
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HDS28-06 Room:104 Time:May 23 17:30-17:45

3D structural analysis of large-scale submarine landslide on a very gentle continental slope off Shimokita Peninsula

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Submarine landslides can be found even on very low angle slope well below the angle of response, and are often greater in size and migration length than onshore landslides. Morita et al. (2011) analyzed METI's 3D seismic data 'Sanrikuoki 3D' obtained off Shimokita Peninsula, and found a number of large-scale submarine landslide deposits in the Pliocene and upper formations. The slump deposits features generally indicate layer-parallel slip on a very gentle and flat continental slope, and often exhibits imbrication structure formed by repeated thrusting of slided sedimentary sheets and related dewatering structure standing on the slip planes. In order to clarify the deformation and fluid migration systems, we have proceeded further analysis of the 3D seismic data and have outlined the morphostructure of slump deposits. Characteristics of the internal structure and dewatering structure are considered to be associated with the slumping system occurring on such very gentle and flat continental slope. In addition, gas hydrate BSR (Bottom Simulating Reflector) is prominently recognized within the slump layers, whereas BSR is not clear in surrounding normal formation. This means that there is a good contrast of acoustic impedance at the depth of the BSR, and gas hydrate may accumulate within the slump deposits, relatively easier than in surrounding formation. This may suggest a typical fluid migration system in the sedimentary basin. In this session, we introduce latest results of structural analysis especially with respect to distribution and morphology of the submarine landslides in the survey area.

Keywords: submarine landslides, 3D seismic data, high methane flux, Shimokita Peninsula

Japan Geoscience Union Meeting 2013
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HDS28-P01 Room:Convention Hall Time:May 23 18:15-19:30

Evidence for Mass Transport Deposits at the IODP JFAST-Site in the Japan Trench

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Several studies indicate that the 2011 Tohoku-Oki earthquake (Mw 9.0) off the Pacific coast of Japan has induced slip to the trench and triggered landslides in the Japan Trench. A major effort in marine geosciences is currently to better understand these processes, including detailed mapping and coring landslides at the trench as well as Integrated Ocean Drilling Program (IODP) drilling (Japan Trench Fast Earthquake Drilling Project, JFAST) to recover the shallow fault zone.

Here we report sediment core data from the rapid response R/V SONNE cruise (SO219A) to the Japan Trench, evidencing mass transport deposits (MTD) in the uppermost section drilled at the IODP JFAST-site. A 8.7 meter long gravity core (GeoB16423-1) recovered from ~7000 meter water depth reveals a 8 m sequence of semi-consolidated mud clast breccias embedded in a distorted chaotic sediment matrix. The MTD is covered by a thin veneer of 50 cm hemipelagic, bioturbated diatomaceous mud. This stratigraphic boundary can be clearly distinguished by using physical properties data from Multi Sensor Core Logging and from fall-cone penetrometer shear strength measurements. The geochemical analysis of the pore-water shows undisturbed linear profiles measured from the seafloor downcore across the stratigraphic contact between overlying younger background-sediment and MTD below. This indicates that the MTD at the JFAST-site is older than the Tohoku-Oki event, and that the investigated section has not been affected by sediment destabilization triggered by the slip-to-the-toe Tohoku-Oki earthquake event. Instead, we report an older landslide which occurred in the relatively young geological past between 700 and 10,000 years ago, implying that submarine mass movements along the Japan Trench are frequent processes.

Keywords: Japan Trench, Mass Transport Deposit, Tohoku-Oki Earthquake, IODP-JFAST, geochemistry, physical property

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HDS28-P02 Room:Convention Hall Time:May 23 18:15-19:30

Identifying mass transport deposits using magnetic fabric analysis: An example from Nankai Trough

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Submarine landslides are a potential hazard to coastal areas all over the world. Studyies of mass transport deposit (MTD) contribute to understanding the nature and process of the submarine landslides. Scientific drilling provides material containing a historical record of the seafloor environment, however, there is not always enough sediment to recognize MTDs by visual information.

We applied magnetic fabric analysis to the drilled cores to examine the potential of magnetic fabrics in identifying MTDs. Among the sites drilled in the framework of the Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE) of the Integrated Ocean Drilling Program, multiple occurrences of MTDs were observed in the recovered cores. We focused on Sites C0008 and C0018 of the slope sediments in the footwall of the megasplay faults. Magnetic fabric analysis was performed with the recovered cores in the MTDs. The shape parameter (T) and the orientation of the axes of magnetic ellipsoids, distinctively scattered in MTDs, suggest mobilization

and/or resedimentation during the formation process. Downward increments in the parameter L near the bottom of MTDs may result from the shear localization near the basal sliding plane. By contrast, the results from the sediments described as a mass transport complex at Site C0008 showed the opposite trend, suggesting a different dynamic process during transportation. Our results show the magnetic fabric analysis is potent in describing MTDs and their internal structures. This may extend the methodology in describing MTDs and the discussion on their dynamic process.

Keywords: Submarine landslide, D/V Chikyu, NanTroSEIZE, Accretionary Prism, Megasplay fault, IODP Expeditions 316 and 333

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HDS28-P03 Room:Convention Hall Time:May 23 18:15-19:30

Research activities for future scientific drilling in large submarine landslide group in Sanrikuoki Basin

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A great number of large slump deposits have been identified in the Pliocene and younger formations in the north Sanrikuoki Basin off Shimokita Peninsula, NE Japan. The slump units and their slip planes have very simple and clear characteristics, such as layer-parallel slip on very gentle slope, regularly imbricated internal structure, widespread dewatering structure, and low-amplitude slip plane layer. So, we recognize the large slump deposits group in this area is an appropriate target for a scientific drilling to determine ”Submarine Landslide Mechanism”, that is one of the subjects on the IODP new science plan for 2013 and beyond. In 2012, we started some research activities to examine the feasibility of the future scientific drilling.

The slump deposits were recognized basically by 3D seismic analysis. Further detailed seismic analysis is being performed for better understanding of geologic structure of the sedimentary basin and the slump deposits, that is to extract suitable locations for drill sites.

Typical seismic features and some other previous studies imply that the formation fluid in this study area is strongly related to natural gas, of which condition is strongly affected by temperature. So, detailed heat flow measurement is going to be performed in the study area. For that purpose, a long-term water temperature monitoring system was deployed on the seafloor in October, 2012. The collected water temperature variation will be applied to precise correction of heat flow values, which will be measured next year. Vitrinite reflectance analysis is also being carried out using sediments samples recovered by IODP Expedition 337, which is conducted in a part of the study area from July through September in 2012. The values of vitrinite reflectance will be available for modeling thermal history in the sedimentary basin.

In September, a science meeting and a field trip were held in Miyazaki Prefecture. These are aimed at identifying the issues for planning the scientific drilling and at developing a science community on this subject. At the field trip, we observed typical geologic structures related to slumping and dewatering in Nichinan Group, which are good onshore objects so as to share the aspects of the slump deposits in the Sanrikuoki Basin among the community.

This study uses the 3D seismic data from the METI seismic survey ”Sanrikuoki 3D” in 2008. The seismic analysis, the vitrinite reflectance analysis, and the science meeting and the field excursion in Miyazaki were supported by the foundation of feasibility studies for future IODP scientific drillings by JAMSTEC CDEX.

Keywords: submarine landslide, slump, layer-parallel slip, dewatering, slip plane, IODP

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Detailed topography and geologic architecture of the submarine landslides in the Jan Mayen Ridge, north Norway

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This paper deals with the detailed topography and the geologic architecture of a large submarine landslide in the Jan Mayen Ridge. The Jan Mayen Ridge, being a continental sliver, is ˜250 km long in N-S direction with a flat plateau of ˜800 m in water depth standing on an abyssal plane of 2500-3000 m in water depth. There is only a large submarine landslide scar of ˜50 km wide in the central east side. In the central east side, the internal geologic architecture is characterized by an Eocene-Oligocene sedimentary sequence, which tilts eastward. This sedimentary sequence is cut by large normal faults, that have formed by the spread of the Norwegina-Greenland Sea since 20 Ma. The wasted mass of the large submarine landslide could slip down along the bedding plane and/or the normal faults dipping to east. Thus, the slide form a big spoon-shaped basin. The slide scar was collapsed retrogressively to make a small spoon-shaped basin on the upper part of the big basin. There are long channels from the retrogressive slide scars to the lower basin. The retrogressive slides would continue to discharge progressively gravity flows to make the long channels on the basin after the large submarine landslide occurred. On contrary to the slide region, the sedimentary sequence has a large anticline in an east foot of the ridge in other regions. This anticline could be an obstruction to a large submarine landslide. Thus, the geologic architecture plays an important role in the formation mechanism of a large submarine landslides in the Jan Mayen Ridge.

Keywords: Submarine landslide, Norway, Jan Mayen Ridge