Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

MIS001-01 Room:304 Time:May 25 14:15-14:30

Slope failures in analogue model experiments of subduction margins

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Analogue model experiments that use dry granular materials commonly produce slope failures on the top free surface, and these failures can be applied to submarine slides. This talk presents some examples of slope failure events found in the models.

Keywords: slope failures, submarine slide, analog model

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MIS001-02 Room:304 Time:May 25 14:30-14:45

Along strike migration of intermittent submarine landslides at subduction margins: a geologic evidence

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Ancient examples of submarine landslides exposed in the Pleistocene Chikura Group represents the lateral migration style of intermittent submarine landslide. The submarine landslide in the Pleistocene Chikura Group was triggered by earthquake induced liquefaction occurred approximately 2 Ma. Although the deposit can be traceable over 5 km based on the key-tephra (HF) tracing, we identified the evidence of lateral variation of sliding ages. In the central part, coherent layers and the key tephra, HF, overlay the slide deposit (HF overlays about 4 meters above the top of the slide sediment). In the westernmost part, however, the HF was included inside the slide deposits as blocks. The HF overlays about 2 meters above the slide deposit in the intermediate part. This is the geologic evidence indicative of the lateral migration of intermittent submarine landslides, which can be correlated to the migration style identified in the physical models (Yamada et al., 2010).

Keywords: submarine landslide, liquefaction, earthquake, accretion

Japan Geoscience Union Meeting 2011
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MIS001-03 Room:304 Time:May 25 14:45-15:00

Anatomy of a thick (~70 m) submarine land slide discovered at Kashinozaki Knoll in the Nankai Trough

Asuka Yamaguchi[1*], Bora Song[2], Pierre Henry[3], Toshiya Kanamatsu[5], MOE Kyaw Thu[5], Scientists the Expedition 333[5]

[1]The University of Tokyo, [2]Rice University, [3]CEREGE, [4]JAMSTEC, [5]IODP

The IODP Expedition 333, a part of NanTroSEIZE project, was operated during December 2010 to January 2011. Three sites including subduction input (Sites C0011 and C0012) and submarine landslide (C0018) were drilled. Site C0012 is located at the top of Kashinozaki Knoll, basement high of the northernmost part of the Philippine Sea Plate in off Kumano region in the Nankai Trough. From 15 to 85 m CSF of Hole C0012C, a steeply-dipping interval (dipping angles of 40-70 degrees to southeastword) probably correspondent with a thick landslide (slump) is discovered. We show the anatomy of this landslide based on the review of shipboard structural, litho- and magneto-stratigraphycal, geochemical, and physical property measurement.

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MIS001-04 Room:304 Time:May 25 15:00-15:45

A new record of submarine landslide history in the Nankai accretionary wedge: Results from IODP Expedition 333

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[1]MARUM, University of Bremen, Germany, [2]CEREGE - College de France,, [3]JAMSTEC, Yokosuka, [4]IODP

Here, we present results from Integrated Ocean Drilling (IODP) Expedition 333, which drilled and cored a Pleistocene-to-Holocene stratigraphic succession of a slope basin seaward of a margin-dominating out-of-sequence thrust (termed megasplay) in the Nankai accretionary wedge, offshore the Kii Peninsula, southwest Japan. The slope-basin represents the depocentre for downslope sediment transport from various sources such as the hanging-wall block of the megasplay, anticline structures within the accretionary prism and the slope apron sedimentary cover. The stratigraphic succession comprise stacked mass-transport deposits (MTDs), including an up to 150 m thick MTD, as identified in 3D reflection seismic data. Continuous coring to 315 meter depth at a location where the MTD bodies wedges-out and where basal erosion by mass-transport events is minimal, reveal a nearly complete stratigraphic succession recording more than 1 Million years of the submarine landslides history in this active tectonic setting.

We present D/V Chikyu shipboard results from IODP Site C0018, including litho- bio- magneto- and tephra- stratigraphy and physical property data. Six MTDs of thickness ranging from 50 cm to 60 m at the drill site were identified from visual core description and X-ray CT-scans. The thick MTD is the oldest and its stratigraphic position coincides with a lithological transition between a sandy turbidite sequence below and ash bearing hemipelagites comprising several MTDs above. The deformation style of these MTDs appeared heterogeneous, with intervals of remoulded sediments and intervals inferred to retain original, coherent bedding. Shear zones and faults have been identified in the lower part of the MTDs and, in three occurrences the base of the MTD is defined by a shear zone within fine-grained sediments. A thick sandy ash layer attributed to a cataclysmic eruption on Kyushu Island dated 1.05 Ma was found immediately below the thick MTD. We hypothesize that part of the ash layer was characterized by excess pore pressure and that liquidization within this layer during earthquakes is one mechanism by which submarine landslides could be triggered in subduction zones.

IODP Exp. 333 Scientists:
Kyaw, M. (JAMSTEC, JP); Alves, T. (Univ. Cardiff, UK); Bauersachs, T. (Christian-Albrecht-Univ., Germany); Daigle, H. (Rice Univ., USA); Ekinci, K. (Univ. Missouri, USA); Gao, S. (Univ. Nanjing, China); Garcon, M. (CEREGE, France); Kawamura, K. (Fukado Geol. Inst., Jp); Kitamura, Y. (JAMSTEC, Jp); Laberg, J.S. (Univ. Tromso, Norway); Lee, G. (Pukyong N. Univ., Korea); Lee, Y. (Korea Inst. of Geosci and Min. Resources); Lu, Y. (Univ. Alabama, USA); Marcaillou, B. (Univ. Antilles e. Guayne, France); Matsubayashi, O. (AIST Tsukuba, Jp); Nagahashi, Y. (Fukushima Univ., Jp); Novak, B. (W. Washington Univ., USA); Saito, Y. (Doshisha Univ., Jp); Satoguchi, Y., (Lake Biwa Museum, Japan); Screaton, E. (Univ. Florida, USA); Scudder, R. (Boston Univ. USA); Yamaguchi, A. (Univ. Tokyo, Jp)

Keywords: IODP, NanTroSLIDE, Nankai Trough, Submarine Landslides, Mass-transport deposits, slope basin sediments

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MIS001-05 Room:304 Time:May 25 15:45-16:00

Stagnation of lithification owing to shear stress in slope basin, Kumano, southwest Japan

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The forearc, slope and trench basins and accretionary prisms are developed in Kumano area where is formed by subduction of the Philippine Sea plate to the northwest beneath southwest Japan. The accretionary prism growth during geologic time period, and many landslides are scattered at slope basin. The stability of the slope basin sediment will depend on geotechnical property of sediment. We investigated physical property of the surface sediment of various sedimentation settings at Kumano area.

Twelve piston and gravity core samples, 0.3 to 5 m in core length were taken from cover sediment of the Miura knoll, Kumano forearc basin, slope basin, small pockmark basin and Nankai trough. The electric resistibility is measured at 2 to 10 mm intervals, and the vane shear test has been carried out at 5 to 30 mm intervals. The electric resistibility, depend on seawater content is an indication for porosity of sediment.

In the result, the electric resistibility and shear strength are increase with depth in all sites, however the increase ratio varied in sedimentation setting. High increase ratio was found at cover sediment of the Miura knoll where the sedimentation ratio is likely very slow. To avoid from time-effect of dewatering and sedimentation ratio, we compared between electric resistibility and shear strength. The shear strength increases with electric resistibility, and the ratio is anywhere almost the same, except the slop and pockmark basin sediments. The strength of slope basin sediment is much smaller than the others basin sediment though similar electric resistibility. The strengthening of the sediment may depend on not only time and porosity but also formation of clay mineral structure. The slope sediment may undergo shear stress in any time, and this probably causes stagnation of formation of clay mineral structure.

Keywords: Nankai, Sediment, strength, Clay mineral structure

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MIS001-06 Room:304 Time:May 25 16:30-16:45

Characteristics of slump units offshore Shimokita: a key to solve ground instability factor in gentle continental slope

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The origin of ground instability leading to submarine landslides has not yet been fully clarified. In general, landslides on land are considered to be caused by changes in the groundwater level or hydraulic gradient due to heavy rains, or the related rapid rise in pore pressure, because such phenomena decrease the frictional properties of the ground. But, the same is not true for landslides that occur in the ocean, where seawater saturates the ground below the sea floor. The behavior of the pore fluid may change the pore pressure and cause ground instability related to submarine landslides. As a result of analysis on a 3D seismic survey of Sanriku-oki basin off Shimokita Peninsula, Japan (METI fundamental seismic survey 2008, Sanriku-oki 3D), we revealed a number of typical deformations due to slumping and the related dewatering structure in the Pliocene and younger formations. The slumping was generated primarily by layer-parallel slip, which seems to have occurred on acoustically typical layers on very gentle continental slope. The formation of the slumping and the dewatering strictures is considered strongly related to fluid circulation in heterogeneous sedimentary sequence, which seems to directly lead to creation of slip plane of the slumping. We are focusing on those deformations of the slumps and the dewatering structures as a key to solve submarine ground instability factor.

Keywords: 3D seismic survey, slump, dewatering structure, slip plane, ground instability factor

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MIS001-07 Room:304 Time:May 25 16:45-17:30

Large-scale gravity collapse of the Boso TTT-triple junction hanging wall: ROV study results

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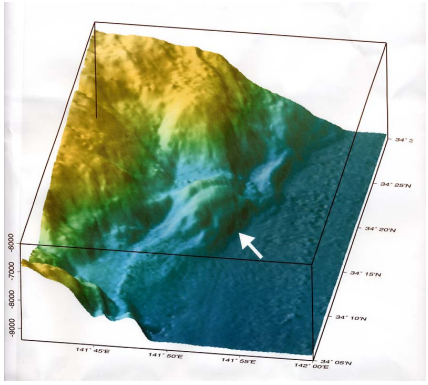
A TTT-triple junction is unstable unless the direction parallels one of the trenches. Boso example is the only case for TTT but displays very systematic history of gravity collapse, continuing for a long time but remarkable in recent years. The junction must have been far SE off than at present, and has been eroded and retarded to NW by gravity collapse due to the instability of the triangle area, probably as a consequence of the NW-ward change of movement of the Philippine Sea plate along the oblique subduction of the Sagami trough. One of the direct lines of evidence is the finding of middle Miocene fossil-bearing mudstone from the large-scale gravity slide deposits just on the junction. Submersible observation and collection of the samples made sense for explanation that the Miocene to present zonal structure of accretionary prisms and related sedimentary basin deposits is now largely collapsed in various scales, particularly on the NW side hanging wall of the junction. NE-trending normal faults in the surface might be the products of horizontal stretching on the North American plate side. Change of the submarine canyons from NW-SE to N-S is also the results of this instability. The paleoseismology, paleotsunamology and field observation in the Boso-Miura Peninsulas are also supporting these stories. Some of them may be related to the total subduction activity simultaneously linked earthquakes from the Nankai trough to Sagami trough.



Keywords: Boso, triple junction, gravity collapse, paleoseismology, ROV

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MIS001-08 Room:304 Time:May 25 17:30-17:45

Underwater landslides and slumps observed along active submarine faults ? a possible source of a devastating tsunami?

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The author would like to show some examples of the results of offshore studies on underwater landslides and slumps along active submarine faults which might be the origin of devastating tsunamis on the adjacent coastal areas.

Case-1: the 1998 Papua New Guinea Tsunami

The northern coast of Sissano Lagoon and Town of Aitape, Sandaun Province of Papua New Guinea enormously suffered from a M7.0 earthquake, which was followed by a large-scale tsunami on 17th 1998. 2,200 fatalities were recorded due to the run-up of the tsunami in Aitape and Sissano areas. The area is characterised by a plate convergent margin along the Wewak Trench where the North Bismarck Sea Plate subducts towards the mainland Papua New Guinea.

The precise topographic survey revealed that an amphitheatre NNE of Sissano Lagoon is associated with a ENE-WSW-trending knoll just off the basin (Pop-up Block = PUB). The western half of the amphitheatre is characterised by erosion by small channels perpendicular to the topographic contour line whilst the eastern half by sediment deposition lobe parallel to the strike of the steep slope. This amphitheatre seems to be most active and with most recent seafloor deformation according to the topographic feature.

The following events were identified on the amphitheatre and PUB areas during the seafloor reconnaissance surveys.

(1) En echelon cracks/fissures on the sediment with sharp edges on both sides were located along the headwall of the amphitheatre. These are apparently ”crown cracks”, indicating the tensile stress applied recently due to a slump on the headwall.

(2) Living mussel and tube-worm colonies were observed on the slope, indicating a cold seepage of nutrient-rich water along a crack.

However, bio-turbated areas were also observed widely away from these active events. Therefore the possible landslide which generated the large-scale tsunami might be due to the movement of the cohesive surface sediment triggred by the mainshock.

Case-2: the 2006 Java earthquake and tsunami

A Mw 7.7 earthquake and subsequent large-scale tsunami occurred on 17th July 2006 off the southern coast of Java Island, Indonesia. A maximum of 7.7 m inundation height was recorded in Pangandaran on the southern coast of Java, according to the field survey just after the tsunami (Tsuji et al., 2006). However, since there are few residents who noticed the earthquake tremors, the earthquake may possibility be so-called ”tsunami earthquake”. The aftershocks from July to September occurred on the fore-arc area and their CMT solution suggests the predominant north-south tensile stress. R/V MIRAI passed the aftershock area in 2004 and 2005 with continuous multi-beam bathymetric survey. The processed topographic map shows a lot of amphitheatres with the scale of 8-20 km along the fault scarps. Convexity landforms are located below the footwall of the amphitheatres, apparently the relics of an underwater landslide, and their relative elevation exceeds 1000 m in maximum. This area is characterised by the south-eastern extension of Mentawai Fault and its associated minor faults ranging from the Sumatra fore-arc area. The observed amphitheatres and relics of underwater landslides are located along the active faults. Considering that the tsunami wave height distribution is concentrated on a specific narrow area compared with the scale of the main-shock, the main-shock possibly triggered underwater landslides on these amphitheatres and the slides generated a large-scale tsunami.

Keywords: underwater landslide, slump, underwater landslide, tsunami

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MIS001-09 Room:304 Time:May 25 17:45-18:00

Recognition and importance of fine-grained slope failure deposits for deep-sea paleoseismology

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Deep-sea slope failure deposits have been used to reconstruct past large earthquakes in the deep-sea environments. Many works used sandy turbidites for the reconstruction. However, fine-grained gravity flow deposits also have the potential to record the slope failures. For example, fine-grained turbidite mud has different characteristics in bulk density, grain size distribution and grain composition from normal hemipelagic mud. Detailed observation of marine cores will provide us information on small-scale slope failure events producing the fine-grained gravity flow deposits.

Keywords: slope failure, turbidite, earthquake, paleoseismology, marine sediment

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MIS001-10 Room:304 Time:May 25 18:00-18:15

Discussions

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In order to stimulate the research, this time is dedicated for active discussion related to this session.