

Japan Geoscience Union Meeting 2011

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

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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

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

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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

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

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 southeastward) 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-stratigraphical, geochemical, and physical property measurement.

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

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:

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

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

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 structures 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

MIS001-07

Room:304

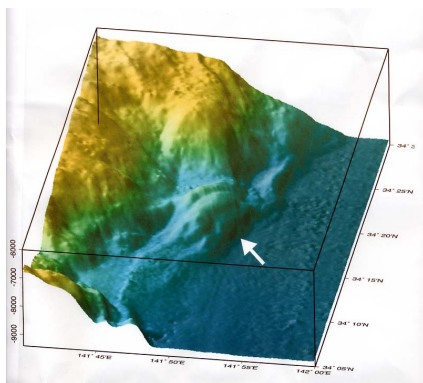
Time:May 25 16:45-17:30

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

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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¹University of the Ryukyus

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 triggered 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 possibly 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

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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¹Geological Survey of Japan, AIST

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

Yasuhiro Yamada^{1*}

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

MIS001-P01

Room: Convention Hall

Time: May 25 10:30-13:00

Detailed observation of topography and geologic architecture on a submarine landslide scar in a toe of an accretionary p

Kiichiro Kawamura^{1*}, Arito Sakaguchi², Toshiya Kanamatsu², Hiroshi Ikeda¹, Ryo Anma³, Michael Strasser⁴

¹Fukada Geological Institute, ²JAMSTEC, ³University of Tsukuba, ⁴University of Bremen

This paper deals with detailed geologic and topographic features of a recent three submarine landslides on a convergent margin. We surveyed a submarine landslide scar on a toe of the Nankai accretionary prism, SW Japan, using the remotely operated vehicle (ROV) KAIKO7000II (7K). The water depth is 3200-3800 m. The total volumes of moved masses are 3.3, 30.6 and 11.3 km³. During the dive survey, the 7K found debris blocks fractured by two directions of joints. These result from retrogressive small collapses at the landslide scar. Seeps being bacterial mats were observed at the top of the scar. These are related to be a formation of the slide.

Keywords: ROV KAIKO7000II, Bacterial mats, Nankai trough, prism toe

MIS001-P02

Room:Convention Hall

Time:May 25 10:30-13:00

High-turbidity layer and its settling in the Nankai accretionary prism off Kumano

Juichiro Ashi^{1*}, Ken Ikehara², Masataka Kinoshita³, KY04-11 shipboard scientists¹, KH-10-3 shipboard scientists¹

¹AORI, Univ. Tokyo, ²AIST, ³JAMSTEC

Earthquake shaking is one of the major triggers for redistribution of slope sediments. Some seafloor observations suggests disturbances during large earthquakes. Core sample analyses also provide information about histories of gravity flows in sedimentary basins. A series of earthquakes of magnitude about 7 occurred southeast off the Kii peninsula in September 2004. We had a chance to obtain undersea video images just after and six years after earthquakes. The seafloor observation was conducted along the prism slope ranging from near the epicenter to 80 km southwest of it by ROV "NSS" during the KY04-11 cruise. The NSS consists of a pilot vehicle, tether cable, and a removable winch system. The pilot vehicle has four thrusters, two underwater TV cameras and hook for a heavy payload. TV observation indicated changes of turbidity with depth: cloudiness increased with depth and was relatively high within the bottom 200m irrespective of the distance from the epicenters. Such turbidity was found in the whole prism slope and was not recognized in the forearc basin. Moreover, extreme high-turbidity layer was observed at the bottom of the slope basin. Complete sinking of the weight of the heat flow probe within this layer suggested thickness of more than 2 meters. NSS revisited this site 6 years after the earthquakes during KH-10-3 cruise and confirmed the seafloor to be normal condition. The seafloor depth 2.4 m deeper than that measured just after the earthquakes using a depth meter (pressure) and an altimeter (acoustic) of the pilot vehicle suggests that the altimeter acoustically recognized the top of the extreme high-turbidity layer as a seafloor in 2004. Our seafloor observation revealed pervasive distributions of turbidity layers probably caused by slumping or sliding in the prism slope and accumulating process in the slope basin.

Keywords: gravity flow, Earthquake shaking, turbidity layer, NSS

MIS001-P03

Room:Convention Hall

Time:May 25 10:30-13:00

Characteristics of turbidites at the deepest part of the Beppu Bay

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¹Geological Survey of Japan, AIST, ²Hokkaido University, ³Ehime University

Many turbidite layers were obtained in a core collected from the deepest part of the Beppu Bay, off Takasaki-yama, Kyushu. Most of the turbidites had less than 1 cm in thickness, but some turbidites were a few tens cm thick. The thick turbidites had a few cm thick sandy part at the base and thick turbidite mud with larger amount of clastic grains, better sorted, and high wet bulk density than normal hemipelagic mud (diatom ooze). Clastic grains in turbidites might be supplied from Oita-gawa and Onogawa rivers. Formation of turbidites might be related to submarine slope failures of the river delta slopes by local earthquakes and floods.

Keywords: turbidite, Beppu Bay, sedimentary structure, earthquake, slope failure