White paper

Earthquake geohazards and submarine landslides at subduction margins

Submitted to WGs of the INVEST meeting:
Geohazards : earthquake
Geohazards : submarine landslide

Yasuhiro Yamada, PhD

Dept of Earth Resources Engineering,
Kyoto University
Katsura, Nishikyo Kyoto 615-8543 Japan
yamada@earth.kumst.kyoto-u.ac.jp

Abstract: Geohazard caused by earthquakes and Tsunamis should be included as an item of new ISPs in the 2nd generation of IODP to send a clear message of 'Contribution of IODP for sustainable development of human society'. For such Geohazard, particularly active at subduction margins, we need to take combinations of several approaches; investigations for shallow geology including submarine landslides, penetration of deep fault zones, and active experiments. From sedimentary cover sequences, characteristic event deposits due to seismic activities can be identified and the lateral (along-margin) distribution of these deposits tells the size (failures of coupled fault segments) of their trigger events. This should be one of the primary targets of 2nd generation of IODP.

As an item of ISPs proposed from Japan, Geohazard is an important concept. This is because IODP must send a clear message of ‘Contribution of IODP for sustainable development of human society’, and Geohazard is one of candidates. There have been some Geohazard -related meetings in the past. The Geohazard workshop in Barcelona in 2006 and one in Portland in 2008 mainly discussed on hazards at passive margins and volcanic collapse respectively. The researchers interested in the hazards at subduction margins, however, were relatively few, maybe because of the geography of the conference venues. As an ISP item proposed from Japan, ‘Geohazard at subduction margins’ is one of the most appropriate themes arisen from its tectonic setting. In particular, seismicity and tsunami hazards at subduction margins must be the first priority. This is because a coupled earthquake at Nankai, east-Nankai and Tokai regions may cause hazard damage in a scale similar to the national budget. This may also cause devastating damage on the world economy. Therefore, we need to show an initiative of ‘IODP contributing to prevention/mitigation of natural disasters’.

Geohazard at sudbuction margins, in particular seismicity and tsunami disasters, requires two different approaches: science on shallow sediments and deep fault drilling based on the seismogenic experiments (SEIZE). From shallow sediments, event deposits formed by submarine landslide need to be extracted to analyze the along-strike distribution of single slide and slide recurrence based on dating technologies. The along-strike distribution suggests source region of the triggering earthquake thus can be used to assess the earthquakes coupling in several adjacent regions. The distribution and thickness of gravity flow deposit depends upon not only seismic magnitude but also submarine topography and provenance basin conditions. Systematic patterns of surface failures along each slope can recently be clarified by analogue models (Fig. 1; Yamada et al., in press) and need to be applied to real event deposits (Fig. 2). Combination of on-land and submarine topography may bring coupling evaluation, recurrence interval and dating of earthquake events in different scales. This topic requires collaboration between researchers in different background including topography, engineering geology and geology. Complete recovery of core samples from surface soft sediments is extremely important technology to be developed. This may require riser system to stabilize the borehole condition and the drilled core in the barrel. Current deep fault drilling uses two approaches: material science that use cores and monitoring with instruments. The deep drilling into seismogenic zones obviously requires riser system. This is because the borehole wall needs to be stabilized at the deep hole, otherwise the drill strings may easily be stacked. The next stage of IODP after 2013 may follow

similar direction, but interdisciplinary collaboration of researchers of seismology, geology and borehole measurements should look for brand new ideas, such as dynamic response of fault rock and its correlation to seismic waveforms. Other types of Geohazard at subduction margins, such as volcanic activity and landslide hazard due to collapse of volcanic body, need to be discussed as potential items of new ISP.

This meeting is an excellent opportunity to search potential collaboration between various fields of geosciences under the keyword of Geohazard. Publicity to various researchers is also very important to send a message that IODP can be a powerful tool to solve their problems. Related proposals/projects include KAP (Kanto Asperity Project) and SEIZE (Seismogenic Zone Experiment) and leading members of proponents and related scientists should be invited to the meeting to discuss the Geohazard issues in their projects and post-SEIZE view. Researchers of soil mechanics and topography should lead discussions on slope stability analysis of the ocean floor. Waveform analysis may also be a key to incorporate the acceleration effects of seismic waves.

Reference

Yamada, Y., Yamashita, Y., Yamamoto, Y. Submarine landslides at subduction margins: insights from physical models. Tectonophysics, in press.

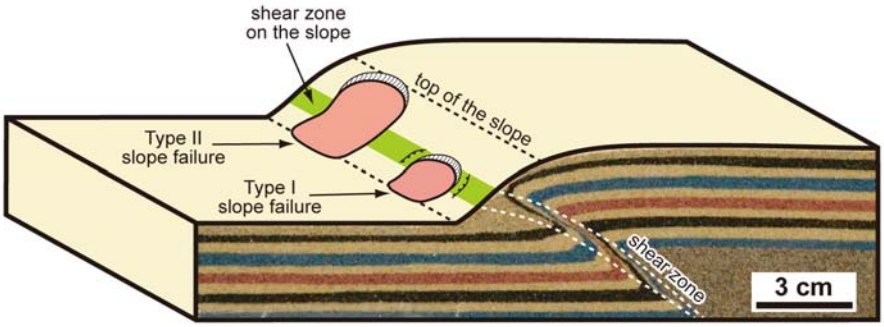

Figure 1. Several types of slope failures triggered by underlain fault activity, constructed from an experimental study (from Yamada et al., in press. Tectonophysics)

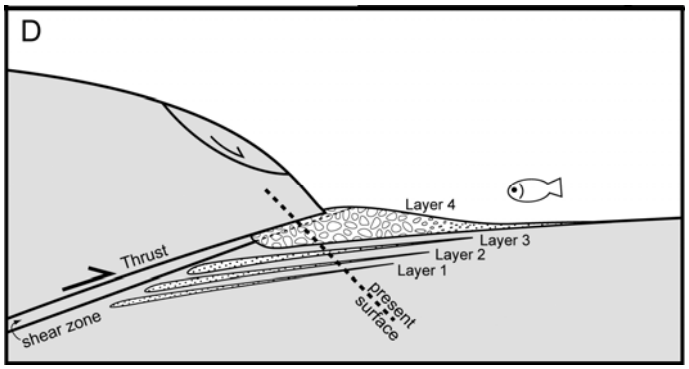

Figure 2. Slope failures and patterns of failed sediments in front of active thrust, constructed a comparative study of experiments and field observations at Boso, central Japan (from Yamada et al., in press. Tectonophysics)