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海底活断層上に発生した海底地辷りが巨大津波の原因か？
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.

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