

Preface

The morphology of continental slopes and rises around the world as well as flanks of oceanic islands are marked with major landslide scars. Many of these involve thousands of square kilometers of sea floor, and their formation represents an important mechanism for transferring sedimentary material to the deep sea. Sand-rich gravity flow deposits form many of the world's largest oil and gas reservoirs, while mud-rich deposits may sequester globally significant volumes of organic carbon. The geohazards associated with submarine slope failures include destruction of sub-sea infrastructure such as pipelines and cables as well as tsunamis induced by landslides and their effects onshore. Due to the source characteristics, tsunamis induced by landslides cause more local effects than those caused by earthquakes. The 1998 Papua New Guinea tsunami that followed from a 5–10 km³ submarine landslide and killed ~2,200 people along a 30 km coastal section illustrates the hazard and risk resulting from such local events. Very large submarine landslides with volumes of several thousands of cubic kilometers are rare, but may cause tsunamis with more widespread effects. Volcanic flank collapses on oceanic islands may also cause tsunamis inducing distant destruction, although their tsunamigenic potential is highly disputed.

The causes of submarine mass movements are manifold, but not yet well understood. Surprisingly many of the larger landslides are associated with much gentler slopes than required to destabilize the sea floor under static conditions. Slope failure is often attributed to some combination of earthquake triggering, rapid sedimentation, the presence of weak layers, excess pore pressures, ice-induced forces in glaciated areas, steeping from tectonic, diapiric or erosional activity, as well as volcano development, but only for very few slope failures a robust scientific case has been made.

The complex nature of submarine mass movements and their consequences calls for a multidisciplinary approach including state-of-the-art seafloor and sub-seafloor mapping, investigations of physical properties (in situ and on cores), numerical

modeling of landslides and associated tsunamis as well as hazard and risk assessment. In order to bring ‘submarine landslide’ scientists together and to minimize the consequences of submarine failures, the International Union of Geological Science (IUGS) and the United Nations Educational, Scientific and Cultural Organization (UNESCO) have sponsored two International Geoscience Programs on ‘Earth’s Continental Margins: Assessing the Geohazard from submarine Landslides’ (IGCP-585) and its predecessor ‘Submarine Mass Movements and Their Consequences’ (IGCP-511).

A central activity of IGCP 585 is the organization of a bi-annual symposium in order to present an up-to-date perspective of submarine mass movements and their consequences by assembling excellent contributions from active international academic, government and industry researchers. The 6th symposium was held in Kiel (Germany) in September 2013; this new volume of the book series on ‘Submarine Mass Movements and their Consequences’ presents new peer-reviewed contributions by international experts in the field. The book is organized in nine parts covering geological, geophysical, engineering and environmental aspects of submarine slope failures. It contains (among others) investigations of physical properties of landslide deposits, partly on samples collected during some of the first attempts at scientific ocean drilling in thick sequences of mass transport deposits, the analysis of long-term records of submarine landslides and their usage in paleoseismology, repeated surveys of active slope failures, as well as a chapter on landslide generated tsunamis. The focus is on understanding the full spectrum of challenges presented by this major coastal and offshore geohazard.

Research on submarine mass movements and their consequences spans several disciplines and several open questions need to be addressed in the future. It is crucial to identify potential precursors of submarine landslides. The emergent field of submarine geodesy will hopefully provide us with the means of measuring small movements on the sea floor, which may occur prior to a catastrophic failure. The new science plan of the ‘International Ocean Discovery Program (IODP)’ identified geohazards as one of the key objectives. First results from dedicated drilling campaigns for understanding submarine landslides are currently published (e.g., offshore Japan, around the Lesser Antilles, the Gulf of Mexico). Future systematic monitoring of *in situ* parameters in drill holes may allow identification of transient signals indicating imminent slope instability. Sophisticated hazard assessment for tsunamis caused by submarine landslides is another important step for mitigating their impacts. So far, most tsunami hazard assessments have been scenario-based and focused on earthquake tsunamis. More recently a probabilistic tsunami hazard assessment approach has been developed, which is largely inspired from probabilistic seismic hazard investigations. However, insufficient age sampling and changing conditions for landslide triggering are major obstacles in translating a probabilistic tsunami hazard assessment approach from earthquake to landslide tsunamis. It is further expected that the landslide tsunami risk is dominated by

the long return periods, generally carrying the largest uncertainties. Hence, a more robust scenario-based tsunami hazard assessment will probably still be the most efficient one to use for landslide tsunamis.

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