Geophysical Research Abstracts, Vol. 9, 02668, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-02668

Mass-Transport Deposits from the Hinlopen Slide, Arctic Ocean - Their Geomorphology, Slide Dynamics and Tsunami Potential

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The Hinlopen Slide on the northern Svalbard margin is in many aspects a remarkable submarine slope failure. The multiple, planar escarpments are several hundreds of metres high, and reach a maximum of over 1400 m at the mouth of the Hinlopen cross-shelf trough. Despite the relatively small slide scar area (roughly 2200 km2, or about 5% of the size of Storegga's), an estimated 1350 to 2400 km3 (i.e. about 50 to 90% of Storegga) of sediments have been evacuated from the upper continental slope. The slide scar morphology suggests the Hinlopen Slide to be a multi-phase, translational margin collapse that developed retrogressively. The mass-transport deposits exposed at the seabed consist of massive debris lobes made up of sediment streams with flow structures and numerous giant slide blocks roughly 60 km downslope the headscarp, with plenty of smaller-scale seafloor irregularities spread around. The blocks' dimensions and shape vary, with the largest block standing 452 m high and containing a volume of 1.89 km3, thus several orders of magnitude larger than in other mass wasting areas on siliciclastic margins. The main debris lobe thickens and widens downslope, and appears as hummocky terrain with arcuate pressure ridges. The crests of the sediment ridges have elevations of more than 20 m, and they are more or less regularly spaced with a wavelength of less than 1 km. Smaller-size debris lobes close to the landslide sidewalls are the result of secondary, marginal failures. The volume of the landslide deposits imaged by our data does not add up for the entire volume evacuated from the continental margin, implying that part of the mass-transport deposits have

travelled further into the deep Nansen Basin. The occurrence of these giant, rafted blocks and debris lobes illustrate the remarkable mobility of sediments involved in submarine landsliding and their dimensions call for numerical modelling to understand their dynamics and potential to generate tsunamis. Simulations of the moving sediments are based on the assumption that the blocks travelling at high speeds may be rafted by a loose debris flow derived from the disintegrating landslide material in the headwall area. The modelling reveals that the main failure process is completed after about 1 hour, and that the upper slide scar is most probably not the source area for the giant blocks. Landslide-generated tsunamis are mainly governed by the volume, initial acceleration, maximum velocity, and the possible retrogressive slide behaviour of the moving masses. The Hinlopen Slide most likely generated a significant tsunami. Due to a combination of high speed of the mass transport, and the huge thickness of the dislodged mass, shorter wave components implying dispersive and nonlinear effects were probably more pronounced than for most other tsunamis generated by submarine landslides. Therefore, the propagation and coastal impact of the tsunami is simulated by a weakly nonlinear and dispersive Boussinesq model. Close to the slide area the simulations of the tsunami show surface elevations over 130 m, whereas the tsunami may have been several tens of meters along the coasts of Svalbard and Greenland.