Geophysical Research Abstracts, Vol. 8, 08509, 2006
SRef-ID: 1607-7962/gra/EGU06-A-08509

Modeling landslides in a submarine canyon within the upper plate of a subduction zone

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Active tectonic margins are often typical locations for the triggering of large landslides that can attain runouts of hundreds of kilometres and impact offshore activities over a considerable area. Although the great mobility of submarine landslides is not very well understood it is necessary to attempt to characterize the risk associated with these events for offshore human activities such as the development of natural resources and the positioning of submarine communication infrastructure. In this work we use a 2D model to simulate these phenomena in an active margin environment, and specifically in a submarine canyon where landslide runout effects can be amplified. The location chosen for the modelling is the San José Canyon along the Guatemala margin. The model is based on a code for incompressible Coulomb flow that is essentially a depth averaged shallow-water granular-flow model. The conservation equations for mass and momentum are solved with a Coulomb-type friction term at the basal interface. The governing equations are solved using a parallel, adaptive mesh, Godunov scheme. The code allows for computing on multiple processors, which increases computational power, decreases computing time, and allows the use of large data sets. Adaptive gridding allows for the concentration of computing power on regions of special interest (Sheridan et al, 2005). Of fundamental importance in these types of simulations is the existence of accurate bathymetric data, which in this case were acquired during Sonne cruise 173 within the SFB574 (Kiel University, Germany), using a Simrad EM120 Multibeam system. The area where the code is being tested is the San José Canyon, located on the Guatemala margin, an area surveyed since the 70s by deep sea drilling projects, and that lies offshore the city of San José (Guatemala) at about 13°N 91°W. The canyon is incised approx. 1.8 km into the edge of the shelf and has a length of ca. 100 km in the upper slope. Across the midslope terrace, normal faults give rise to a horst and graben structure, that causes the canyon to develop sub-parallely to the

trench for several kilometres until it veers abruptly 90° and again heads towards SO, directly towards the trench, probably in correspondence of a major tectonic lineament. The canyon tapers out near the base of the lower slope. Core and log data from site 570 of DSDP Leg 84, located several tens of kilometres from the canyon, indicate the presence of a 15-m-thick hydrated zone containing a 4-m thick nearly pure hydrate section beneath over 200 m of hemipelagic sediment. Bottom Simulating Reflectors (BSR), negative polarity compressional (p)-wave reflections sub-parallel to the sea floor, also provide a tool for gas hydrate detection. The presence of BSRs within the seismic sections shows that gas hydrate layers in the area have a significant spatial extension, and likely reach the walls of the San Jose Canyon. Gas hydrate layers could provide both preferential slip planes and triggering factors for submarine landsliding and were therefore used as the lower boundary for the modelled events. The age of redeposited sediments indicates that the canyon already existed in the late Miocene. However, the lack of a fan and sediments in the trench are indication of an absence of recent sediment transport through the canyon. This can possibly be explained by a sporadic landslide activity and/or by the total subduction of the sediment accompanying the high rate of subduction (˜ 7.8 cm/yr) of the Cocos plate beneath the Guatemala margin. Thus, another objective of the modelling is to understand the relationship between landslide volume and plate subduction rates.