Geophysical Research Abstracts
Vol. 21, EGU2019-8050, 2019
EGU General Assembly 2019

New Constraints on the Failure Mechanism and Kinematics of the Tampen Slide (North Sea) from 3D Seismic Data

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A series of large-scale submarine landslides have occurred on the Norwegian continental margin over the past ∼400 ka. The most recent and well-studied of these "megaslides" is the Storegga Slide (ca. 8 ka), whose resulting tsunami inundated the coastlines of Norway, Scotland, and the Shetland Islands. However, lack of surface exposure means that significantly less is known about the nature and tsunamigenic potential of those Norwegian continental megaslides that predate Storegga. The Tampen Slide is thought to have occurred 120-130 ka and is buried beneath up to 450 m of glacigenic debris flow and glacimarine deposits. Using 3D seismic data from the Tampen Slide headwall region, we present new constraints on the failure mechanism and stages of the Tampen Slide. The high-quality 3D seismic data were acquired in 2017 and cover approximately 16,000 km^2. The reprocessed data have vertical and horizontal resolutions of ∼8 m and ∼20 m, respectively. We extracted the upper and lower surfaces of the Tampen Slide through dense horizon-picking at up to 150 m increments, and performed geomorphological and statistical analysis on the time and amplitude surfaces. The upper surface of the up to 180 m thick Tampen Slide is irregular and can be divided into distinct morphological categories that correspond with variations in the internal deformation of the slide. Contrastingly, the basal glide plane of the Tampen Slide is smooth and laterally continuous, and consists of a variable amplitude positive reflection overlain by a very high amplitude negative reflection. We propose that the Tampen Slide occurred in three main stages. The first stage involved translational motion and resulted in the complete evacuation of the failed material from the headwall region. The resulting loss of support at the base of the western sidewall resulted in lateral spreading at that sidewall, which disintegrated into a debris flow downslope and involved >850 km^3 of sediments. These first two stages were followed by a ∼60 km^3 debris flow that developed retrogressively from the original headwall. Multiple subsequent, small-volume (<0.2 km^3) retrogressive failures of the original headwall are also observed.