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The role of overpressure and seismic activity for the generation of the Tampen Slide, North Sea Trough Mouth Fan

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Trough mouth fans (TMFs) are environments characterized by high sediment supply during glacial stages and repeated slope failure. The Tampen Slide, which removed ∼1800 km3 of sediment at ∼130 ka BP, is one of several paleo-slides at the North Sea TMF deposited at the outlet of the Norwegian Channel, SE Nordic Sea margin. Here we use 2D Finite Element Modeling to evaluate the effects of variations in sedimentation rates and sediment properties on overpressure generation and slope stability of this TMF system. The model domain, 40 km in length and 2 km in height, is dominated by deposits of glacigenic debris flows and glacimarine processes. We use geotechnical values measured on samples of glacial debris and (glaci)marine deposits from over the Ormen Lange gas field area. Slope stability has been modeled for constant temporal sediment loading, episodic changes in sedimentation rates and abrupt pulses in sediment delivery for the 61 ka of marine isotope stage 6. The models show that increased sedimentation rates during glacial stages generate insufficient overpressure to trigger the Tampen Slide. Furthermore, the simulated overpressures do not significantly differ at the end of the model runs characterized by different sedimentation patterns. The results also highlight the importance of a basal glacimarine layer underneath the rapidly-deposited sediments for the build-up of overpressure. Consequently, this glacimarine layer has the inherited potential to act as a weak layer facilitating instability. However, as overpressure due to sediment deposition alone does not result in slope failure, we couple the preconditioned slope with earthquake ground shaking. Based on attenuation models, an earthquake of M6.9 or larger at a short distance from the Tampen Slide headwall could have triggered the Tampen Slide. Therefore we suggest glacial sedimentation and a glacimarine layer to represent preconditioning factors, and seismic shaking as the controlling factor for the Tampen Slide.