Proceedings of the Eighteenth (2008) International Offshore and Polar Engineering Conference
Vancouver, BC, Canada, July 6-11, 2008

ISBN 978-1-880653-70-8 (Set); ISBN 1-880653-68-0 (Set)

Sediment properties in the upper part of the Hinlopen-Yermak landslide, northern Svalbard continental margin

S.L.Yang M.Vanneste C.F.Forsberg and A.Solheim
International Centre for Geohazards, Norwegian Geotechnical Institute, Oslo, Norway

ABSTRACT

The Hinlopen-Yermak Slide (HS) is one of the largest exposed submarine landslides on the world's continental margins, and is comparable in dimensions as well as slope failure processes to the Storegga Slide (SS). Index properties of the sediments from gravity cores retrieved from the upper slidescar area of the Hinlopen -Yermak Slide are analysed in this study. Sediment type, plasticity, activity, compressibility, undrained shear strength and remoulded undrained shear strength from fall cone tests are presented and compared with results from Storegga slide when possible. The available data illustrate that the sediments in the Hinlopen-Yermak Slide area are inorganic and inactive with low to medium plasticity. The compressibility is lower than that in the Storegga Slide, whereas the sensitivity is generally higher than those from similar locations in the Storegga Slide.

KEY WORDS: Sediment property; plasticity index; undrained shear strength; compressibility.

INTRODUCTION

Submarine mass transport processes (e.g. landsliding, slumping and debris flows) play a key role in shaping the architecture of continental margins globally (Locat and Mienert, 2003). The geological record indicates that repeated, large-scale landslides are common on glacially-fed siliciclastic margins, and typically involve more sediments compared to landslides on river-fed settings (Canal, et al., 2004). This observation suggests a causal link between submarine landslides and sedimentary processes in response to climatic changes which affect oceanographic patterns (contourite deposition or reworking), the waxing and waning of ice sheets, and ice-stream dynamics (Solheim et al., 2005).

The Storegga Slide (mid-Norwegian margin) and the Hinlopen-Yermak Slide (northern Svalbard margin, Arctic Ocean) are two of the largests exposed submarine landslides in the world (Fig.1). Both of these slides developed retrogressively, and evacuated a huge amounts of sediments, in the order of 1300-3000 km^3. The headwalls coincide with the shelf edge where massive trough mouth fans – fed by ice streams – have accumulated during peak glacial times (Winkelmann, et al., 2006, Vanneste, et al., 2006, Vanneste et al., in press). In addition, the inclination of the slip planes is less than 3° (Kvalstad, et al., 2005; Vanneste et al. , 2006). However, the slidescar area of the Hinlopen-Yermak landslide is significantly smaller compared to Storegga's, but its headwalls are higher. The Hinlopen-Yermak landslide is an older landslide than the Storegga landslide ((Winkelmann, et al., 2006; Haflidason et al. ,2005).

Whereas the landslide history and dynamics in the Storegga landslide area have been investigated intensively (Kvalstad, et al., 2005, Bryn et al., 2005, Solheim et al., 2005, amongst others), only scarce information is available of the Hinlopen-Yermak area in the Arctic Ocean. Few papers used swath bathymetry and seismic reflection data as well as some sedimentological results to discuss the landslide dimensions, processes and the age of this landslide (Cherkis, et al., 1999, Vanneste et al., 2006, Winkelman et al., 2006, Winkelman et al., 2007, Vanneste et al., in press), whereas no papers are available for the physical and geotechnical properties of the sediments for the Hinlopen-Yermak landslide due to difficulty to retrieve samples from the seabed. The purpose of this study is to present index properties of the sediments in the Hinlopen-Yermak landslide, discuss the behaviour of the sediments in the Hinlopen-Yermak landslide area, and compare them with the properties of the sediments in the Storegga landslide area,.

GEOLOGICAL SETTING

Subsidence and sediment deposition following the rifting and continental spreading in the Eurasia Basin at c. 60-55 Ma resulted in the development of the passive, northern Svalbard margin (Eiken, 1994). The continental margin is bordered to the west by the Yermak Plateau. To the northeast, the northern Svalbard margin connects to the Nansen Basin. The continental shelves offshore the main islands of Spitsbergen and Nordaustlandet are relatively flat and extend between 50 and 100 km beyond the coastlines. Several transverse depressions (e.g. Hinlopen cross-shelf trough) incise the shelf banks at the mouths of fjords .

Fluctuating ice masses characterise the entire Plio-Pleistocene period (Butt et al., 2000) and have largely shaped the geomorphology of the northern Svalbard margin (Vorren 2003; Ottesen et al., 2005).