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# Late Cenozoic glacial history and evolution of the Storegga Slide area and adjacent slide flank regions, Norwegian continental margin

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**Abstract**

Acoustic data and sediment cores collected from the Storegga Slide and its adjacent slide flanks, i.e. the Vøring Plateau to the north and the North Sea Fan to the south, have been used to study the Late Cenozoic glacial history and geological development of this region. Age constrains obtained from the investigated cores show that the Fennoscandian Ice Sheet reached the shelf edge during Marine Isotope Stages (MIS) 12, 10, 8, 6 and 2. Ice sheet fluctuations within each glaciation might have occurred, as is evidenced for the Last Glacial Maximum (MIS 2). The first extensive ice advance is identified in the Early Pleistocene, at c. 1.1 Ma; however, between 2.6 and 0.5 Ma the ice sheets were largely restricted to the fjords and inner shelf. During each glacial maximum, glacigenic debris flows (GDFs) transported basal till, deposited at the shelf edge, into the deep sea along the entire studied margin. The most voluminous GDF sequences are found on the southern Storegga Slide flank (North Sea Fan), where the individual flows are found as far as 500 km from the shelf edge. On the Vøring Plateau glacimarine/hemipelagic sedimentation has dominated the last c. 250,000 yr. During MIS 2 such sediments were rapidly deposited, covering the upper-slope-limited GDF units in this region. Between c. 15,700 and 15,000 $^{14}$C yr BP, i.e. during the last deglaciation of the Norwegian margin, a presumed meltwater plume, released from the disintegrating Norwegian Channel Ice Stream, transported and rapidly deposited up to 20 m of fine-grained sediments in the region north of the North Sea Fan. The rapid deposition of large volumes of GDFs, glacimarine and meltwater related sediments might have influenced the stability of the slope sediments in the studied region, promoting conditions favorable for failure. Furthermore, these high sedimentation rates also partly account for the high subsidence rates observed on the Norwegian continental margin in the Late Cenozoic.


*Keywords:* Late Cenozoic; Continental margin; Offshore Norway; Glaciations

## 1. Introduction

The Storegga Slide, on the Norwegian continental margin, is flanked by the Vøring Plateau to the north and the North Sea Fan to the south (Figs. 1 and 2). The flank regions have been the location for major depocentres during the Late Plio-Pleistocene, and on the Vøring Plateau these Late Cenozoic sediments define a thick prograding wedge (e.g. Hjelstuen et al., 1999). At the southern slide flank the North Sea Fan represents a huge Late Cenozoic trough mouth fan complex at the outlet of the Norwegian Channel (e.g. Nygård et al., 2005), whereas within the Storegga Slide region itself the Late Plio-Pleistocene sedimentary succession is thinner due to lower sediment supply and repeated slide events (Evans et al., 2002).

The Late Plio-Pleistocene deposits define important archives for the study of changes in sedimentary processes, paleoclimate and geological development through time. Here, we summarize the seismic facies characteristics and composition of these sediments, in order to present a synthesis of our knowledge on the Late Plio-Pleistocene glacial history and geological evolution of the Storegga Slide area and adjacent slide flank regions (Fig. 2).

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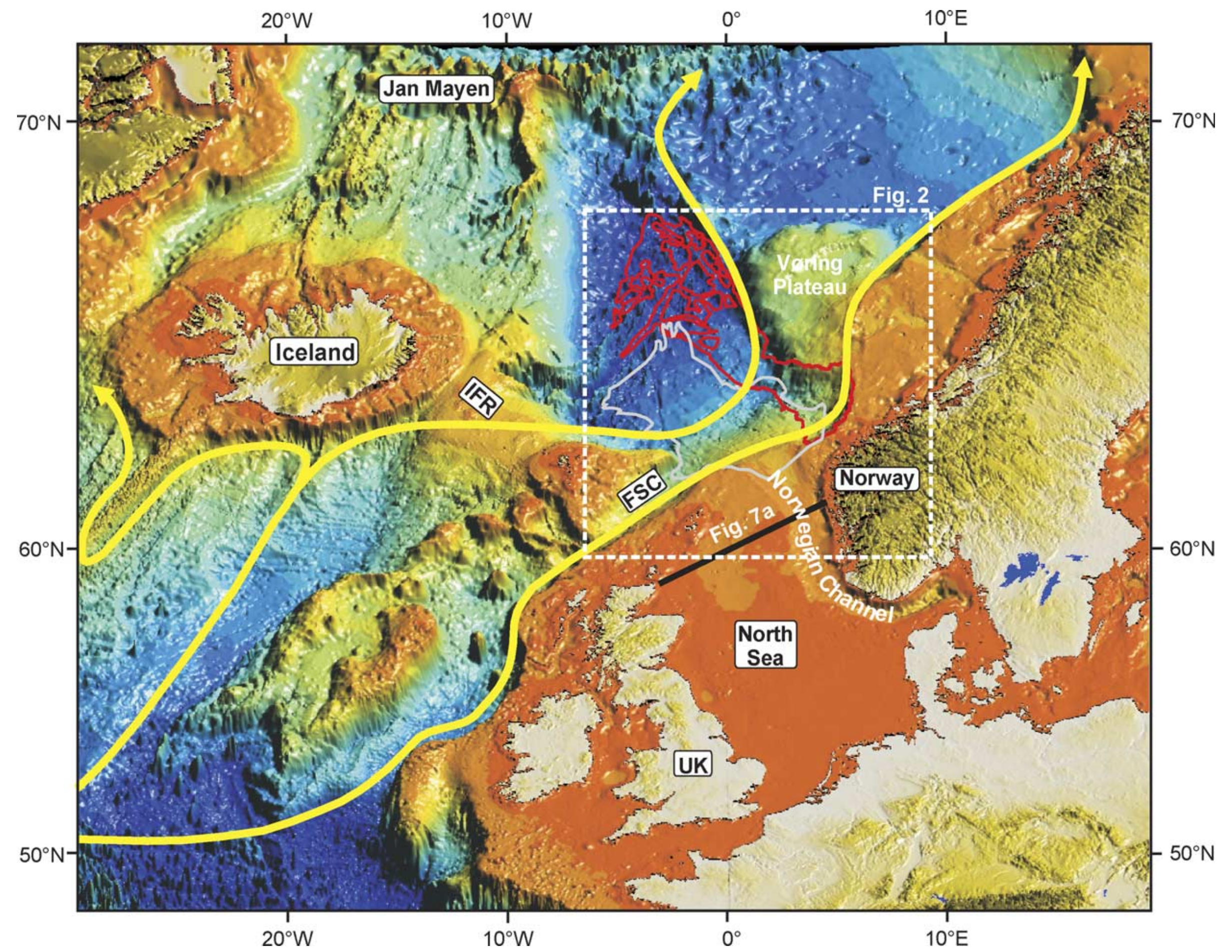


Fig. 1. Overview map of the NE Atlantic continental margin, showing present day seabed morphology within the region. The North Sea Fan and Storegga Slide are outlined by grey and red lines, respectively; whereas main pathways of near-surface Atlantic water is indicated by yellow arrows. Study area within box. FSC: Faroe-Shetland Channel; IFR: Iceland-Faroe Ridge. Seabed morphology is from Smith and Sandwell (1997), whereas current pathways are based on Orvik and Niiler (2002). Outline of North Sea Fan and Storegga Slide from Nygård et al. (2005); Haflidason et al. (2005), respectively.

In addition to previously published data, the main contribution to this paper is from recently and ongoing analyses of acoustic records and sediment samples collected by the University of Bergen and the industry during the last few years. The acoustic data sets have comprised records such as mini-air gun and deep-towed boomer profiles, conventional 2D multichannel seismic, 3D surveys, side scan sonar records and swath bathymetry; whereas geo-technical borings, IMAGES and short cores, raised from a wide range of water depths, define the sediment sample database.

## 2. Physiographic and oceanographic settings

The shelf break within the studied region is found between c. 200 and c. 500 m water depth and represent the western limit of a continental shelf characterised by cross-shelf troughs and shallow banks (Ottesen et al., 2001) (Fig. 1). The continental shelf expanded considerably during deposition of the glacigenic Late Plio-Pleistocene wedge, as is reflected both by the broad continental shelf off mid-Norway and the bathymetric bulge at the outlet of the Norwegian Channel (Fig. 2). We note that the Late Cenozoic sedimentary succession caps a substratum of fine-grained Miocene–Oligocene biosiliceous ooze and coarse-grained Eocene–Paleocene sediments (e.g. Eldholm et al., 1989).

At present, two near-surface current systems, the Norwegian Atlantic Current (NwAC) and the Norwegian Coastal Current, dominate the oceanographic regime in the studied region (Hansen and Østerhus, 2000). The Atlantic Water within the NwAC enters the study area over the Iceland-Faroe Ridge and through the Faroe-Shetland Channel as two separate branches (Fig. 1) (Orvik and Niiler, 2002). The western NwAC branch follows the slope of the Vøring Plateau towards Jan Mayen before turning northeastward, whereas the eastern branch follows the shelf edge within the study area. The Atlantic water masses overlie and are sharply bounded downwards, at a water depth of c. 700 m, to the deep-water in the Norway Basin (Holtedahl, 1981).