Marine Geology, 111 (1993) 189–207
Elsevier Science Publishers B.V., Amsterdam

Multiple Pleistocene ice advances into the Skagerrak: A detailed seismic stratigraphy from high resolution seismic profiles

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(Received August 6, 1991; revision accepted February 20, 1992)

ABSTRACT

Von Haugwitz, W.R. and Wong, H.K., 1993. Multiple Pleistocene ice advances into the Skagerrak: A detailed seismic stratigraphy from high resolution seismic profiles. In: G. Liebezeit, T.C.E. van Weering and J. Rumohr (Editors), Holocene Sedimentation in the Skagerrak. *Mar. Geol.*, 111: 189–207.

A detailed Pleistocene seismic stratigraphy is proposed for the Skagerrak, an over 700 m deep, elongated depression in the northeastern North Sea. By comparing our high resolution seismic results with those from glacial environments of Canada, Alaska and Antarctica, we conclude that at least during the Weichselian (if not also during the Saalian) a glacier grounded in the eastern Skagerrak and advanced well into its western part as indicated by a thick layer of basal till. The surging glacier truncated the basinal flank of a ridge-like "delta moraine" that was presumably deposited under uniform glacial conditions in an ice-distal environment. The deposition of the *Hirtshals Moraine* in shallow waters off Hirtshals might originate from a glacier that advanced from Sweden into North Jutland.

Soon after the ice withdrawal from the Skagerrak, a layer of well-stratified glaciomarine sediments was deposited over the basal till suggesting floating ice conditions in a fjord-like environment. Due to the rising sea level in the Late Pleistocene, fluvioglacial and shallow marine deposits soon dominated over the glaciomarine sediments, indicating an end of glacial conditions in this region. These post-glacial sediments were first deposited in the western Skagerrak, but as the transgression came to an end in the Mid-Holocene, the depocenter shifted to the east. Today the highest sedimentation rates are found in this eastern part.

Introduction

To marine scientists, the Skagerrak represents a remarkable morphostructure in the otherwise flat and shallow North Sea shelf environment (average depth: 90 m). Because of its exceptional depth (>700 m), it was a unique depositional site for glacial and glaciomarine sediments when the southern and central North Sea were dry land during the Pleistocene glacial periods. Its position close to the ice front permitted accumulation of sediments which are extremely valuable for a reconstruction of Quaternary climatic variations. However, piston coring so far has not penetrated considerably into the Late Pleistocene sediments. Therefore, to date much of the Pleistocene history of the Skagerrak is inferred from geological field observations in Norway as well as from sediment sampling in shallow coastal waters (Sörensen, 1979, 1983; Stabell and Thiede, 1985; Holtedahl, 1986, 1988, 1989). Apart from the well documented moraines which indicate episodic ice retreat in the Skagerrak, little is known about how, when, if and to what extent any glaciers that came from Norway affected the Skagerrak itself. Seismic profiling revealed an acoustically stratified sequence underlying the Holocene which was assumed to be glaciomarine in origin (Van Weering, 1975, 1982a; Salge and Wong,

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0025-3227/93/$06.00