The geological implications of the upper seismic unit, southeastern Barents Sea

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Occurrence

An upper Quaternary seismic unit has been mapped to the east and southeast of Bjørnøyrenna in the Barents Sea. The unit is defined by interpretation of shallow seismic (sparker) data, and occurs as an upper, seismically transparent sequence in the Quaternary succession. Discontinuous internal reflections do, however, occasionally occur, especially in the lower part of the unit. The sediments in the unit are interpreted to be of a glaciogenic origin and they most likely consist mainly of till.

The unit wedges out towards the west in present water depths generally between 300 and 400 m (Fig. 1). In Bjørnøyrenna the unit has been mapped down to more than 440 m water depth. The unit is mapped northwards to approximately 74°N, but it continues farther. Its eastern boundary is mapped only in a small area.

The boundaries are partly uncertain due to limitations in the resolution of the data (approximately 10 m). It is thus possible that the unit occurs in a far wider area than the one presently mapped.

Stratigraphic relations

The base of the unit is defined partly by a strong, smooth and continuous reflection, partly by a weak and irregular reflection. The latter type, which locally resembles iceberg ploughed sea bed relief, dominates in the western part of the unit.

In the east the unit is in some areas overlying older Quaternary sediments, whereas it partly rests directly on the upper regional angular unconformity (top pre Quaternary sediments). Samples from shallow drilling in the area show that the sediments immediately above the unconformity are diamictons of glacial origin. The last erosional phase of the unconformity will in large areas most probably comprise several episodes of glacial erosion. This concurs with the observations by Solheim & Kristoffersen (1984) farther west and Vorren et al. (1986) farther south. The glaciogenic sediments below the mapped unit become continuous and thicken westwards, normally to 50–75 m.

The mapped unit occurs above a locally more than 200 m thick seismically transparent succession in Ingøydjupet. This relation is, however, uncertain due to lack of seismic data. An equally probable interpretation is to include parts of the succession in Ingøydjupet in the upper seismic unit.

Towards the north, in eastern Bjørnøyrenna, an intra Quaternary reflection occurs which could represent the base of the mapped unit. This, however, remains to be solved. The westward thinning of this unit in a part of western Nordkappbanken is clearly seen on the IKU deep towed boomer records (Fig. 2).

Generalized sediment description

Push samples and hammer samples from the described unit have been obtained by shallow drilling at 6 locations. These samples are obtained at depth intervals of 5–10 m from 8 m down to approximately 30 m below the sea bed.

The samples comprise silty clay with some sand and scattered fragments of gravel and pebble size. The grain size distribution is fairly uniform for all the sites: 35–45% clay and 30–40% silt. The sediment colour, according to the Munsell Colour chart, is grey (5 Y 4/1) to very dark grey (5 Y 3/1), occasionally dark olive grey (5 Y 3/2).

Geotechnical properties

The soil mechanical tests reveal a clearly overconsolidated sediment. Natural water content ranges from 16% to 35% (in per cent of dry weight). The water content is often close to the plasticity limit, which is normally about 20%, and always well below the liquid limit which is found at 40–50%. Undrained shear strength, s_u, is measured by falling cone and triaxial testing. The values range from approximately 30 kN/m^2 to approximately 370 kN/m^2. The latter value is recorded about 10 m below the sea bed at the easternmost drill site.

Oedometer tests are done on 7 samples from depths ranging from 8 to 23 m. Measured effective preconsolidation pressure ranges from 120 to 800 kN/m^2. The overconsolidation ratio varies from 1.5–7.0. Neither of these parameters should, however, be used directly to calculate maximum static effective vertical load, as it is uncertain what could be the effect on recorded preconsolidation of shear from the ice during and after deposition.

Inferred depositional history

Our present interpretation is that the unit consists of sediments mainly deposited as basal till. Exceptions may be an upper blanket of Late Weichselian glaciomarine and Holocene sediments a few metres thick. In the eastern part of Bjørnøyrenna

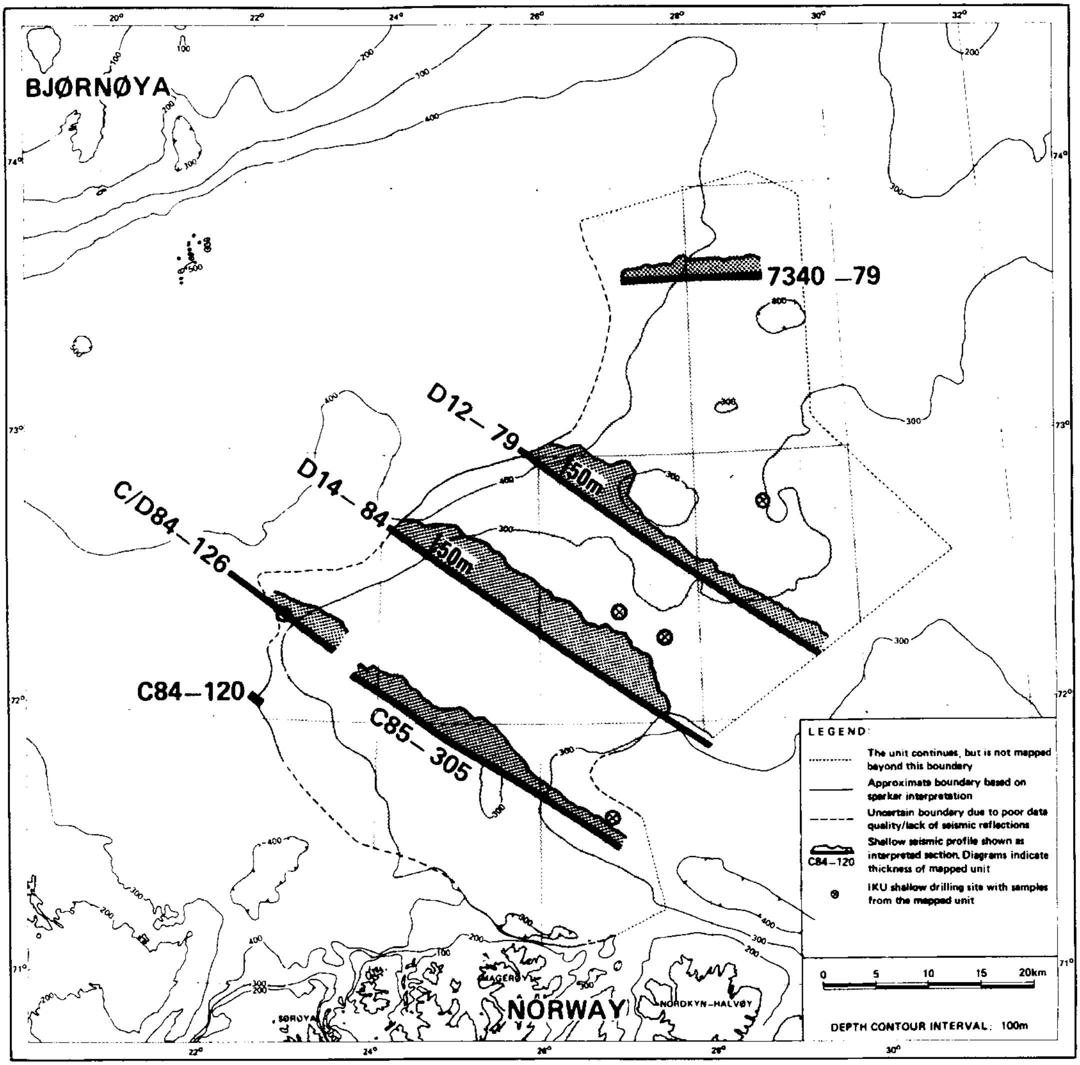

Fig. 1. The upper Quaternary seismic unit based on seismic interpretation. Typical thickness variations are shown in the thickness diagrams.

(approximately 73°10′N, 26°50′E) there is a local occurrence of acoustically stratified sediments. Deep towed boomer data indicate that these sediments are deposited contemporaneously with the till, close to the grounding line, but on the distal side (King & Fader 1986; King et al. 1987).

The unit is clearly older than the deglaciation of the area which happened before 13,290 B.P. (Vorren & Kristoffersen 1986). Vorren & Kristoffersen (1986) argue for a maximum Late Weichselian ice sheet margin 100 km west of the area described herein. The seismic stratigraphic correlation between the two areas is not evident. Preliminary evaluation of amino acid measurements does, however, indicate an age younger than 20,000 B.P. for the mapped unit.

The entire unit is interpreted to be deposited during one glacierization in the area. However, a faint internal reflection outlines an up to 50 m thick sediment wedge on the shallowest part of Nordkappbanken. This evidence suggests a multi-episode formation of the unit which may include several glacierizations, or, as we find equally likely, shifts in zones of erosion and deposition and of grounding line position during one glacierization.

A tentative interpretation is that the mapped unit (or part of it) was deposited during the last glaciation in the area. During much of the deposition of the unit the ice sheet grounding line was probably located close to the western boundary of the unit. Local observations on deep towed boomer data support this interpretation. The mapped unit could possibly be correlated with the deepermost marginal features along the northwestern

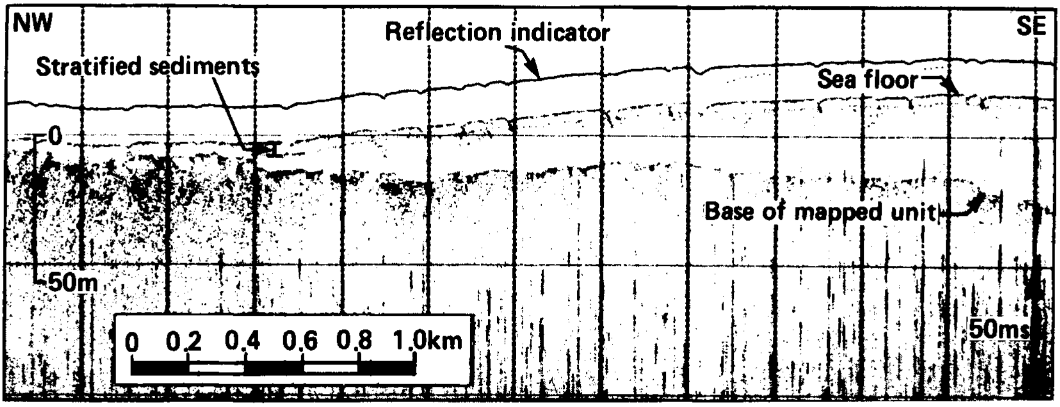

Fig. 2. The high resolution boomer profile shows the westward termination of the described upper seismic unit. An overlying thin stratified layer thins out both eastwards and westwards.

flank of Bjørnøyrenna observed by Elverhøi & Solheim (1983, Fig. 14).

Westward thinning of the unit could, however, also be the result if meltout of basal debris ceased to the east of the mapped western boundary. Alternatively, the thinning could (at least locally) be due to erosion.

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