Late Weichselian glaciation of the northern Barents Sea – a discussion

ANDERS ELVERHØI AND ANDERS SOLHEIM

Elverhøi, A. & Solheim, A. 1987: Late Weichselian glaciation of the northern Barents Sea – a discussion. *Polar Research 5 n.s.*, 285–287.

Anders Elverhøi and Anders Solheim, Norsk Polarinstitutt, Box 158, N-1330 Oslo lufthavn, Norway.

The Holocene age of the raised beaches in eastern Svalbard combined with the wide distribution of only a thin veneer of glacigenic sediments in the northern Barents Sea strongly indicate the existence of a Late Weichselian ice sheet in the region (Salvigsen 1981; Elverhøi & Solheim 1983; Solheim et al. 1988) (Figs. 1 & 2). However, the maximum extent of the ice sheet, the timing and pattern of deglaciation are still much debated. Moraine ridges in the southwestern marginal parts of the Barents Sea may indicate a coalescence of the Fennoscandian and Svalbard/northern Barents Sea ice sheet covering the entire shelf (Vorren & Kristoffersen 1986). Ridge complexes fringing the northern Barents Sea bank areas at 250–300 m water depth may represent a major stage during the retreat, or alternatively represent the maximum extent (Elverhøi & Solheim 1983).

The unlithified sediments on the sea floor (Fig. 1) are interpreted as a continuous sequence consisting of till overlain by proximal/iceberg dominated glaciomarine deposits, which grade into a distal glaciomarine facies representing the present day sea ice dominated environment (Elverhøi & Solheim 1983; Solheim et al. 1988). Laminated sediments may be present in the transition zone between the two glaciomarine units, in particular below 300 m water depth. From extrapolation of the sedimentation rate in the upper unit (based on datings of mainly Astarte sp., Fig. 2), the transition between the distal and the proximal/iceberg dominated glaciomarine deposits is tentatively dated to 10–12 ky B.P. The 10 ky is a minimum age based on findings of *Portlandia arctica* with an age of 10,080 ± 110 (south of Nordaustlandet). Accordingly, at 10 ky B.P. (at the latest) the Late Weichselian ice sheet had retreated to onshore positions with only minor outlet glaciers and iceberg production.

The proximal/iceberg dominated facies, a unit suggested to be associated with the withdrawal of the Late Weichselian Barents Sea ice sheet, has not been dated. The unit is characterized by a low content (10–1,000 individuals per 100 g sediment) of foraminifera. Accelerator dating of foraminifera and calsispheres in two levels in a core from the central Barents Sea (Figs. 1 & 2) shows reversed ages, 28 ka and 21 ka at 0.6 and 1.8 m sediment depth, respectively. (Each sample was collected from a 40 cm interval of a 110 mm split core, and approximately 5 mg were dated.) Due to the low microfossil content, a mixed assemblage had to be used, and the foraminifera showed clear evidences of abrasion. The dated samples are therefore interpreted as consisting of foraminifera of mixed ages. Similarly, accelerator datings of foraminifera south of Nordaustlandet (Figs. 1 & 2) are, until more data are available, interpreted in the same way.

The thickness of the proximal/iceberg dominated unit is in general 3–5 m, except for local accumulations (Elverhøi & Solheim 1983; Solheim et al. 1988). A basic problem is to identify the onset of the proximal/iceberg glaciomarine sedimentation, and thereby date the withdrawal of the grounded Late Weichselian ice sheet. The low content of foraminifera indicates a harsh environment – cold water and a relatively rapid sedimentation rate. Application of a rate of 100 cm/ka results in a depositional period of 3–5 ka. This, and also higher rates, are comparable to rates found in modern ice proximal regions (Elverhøi et al. 1983; Molnia 1983; Powell 1984). According to such a depositional rate, the breakup of the northern Barents Sea ice sheet took place relatively early, 13–17 ky B.P. Indications of an early breakup may be found from the increased input of terrigeneous material corresponding to termination I_A in sediment cores from Framstretet and the eastern Arctic Ocean (Knudsen 1985; Zahn et al. 1985; Thiede et al. in press). If this timing is correct, the deglaciation of the Barents Sea may have contributed significantly to the light isotope peak of termination I_A, about 13 ky B.P.

Former reconstructions of the Barents Sea ice sheet have included the existence of extensive ice shelves, both for a maximum model with grounded ice to the shelf edge (Denton & Hughes 1981) and for a more limited situation with grounded ice only on the banks in the northern regions (Matishov 1984). The current data background is inadequate for a thorough discussion of ice shelves associated with the Barents Sea ice sheet. However, for the limited model, we consider at least large ice shelves unlikely as the Barents Sea is too shallow and without sufficient topographic relief providing the necessary anchor points. For the limited model the various troughs, e.g. Bjørnøyrenna and Franz Victoriarenna (Fig. 1), have acted as calving bays with sediment and iceberg supply from a grounded ice front. The 40–70 m thick glaciomarine accumulations in the inner parts of the troughs and along the slopes of the banks (Elverhøi & Solheim 1983; Solheim et al. 1988) may represent the extensive sediment output during a recessional stage.

In conclusion, the Barents Sea was most likely covered by grounded ice at least down to the present day 300 m contour (a limited model). The possibility that the northern Barents Sea ice sheet coalesced with the Fennoscandian ice sheet and covered the entire Barents Sea to the shelf edge is still open to discussion. However, the timing of deglaciation is not known.

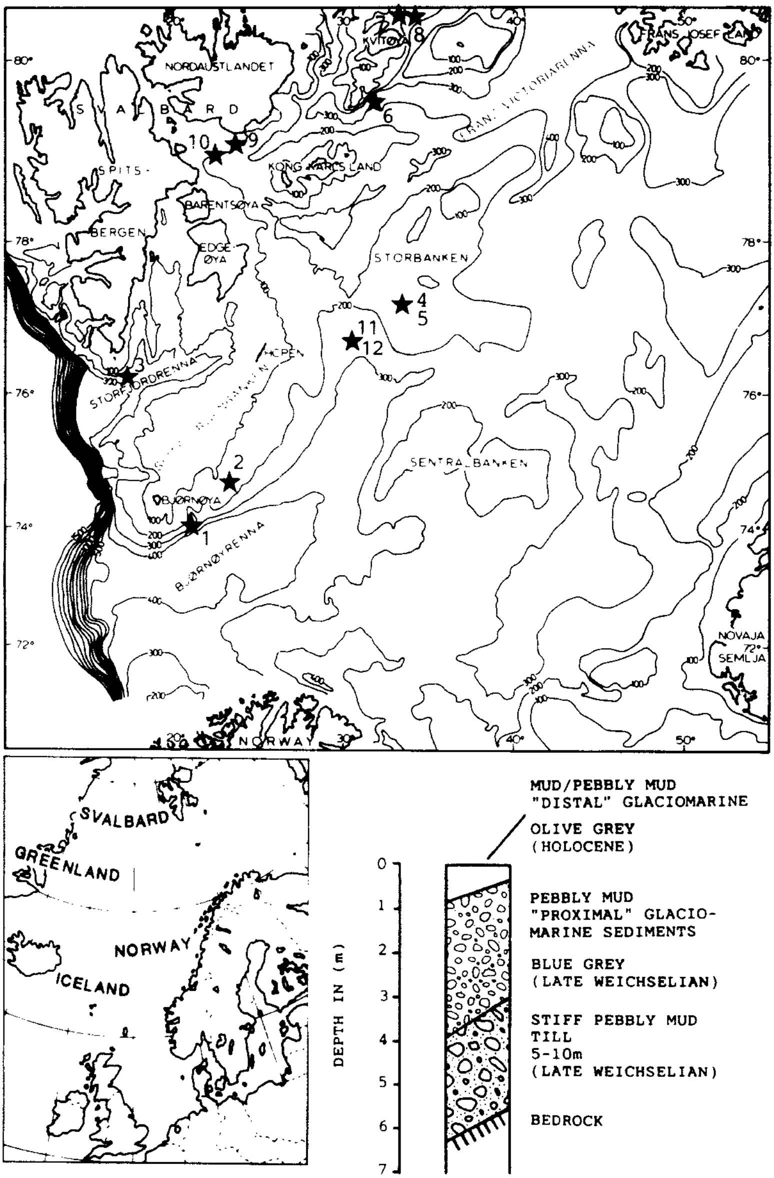


Fig. 1. Bathymetric map of the Barents Sea, including generalized lithological description of the unlithified sediments in the northern Barents Sea.

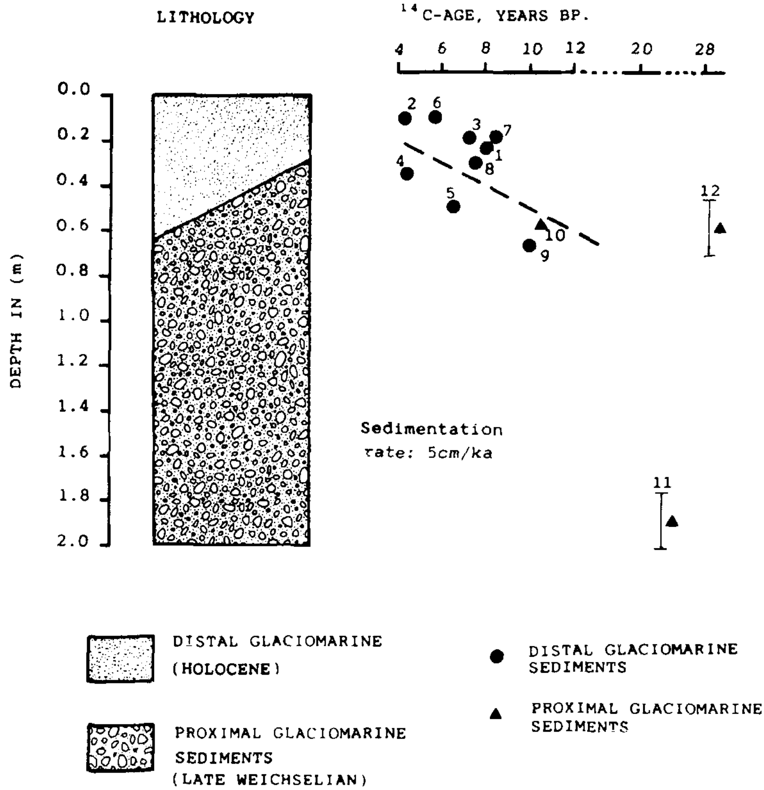
Based on the combination of datings and extrapolation of sedimentations rates, 10 ky B.P. is regarded as a minimum age of the transition from a proximal/iceberg facies to the present day sea ice dominated sedimentary environment. Estimation of sedimentation rates for the proximal facies may indicate deglaciation of the northern Barents Sea as early as 13–17 ky B.P. The withdrawal of the Barents Sea ice sheet probably caused a significant support to the light isotope influx at isotope stage I_A and to the increased clastic supply in Framstretet and the eastern Arctic Basin during this interval, which is supposed to be about 13 ky B.P.

References

Denton, G. H. & Hughes, T. J. 1981: The Arctic Ice Sheet: An outrageous hypothesis. Pp. 437–467 in Denton, G. H. & Hughes, T. J. (eds): *The Last Great Ice Sheets.* John Wiley & Sons.

Elverhøi, A. & Solheim, A. 1983: The Barents Sea ice sheet – a sedimentological discussion. *Polar Res. 1 n.s.*, 23–42.

Elverhøi, A., Lønne, Ø. & Seland, R. 1983: Glaciomarine sedimentation in a modern fjord environment, Spitsbergen. *Polar Res. 1 n.s*, 127–149.



SAMPLE NR. 1-8, from Elverhøi & Solheim 1983.

Sample nr.	Water depth(m)	Material	^{14}C-Age years BP	Depth in core (m)	Lab. ref. nr. *
9	112	Port. Arct.	10080±170	68	Ua 302
10	100	Forams	10390±170	50-58	Ua 301
12	280	Forams/Calc.	28080±1125	175-200	Ua 304
11	280	Forams	21200±825	45-70	Ua 305

* Tandem accelerator, University of Uppsala, Sweden.

Fig. 2. ^{14}C-datings and sedimentation rate of Late Quaternary sediments in the northern Barents Sea. (Dashed line: linear regression, locations in Fig. 1.)

Knudsen, B.-E. 1985: *Sen-Kvartært paleomiljø i Framstretet.* Unpubl. Cand. Scient. thesis. Univ. of Oslo. 74 pp.

Matishov, G. G. 1984: *Bottom of the ocean during glacial periods.* Nauka, Leningrad. 176 pp. (in Russian).

Molnia, B. 1983: Subarctic glacial-marine sedimentation: A model. Pp. 95–144 in Molnia, B. (ed.): *Glacial-Marine Sedimentation.* Plenum Press, NY.

Powell, R. D. 1984: Glaciomarine processes and inductive lithofacies modelling of ice shelf and tidewater glacier sediments based on Quaternary examples. *Marine Geol. 57,* 1–52.

Salvigsen, O. 1981: Radiocarbon dated raised beaches in Kong Karls Land, Svalbard, and their consequences for the glacial history of the Barents Sea area. *Geogr. Ann. 63A,* 283–291.

Solheim, A., Milliman, J. D. & Elverhøi, A. 1988: Sediment distribution and sea floor morphology of Storbanken; implications for the glacial history of the northern Barents Sea. *Canadian Journal of Earth Sciences* (in press).

Thiede, J., Clark, D. L. & Herman, Y. 1988: Late Mesozoic and Cenozoic paleoceanography of northern polar oceans. In Grantz, A., Johnson, L. & Sweeny, W. (eds.): *DNAG Arctic Vol.* (in press).

Vorren, T. O. & Kristoffersen, Y. 1986: Late Quaternary glaciation in the south-western Barents Sea. *Boreas 15,* 51–59.

Zahn, R., Markussen, B. & Thiede, J. 1985: Stable isotope data and depositional environment in the Late Quaternary Arctic Ocean. *Nature 314,* 433–435.