Available online at www.sciencedirect.com
ScienceDirect
Quaternary Research 69 (2008) 72–76
QUATERNARY RESEARCH
www.elsevier.com/locate/yqres

Short Paper

An early Holocene Greenland whale from Melville Bugt, Greenland

Ole Bennike

Geological Survey of Denmark and Greenland, Øster Voldgade 10, DK-1350 Copenhagen K, Denmark

Received 29 June 2007
Available online 13 November 2007

Abstract

Radiocarbon age determination of a Greenland whale (*Balaena mysticetus*) vertebra from Melville Bugt in northwestern Greenland yields an age of 9259–8989 cal yr BP. The margin of the Greenland Ice Sheet in Melville Bugt was situated behind its AD 1950–2000 position in the early Holocene, at a similar position to that being reached following rapid retreat in recent years. Such an early deglaciation of areas close to the Greenland Ice Sheet is unusual. This probably reflects the unique glaciological setting resulting from the narrow fringe of ice-free islands and peninsulas and offshore waters with deep areas that characterize this part of Greenland. The timing of Greenland Ice Sheet retreat to its present margin varies significantly around Greenland.

Keywords: Holocene; Greenland; Greenland whale; Bowhead; Balaena mysticetus

Introduction

The Melville Bugt region (Fig. 1) in northwestern Greenland is heavily glaciated. Only a narrow fringe of ice free islands, peninsulas and nunataks are found between the sea and the Greenland Ice Sheet. This part of Greenland is characterized by a narrow shelf and deep water areas with over 500 m water depth near the coast.

Little is known about the Quaternary history of Melville Bugt, and few radiocarbon dates are available. Radiocarbon age determination of basal gyttja in a low-elevation lake from central Melville Bugt, called Langesø, gave an age of 9910–9255 cal yr BP (K-3276; Table 1). Minerogenic sediments below the organic gyttja did not contain marine shells or marine diatoms, and no raised shorelines were noted in the area (Fredskild, 1985). In the northern part of Melville Bugt, shells of marine molluscs found in neoglacial moraines were dated to 9005–8547 cal yr BP (HAR-2950; Table 1). The lack of raised marine features in the central and northern parts of Melville Bugt is in accordance with geophysical modelling by Fleming and Lambeck (2004), who found that the relative sea level change from 12,000 to the present in Melville Bugt has been between −50 and −100 m.

South of Melville Bugt, raised marine deposits were noted on Svartenhuk Halvø. Radiocarbon age determination of shells of marine bivalves gave an age of 10,653–10,433 cal yr BP (AAR-3131; Table 1). The dated material comes from a position far from the present ice margin, and the date does not provide information about the time when the margin retreated to its present position. The marine limit at the site was 6.5 m a.s.l., but it increases to around 130 m a.s.l. farther south in western Greenland (Kelly, 1985). In the Thule region north of Melville Bugt, the marine limit reaches an elevation of around 45 m a.s.l., and the oldest radiocarbon age determined from shells from raised marine deposits is 11,092–10,254 cal yr BP (I-9663; Table 1). North of the Thule region, the marine limit increases to *c.* 120 m a.s.l. (Kelly and Bennike, 1992).

In the summer of 2005, a local hunter, Tobias Hansen, found a vertebra (Fig. 2) of a Greenland whale (also known as Greenland right whale or bowhead whale; *Balaena mysticetus* Linnaeus, 1758) on Nunatarsuaq (Hovgård Kystland) in Melville Bugt, at *c.* 74°44′N, 56°55′W. The glaciers in Melville Bugt have retreated markedly during the last years, and the whale bone was found in an area that has been deglaciated recently. No information is available on the substratum of the find, but the area is characterized by ice-scoured bedrock with patches of till. To the east of this location, between Nunatarsuaq and the margin of the Greenland Ice Sheet, a floating glacier

E-mail address: obe@geus.dk.

0033-5894/$ - see front matter
doi:10.1016/j.yqres.2007.10.004

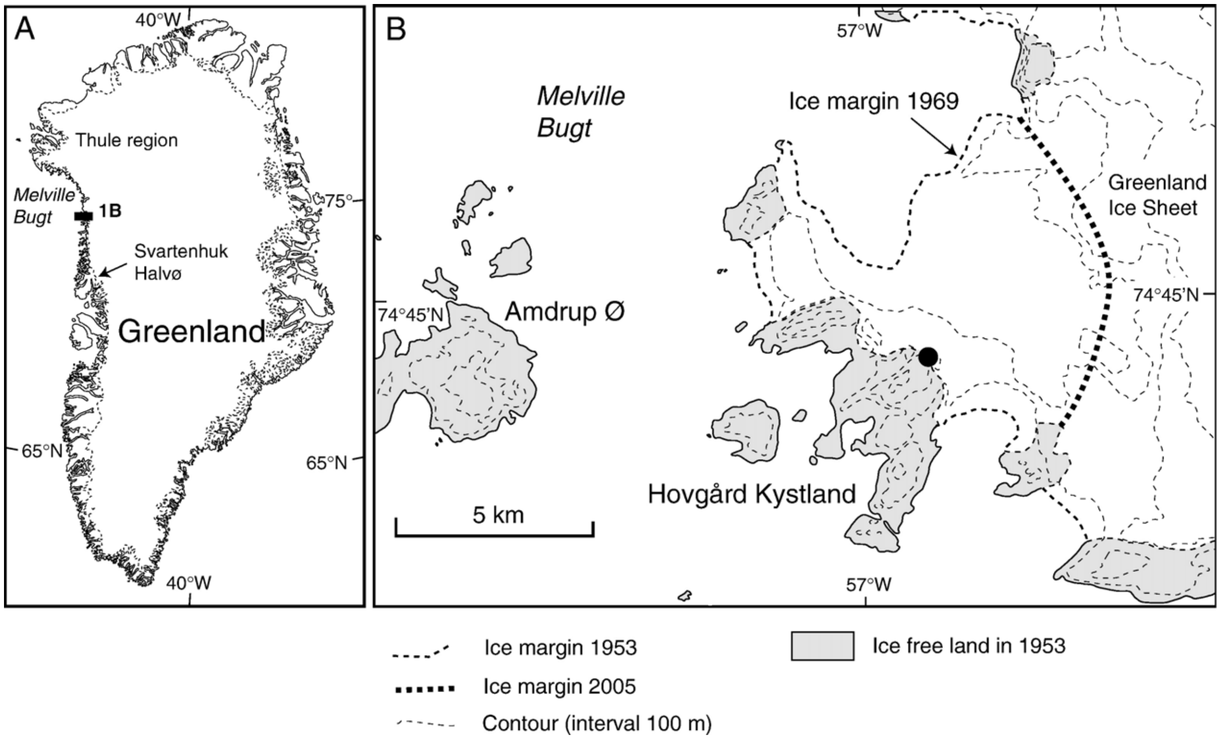

Figure 1. (A) Map of Greenland showing the position of Nunatarsuaq (Hovgård Kystland) (black rectangle) in northwestern Greenland. (B) Map of the Nunatarsuaq area showing the position of the whale bone find (black dot), the position of the ice margin in 1953 (from the 74 V.1 map sheet, issued by the Danish Geodetic Institute in 1969) and in 2005 according to information from Tobias Hansen. The ice margin in 1953 and 1969 was similar.

persisted until a few years ago, but this has disappeared in connection with the retreat of the glaciers.

Methods and result

The whale bone was dated by accelerator mass spectrometry (AMS) radiocarbon age determination on the collagen fraction at the Radiocarbon Dating Laboratory, Lund University. The date is corrected for isotopic fractionation by normalizing to a $\delta^{13}C$ value of −25‰ on the PDB scale. The $\delta^{13}C$ measurement was performed on a conventional mass spectrometer. Some of the other older radiocarbon dates on marine material discussed in this paper have been corrected for isotopic fractionation by normalizing to a $\delta^{13}C$ value of 0‰ on the PDB scale, or no

Table 1
Radiocarbon age determinations discussed in this paper or shown in Figure 3

Loc. no.	Laboratory no.	Age, ^{14}C yr BP	Rcorr, ^{14}C yr BP [a]	Calibrated age ±1 SD, cal yr BP	Material	Reference
1	LuS-6443	8525±50	8125±50	9259–8989	*B. mysticetus*	This work
2	K-3276	8540±120		9910–9255	Basal gyttja	Fredskild (1985)
3	HAR-2950	7910±90	7510±90	9005–8547	Marine shells	Kelly (1980)
4	W-48	8500±200	8300±200	9680–8647	*B. mysticetus*	Suess (1954)
5	I-9663	9385±145	9385±145	11092–10254	Marine shells	Weidick (1978)
6	Lu-3661	8290±100	8140±100	9416–8764	*B. mysticetus*	Bennike (1997)
7	AAR-5762	7240±65	6690±65	7665–7460	Marine shells	Bennike (2002)
8	HAR-6287	6480±100	5930±100	7139–6495	Marine shells	Kelly and Bennike (1992)
9	Ua-4587	6030±80	5480±80	6441–6017	Marine shells	Landvik et al. (2001)
10	HAR-3563	7280±90	6730±90	7736–7434	Marine shells	Funder (1982)
11	Ua-10557	7480±170	6930±170	8154–7479	Marine shells	Bennike and Weidick (2001)
12	AAR-4703	7855±65	7305±65	8305–7976	Marine shells	Bennike and Weidick (2001)
13	I-9131	8075±130	7925±130	9122–8445	Marine shells	Weidick (1977)
14	I-9658	6760±115	6610±115	7677–7293	Marine shells	Weidick (1978)
15	Lu-1070	7530±75	6980±75	7950–7677	Marine shells	Håkansson (1976)
16	Lu-1095	8580±85	8030±85	9133–8606	?*B. mysticetus*	Håkansson (1976)
17	I-5421	7140±130	6990±130	7950–7677	Marine shells	Funder (1978)
18	CURL-4914	8560±50		9627–9470	Bryophytes	Kaplan et al. (2002)
19	K-1664	7140±130	7140±130	8279–7684	Marine shells	Weidick (1972)
20	AAR-3131	9730±60	9330±60	10653–10433	Marine shells	Bennike (2000)

[a] Sea water reservoir corrected dates.

https://doi.org/10.1016/j.yqres.2007.10.004 Published online by Cambridge University Press

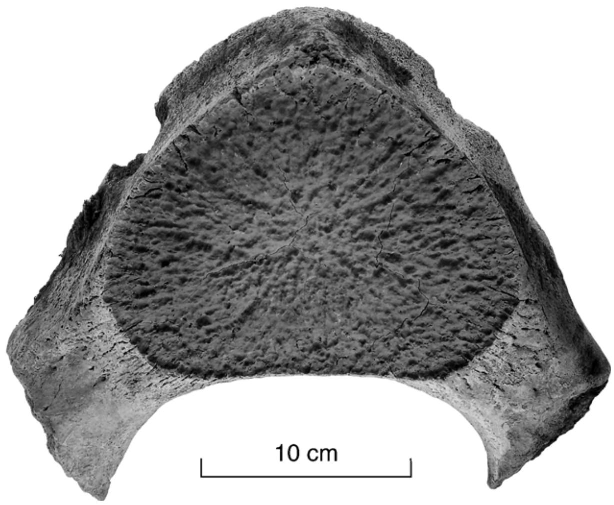

Figure 2. Photograph of the Greenland whale vertebra from Melville Bugt. The bone is deposited in the collections of the Zoological Museum in Copenhagen.

correction for isotopic fractionation was made. The radiocarbon dates were calibrated using the computer programme OxCal version 4.0, based on the INTCAL04 data set (Reimer et al., 2004), after correction for the local marine reservoir effect (Bennike, 1997). The whale bone gave an age of 8525±50 ^{14}C yr BP, which corresponds to 9259–8989 cal yr BP (LuS-6443). The δ^{13}C value was −16.8‰ on the PDB scale. This is a normal value for bone collagen of marine mammals.

Discussion

The whale bone was found on land, in an area that had been recently deglaciated. It is suggested that it lived in Melville Bugt at a time when the glaciers had extensions similar to that seen in recent years. After the whale died, the carcass drifted into the bay east of the finding site. Greenland whales are extremely fat, and the carcass can float for weeks or some months. It could have originated from somewhat further south and have been brought north by the West Greenland Current. However, this

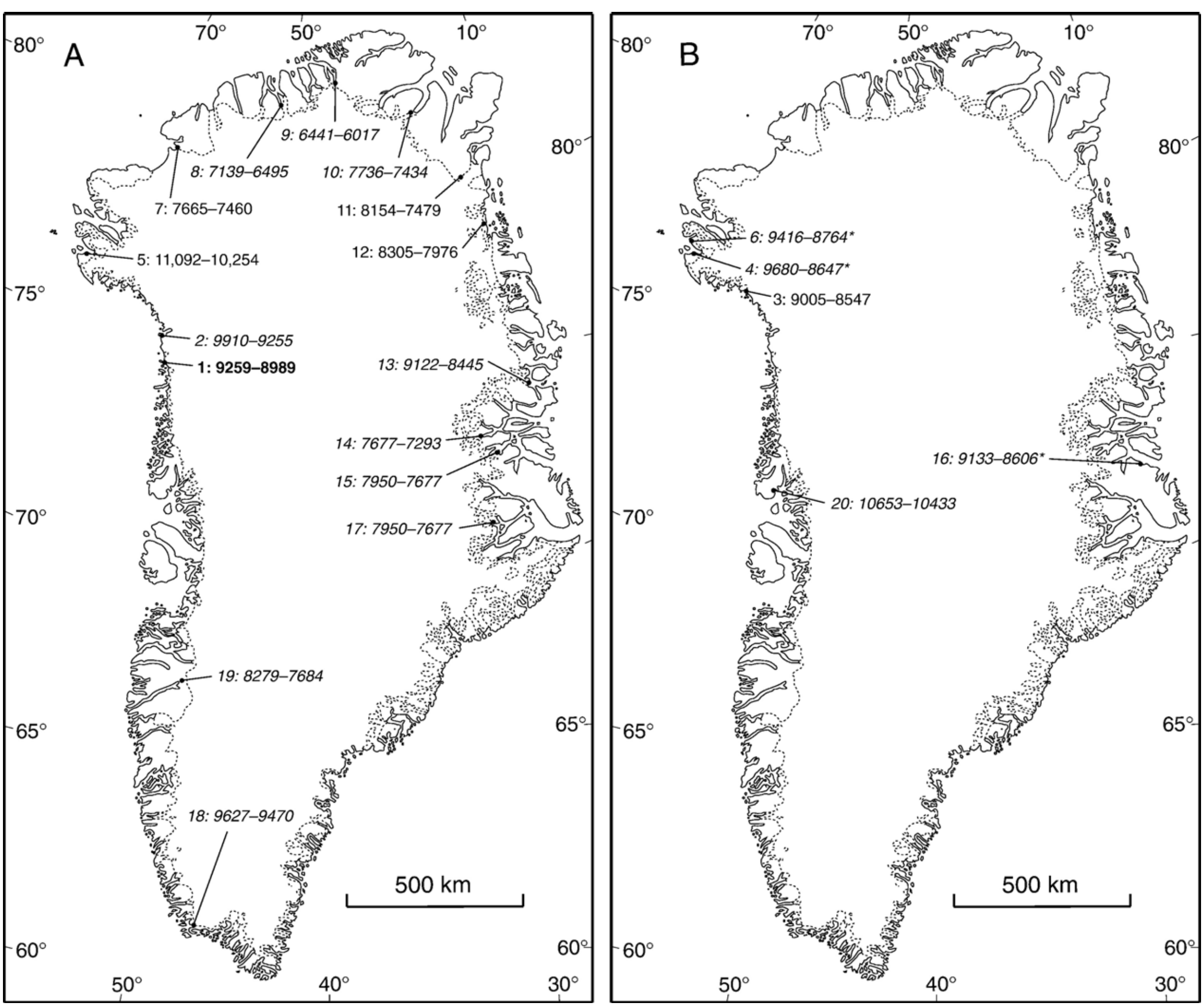

Figure 3. (A) Map of Greenland showing the distribution of selected oldest radiocarbon dates (cal yr BP) pertaining to the deglaciation of the ice free areas close to the margin of the Greenland Ice Sheet. Dates are given in calibrated years before present. (B) Other dates of Greenland Whale and marine shells discussed in the paper. Dates in italic mark material not reworked during Neoglaciation. The date from site 1 (in bold) is new. Dates marked by an asterisk are dates on bones from Greenland whale. Details see provided in Table 1.

https://doi.org/10.1016/j.yqres.2007.10.004 Published online by Cambridge University Press

does not greatly affect the interpretation. At some stage the bones settled on the sea floor. During the neoglaciation, from *c.* 4000–100 yr BP, when glaciers in Greenland expanded, the bone was incorporated in the sole of the advancing local glacier and carried up on land, where it was left as the ice retreated.

The dated whale bone shows that the margin of the Greenland Ice Sheet in Melville Bugt in the early Holocene was situated inside its ca. AD 1950 to 2000 position. During retreat in the early Holocene, the ice sheet was locally reduced to a size equal to or smaller than its present dimension. This is consistent with the results from the dating of basal gyttja reported by Fredskild (1985). In this sector of the ice sheet, the ice sheet margin had apparently attained a position similar to the present position at around 9500–9000 cal yr BP.

Comparisons with other parts of the Greenland Ice Sheet show that such an early attainment of the present position is fairly unusual. In northern Greenland, the oldest radiocarbon age determinations of organic remains from sites near the present ice margin have given dates between 7600 and 5800 cal yr BP. In northeastern Greenland, the oldest dates are between 8100 and 5800 cal yr BP. In central western Greenland, the oldest date is around 8000 cal yr BP (Fig. 3). However, in the southern sector of the Greenland Ice Sheet, areas close to the present ice margin were deglaciated at around the same time as in Melville Bugt, around 9500 cal yr BP (Weidick et al., 2004).

During the last deglaciation of the now ice-free parts of Greenland, the dynamics of ice retreat changed when the ice margin reached the outer coast. In the early stage of deglaciation, ice loss was mainly by calving in the marine environment. In the later stage, ice loss was mainly by ablation, and calving was restricted to the more or less narrow fjords. In those parts of Greenland where extensive ice-free areas are found between the ice margin and the sea, it took a long time before the ice margin reached its present position. Rapid deglaciation of Melville Bugt was further enhanced because the bay is characterized by several deep trenches that extend from Baffin Bay to near the coast of Greenland. In contrast to many other parts of Greenland, no broad, shallow shelf is found here.

Whereas bones of whales are common on raised marine beaches in many parts of arctic Canada (Dyke et al., 1996) and Svalbard (e.g. Bondevik et al., 1995), whale bones are rare on raised beaches in Greenland (Bennike, 1997). A total of nine radiocarbon dates of whale bones that have been identified, with various degree of certainty, as Greenland whales, are available from the whole Greenland sub-continent (Bennike, 1997; Bennike and Weidick, 2001). The find from Melville Bugt is one of the oldest dated finds. Two finds from the Thule region have given similar dates (Table 1; 9680–8647 and 9416–8764 cal yr BP). A find from East Greenland, tentatively identified as Greenland whale, has also given a slightly younger age (Table 1, 9133–8606 cal yr BP).

The dated finds show that Greenland whale was a member of the early Holocene vertebrate fauna of northwestern Greenland. The oldest finds from Arctic Canada have been dated to around 11,500 cal yr BP (Dyke et al., 1996). The species may have spread from the north Pacific Ocean after the flooding of the Bering Strait to the Beaufort Sea and from there to central Arctic Canada. It is possible that Greenland whale colonized western Greenland from Arctic Canada because the oldest Greenland dates come from northwestern Greenland. Eastern Greenland may have been colonized from Svalbard, from where the oldest date on whale bones postdating the last deglaciation is 16,134–14,987 cal yr BP (Forman, 1990; B-10968). Svalbard may have been colonized from northwestern Europe, where a stock of Greenland whale was found during the late glacial (Fredén, 1975). Greenland whale, narwhale (*Monodon monoceros*), walrus (*Odobenus rosmarus*) and ringed seal (*Phoca hispida*) are the only marine mammals that have been documented for the early to mid Holocene of Greenland (Bennike, 1997; Hjort, 1997; Bennike and Andreasen, 2007).

A number of Greenland whales visit the Disko Bugt area in the spring, during their migration from the main wintering area in Hudson Strait to the breeding grounds in eastern arctic Canada (Heide-Jørgensen et al., 2006). During the migration, some animals travel up along the west Greenland coast to Melville Bugt and the North Water polynya between the Thule region and Canada. Some animals also winter in the North Water. The finds of early Holocene Greenland whales from Melville Bugt and the Thule region could indicate that this pattern was established at an early stage. In the period from around 1600 to around 1900, the Greenland whale was almost exterminated in the North Atlantic by European whalers, but in recent years some recovery has been noted for the population in eastern arctic Canada (Cosewic, 2005).

Conclusions

It is concluded that the margin of the Greenland Ice Sheet was situated behind its AD 1950–2000 position in the early Holocene. After rapid retreat in recent years, a similar position has been reached. A position of the ice margin similar to the present was reached earlier in northwestern Greenland than in most other parts of Greenland, which reflects that it is characterized by a narrow ice-free land area. In addition, offshore waters with more than 500 m deep areas are found close to the coast.

The Greenland whale was an early immigrant to northwestern Greenland after the last deglaciation. This species spread from the North Pacific, after the flooding of the Bering Strait, to the Beaufort Sea, to the central Canadian arctic and then to eastern arctic Canada. Western and northwestern Greenland may have been visited during the spring migration or during the winter.

Acknowledgments

The whale bone was collected by Tobias Hansen in Kullorsuaq and sent to Denmark by Bo Albrechtsen, Upernavik Museum. It was identified by Jeppe Møhl, the Zoological Museum, Copenhagen University, and dated under the supervision of Göran Skog, Lund University. Comments from two anonymous referees are greatly appreciated.

References

Bennike, O., 1997. Quaternary vertebrates from Greenland: A review. Quaternary Science Reviews 16, 899–909.

Bennike, O., 2000. Palaeoecological studies of Holocene lake sediments from West Greenland. Palaeogeography, Palaeoclimatolology, Palaeoecology 155, 285–304.

Bennike, O., 2002. Late Quaternary history of Washington land, North Greenland. Boreas 31, 260–272.

Bennike, O., Weidick, A., 2001. Late Quaternary history around Nioghalvfjerdsfjorden and Jøkelbugten, North-East Greenland. Boreas 30, 205–227.

Bennike, O., Andreasen, C., 2007. Radiocarbon dating of walrus (*Odobenus rosmarus*) remains from Greenland. Polar Record 43, 361–365.

Bondevik, S., Mangerud, J., Ronnert, L., Salvigsen, O., 1995. Postglacial sea-level history of Edgeøya and Barentsøya, eastern Svalbard. Polar Research 14, 153–180.

Cosewic, 2005. COSEWIC assessment and update status report on the bowhead whale *Balaena mysticetus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. viii + 51 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Dyke, A.S., Hooper, J., Savelle, J.M., 1996. A history of sea ice in the Canadian Arctic Archipelago based on postglacial remains of the bowhead whale (*Balaena mysticetus*). Arctic 49, 235–255.

Fleming, K., Lambeck, K., 2004. Constraints on the Greenland Ice Sheet since the Last Glacial Maximum from sea-level observations and glacial-rebound models. Quaternary Science Reviews 23, 1053–1077.

Forman, S., 1990. Post-glacial relative sea-level history of north-western Spitsbergen, Svalbard. Geological Society of Greenland Bulletin 102, 1580–1590.

Fredén, C., 1975. Subfossil finds of arctic whales and seals in Sweden. Sveirges Geologiska Undersökning Årsbok 69 (2) 62 pp.

Fredskild, B., 1985. The Holocene vegetational development of Tugtuligssuaq and Qeqertat, Northwest Greenland. Meddelelser om Grønland. Geoscience 14, 20 pp.

Funder, S., 1978. Holocene stratigraphy and vegetation history in the Scoresby Sund area, East Greenland. Bulletin Grønlands Geologiske Undersøgelse 129, 66 pp.

Funder, S., 1982. C^{14}-Dating of samples collected during the 1979 expedition to North Greenland. Rapport Grønlands Geologiske Undersøgelse, vol. 110, pp. 9–14.

Heide-Jørgensen, Laidre, K.L., Jensen, M.V., Dueck, L., Postma, L.D., 2006. Dissolving stock discreteness with satellite tracking: Bowhead whales. Marine Mammal Science 22, 34–45.

Hjort, C., 1997. Glaciation, climate history, changing marine levels and the evolution of the Northweast Water Polynya. Journal of Marine Systems 10, 23–33.

Håkansson, S., 1976. University of Lund radiocarbon dates IX. Radiocarbon 18, 290–320.

Kaplan, M.R., Wolfe, A.P., Miller, G.H., 2002. Holocene environmental variability in southern Greenland inferred from lake sediments. Quaternary Research 58, 149–159.

Kelly, M., 1980. Preliminary investigations of the Quaternary of Melville Bugt and Dundas, North-West Greenland. Rapport Grønlands Geologiske Undersøgelse, vol. 100, pp. 33–38.

Kelly, M., 1985. A review of the Quaternary geology of western Greenland. In: Andrews, J.T. (Ed.), Quaternary environments. Eastern Canadian Arctic, Baffin Bay and western Greenland. Allen & Unwin, Boston, pp. 461–501.

Kelly, M., Bennike, O., 1992. Quaternary geology of western and central north Greenland. Rapport Grønlands Geologiske Undersøgelse, vol. 153. 34 pp.

Landvik, J.Y., Weidick, A., Hansen, A., 2001. The glacial history of the Hans Tausen Iskappe and the last glaciation of Peary Land, North Greenland. Meddelelser om Grønland. Geoscience 39, 27–44.

Reimer, P.J, Baillie, M.G.L., Bard, E., Bayliss, A., Beck, J.W., Bertrand, C.J.H., Blackwell, P.G., Buck, C.E., Burr, G.S., Cutler, K.B., Damon, P.E., Edwards, R.L., Fairbanks, R.G., Friedrich, M., Guilderson, T.G., Hogg, A.G., Hughen, K.A., Kromer, B., McCormac, G., Manning, S., Bronk Ramsey, C., Reimer, R.W., Remmele, S., Southon, J.R., Stuiver, M., Talamo, S., Taylor, F.W., van der Plicht, J., Weyhenmeyer, C.E., 2004. IntCal04 terrestrial radiocarbon age calibration, 0–26 cal kyr BP. Radiocarbon 46, 1029–1058.

Suess, H.E., 1954. U.S. Geological Survey radiocarbon dates I. Science 120, 467–473.

Weidick, A., 1972. Holocene shore-lines and glacial stages in Greenland—An attempt at correlation. Rapport Grønlands Geologiske Undersøgelse, vol. 41. 39 pp.

Weidick, A., 1977. C^{14} dating of survey material carried out in 1976. Rapport Grønlands Geologiske Undersøgelse, vol. 85, pp. 127–129.

Weidick, A., 1978. C^{14} dating of survey material carried out in 1977. Rapport Grønlands Geologiske Undersøgelse, vol. 90, pp. 119–124.

Weidick, A., Kelly, M., Bennike, O., 2004. Late Quaternary development of the southern sector of the Greenland Ice Sheet, with particular reference to the Qassimiut lobe. Boreas 33, 284–299.