Note

Evidence of a warmer climate around AD 600, Mittivakkat Glacier, South East Greenland.

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Abstract

During a field campaign in 1999, woody remains from Salix glauca were found on a nunatak, 515 m.a.s.l. on the Mittivakkat Glacier, South East Greenland. Radio carbon dating determi ned the age of a wood sample to AD 640. Together with analyses of macroscopic botanical remains and insect rests in peaty material found nearby, these results indicate, that a warmer climate prevailed near the glacier around AD 600. These findings are in accordance with temperature records based on studies of ice cores from the Greenland Ice sheet.

Keywords

Climate, carbon-14 dating, Mittivakkat Glacier, Greenland.

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The study is part of an interdisciplinary study of landscape forming processes in the Mittivak kat Glacier area, SE Greenland. During the field trip, August 1999, woody material was found on a nunatak, 515 m.a.s.l. In this area glacial erosion is one of the main geomorphological processes and the meltwater from the glaciers is important as a transporting agent for the eroded sediment. Glaciers also play a significant role in the waterbalance of the area and they are also important indicators of climatic change and a possible archive of responses to these changes. Therefore, the Mittivakkat Glacier and its mass balance has been studied since K. Milthers in 1933 took the first photos and measured the position of its terminus: Fristrup (1960, 1970), Hasholt (1976, 1986, 1987, and 1988) and Knudsen and Hasholt (1999). Generally these studies document a retreat of the terminus of about 400 m from the recent coastline in 1933 to about 1800 m in 1999, together with a thinning of the ice. Well developed terminal moraines, approx. 50 m from the present coastline and in lowland areas north of the glacier, indicate the position of the terminus of the glacier at the end of the Little Ice Age around AD 1900. Recent studies of the mass balance (Hasholt 1987, 1988, Knudsen and Hasholt 1999), demonstrate fluctuations in surface level of the glacier in the order of 5 - 10 meters in the upper part of the glacier and at the equilibrium line, around 500 m.a.s.l. These fluctuations reflect the normal yearly variation in snowfall and snowmelt, partly due to the strong storms (piteraq) which mainly come from an easterly direction and draw long drifts from the lee side of mountain peaks situated at the eastern border of the glacier.

Study Area

During the establishment and maintenance of the stake network for monitoring of the mass balance, a small nunatak (bedrock outcrop on the glacier surface) has been used as a base camp site, (see figs. 1 - 2). The nunatak, 65°42' N and 34° 49' W, 515 m.a.s.l., proved to be located at or very close to the present equlibrium line of the glacier. Therefore, in 1993 a climate station and a small hut were established on the nunatak in order to monitor the climate of the glacier and to provide a safer weather shelter for the field teams. Inside the hut are batteries, dataloggers and an automatic camera for monitoring the snowcover. The nunatak surface consists mainly of solid rock; on the southern side, however, part of the rocks are strongly weathered and smaller fields of pebbles and gravels are present. The nunatak is usually visited in May-June, when it is often snowcovered, except for the steep northfacing slopes. During this visit the winter balance is determined. The next visit takes place in mid- to late August, when the summer balance is determined. During this last yearly visit the snowcover is at or close to its minimum extent and the more flat southfacing parts of the nunatak are therefore exposed. The present vegetation cover on the nunatak is sparse, but to date it has not been examined by professional botanists. A few numbers of grass species and a few very tiny individuals of arctic willow (Salix glauca) are normally found. Some moss is found on the moister part of the gravel patches mentioned above and some lichens are found on the rocks.

Collection of samples for radio carbon dating In 1994 the snowcover was very deep, but since then a decline has taken place, indicated by the exposure of cables and other items previously buried underneath the snow. In August 1999, it was observed that an old stake used for monitoring of snowmelt in 1982 was lying on the surface of the glacier just south of the nunatak. Also a new nunatak east of the present one was exposed this year, indicating a very low level of the glacier surface. The margins of the nunatak were surveyed

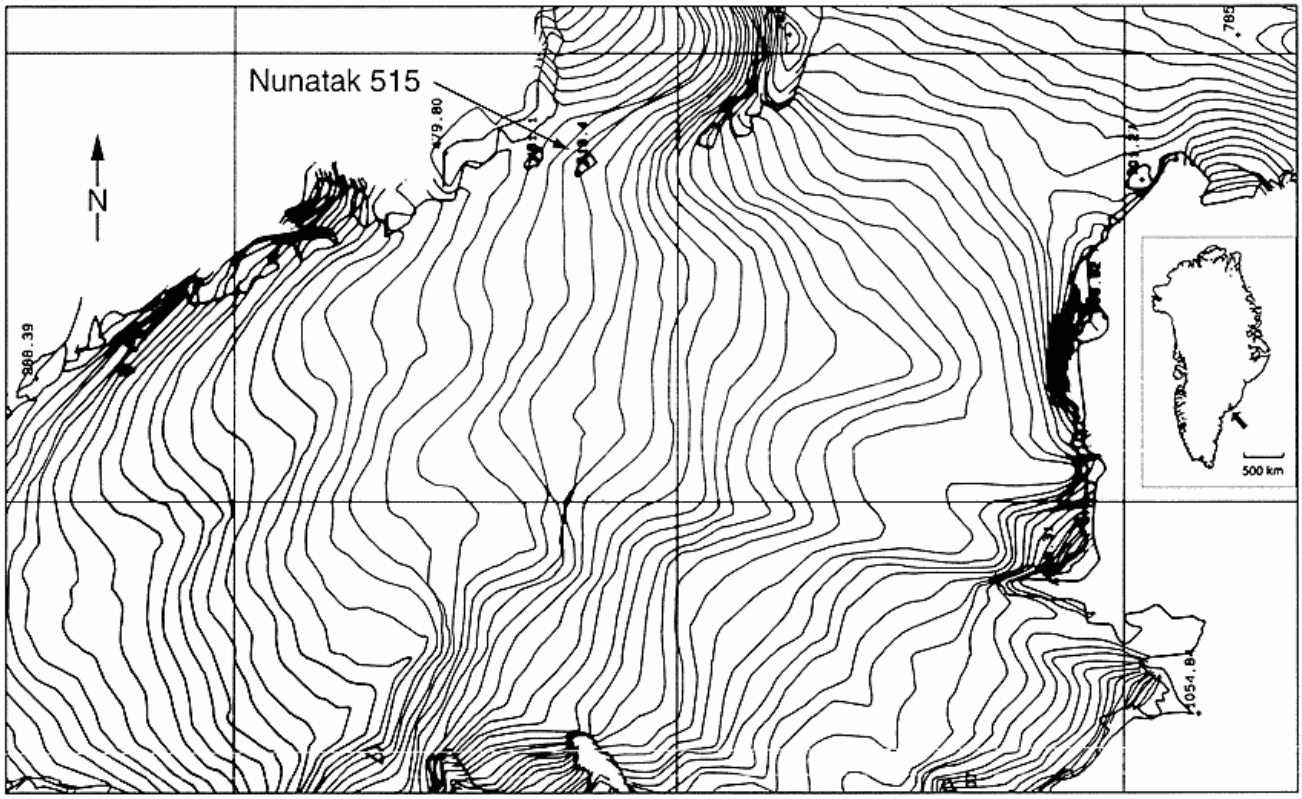

Figure 1: Map of the location of Nunatak 515. Map based on airphotos from 1981, local grid with 2 km sides and 10 m contour intervals. Approximate geographic coordinates of the nunatak are: 65° 42' N and 37° 48' W.

and the position of the margin was marked with paint marks and date of observation. At the southeast margin thick roots and stems of arctic willow was found, indicating an in situ position. About 10 - 20 m west of this position, a layer of dark peaty sand and gravel was found. Samples of the woody material were collected and sent to Denmark in plastic bags for carbon 14 dating. Also some samples of the peaty material were collected, because it looked very different from other deposits on the nunatak.

Dating and further analysis of the samples

The samples were forwarded to J. Heinemeier at the AMS Laboratory, Institute of Physics and Astronomy, University of Aarhus. The calibrated ages were AD 640, AD 560-660 (fig.3). In conventional radio carbon years the age was 1435 BP ± 60, the 13 value was -26.5 ‰. The calculated ages have been corrected for fractionation to make equivalent with the standard 13 value of -25‰ (wood). The peaty material was analysed for macroscopic botanical remains by B. Fredskild, who is participating in the project. The major part of the botanical material was roots of willow, most probably arctic willow, leaves and fruit stones of crowberry (Empetrum hermaphroditum), together with leaves of arctic blueberry (Vaccinium uliginosum) and herb-like willow (Salix herbacea). Furthermore, thousands of scleroties of the fungus (Cenocococ cum) were found, which are generally found in the humus layer under dwarf-shrub heaths. During his examination of the sample, B. Fredskild discovered some insect remnants, which were kindly determined by J. Bøcher. These insect fragments were from two species of beetles, namely Bembidion grapii and Otiorhyncus arcticus; both are known from the Ammassalik area, but normally they are not found under such harsh climatic conditions as occur on the nunatak, (Bøcher 1988).

Figure2: Nunatak, summer 1998 seen from glacier, sample location at arrow.

Discussion

Considering the known history of the glacier, from 1933 to the present, it is clear that the glacier has retreated at a variable velocity since the end of the Little Ice Age, around 1900. Although some upper parts of the glacier have been stochastically lowered due to wind drift and melting, it is evident that at 500 m.a.s.l. the climate has been colder than it is today for an extended period. The very sparse vegetation on the nunatak today indicate that conditions suitable for development of peat and lush vegetation have not been present for a sufficient period. However, both the dating and the supplementary analysis of macroscopic plant matter and insect remains are mutually conclusive and indicate that a warmer climate prevailed around AD 600 . This warm climate could have been a local phenomenon, because there are indications that changes in the wind field can have a strong influence on the distribution of the local snowcover. Recently, Dahl-Jensen et al. (1998), demonstrated, using reconstructed temperature histories from GRIP and DYE3, that a warmer climate prevailed from approx. AD 300 to approx. AD 1200 , with a maximum around year 900 AD . Dahl-Jensen et al. (1998) suggested that the reconstructed climate must represent events that occur over the whole of Greenland, as well as the high-latitude North Atlantic region. The findings support the conclusion from the present investigation that the warm period did occur, and that it was not a local phenomenon.

Acknowledgements

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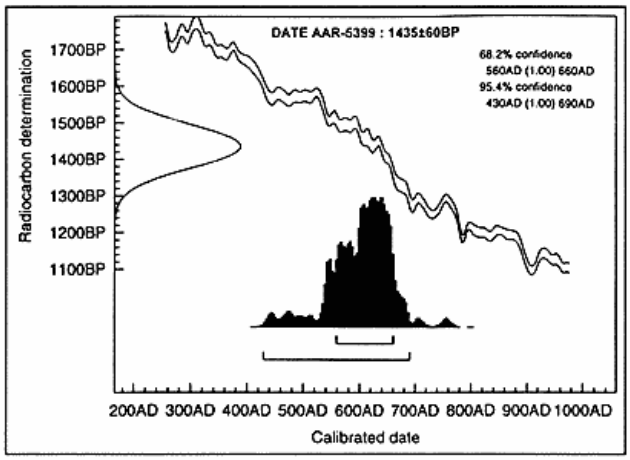

Fig. 3 Radiocarbon determination and calibrated date.

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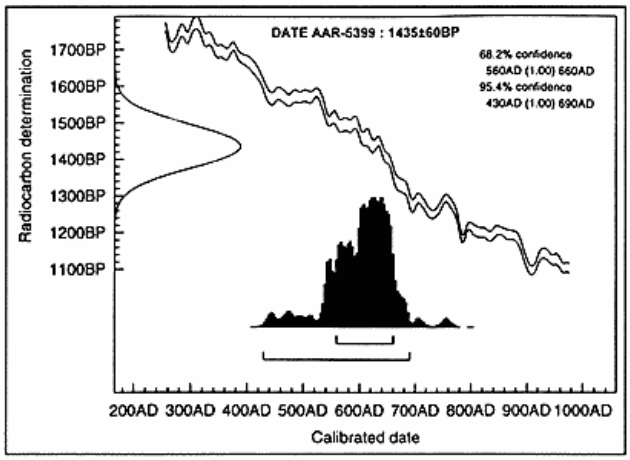

Fig. 3 Radiocarbon determination and calibrated date.