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Chronostratigraphic and palaeoenvironmental analysis of lake deposits in relation to deglaciation of the Søndre Strømfjord area, West Greenland: a preliminary report

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Introduction

Funder (1989) gives a general overview of the retreat of the Greenland Inland Ice during the Late Wisconsinan and the Holocene. The shift from an ice margin position close to the present coast to its present limit took place approximately between 11 000-10 000 yr B.P. and 7000 yr B.P. The ice margin may have been located slightly inside its present position until 3000 yr B.P., when a readvance began. The work of Ten Brink (1975) on the deglaciation chronology of the area between the Inland Ice and Sukkertoppen (south of Søndre Strømfjord; for location see Fig. 1), revealed the presence of several major Holocene moraine systems. A tentative chronology of these systems was obtained by ^{14}C dating of shells from marine terraces, which were correlated with the moraine systems. The two youngest moraine systems (the Keglen system and the Ørkendalen system) occur in the area between Søndre Strømfjord Air Base and the Inland Ice (Fig. 1). Their ages are estimated by Ten Brink (1975) at 6500-6000 yr B.P. and 700-300 yr B.P., respectively. In order to understand the deglaciation history of this area in more detail, and to relate it to Holocene climatic fluctuations, much more data is necessary. Palaeoclimatic data for West Greenland, based on palynological evidence, has been mainly published by Fredskild (e.g., Fredskild 1973, 1984, 1985). However, the sites closest to Søndre Strømfjord for which pollen diagrams exist are located several 100 km away.

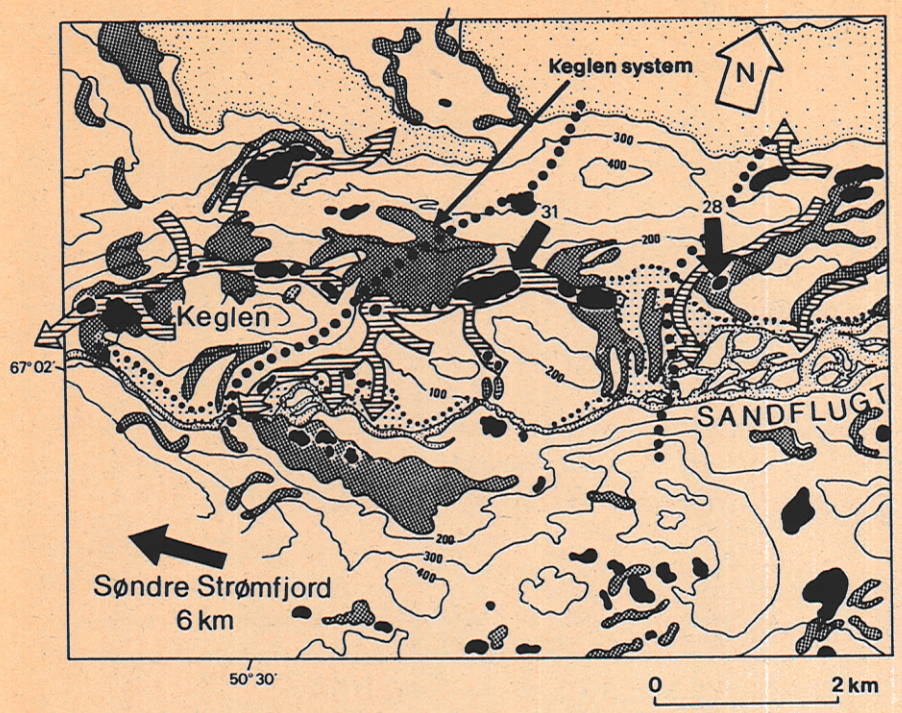
The large number of small lakes between Søndre Strømfjord Air Base and the Inland Ice (Fig. 1) offers abundant opportunities to establish minimum ages of melting of the ice, by ^{14}C dating the lowermost organic lake sediments. Furthermore, lake deposits can reveal important palaeoenvironmental information. This will usually reflect changes in more or less local processes. However, in some cases it may be possible to infer palaeoclimatic fluctuations, which, in turn, may be related to fluctuations in glacier retreat. Valuable information may therefore be obtained from the analysis of the lithology, as well as pollen and diatom assemblages of lake sediment cores.

The ultimate goal of the project is to contribute to the understanding of the deglaciation history of the Søndre Strømfjord area during the Holocene within a framework of investigations on fluctuations of the margin of the Greenland Inland Ice in relation to climatic change. This paper reports on the main field activities during the summer of 1991, and briefly discusses some preliminary results of the geomorphological mapping and the lake sediment investigations. Finally, the purpose of ongoing research topics on the lake cores is discussed.

Field methods

Fieldwork in Sandflugtdalen was carried out from mid-June to mid-August 1991. During the first month of the field period, geomorphological mapping of glacial phenomena was carried out, based upon air photo interpretation and a field check (Fig. 1). A general survey of the lakes in the study area was accomplished during the same period. Measurement of water depth and sediment thickness, as well as a description of the lake sediments, was carried out in approximately 20 lakes throughout the area. Water, plankton and epiphyte samples of 25 lakes were collected to investigate present-day water chemistry and diatom assemblages.

During the second month, cores were collected from a restricted number of selected lakes (indicated by numbers in Fig. 1), using a slightly modified Livingstone-system (core diameter 5 cm). Lake position in relation to major former ice margin positions and meltwater systems was the main selection criterion. Also characteristics of the lake bathymetry and the nature of sedimentary sequences were taken into account. Water depth, sediment thickness, and areal distribution of sediments were investigated in 10 x 10 m or 20 x 20 m grids. Cores were collected of the organic sediments and the upper part of the underlying clastic sediments, which usually inhibited deeper coring. A thorough description was made of the geomorphology



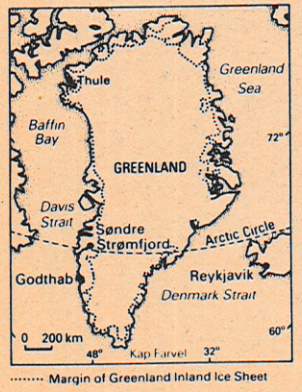
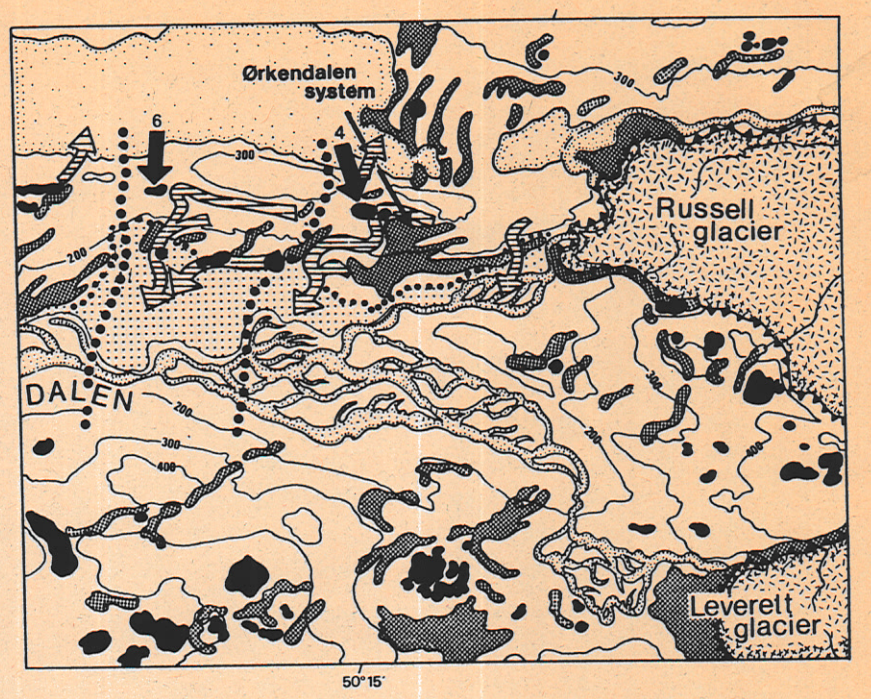


Figure 1. Geomorphological map of Sandflugtdalen and surrounding areas.



Legend

- Small lake
- Large lake
- Fluvioglacial terrace and sand sheet
- Braided river and present–day floodplain
- Moraine complex
- Abandoned glacial meltwater system
- Sampling sites
- Division line between major meltwater systems
- Outlet glaciers
- Countour line (100m–intervals)

and plant communities in the direct vicinity of the lakes. Moss samples were collected for studies on present-day pollen deposition.

One of the cores (lake 31) which was collected in 1985 during a field excursion of physical geographers of the University of Stockholm (Sweden) is included in the present investigation.

RESULTS

Geomorphological mapping and deglaciation

The geomorphological map (Fig. 1) gives an impression of the distribution of glacial and fluvioglacial features in the study area. A total of some 30 minor phases of glacial stillstand or possible readvance has been identified. These can be grouped into five major stages, which are characterized by the combined presence of large moraine complexes and glacial meltwater systems. These systems represent preferential directions of glacial meltwater flow towards the main channel, which was most likely located in the lowest part of Sandflugtdalen. The dry valleys, which are the present-day remains of these meltwater systems, contain numerous lakes. Since it seems reasonable that organic production in these lakes started when the meltwater systems lost their function, ^{14}C dating of the lowermost organic deposits in the lakes should yield a minimum age of the deglaciation stage of the meltwater systems to which they belong.

Organic material occurring in sandy silt, which is presumably of fluvioglacial origin, and which underlies some 90 cm of gyttja in lake 31, revealed a ^{14}C age of 5030 ± 60 yr B.P. (UtC-1586). This can be considered the minimum age for the meltwater system in which the lake is situated. It is consistent with the age for the Keglen moraine system as estimated by Ten Brink (1975).

Eolian deposits cover most of the study area. They originate from the extensive floodplain of the braided river system in Sandflugtdalen. Eolian sand sheets occur adjacent to the floodplain, whereas uphill the eolian material consists of a 0.4 to 1 m thick silt cover (proximal loess). Most of the upper parts of the hills consist of bare rock, sometimes with a thin morainic cover, but usually with unweathered, glacially polished bedrock at the surface.

Lake sediments

Data for lake 4, one of the lakes that was selected f sampling, is

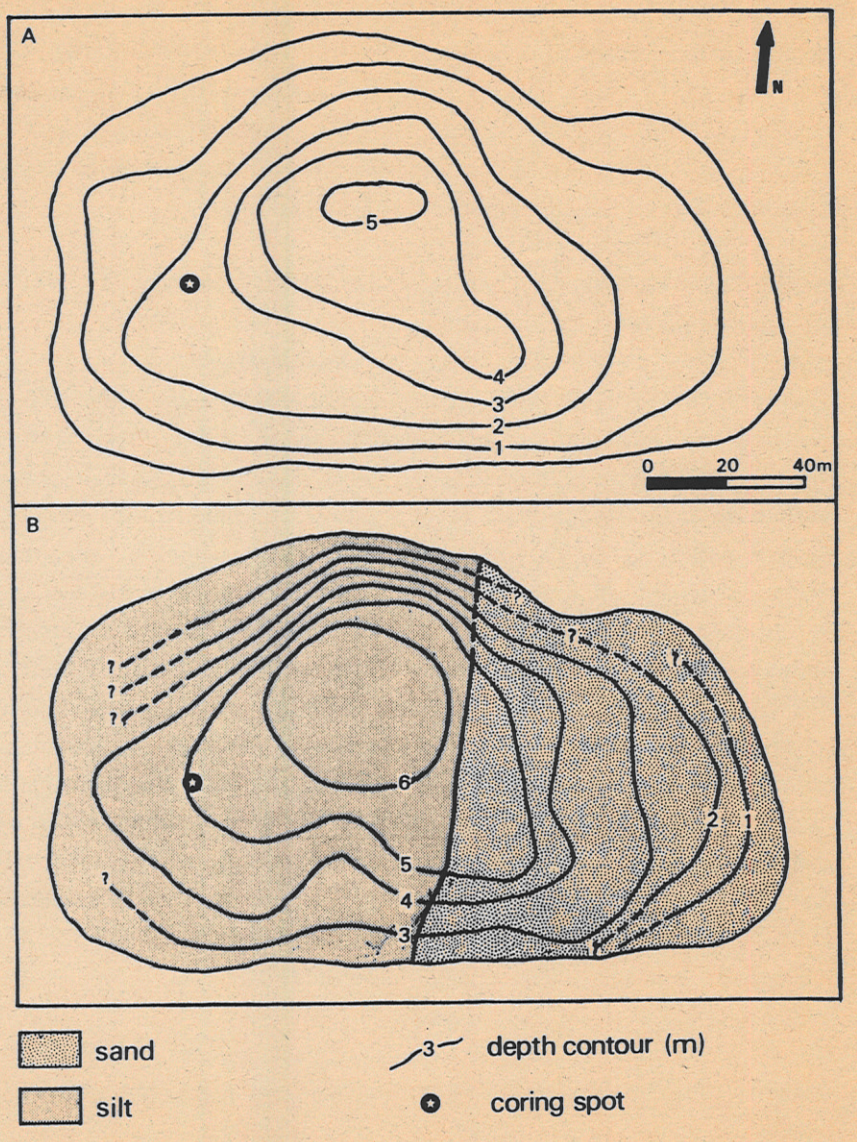


Figure 2. Bathymetry (A), sediment thickness (B), and areal sediment distribution (B) in lake 4 (for location see Fig. 1).

presented here as an example (Fig. 2). Lake 4 is situated a few kilometres west of the ice margin, just outside the Ørkendalen moraine system (Fig. 1). The lake is located close to a former glacial meltwater system, and it can therefore be expected that the basal part of the lake sediments consist of essentially glaciolacustrine deposits. The uppermost part of the basal clastic sediments in this lake is characterized by a rapid facies change from coarse sand in the east to massive silt in its western part (Fig. 2). This suggests that a subaquatic delta was formed in the lake. Well before the lake became completely filled, the contact with glacial meltwater disappeared, and the lake became an isolated system. Organic accumulation was then initiated with up to 3 m of gyttja developing. The organic matter content of the gyttja does not exceed 30 %, indicating that clastic material is still the major component (Fig. 3). The clastic material consists essentially of silt, with a grain-size distribution comparable to that of the proximal loess, as described by Dijkmans & Törnqvist (1991). If it is assumed that organic production through time has not varied too much, it can be concluded that the input of clastic material increased significantly in the upper part of the core (Fig. 3). Most likely, this can be related to an increase of eolian activity in the area, which has also been described by Dijkmans & Törnqvist (1991).

FUTURE RESEARCH

Pollen analysis

Palynological study of the lake cores will be of value both for stratigraphical and for palaeoecological purposes. Chronological information may, in principle, be obtained by fluctuations in the regional pollen curves (pollen trends; cf. Janssen & Törnqvist 1991). Furthermore, the possibilities of using pollen concentrations, notably of long-distance pollen, for chronological purposes (cf. Middeldorp 1982) will be explored, although results of Fredskild (1973) demonstrate that considerable difficulty may be inherent to this method.

Regional pollen assemblages can give information on vegetation succession after deglaciation (e.g. Fredskild 1973; Kelly & Funder 1974). Fluctuations in eolian activity may be detected, using indicator pollen types for the eolian sand sheets (cf. Dijkmans & Törnqvist 1991).

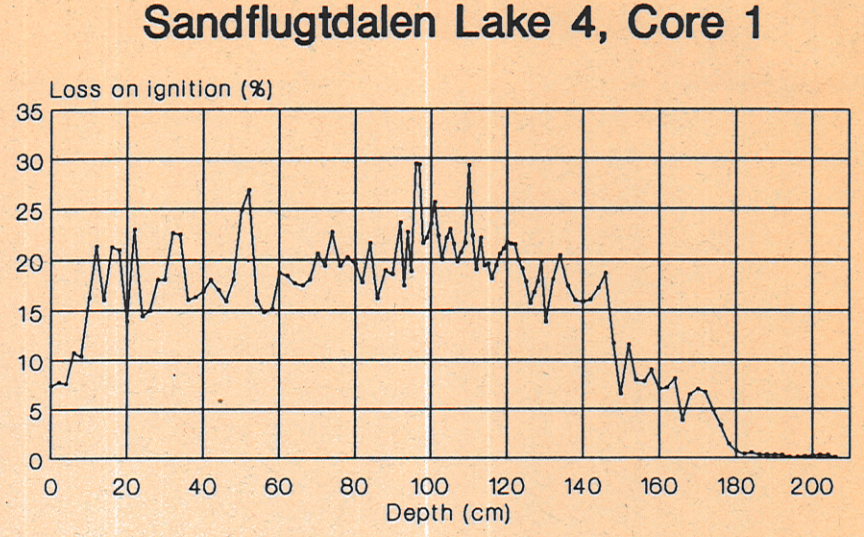


Figure 3. Loss on iginition curve for a core from lake 4 (for position of core see Fig. 2).

Preliminary results indicate that palaeoecological information may be expected, especially from the local pollen assemblages. Böcher (1949) reported the presence of salt lakes in the area, which is not surprising in view of the extremely low precipitation (130 mm yr^{-1}; Dijkmans & Törnqvist 1991). Nearly all lakes are isolated depressions without inlets or outlets. Former fluctuations in precipitation and evaporation (and thus temperature) would have influenced water chemistry, biology, and possibly also water depth. These may be discerned by the local pollen stratigraphy.

Diatom analysis

Only a few studies have concentrated on diatoms in West Greenland, and little is known about diatom assemblages in Holocene deposits (Foged 1953, 1977). Samples from 25 lakes in Sandflugtdalen are being examined for hydrochemical parameters and present-day diatom assemblages, thus providing a way to interpret diatom assemblages from the sedimentary record in terms of (aquatic) environmental conditions. Since diatoms are very sensitive to

hydrochemical conditions (probably even more than aquatic vegetation), fossil diatom assemblages may contain information on climatic oscillations. A comparison between biozones based on diatoms and local pollen assemblages is currently in progress.

^{14}C dating and chronostratigraphy

In order to reconstruct the deglaciation history of Sandflugtdalen, the lowermost organic material from the lake cores has been submitted for ^{14}C dating. In view of the low accumulation rate, which makes thinsamples preferable, and the generally low organic matter content of the material, dating is being carried out by means of accelerator mass spectrometry. In the few cases where it is possible, terrestrial macrofossils are being used. At a later stage, additional ^{14}C ages throughout the cores will be obtained, not only to construct a timescale for palaeoenvironmental changes, but also to enable calculation of pollen influxes. Likewise, mean loss on ignition values per unit time can be calculated in this way (cf. Zale & Karlén 1989).

Acknowledgements

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