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Research paper

Paleoceanographical development off Sisimiut, West Greenland, during the mid- and late Holocene: A multiproxy study

Dorthe Reng Erbs-Hansen [a], Karen Luise Knudsen [a,*], Jesper Olsen [b,c], Holger Lykke-Andersen [a], Jens Ambrosius Underbjerg [a], Longbin Sha [d]

[a] Department of Geoscience, Aarhus University, DK-8000 Aarhus C, Denmark
[b] School of Geography, Archaeology and Palaeoecology (GAP), Queen's University, Belfast BT7 1NN, Northern Ireland, UK
[c] Department of Physics and Astronomy, Aarhus University, DK-8000 Aarhus C, Denmark
[d] State Key Laboratory of Geographic Information Science, East China Normal University, 200062 Shanghai, PR China

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ABSTRACT

A multiproxy study of paleoceanographic and climatic changes in Holsteinsborg Dyb on the West Greenland shelf shows that the area is sensitive to variations in the mixing between the two components of the West Greenland Current, i.e., the Atlantic Water of the Irminger Current and the Polar Water from the East Greenland Current. A seismic profile illustrates the general development in the area since the deglaciation, and analyses of benthic foraminifera, stable isotopes ($\delta^{18}O$ and $\delta^{13}C$), and X-ray fluorescence elemental counts in two cores, covering ca. 6650 and 1100 years, respectively, provide details on the oceanographic changes during the mid- and late Holocene. The chronology is based on ^{210}Pb and AMS ^{14}C age determinations. During the time interval of 6650–1600 cal. yr BP, the bottom waters are characterized by the presence of modified Atlantic Water, with some influence of meltwater, either local or regional. Depleted $\delta^{18}O$ values and relatively high Si/Fe ratio suggest warmer conditions from 6650 to 3800 cal. yr BP, corresponding in time to part of the Holocene Thermal Maximum, followed by a general slight cooling with some fluctuation after 3800 cal. yr BP. At 1600 cal. yr BP, there is an abrupt change in almost all investigated proxies. The foraminiferal assemblage and the $\delta^{18}O$ values suggest cold, low-salinity bottom-water conditions, and there is indication of seasonal sea-ice cover between 1400 and 1200 cal. yr BP, corresponding in time to the Dark Ages Cold Period and to a minimum in solar irradiance. From ca. 1150 to 580 cal. yr BP, a time interval equivalent to the historical Medieval Warm Period (MWP), the foraminiferal fauna remains indicative of cold, low-salinity bottom waters, but without any indication of sea-ice cover. The influence of Polar Water/meltwater at the sea floor during the MWP is thought to be a result of enhanced mixing of the two components of the West Greenland Current caused by an increase in wind activity during generally positive North Atlantic Oscillation conditions, maybe combined with a displacement of the Irminger Current pathway to the outer shelf. During the Little Ice Age (LIA), there is a strong influence of modified Atlantic Water at the sea floor, related to sea-ice formation and stratification of the water column. After AD 1900, the benthic foraminiferal assemblage suggests a slight increase in Polar Water influence and thereby mixing, even though the environment is not much different from that during the LIA.

1. Introduction

The West Greenland shelf is a key area for the study of regional climate changes, because it is located in a climatically sensitive region close to the atmospheric archive of the Greenland Ice Sheet and in a region, in which the marine environment is closely related to the entire North Atlantic oceanographical system (e.g., Zweng and Münchow, 2006). In instrumental time, this relation has for example been documented during the Great Salinity Anomaly around 1970, when an anomalously high inflow of Polar Waters through the Fram Strait to the North Atlantic propagated into the West Greenland waters (e.g., Buch, 2002). In addition, a correlation of the Atlantic Multidecadal Oscillation index (cf. Kerr, 2000) with the subsurface, as well as the surface-water temperatures off West Greenland has been demonstrated by Lloyd et al. (2011) and by Sha et al. (2012), respectively.

The West Greenland shelf is dominated by the north-flowing West Greenland Current, which consists of two components, the Irminger Current component originating from the Atlantic Water (Irminger Sea-derived subsurface water) and the East Greenland Current component bringing water masses of Polar origin to the area (Fig. 1A) (e.g., Buch and Nielsen, 2001; Ribergaard and Buch, 2005; Ribergaard, 2011). The two components of the West Greenland Current are usually clearly distinguishable off SW Greenland, with the East Greenland Current waters flowing closest to the coast and the underlying Irminger

* Corresponding author at: Department of Geoscience, Høegh-Guldbergs Gade 2, Aarhus University, DK-8000 Aarhus C, Denmark. Tel.: +45 87156439, +45 21787844 (mobile).
E-mail address: karenluise.knudsen@geo.au.dk (K.L. Knudsen).

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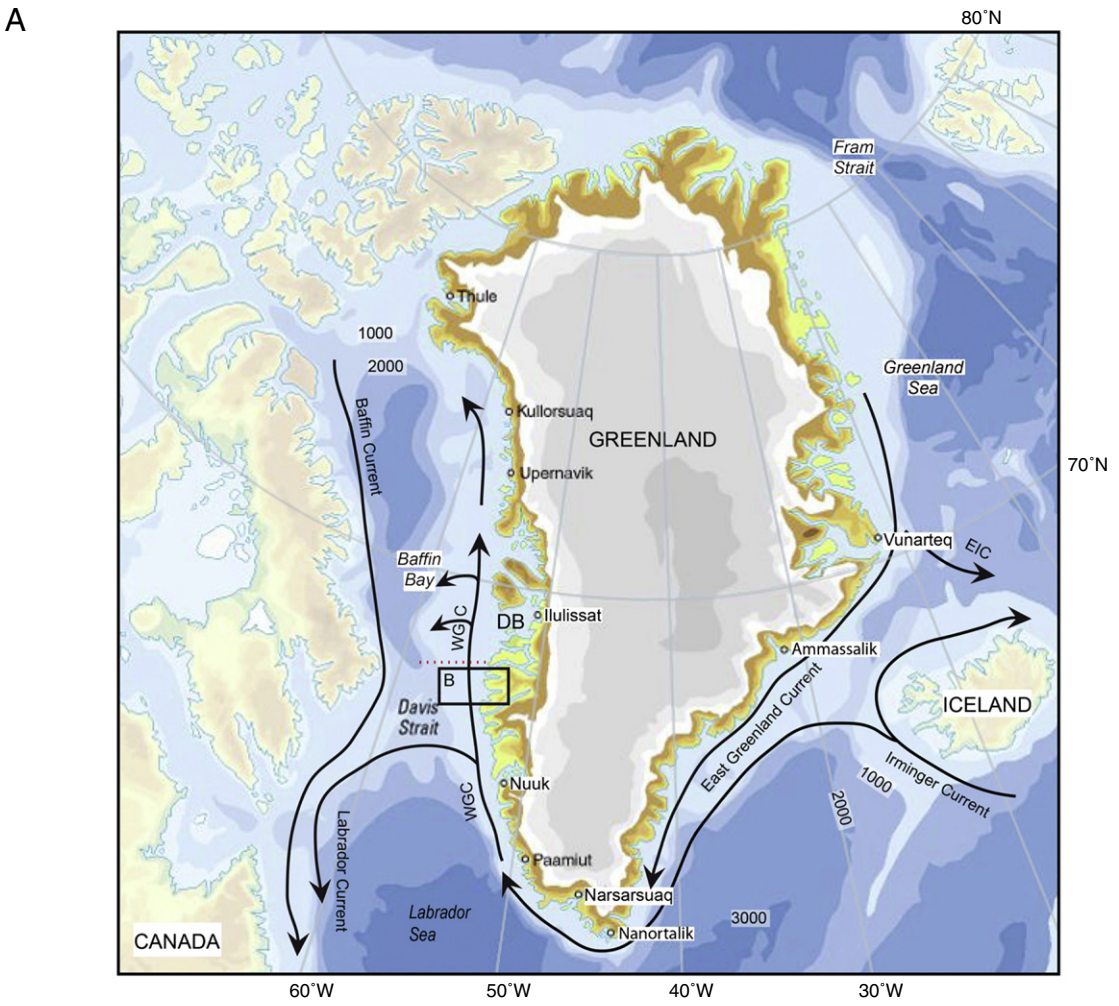
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80°N
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50°W
40°W
30°W
Fram Strait
Thule
1000
2000
Greenland Sea
Kullorsuaq
GREENLAND
Upernavik
Baffin Current
Vunarteq
EIC
Baffin Bay
WGC
DB
Ilulissat
Ammassalik
B
Davis Strait
ICELAND
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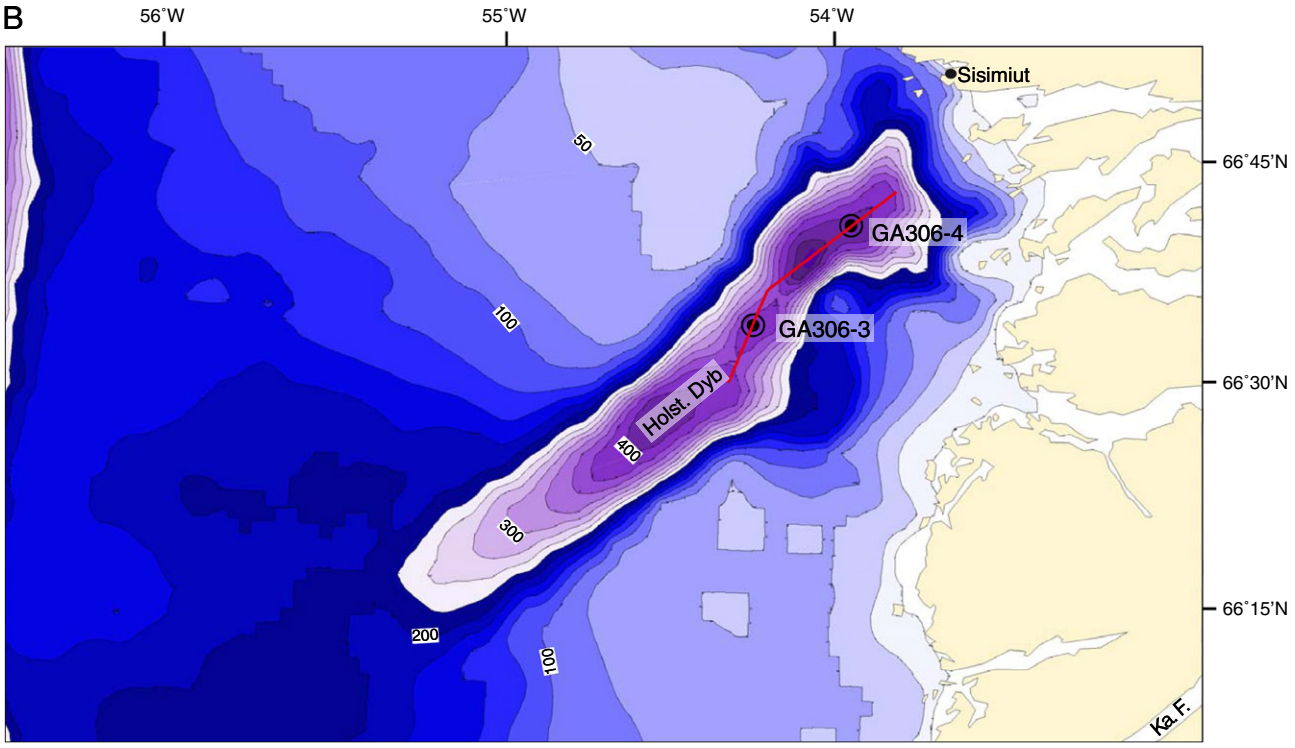
B
56°W
55°W
54°W
Sisimiut
66°45'N
66°30'N
66°15'N
50
GA306-4
100
GA306-3
Holst. Dyb
400
300
200
100
Ka. F.