A Re-Evaluation of the Late Pliocene - Pleistocene Behavior of the Scoresby Sund Sector of the Greenland Ice Sheet*

J. S. Laberg¹, M. Fwick¹, K. Husum¹, and T. Nielsen¹

Abstract

A major conclusion of Ocean Drilling Program Leg 162, drilling the western Svalbard and eastern Greenland continental margins, was that the Svalbard – Barents Sea Ice Sheet reached the shelf edge during peak glaciations much more frequently than the Greenland Ice Sheet during the late Pliocene – Pleistocene period. Both areas have a continental margin dominated by large, across-shelf-oriented troughs terminating at the shelf edge. In front of these troughs, large depocenters of glacigenic sediments, Trough-Mouth-Fans (TMFs), are located. Ice streams drained the ice sheets through these troughs during glacial, eroding and transporting large quantities of sediments to the shelf edge, from where they subsequently were remobilized as glacigenic debris flows. The deposits of the latter have a characteristic lens-formed morphology in cross-section. In order to tie the stratigraphy of ODP Site 987, located on the very distal part of the Scoresby Sund TMF on the east Greenland continental margin, to the more proximal parts where most of the glacigenic sediments have been deposited, a regional seismic line was acquired. The seismic line reveals that lithological unit IIA of site 987, interpreted to be debris-flow deposits, corresponds to an acoustically transparent unit. The overlying lithological unit I, found to be dominated by hemipelagic sediments comprising varying amounts of ice-rafted debris, is acoustically laminated. Tracing this unit south-westwards shows a transition from an acoustically laminated facies to stacked sub-units of transparent lenses of glacigenic debris flows, very similar to the signature of other TMFs. This shows that ODP Site 987 was located too distal to sample the glacigenic debris-flow deposits that dominate the deposits of the last ~2.58Ma on the more proximal part of the fan. From this we conclude that at least the Scoresby Sund sector of the East Greenland Ice Sheet had a much more dynamic behavior during the late Pliocene – Pleistocene period than previously realized, implying a more profound glacial erosion of this part of the shelf.

Selected References


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Aims of study

• Reconstruct the Neogene evolution of the northeastern Greenland continental margin

• Elucidate on the Neogene glacial history of the northeast Greenland

• Quantify glacial erosion and sedimentation
Outline

• Study area

• The glacial history – a review

• Glacial sedimentation- and erosion rates

• The next step: what is needed for a better understanding of the Neogene evolution of the northeast Greenland continental margin?

• Summary
The glacial history – a review

• Based on results from Ocean Drilling Program Legs 152 (SE Greenland) and 162 (Scoresby Sund)
South-East Greenland
South-East Greenland

Larsen et al. (1994)
South-East Greenland

The SE Greenland Ice Sheet reached the continental shelf ~7 Ma ago and repeatedly thereafter

Solgaard et al. (2011)
Scoresby Sund
Scoresby Sund

Solheim et al. (1998)
Scoresby Sund
Scoresby Sund

Laberg et al. (in press)
Scoresby Sund

Laberg et al. (in press)
Scoresby Sund

Sub-units of glacigenic debris flow deposits

Laberg et al. (in press)
Scoresby Sund

Laberg et al. (in press)
ONSET OF GLACIGENIC SEDIMENT PROGRADATION OFF THE COAST

- SE Greenland
- Scoresby Sund Greenland
- Fennoscandian (mid-Norway)
- SW Barents Sea
- Fennoscandian (North Sea)

Includes periods when onshore ice retreated from the coast

Sejrup et al. 2005

Dahlgren et al. 2005
Rise et al. 2010

Andreassen et al. 2007
Knies et al. 2009
Laberg et al. 2010

- ird in the NGS from 38 - 30 Ma from the Greenland Ice Sheet (Eldrett et al. 2007)
- ird offshore mid-Norway ODP Leg 104 from 15 Ma linked to the Fennoscandian Ice Sheet (Jansen & Sjoholm 1991)
Glacial sedimentation- and erosion rates
## Glacial sedimentation and erosion rates

<table>
<thead>
<tr>
<th>Area</th>
<th>Av. erosion rate</th>
<th>Av. sedimentation rate</th>
<th>Period</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southwestern Barents Sea</td>
<td>0.4 mm/yr</td>
<td>38 cm/kyr</td>
<td>0 – 2.7 Ma</td>
<td>This study</td>
</tr>
<tr>
<td>Western Fennoscandia</td>
<td>0.19 mm/yr</td>
<td>24 cm/kyr</td>
<td>0 – 2.7 Ma</td>
<td>Dowdeswell et al. (2010)</td>
</tr>
<tr>
<td>South-western Fennoscandia</td>
<td>0.12 mm/yr</td>
<td></td>
<td>0 – 1.1 Ma</td>
<td>Hjelstuen et al. (in review)</td>
</tr>
<tr>
<td>Eastern Canada</td>
<td>0.13 mm/yr</td>
<td></td>
<td>0 – 0.8 Ma</td>
<td>Hiscott and Aksu (1996)</td>
</tr>
<tr>
<td>East Greenland</td>
<td>?</td>
<td>2.8/4.8 cm/kyr</td>
<td>0 – 15 Ma</td>
<td>Berger and Jokat (2008)</td>
</tr>
<tr>
<td>East Antarctica</td>
<td>0.001 - 0.002 mm/yr</td>
<td></td>
<td>0 – 34 Ma</td>
<td>Jamieson et al. (2005)</td>
</tr>
</tbody>
</table>

Laberg et al. (2012)
The next step:

• More detailed seismic facies analyses of the glacigenic sediments – onset of shelf glaciations

• More detailed volume estimates of the glacigenic sediments

• Lithology/Chronology

• Estimates of sediment drainage area
Summary

• The SE Greenland Ice Sheet reached the continental shelf ~7 Ma ago and repeatedly thereafter

• During the Pleistocene the Scoresby Sund sector of the east Greenland Ice Sheet developed in line with other parts of the Ice Sheet, and was more dynamic and sensitive to past climatic changes than hitherto realized.

• Little is still known on the evolution of the Neogene (glacial) part of the east Greenland continental margin – due to the lack of data

• Estimates of glacial erosion and sedimentation rates are still tentative
Acknowledgement

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Thanks for your attention!