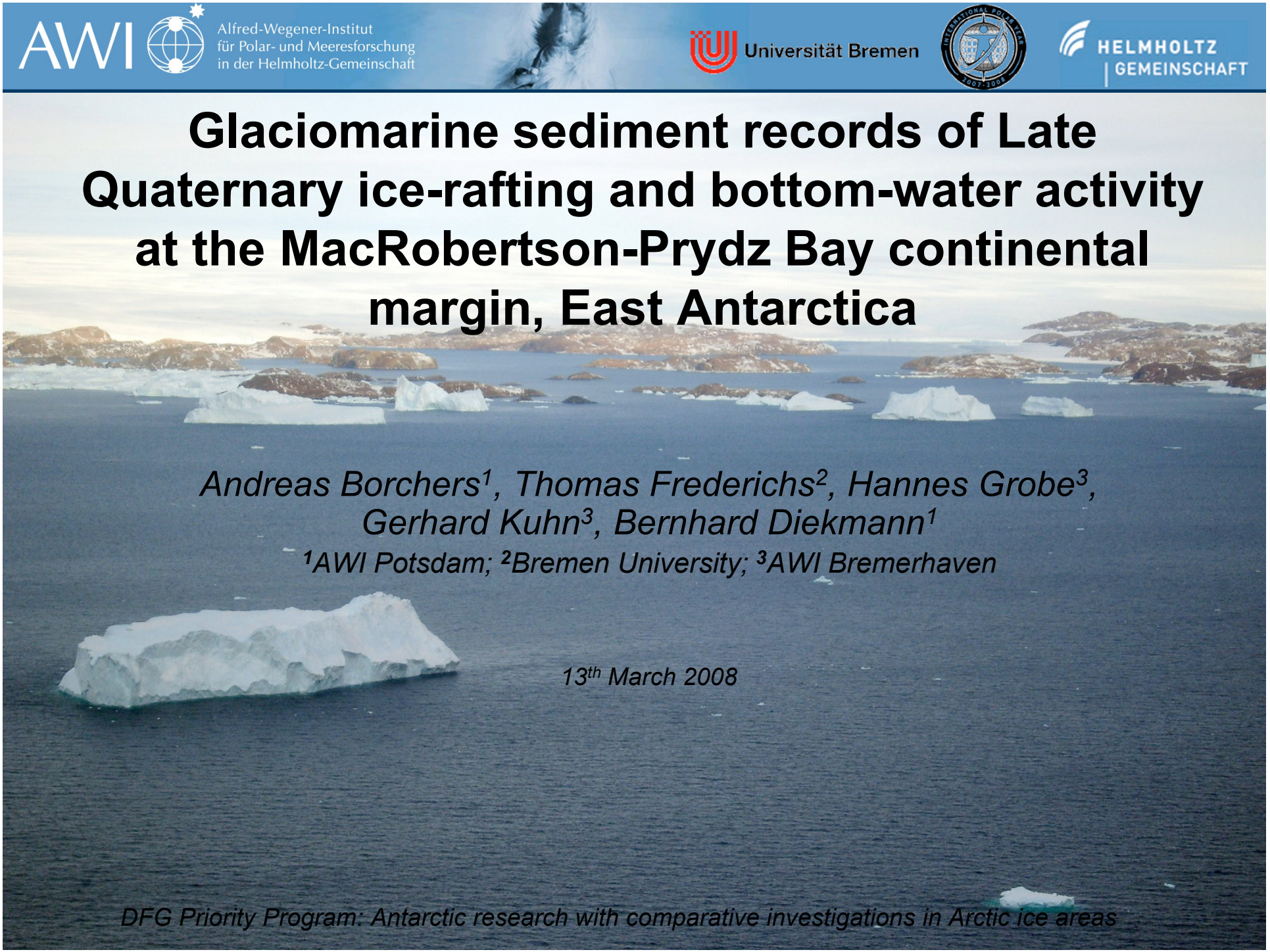


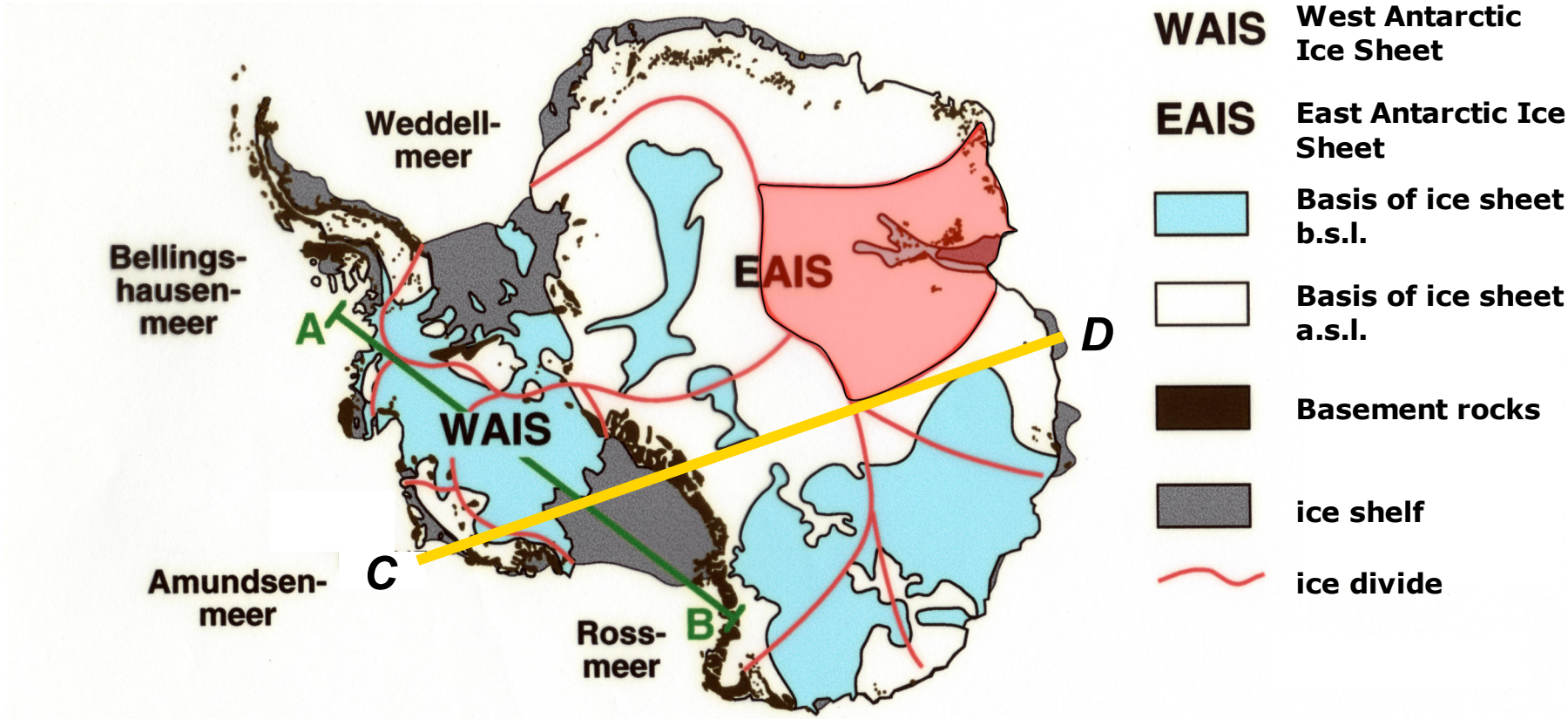
Glaciomarine sediment records of Late Quaternary ice-rafting and bottom-water activity at the MacRobertson-Prydz Bay continental margin, East Antarctica

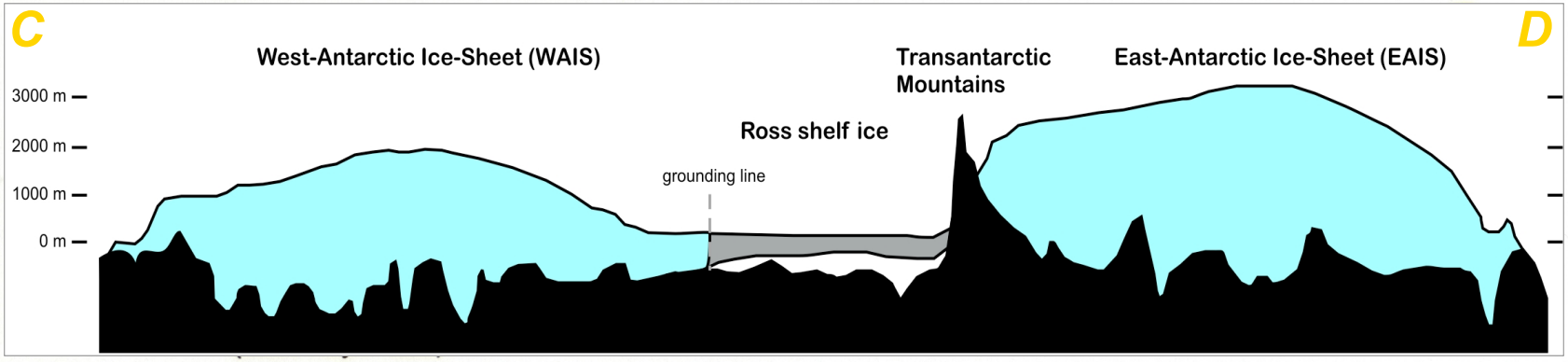
Andreas Borchers[1], Thomas Frederichs[2], Hannes Grobe[3], Gerhard Kuhn[3], Bernhard Diekmann[1]

[1]AWI Potsdam; [2]Bremen University; [3]AWI Bremerhaven

13th March 2008

DFG Priority Program: Antarctic research with comparative investigations in Arctic ice areas





after Bentley, 1989 and Keys, 1990. Compiled by Hillenbrand, 2000.

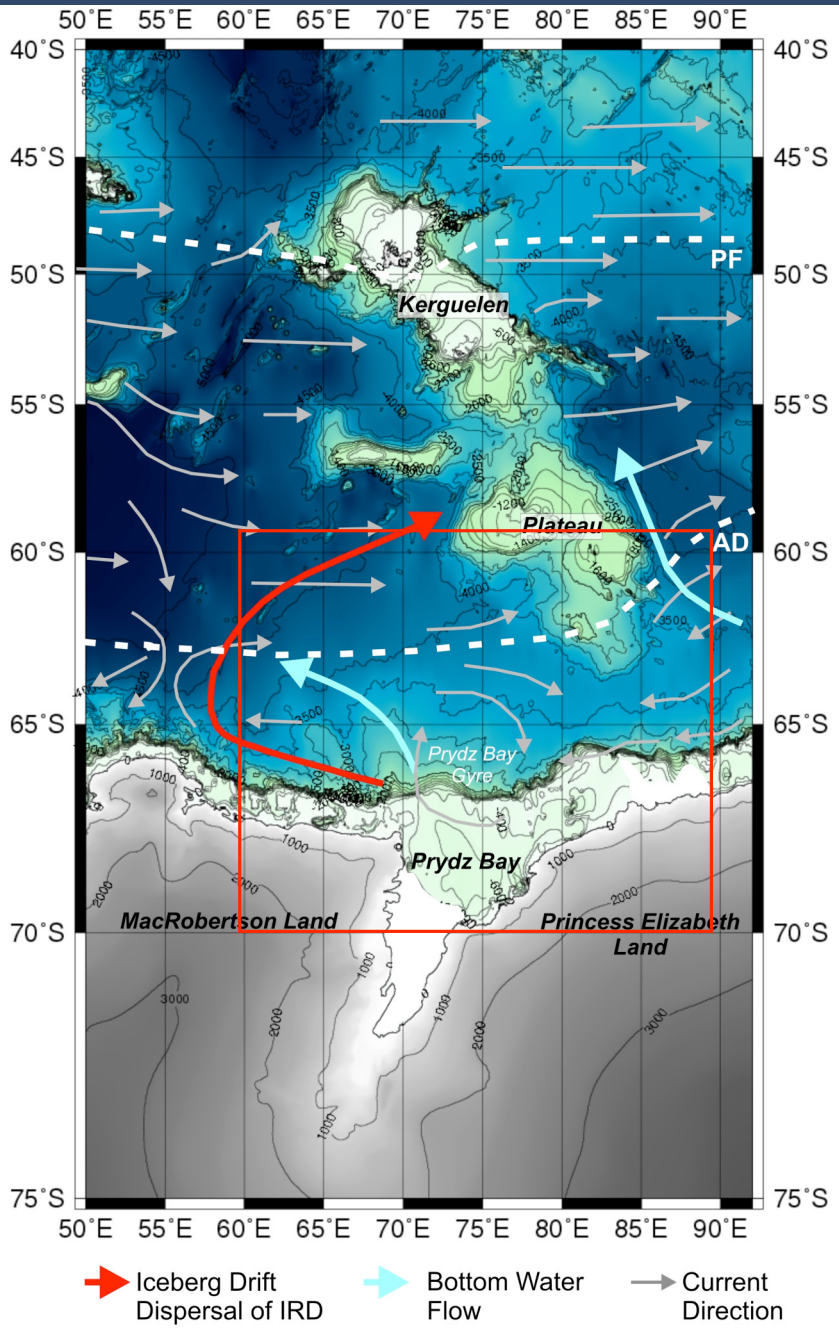
Main Goal

- inference of late Quaternary East Antarctic Ice-Sheet Dynamics of the last 40 – 125 ka

Approach

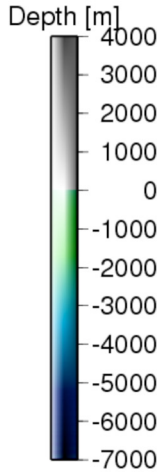
Reconstruction of the glaciomarine environment

- sedimentology/ grain size distributions
  - → input of ice-rafted debris
  - → glacial reworking of shelf sediments to the continental slope
  - → variability of bottom-water production and outflow under the floating ice shelf
- mineralogy/ geochemistry (wet chemical analysis – ICP-OES)
  - → provenance of
  - ice-rafted debris: heavy minerals
  - current derived material: clay minerals

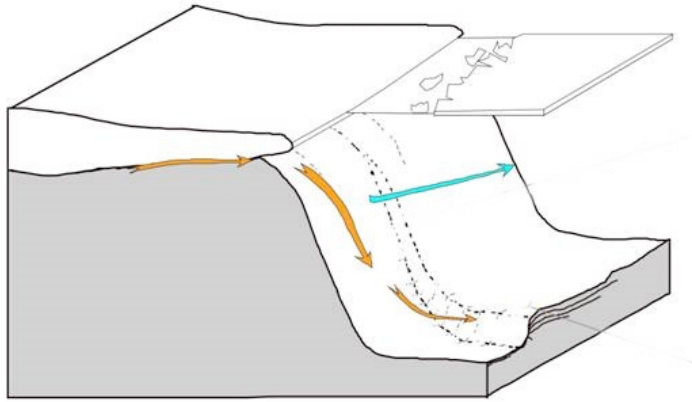


Antarctic Circumpolar Current

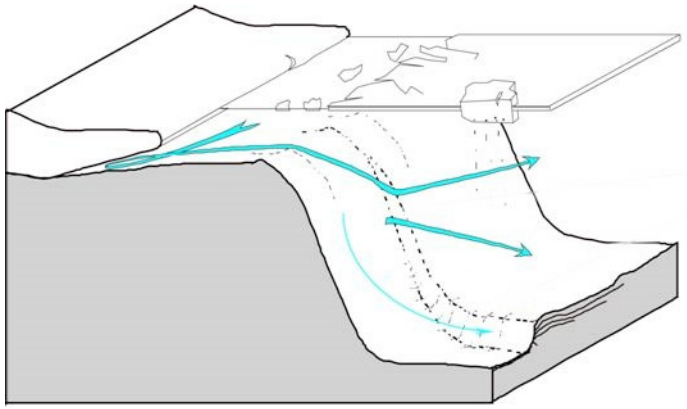
Coastal Current



Glacial Scenario

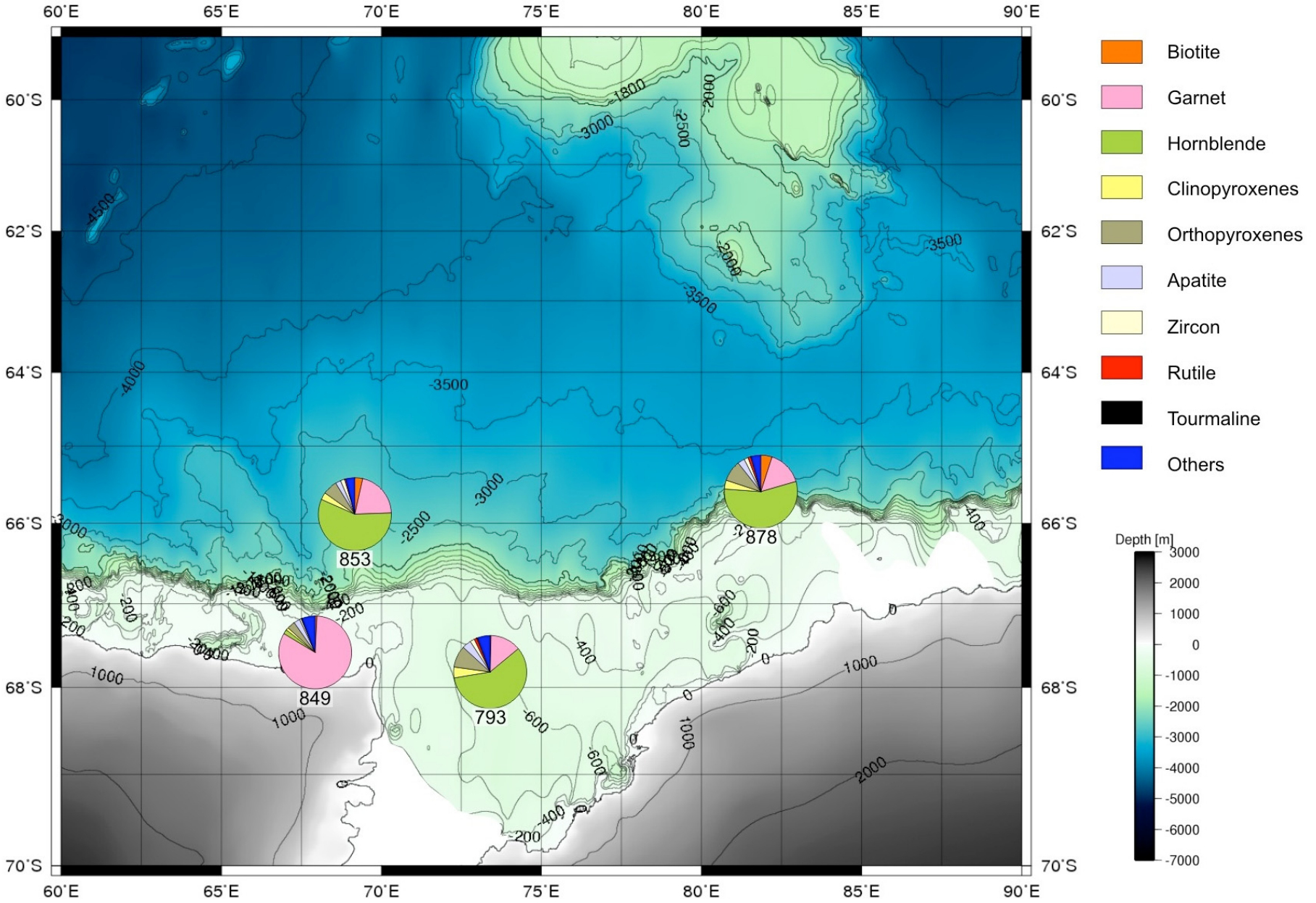


Interglacial Scenario

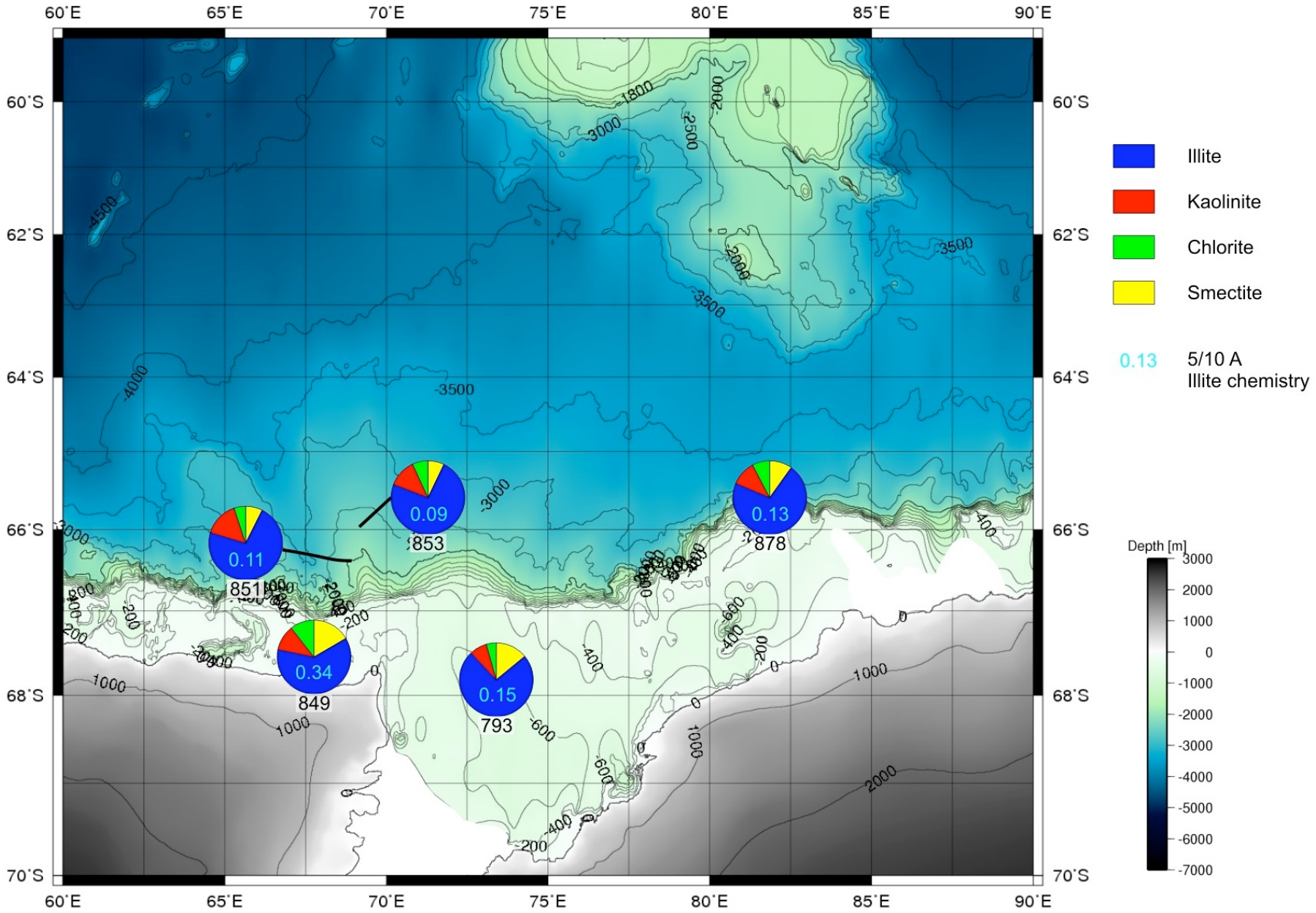


after: Grobe & Mackensen (1992), Melles et al. (1995), Diekmann & Kuhn (1997, 1999), Diekmann et al. (2003)

Bathymetric information:GEBCO data base



Bathymetric information: GEBCO data base



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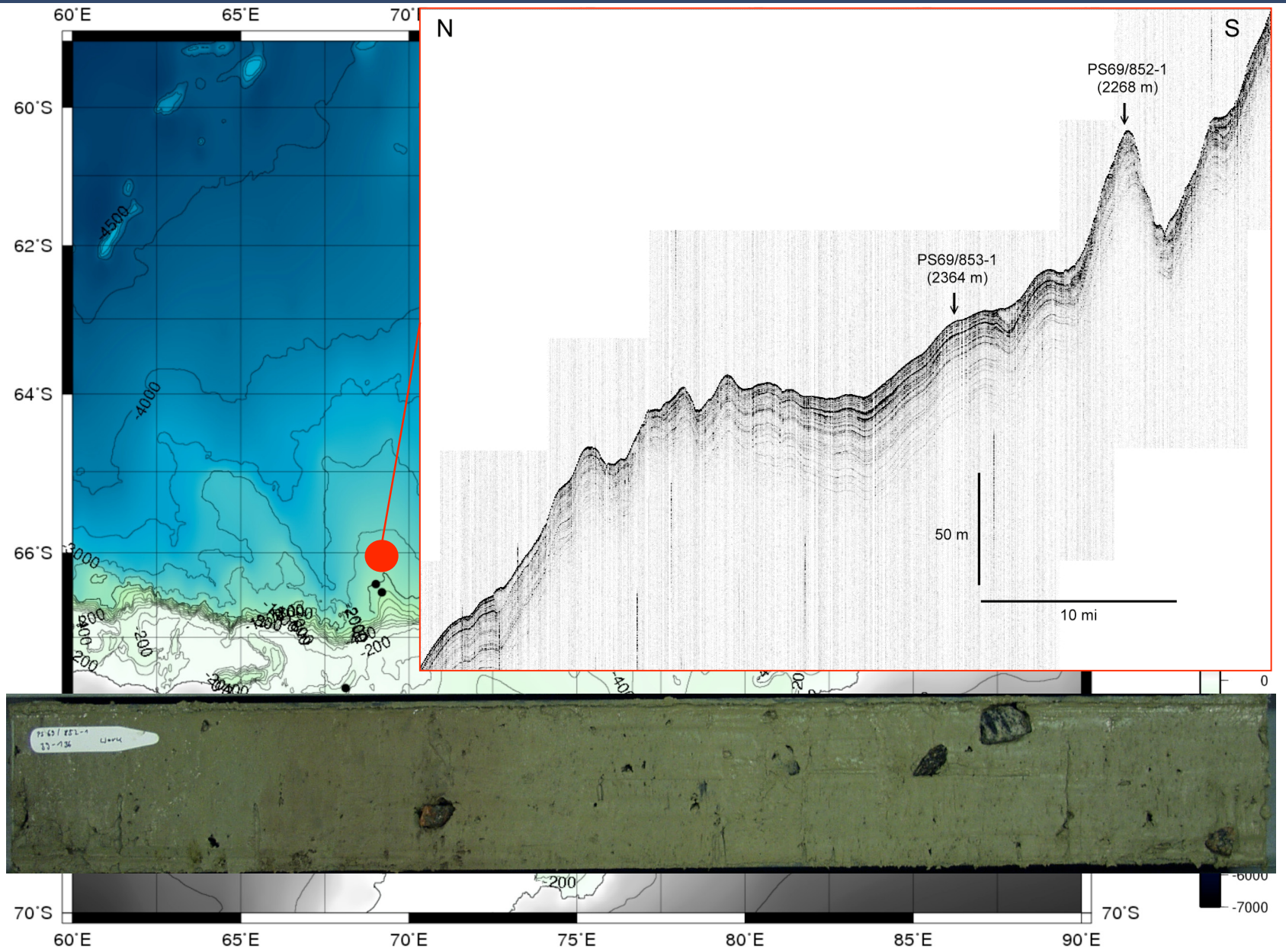
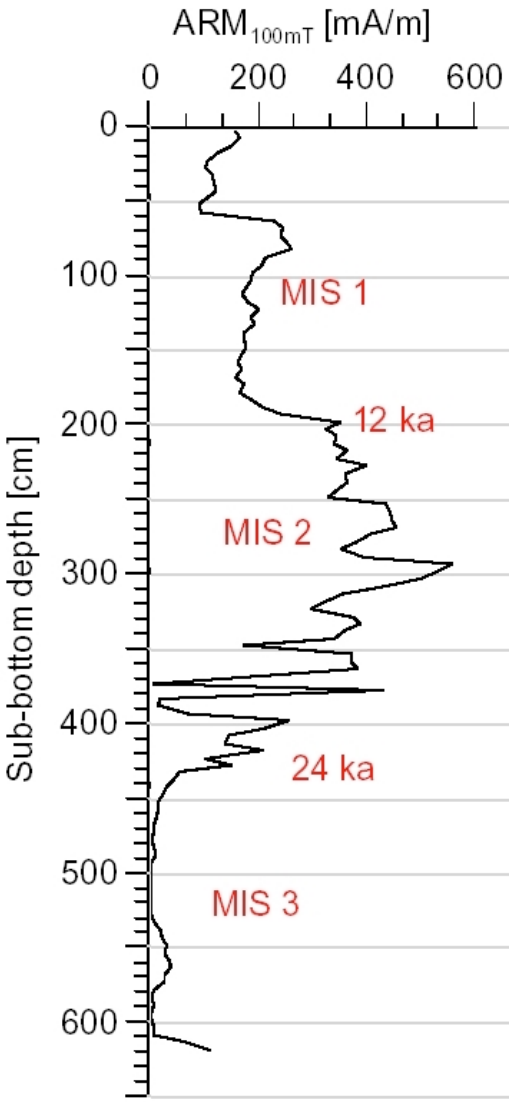


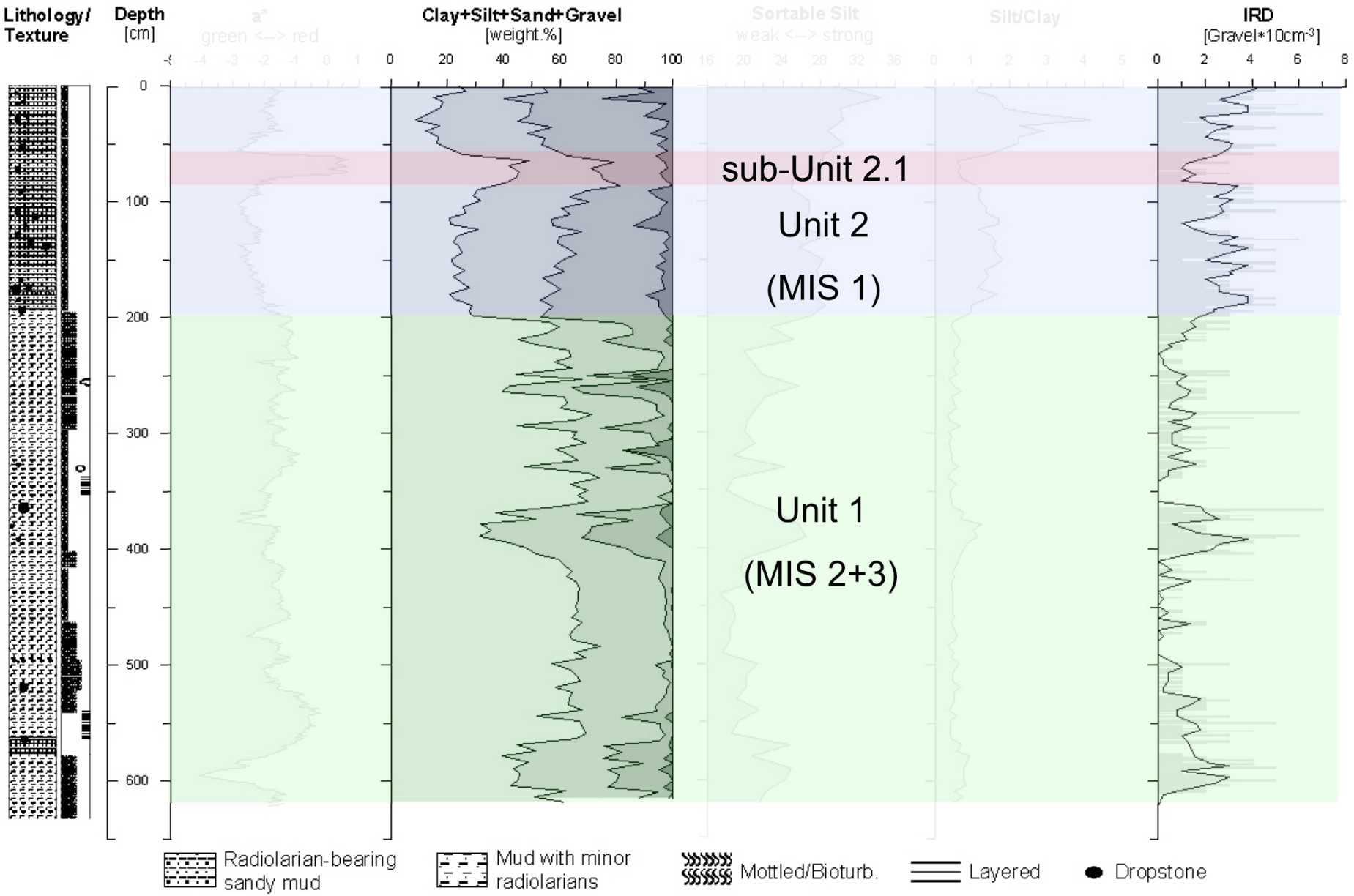
Bathymetric information: GEBCO data base

Dating

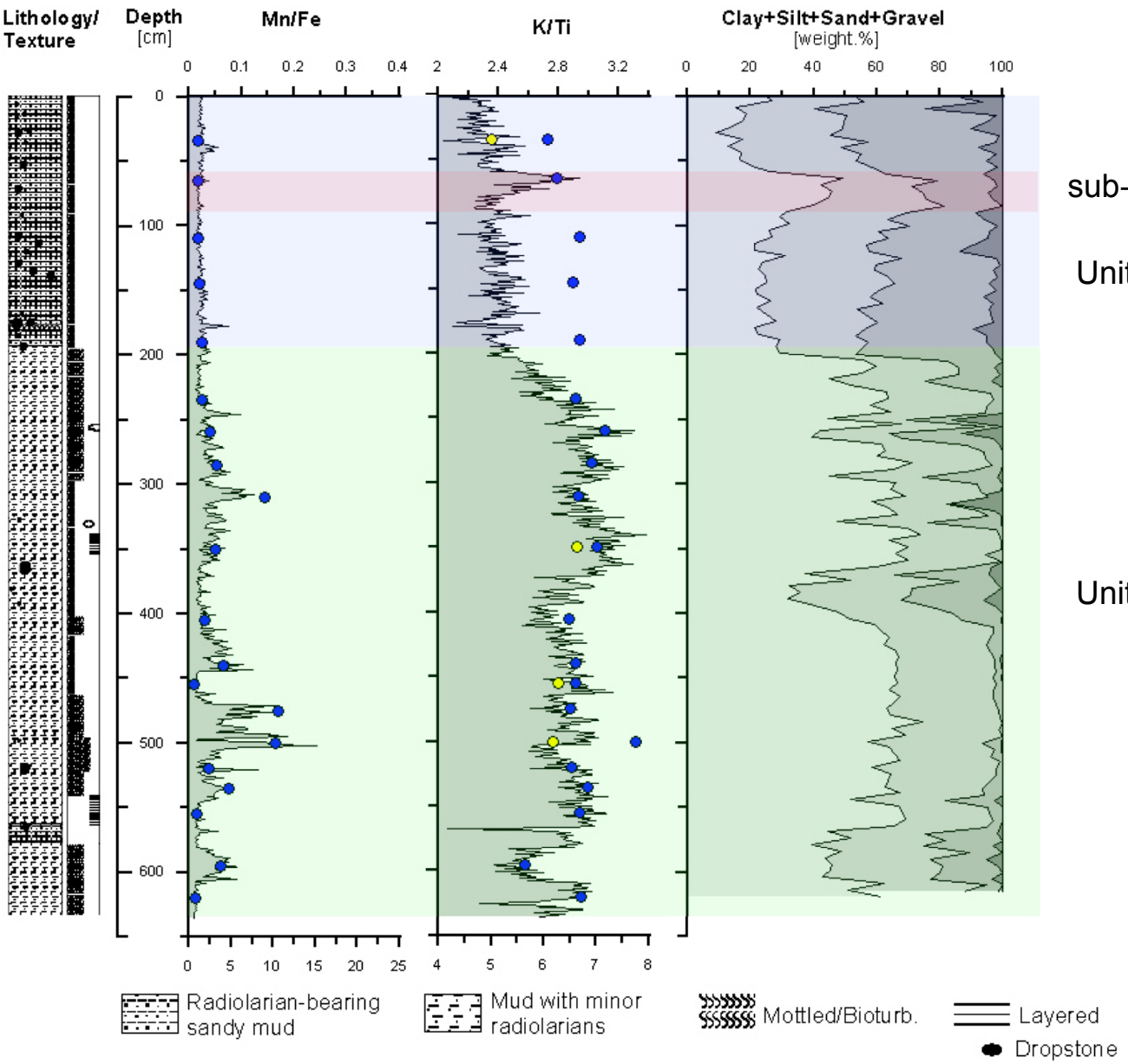


- no C14 possible due to very low content of TOC and the absence of foraminifera
- ARM: palaeomagnetics by Th. Frederichs
- planned: Cycladophora davisiana fluctuation stratigraphy supervised by A. Abelmann

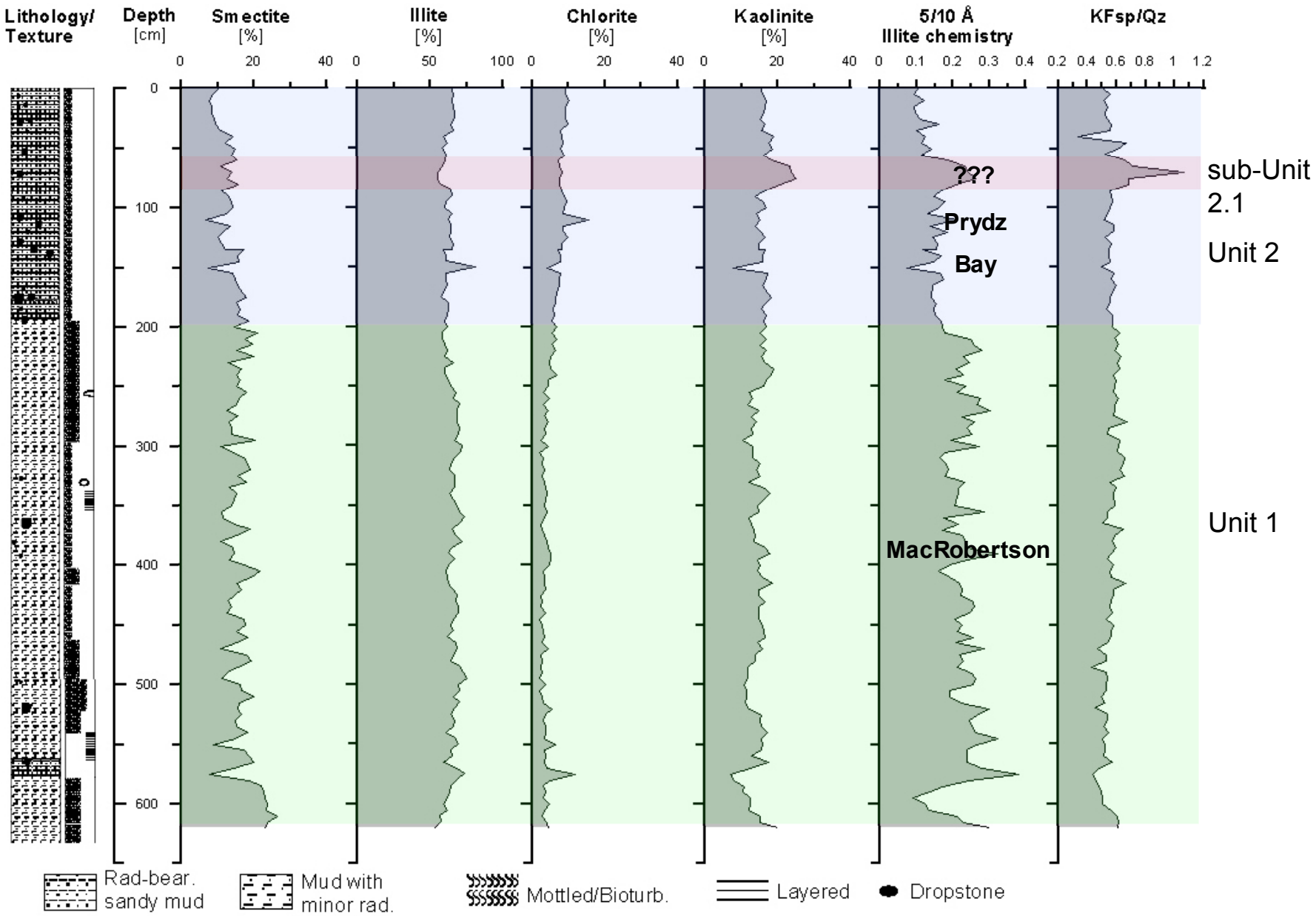
Grain Size Distribution

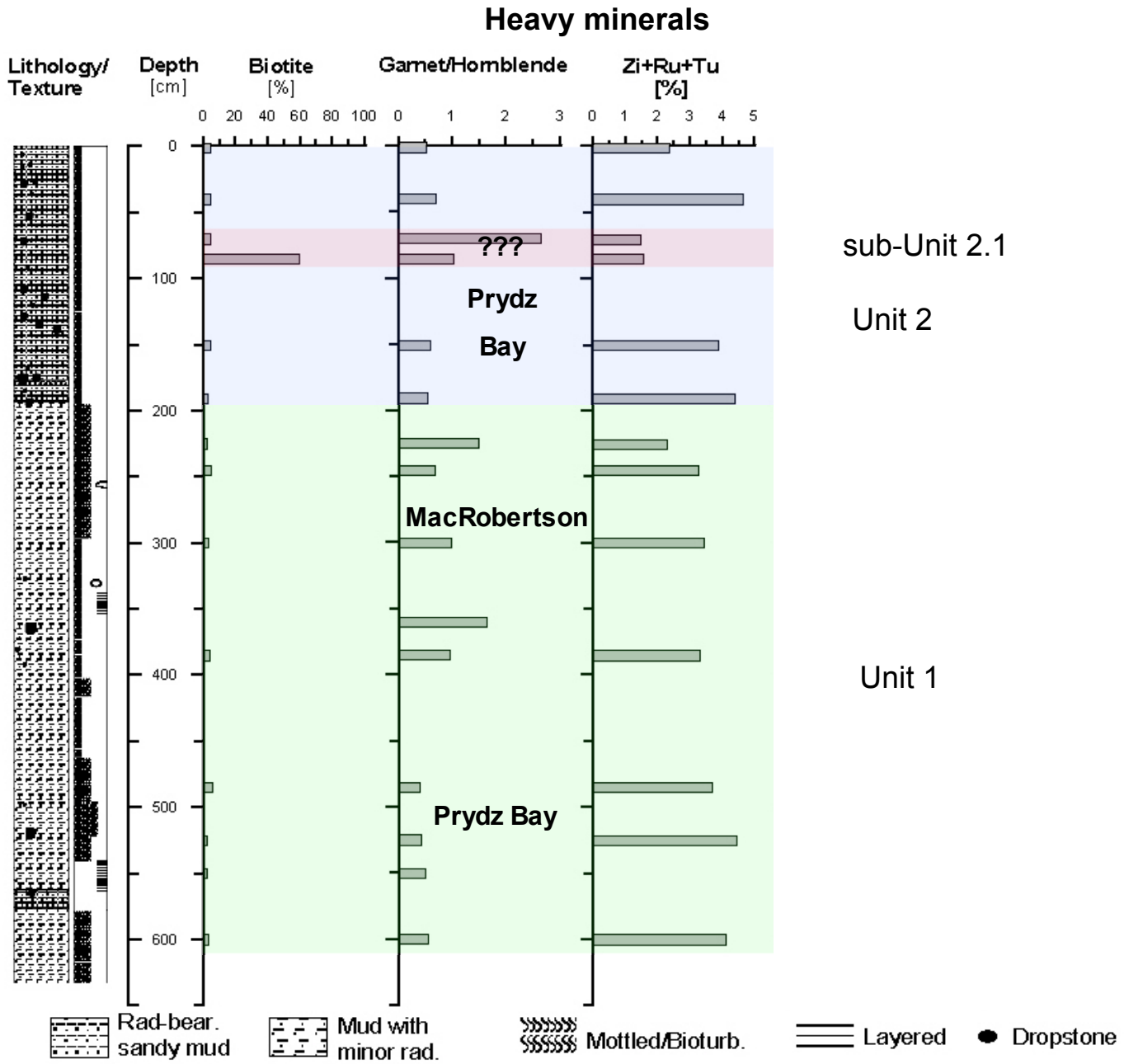


XRF/ Geochemistry (ICP-OES)

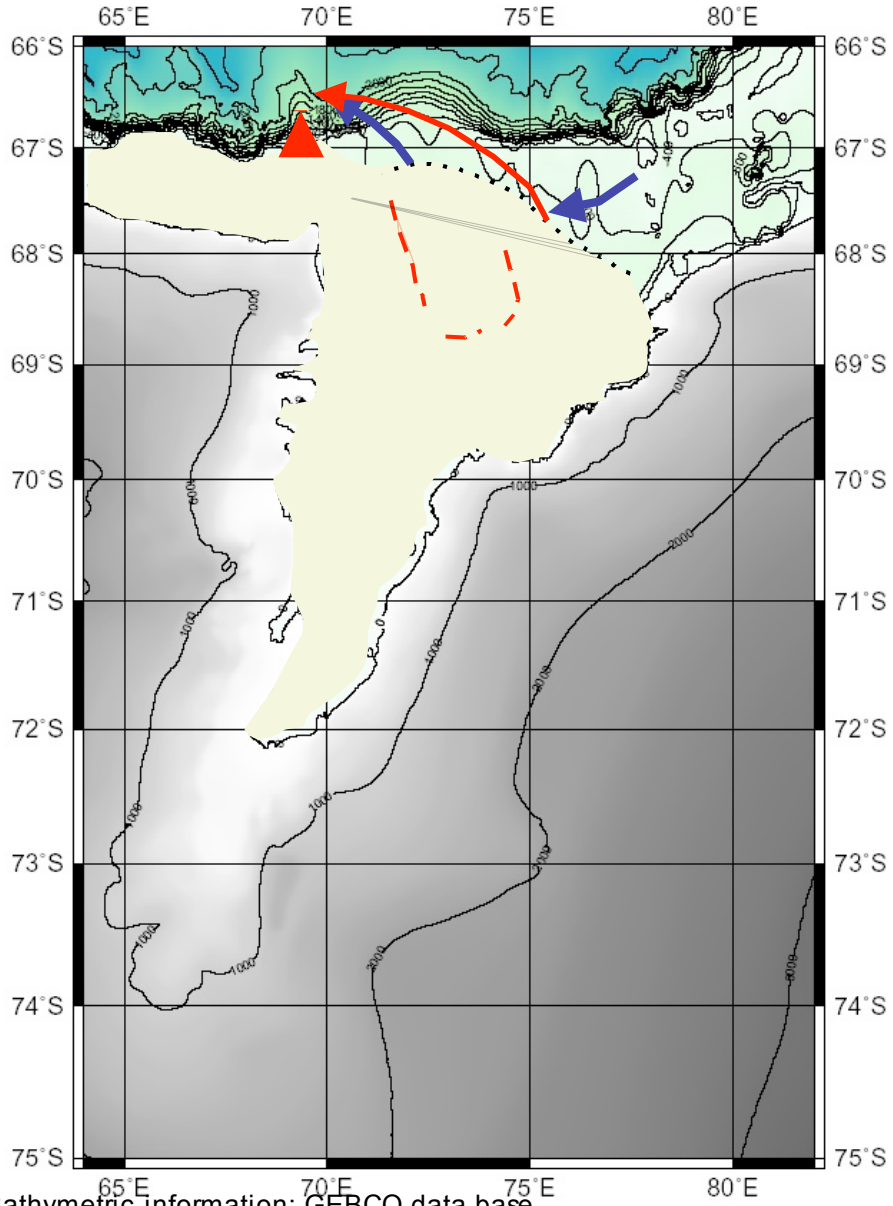


Clay minerals




Heavy minerals
Lithology/ Texture
Depth [cm]
Biotite [%]
Garnet/Hornblende
Zi+Ru+Tu [%]
0 20 40 60 80 100
0 1 2 3
0 1 2 3 4 5
0
100
200
300
400
500
600
???
Prydz Bay
MacRobertson
Prydz Bay
sub-Unit 2.1
Unit 2
Unit 1
Rad-bear. sandy mud
Mud with minor rad.
Mottled/Bioturb.
Layered
Dropstone

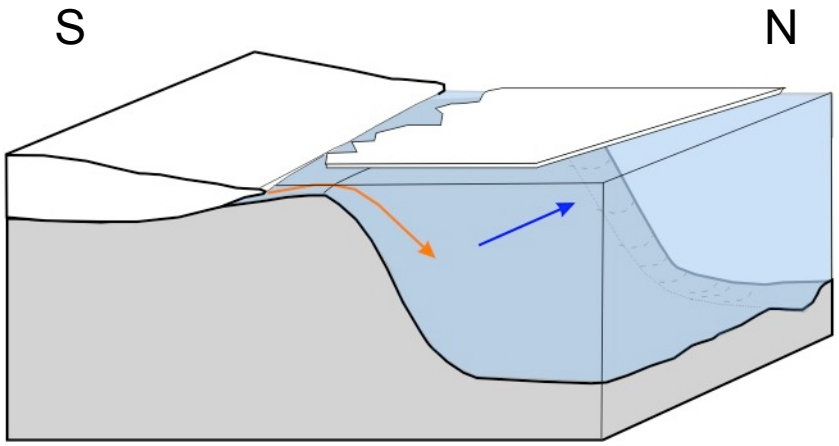
Deposition model



Bathymetric information: GEBCO data base compiled after Domack et al., 1998; Fricker et al., 2002 and Hemer & Harris 2003

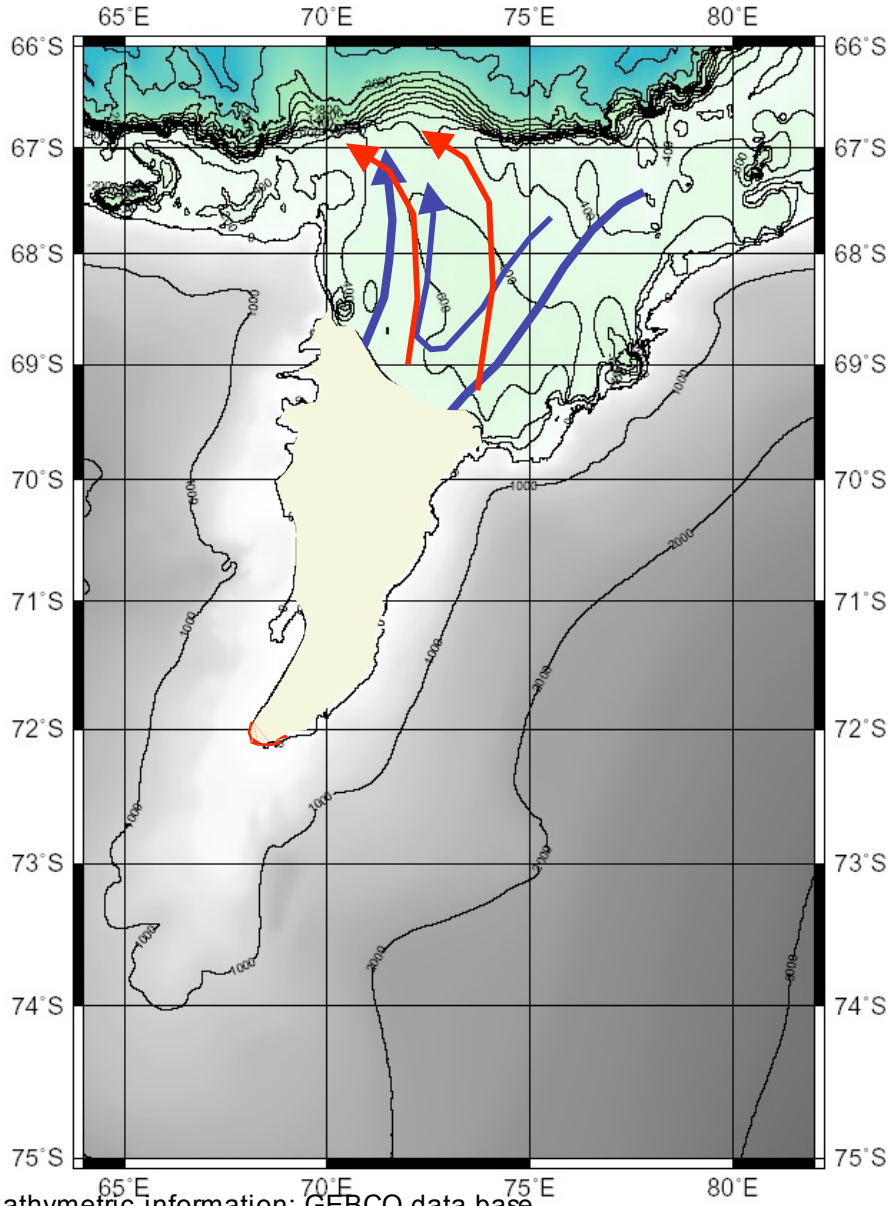
Unit 1 – Cold stage: ?MIS 2+3?

- low bottom-water production
  - grounding zone in the north
  - sediment reworking on MacRobertson shelf
- minor calving of icebergs and hampered mobility of ice-rafting
  - material derived from Prydz Bay and later on from MacRobertson shelf



After: Grobe & Mackensen (1992), Melles et al. (1995)

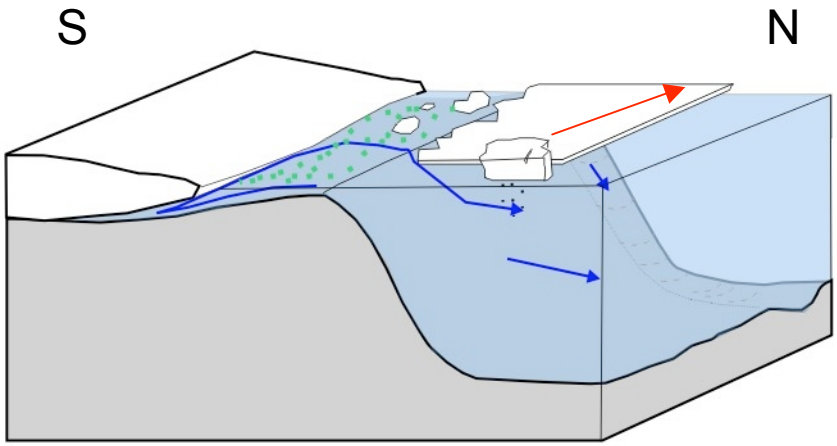
Deposition model



Bathymetric information: GEBCO data base compiled after Domack et al., 1998; Fricker et al., 2002 and Hemer & Harris 2003

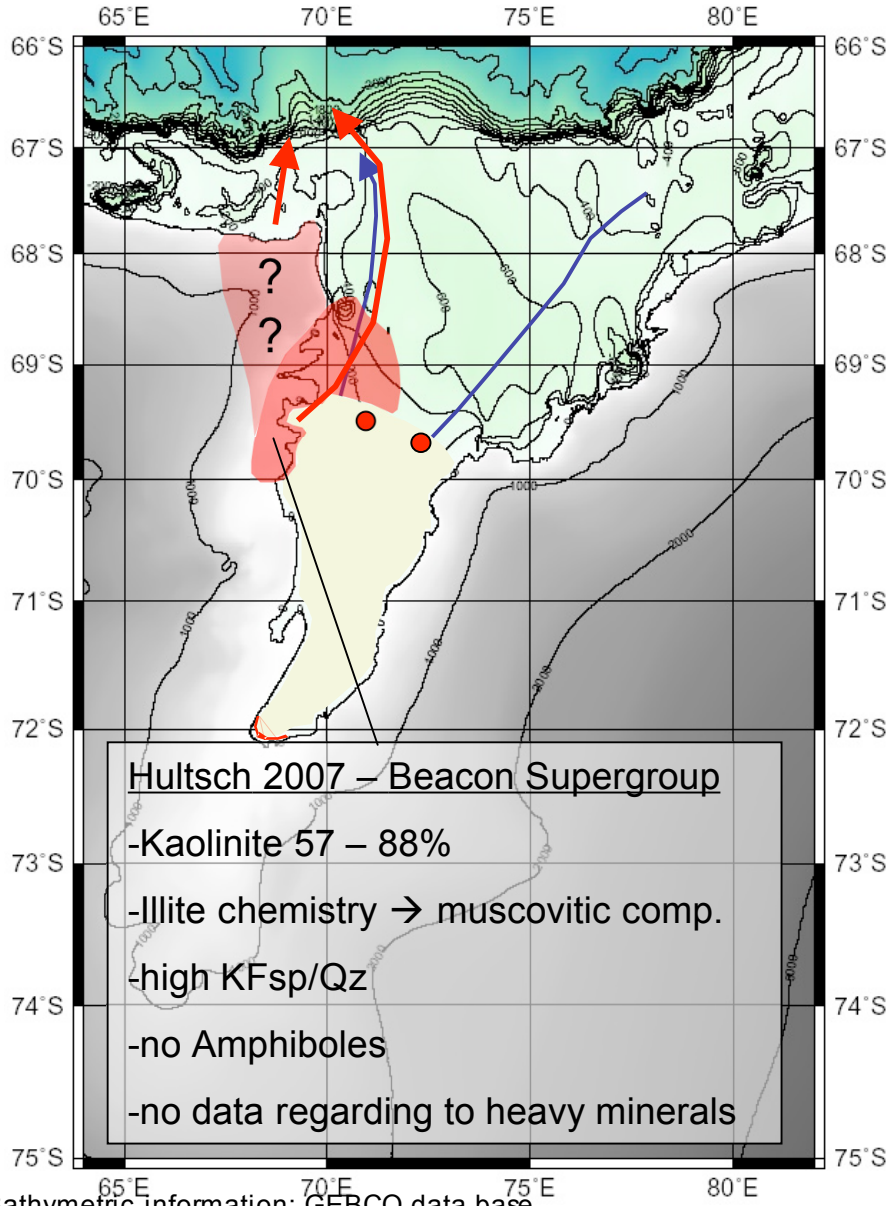
Unit 2 – Warm stage: ?MIS 1?

- increased bottom-water production
  - grounding zone in the south
- enhanced iceberg-rafting and mobility
  - melt-out of material in ice-proximal regions
  - Gn/Hb and stabile minerals → material from Prydz Bay



After: Grobe & Mackensen (1992), Melles et al. (1995)

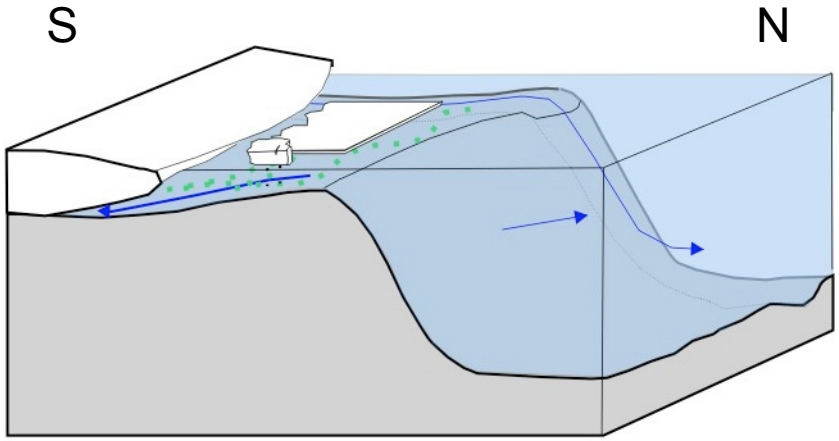
Deposition model



Bathymetric information: GEBCO data base compiled after Domack et al., 1998; Fricker et al., 2002 and Hemer & Harris 2003

Unit 2.1 – ?Peak warm stage: mid-Holocene?

- reduced bottom-water production due to recession of Amery Ice Shelf
  - high Kaolinite + KFsp + Illites of muscovitic composition → Beacon source
- decline in deposition of ice-rafted material due to distance to calving line
  - material probably derived from Beacon-source (high garnet and distinct decrease in Hb content)



After: Grobe & Mackensen (1992), Melles et al. (1995)

Further investigations:

- Holocene sediment cores from the shelves with good age control
  - biogenic opal → palaeoproductivity→ sea ice conditions, mobility of icebergs
  - sortable silt → bottom water strenght
    - especially in central Prydz Bay dynamics of Ice Shelf Water production during the Holocene
  - heavy minerals on MacRobertson shelf during the mid-Holocene

- sediment cores from distal regions (0-125 ka)
  - deposition of ice-rafted debris → iceberg survivability
  - clay mineralogy → bottom water provenance shifts
  - sortable silt → variability of bottom-water strength from glacial to interglacial times

Summary

- Unit 1 tentatively associated with the last glacial stage
  - deposition of fine grained material under weak current velocities
  - grounded ice-sheet on MacRobertson shelf

- Unit 2 reflects interglacial conditions
  - increased deposition of ice-rafted debris → enhanced iceberg calving/ mobility
  - enhanced bottom-water production with illite chemistry pointing to Prydz Bay as the source for the fine grained material

- Unit 2.1: red horizon is tentatively assigned to the final stage of the mid-Holocene climate optimum with reduced bottom-water production in Prydz Bay and channelised outflow through Lambert Deep region

Sediment cores from the shelves and distal regions have to be investigated to confirm the theories.