Factors Regulating Post-LGM Retreat of the Pine Island and Marguerite Ice Streams

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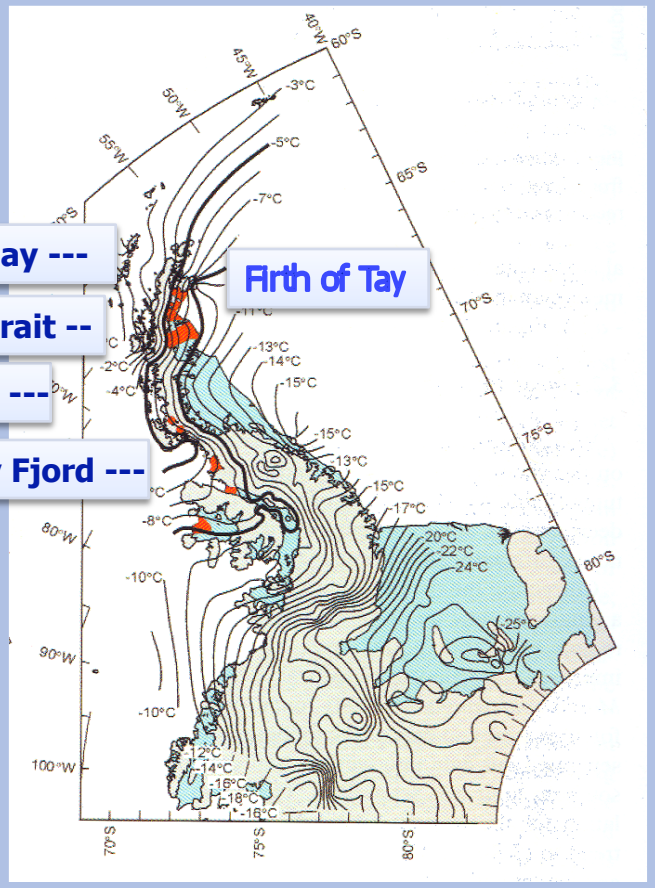
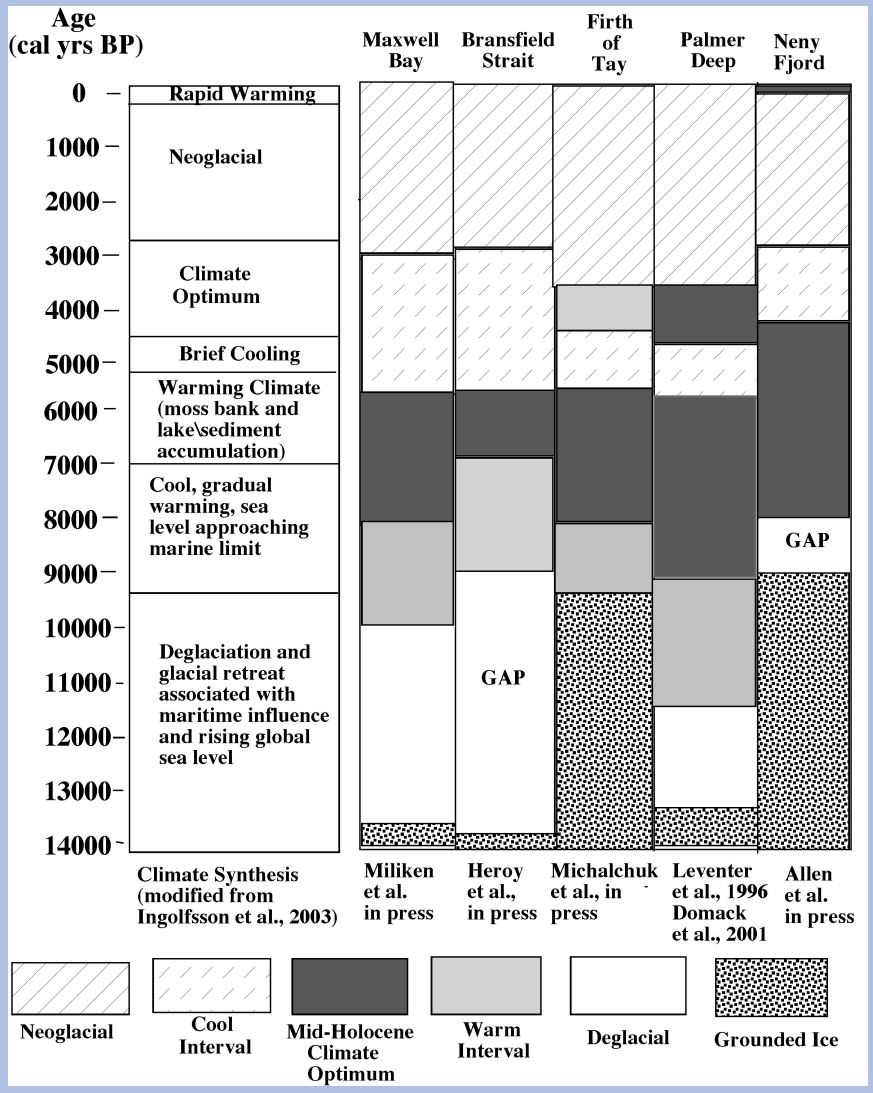
Mechanisms for Ice Sheet Retreat

- CLIMATE WARMING
- SEA-LEVEL RISE
- WARM WATER INTRUSION
- SUB-GLACIAL MELTWATER

Holocene Climate History of the Antarctic Peninsula

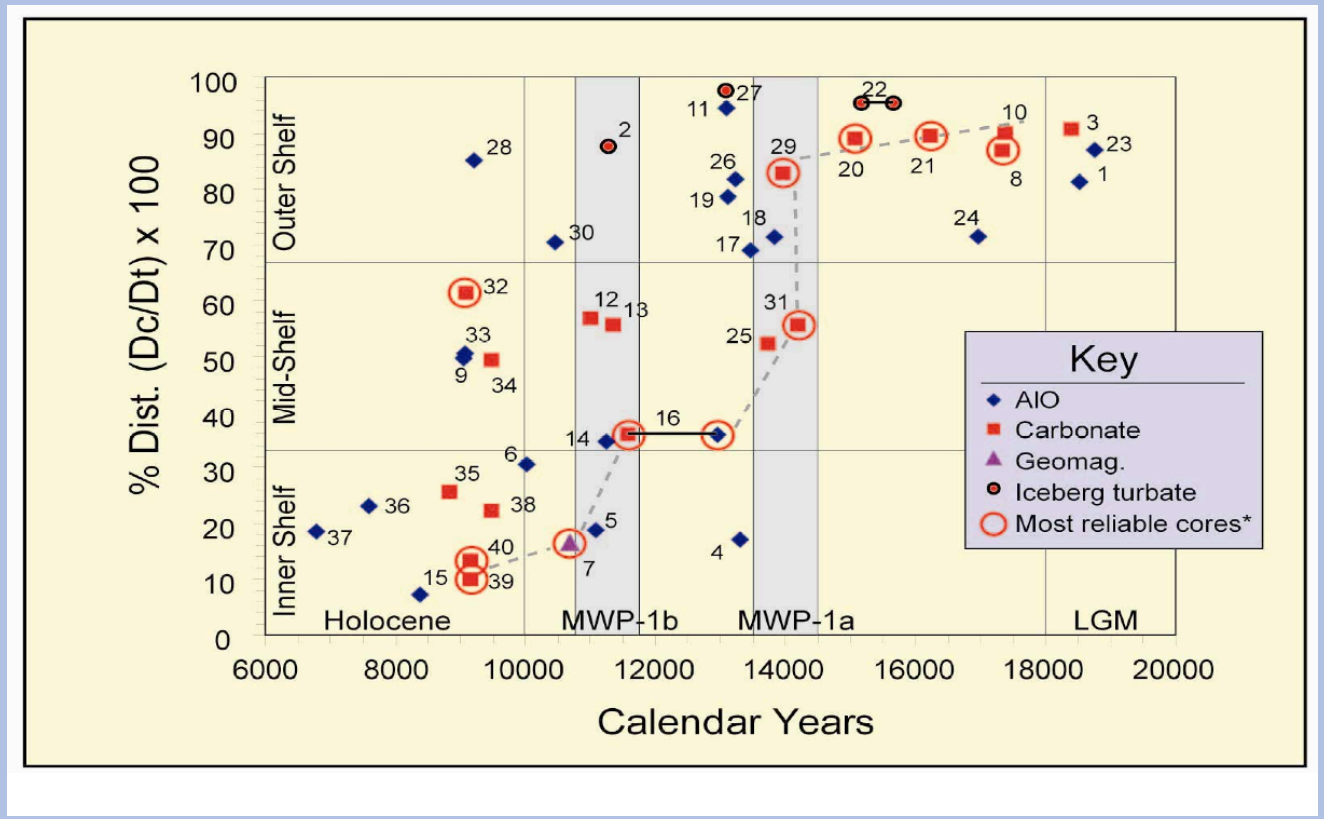




- Domack et al., 2001, Holocene
- Heroy et al., 2008, Holocene
- Allen et al., 2009, In press
- Leventer et al., 1996, GSA Bull.
- Milliken et al., In press, GSA Bull.
- Michalchuck et al., In press, QSR

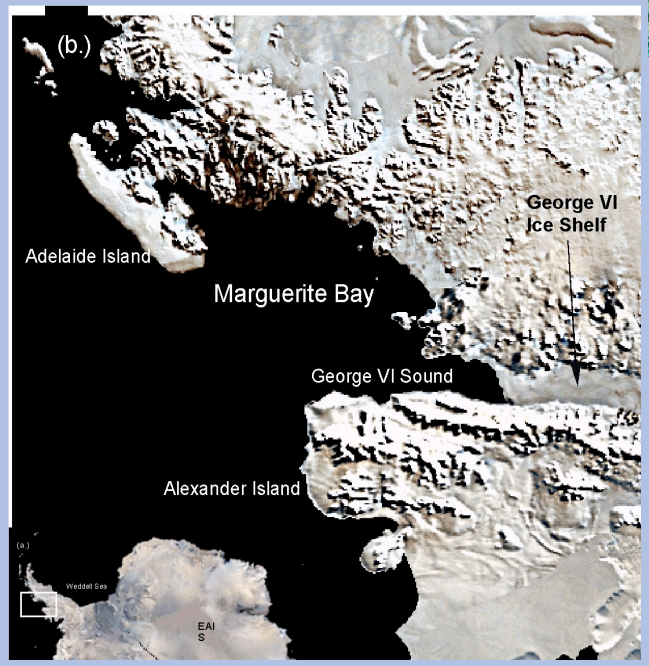
Note: Onset of Mid-Holocene Climate Optimum Was between 7000 and 9000 cal yrs. BP

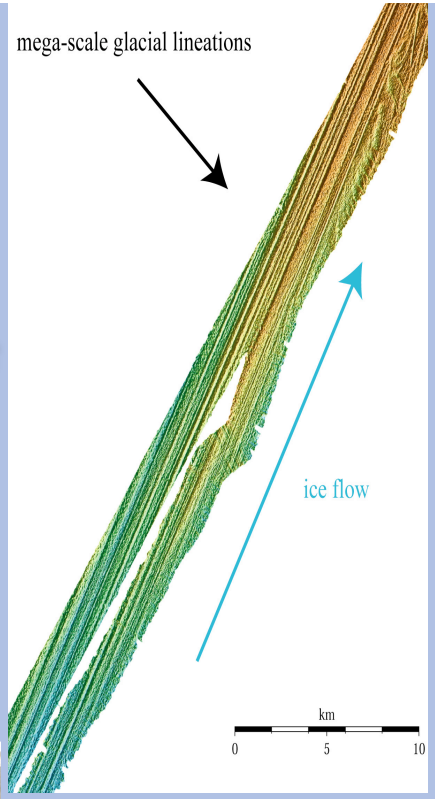
Sea-level rise



Heroy and Anderson, 2008

Marguerite Bay Retreat from shelf just prior to 12 ka with little evidence of back-stepping grounding line





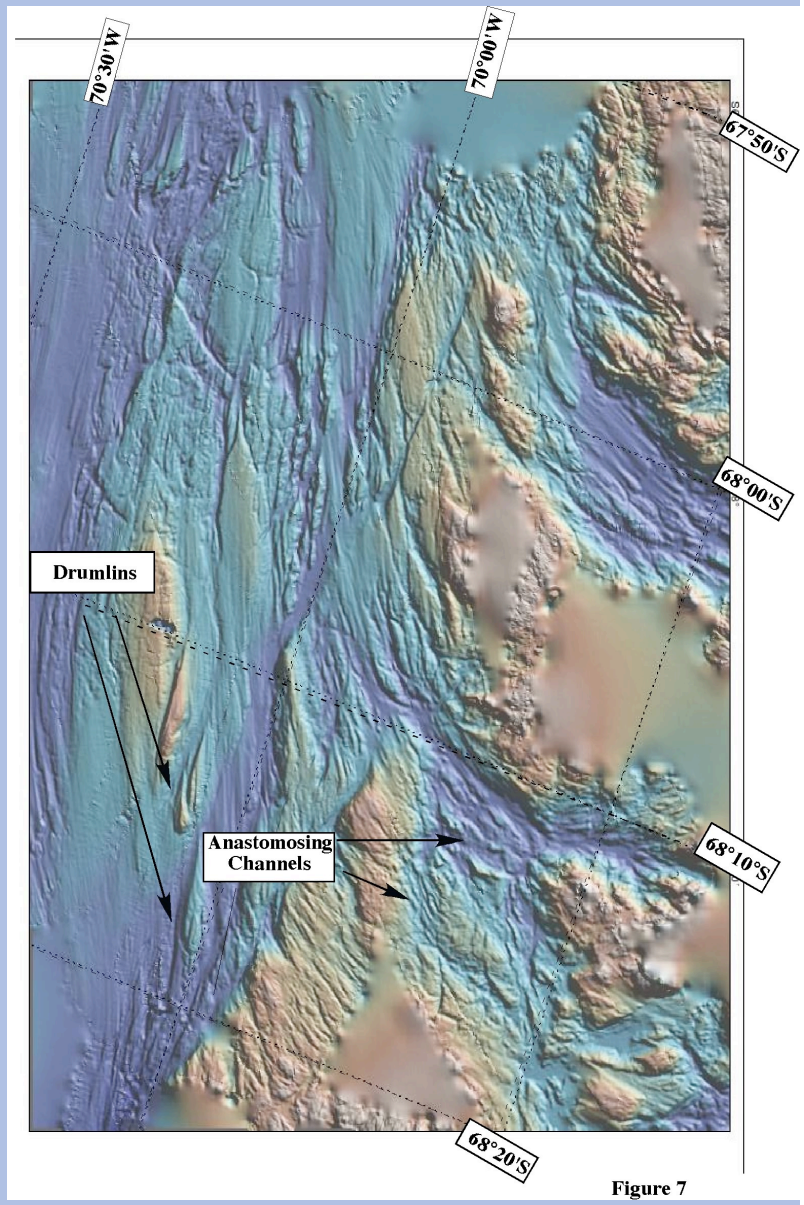


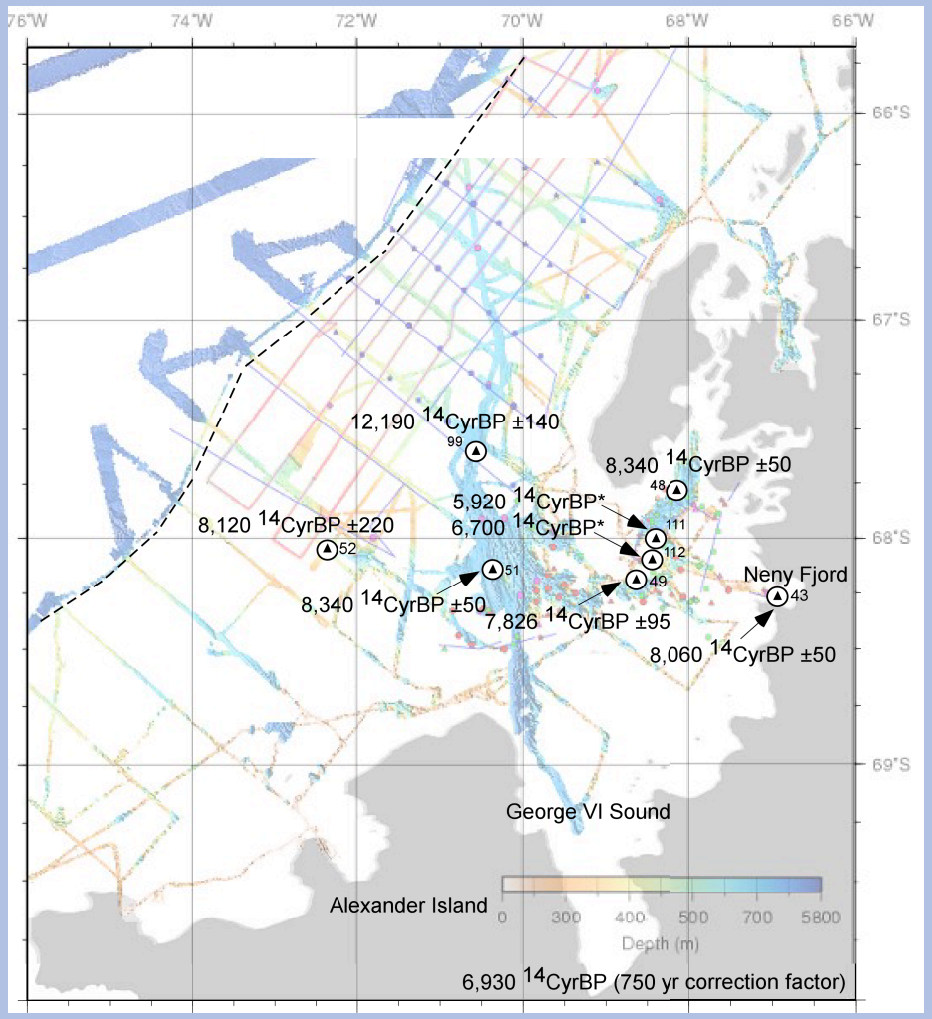
Figure 7

- Marguerite Bay-rugged bathymetry influenced final retreat, which appears to have been rapid

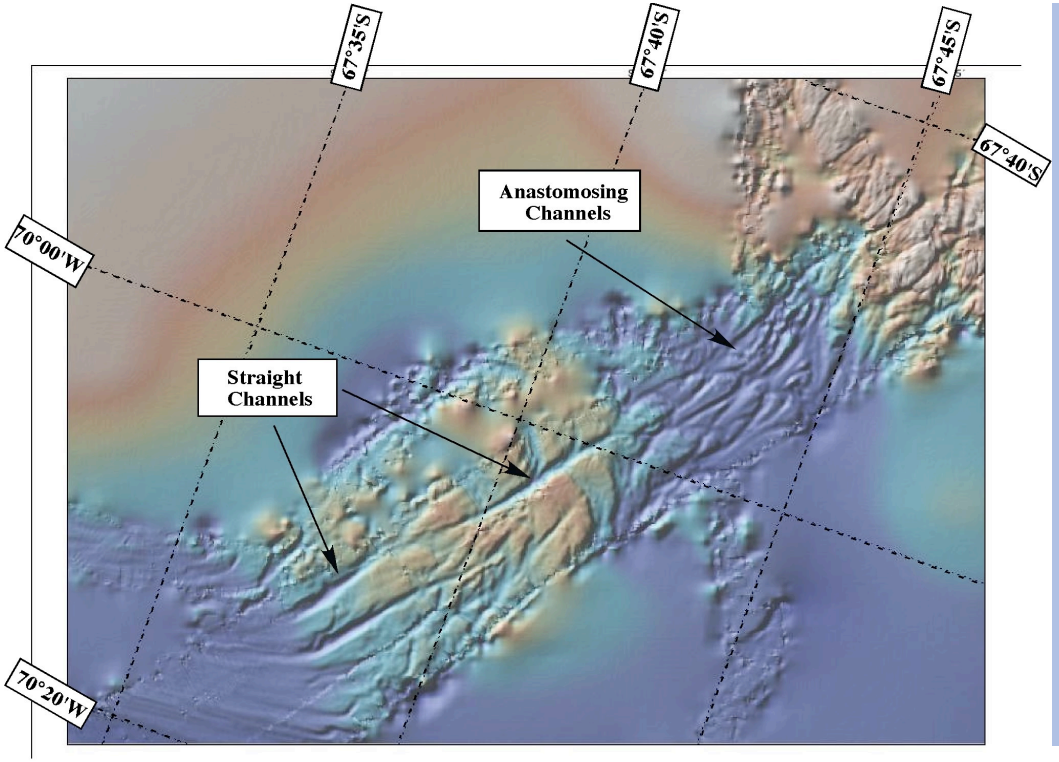
  What controlled grounding line retreat from the bay?

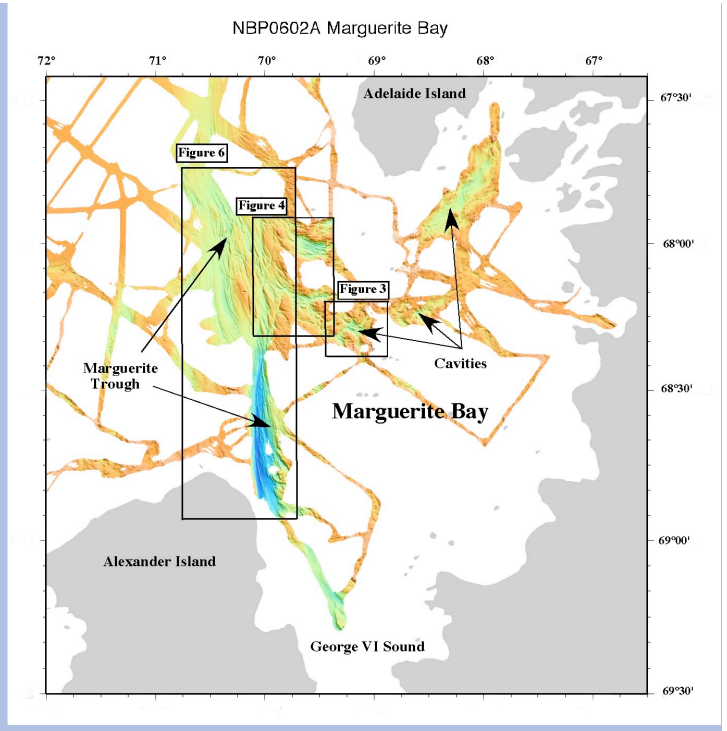
  Warm Deep Water Intrusion (Allen et al., in press)

  Subglacial meltwater (Anderson and Oakes-Fretwell, 2008)



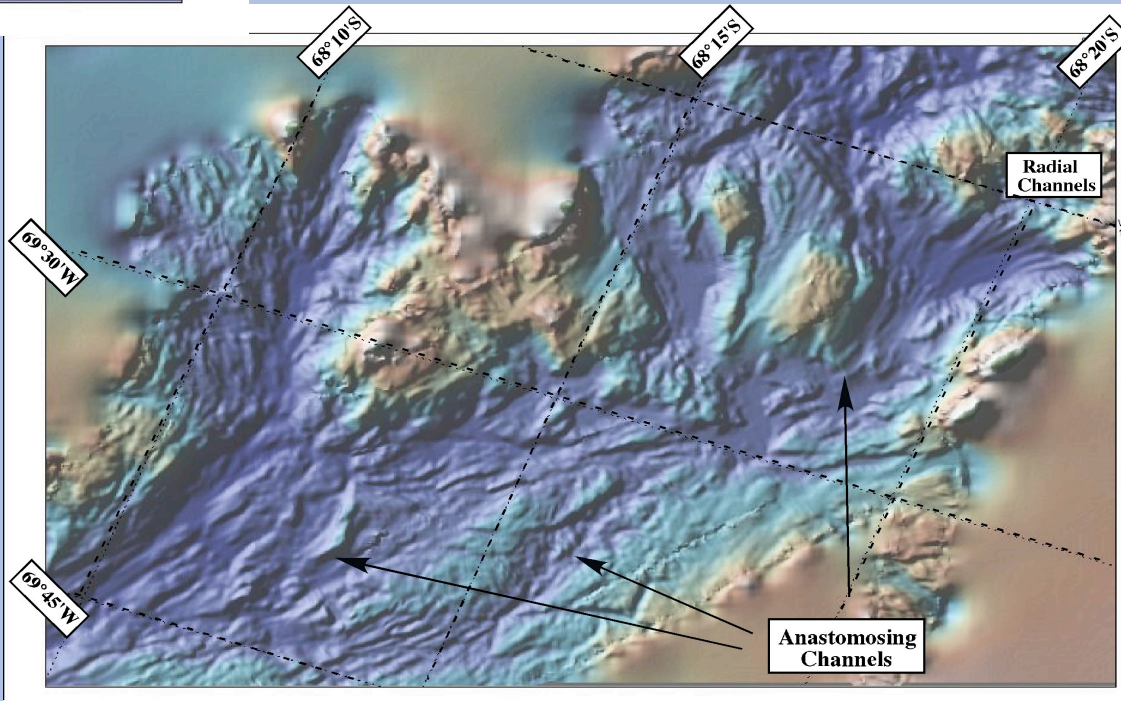
- Sub-glacial Meltwater
- Meltwater Intrusion

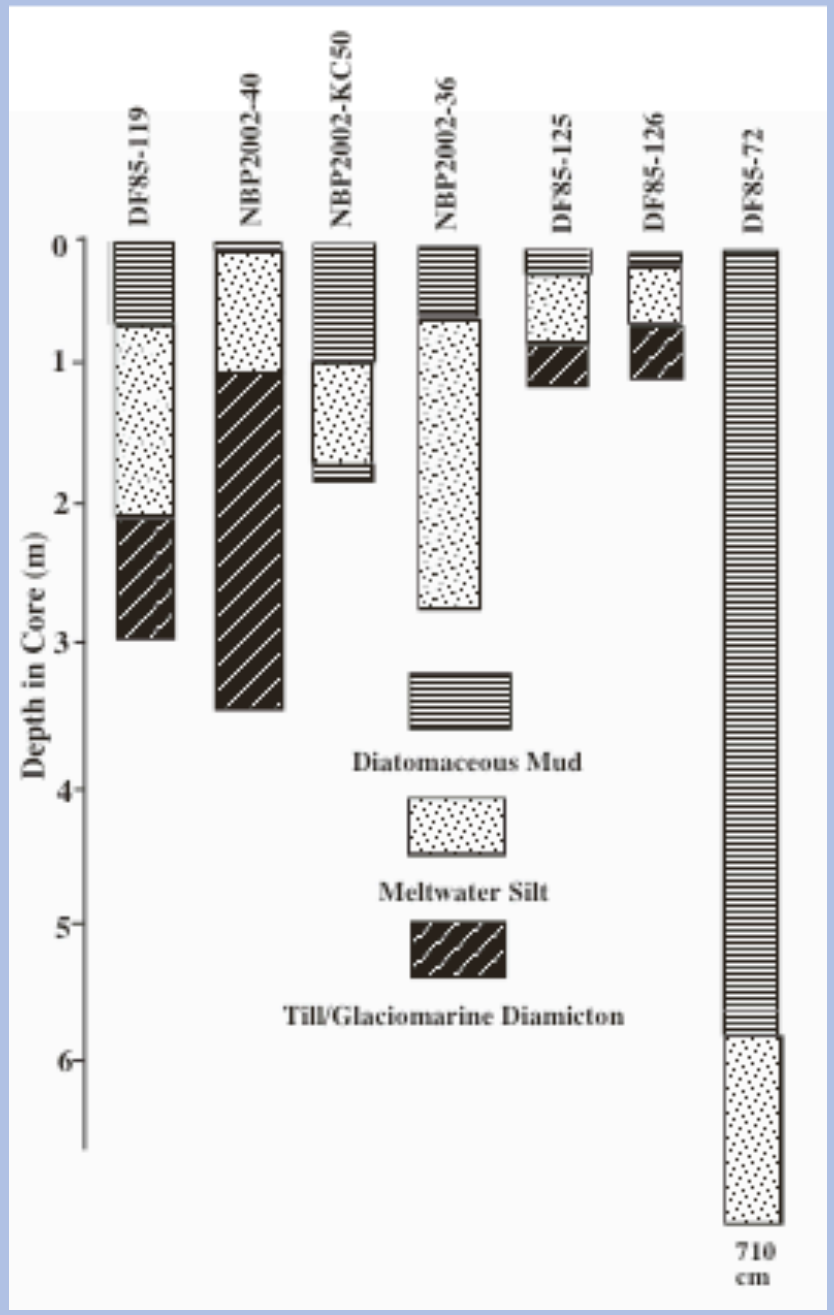




(Anderson and Oakes-Fretwell, 2008)

Subglacial meltwater



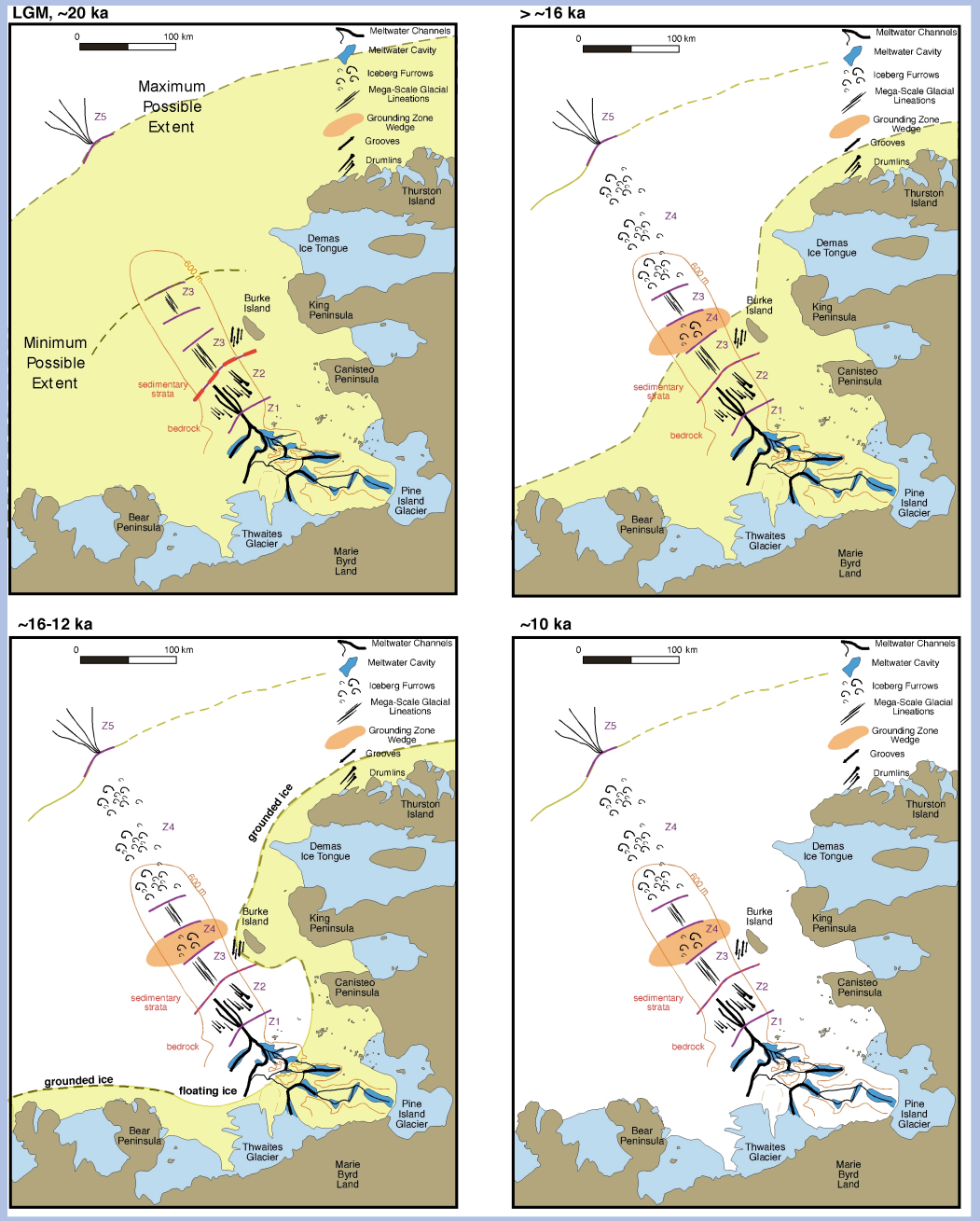

DF85-119
NBP2002-40
NBP2002-KC50
NBP2002-36
DF85-125
DF85-126
DF85-72
Depth in Core (m)
0
1
2
3
4
5
6
Diatomaceous Mud
Meltwater Silt
Till/Glaciomarine Diamicton
710
cm


NBP99-02-46TC
20cm

Pine Island Bay

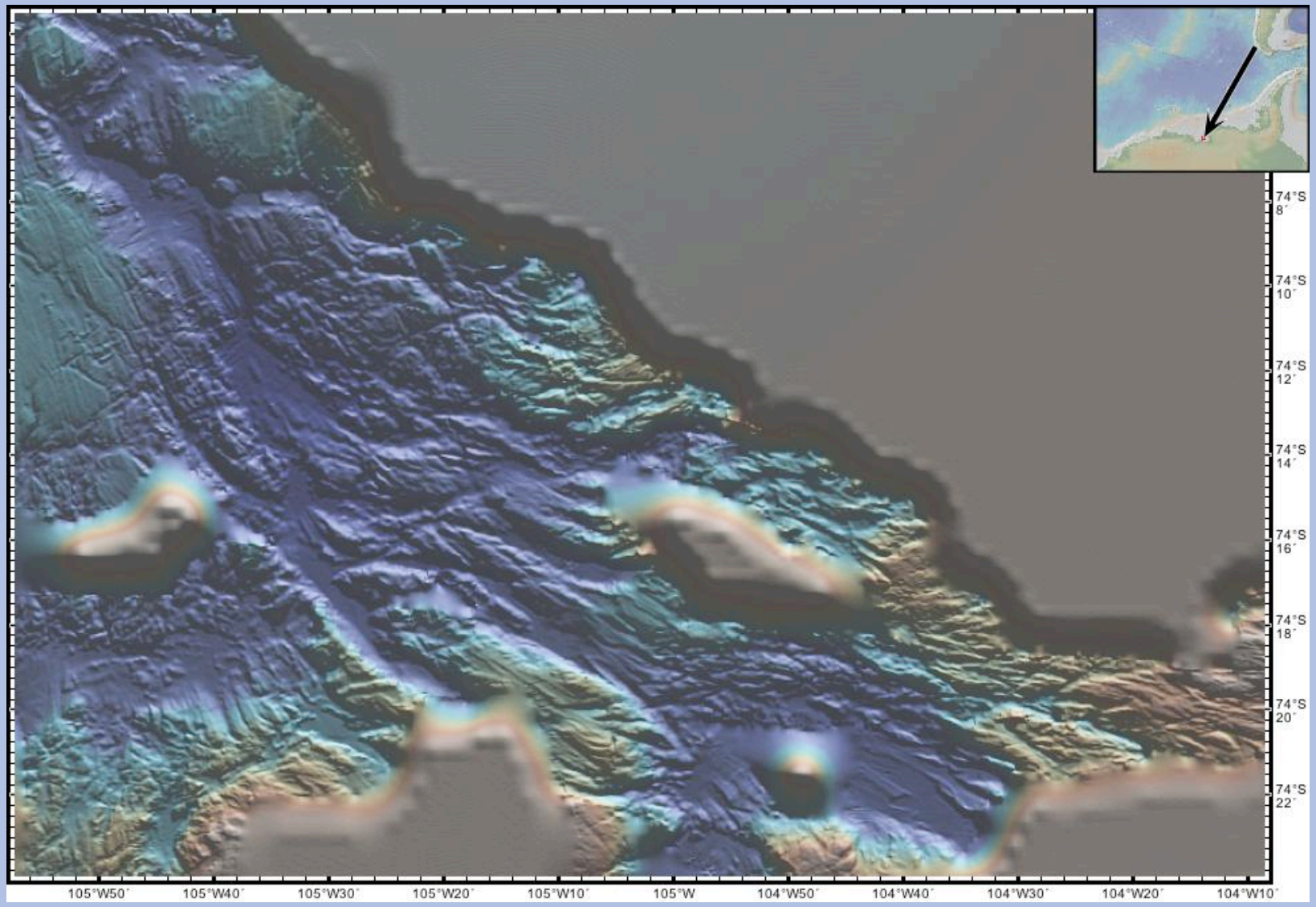
Grounding Line retreat from bay ~16 - 10 ka

But how fast and what caused the retreat?



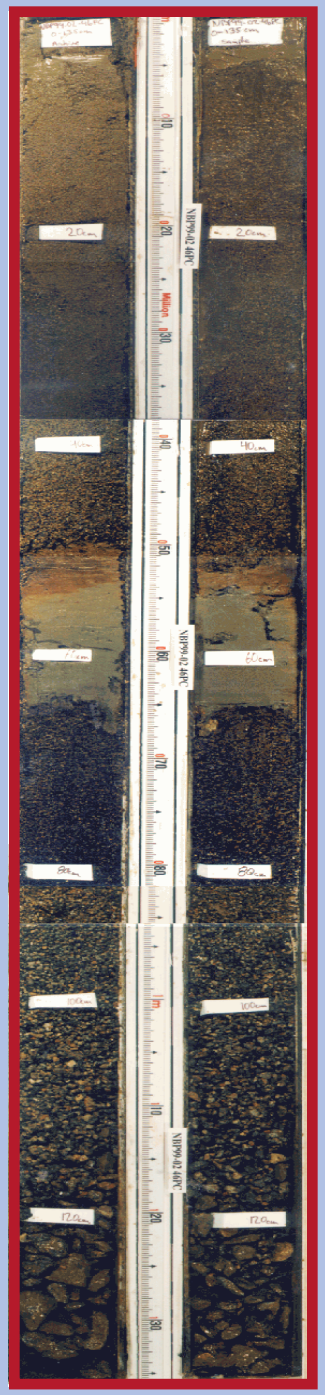
Lowe and Anderson, 2002

Subglacial plumbing system
We also know that warm deep water impinges on shelf today

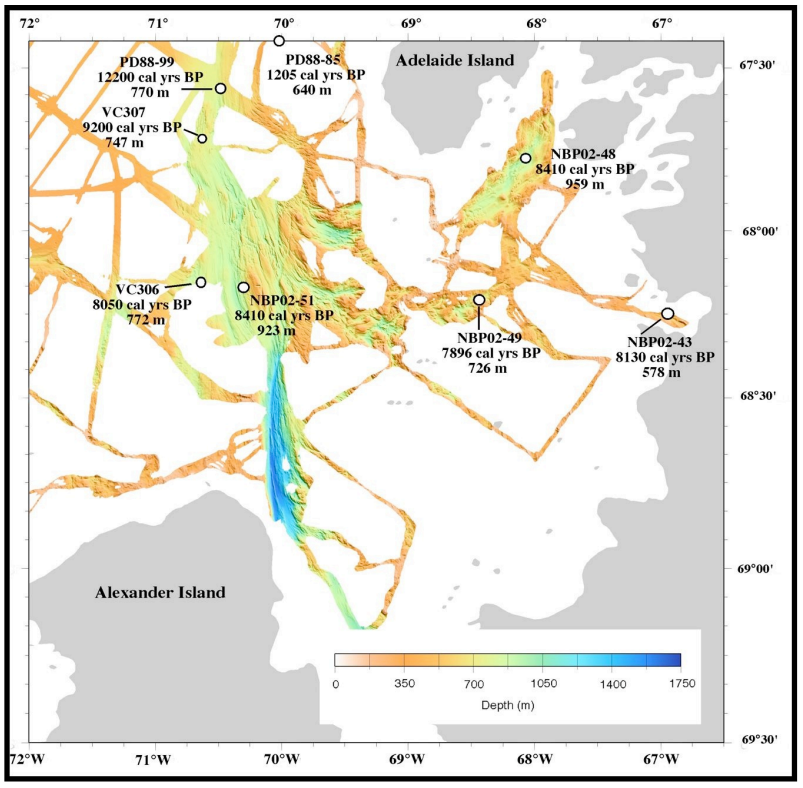


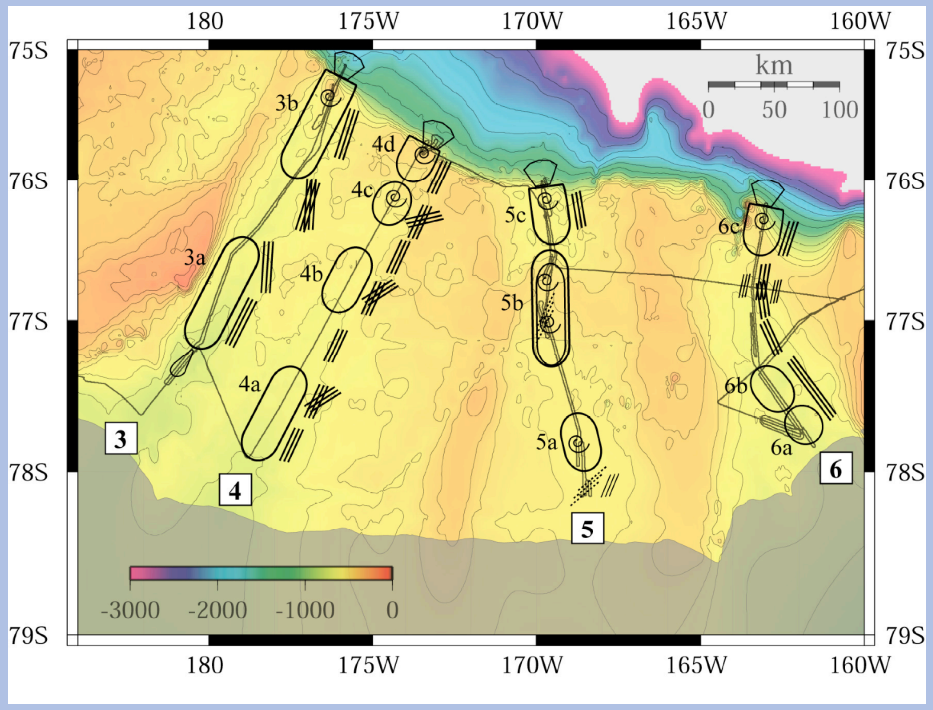
NBP9902
PC46

Possible meltwater deposits



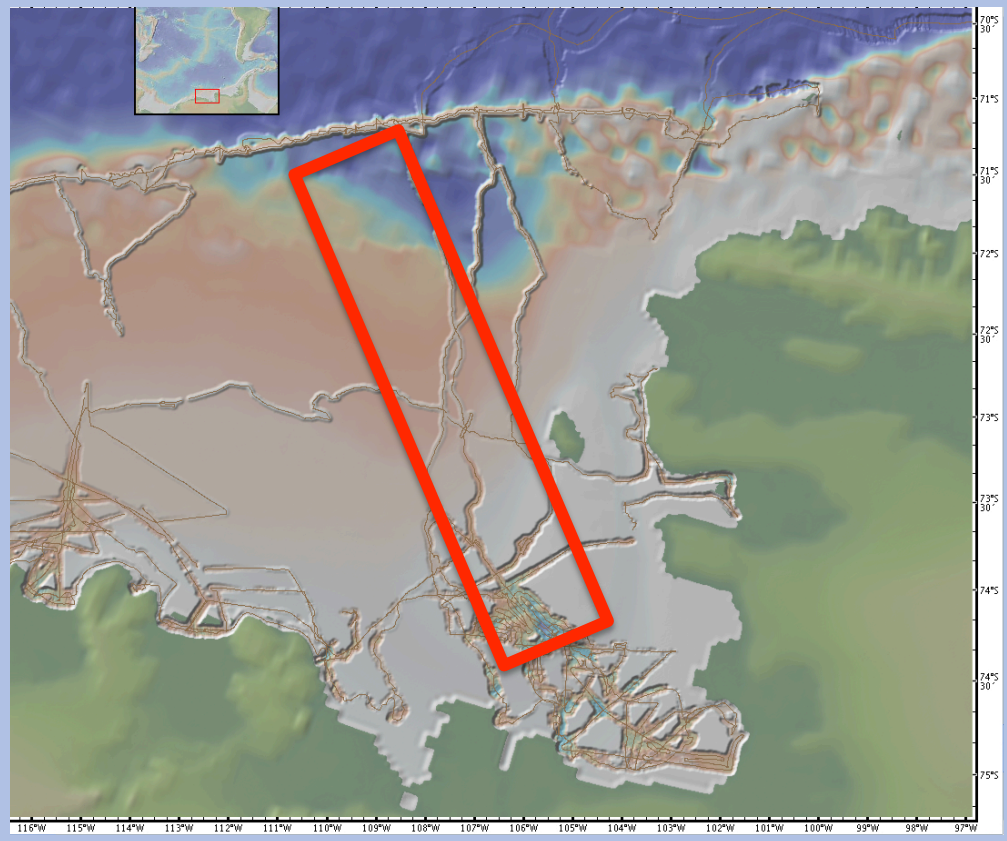
Pine Island Bay shares similarities to both Marguerite Bay (rugged inner bay bathymetry) and the Ross Sea (extensive, outer shelf with large trough and thick sedimentary cover). Ross Sea experienced episodic retreat while Marguerite Bay experienced rapid retreat.



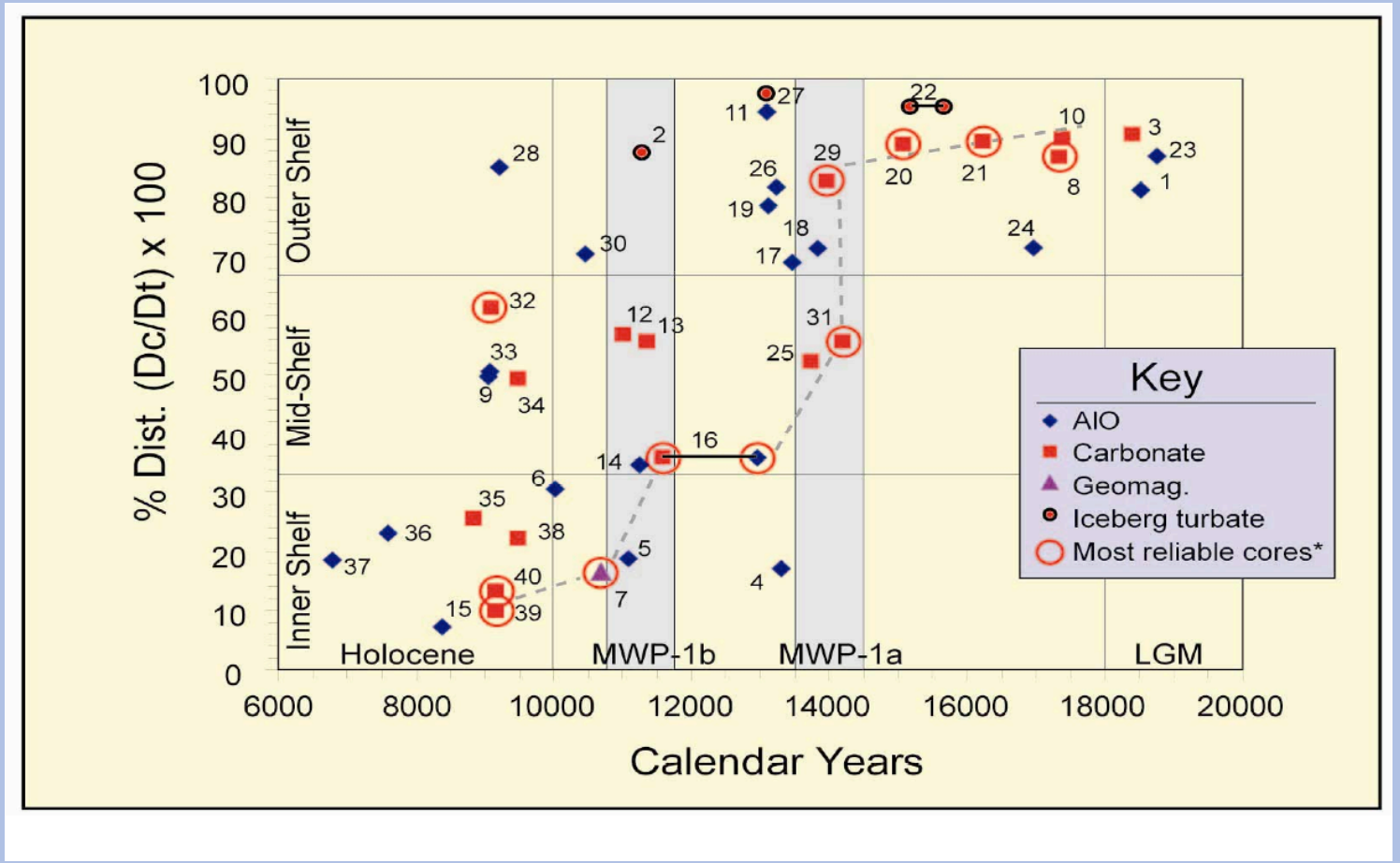


Oden 2010 Cruise Objectives

- Additional swath bathymetry mapping to search for grounding zone wedges
- Obtain better radiocarbon constraints on the timing of ice sheet retreat from the shelf
- Coring in outer trough to sample distal meltwater deposits and search for diatom and foraminiferal assemablages that indicate WDW presence on the shelf



Between 18 ka and 12 ka the perfect storm in terms of ice sheet collapse. Warming atmosphere, rising sea level and ice sheets that had advanced onto a landward sloping shelf with thick sediment. After 10 ka ice sheets retreated across rugged bedrock topography of the inner shelf. From that time on retreat was more localized and surely episodic.



After 10 ka, sea-level rise was relatively slow and likely episodic, with decimeter-scale rapid rises having significant impact on low gradient coasts