High-Latitude Marine Paleoclimatology

What tools do we have to reconstruct past Arctic marine climate?

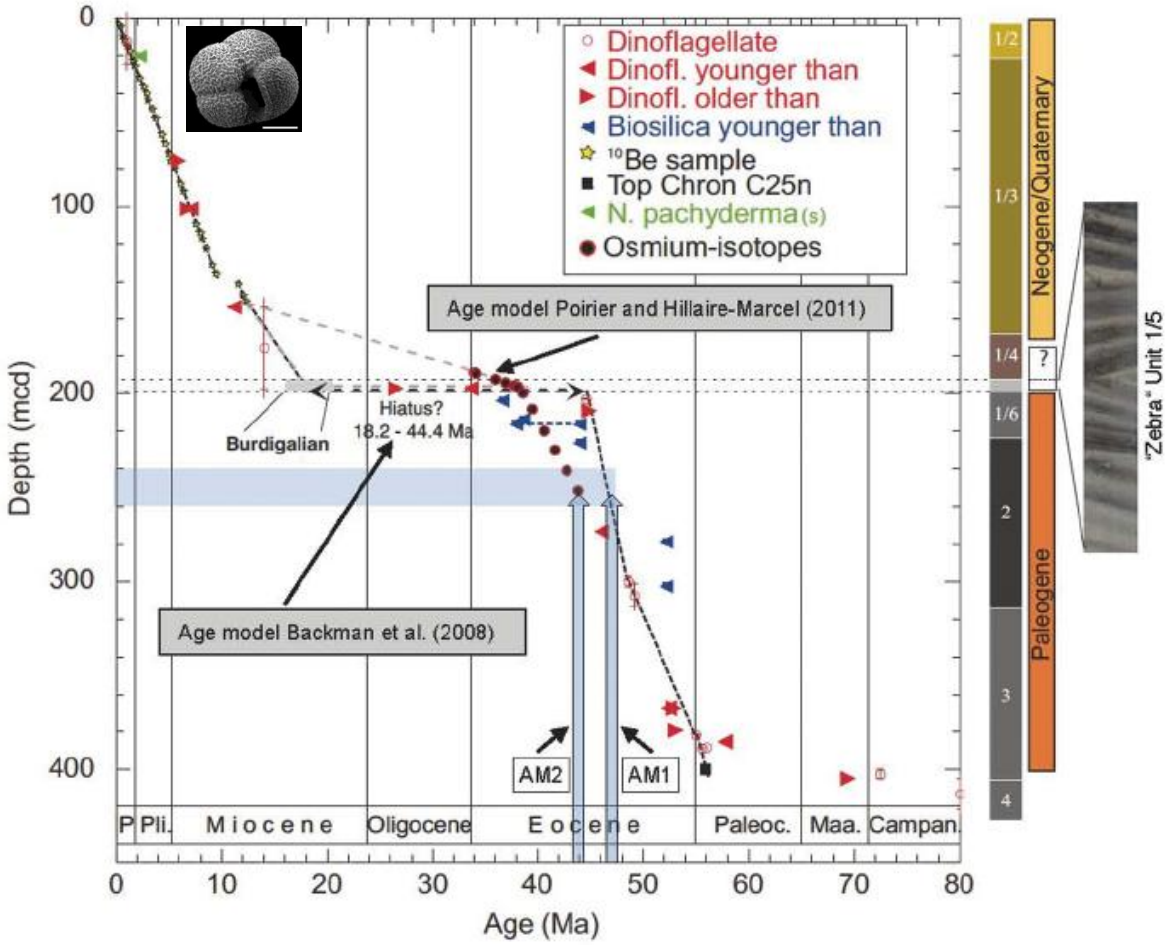
Low Resolution

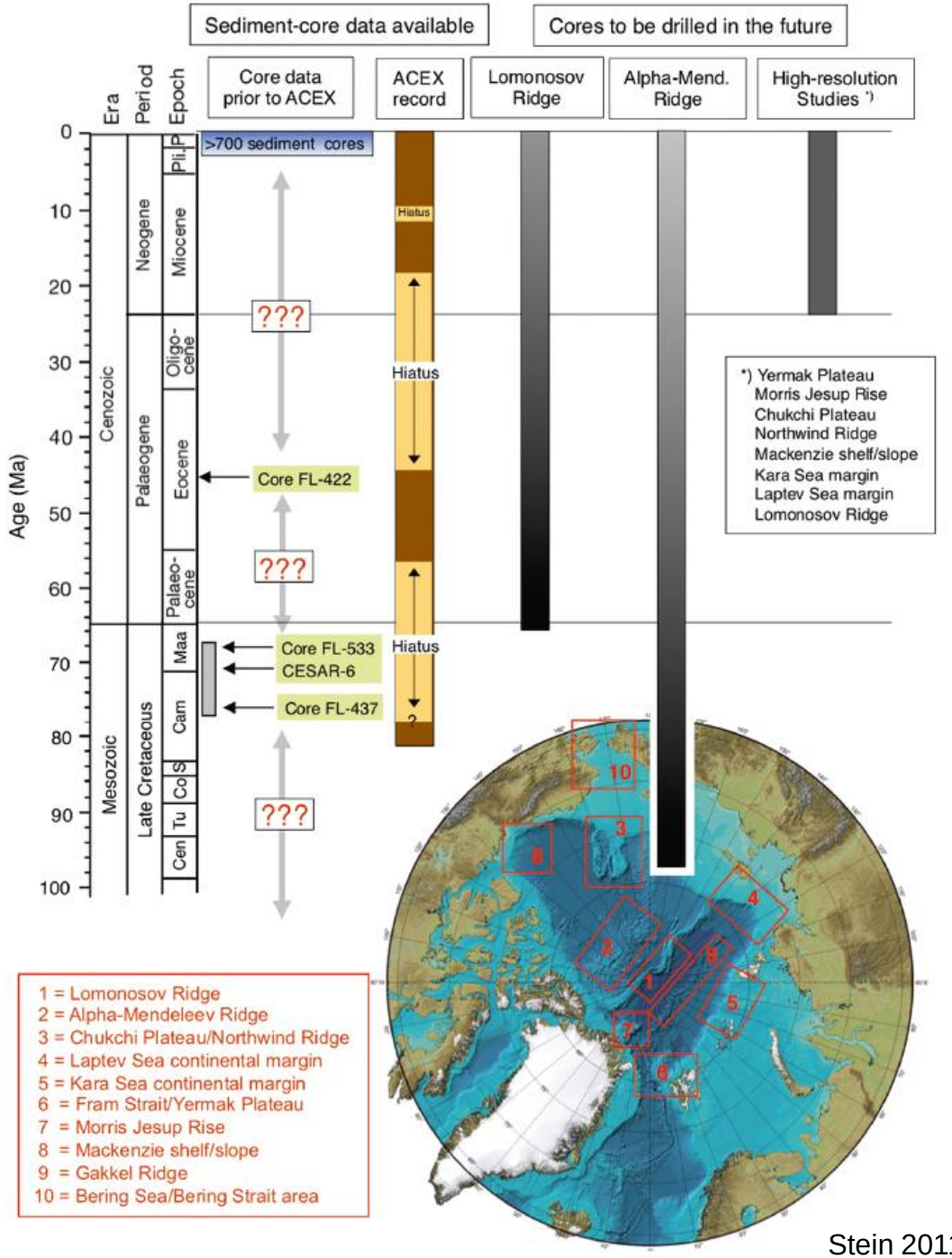
- Marine Sediment Cores
  - Ice Rafted Debris
  - Sea Ice Biomarker IP25

High Resolution

- Bivalves
- Coralline Algae

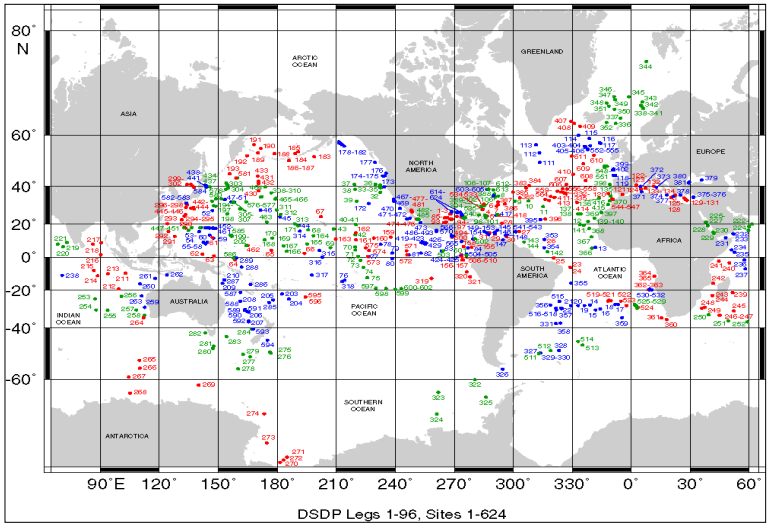
Marine sediment cores



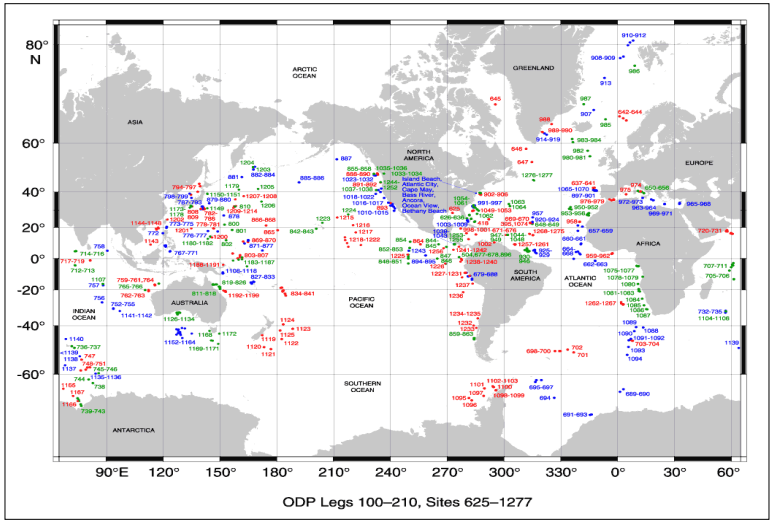


Stein 2011

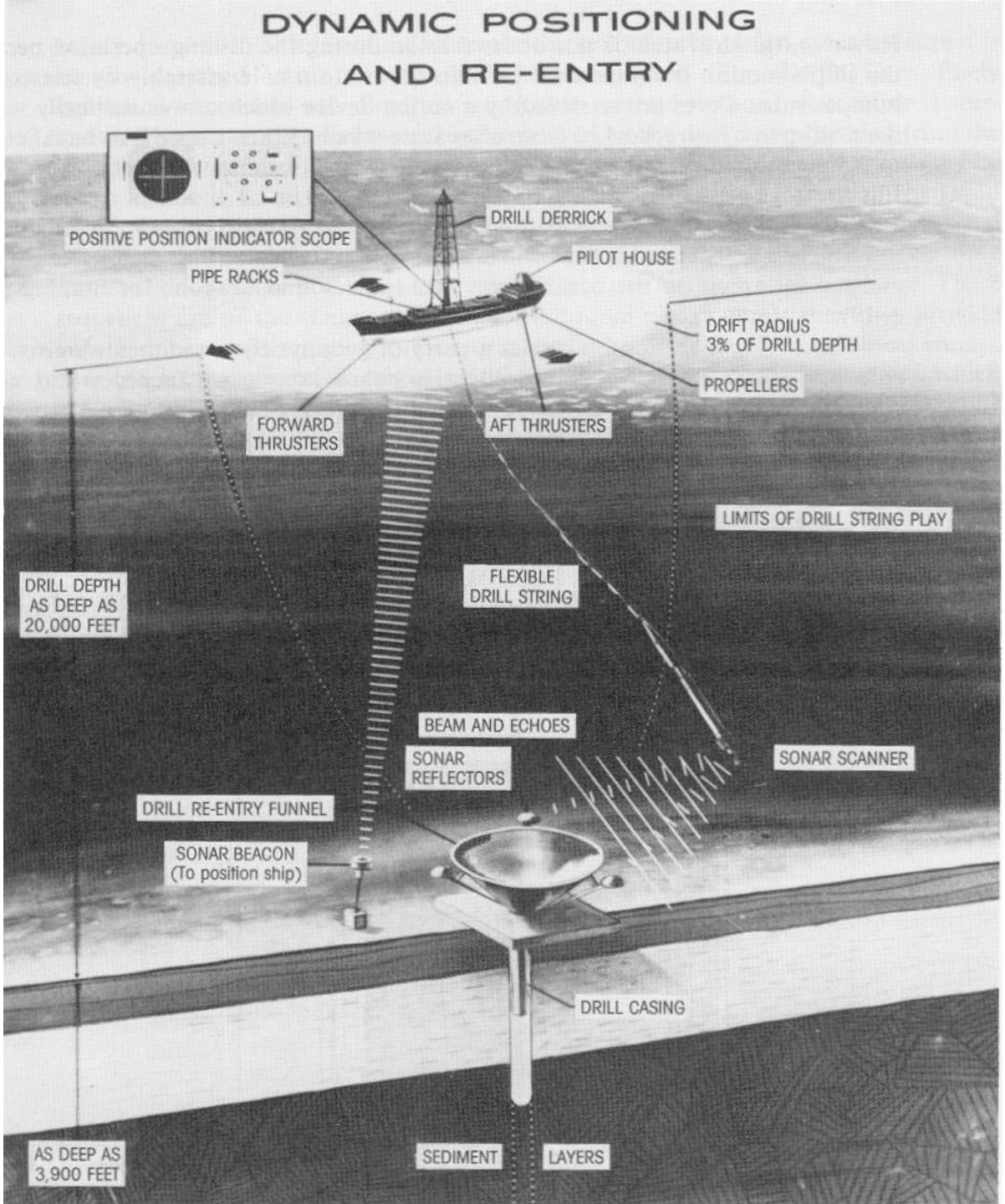
Deep Sea Drilling Project 1968-1983

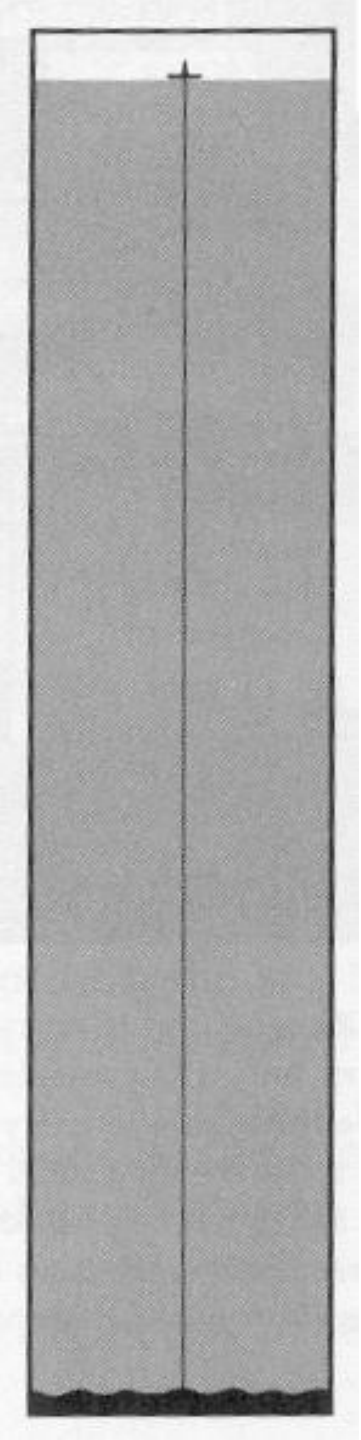


Ocean Drilling Program 1985-2003



DYNAMIC POSITIONING AND RE-ENTRY

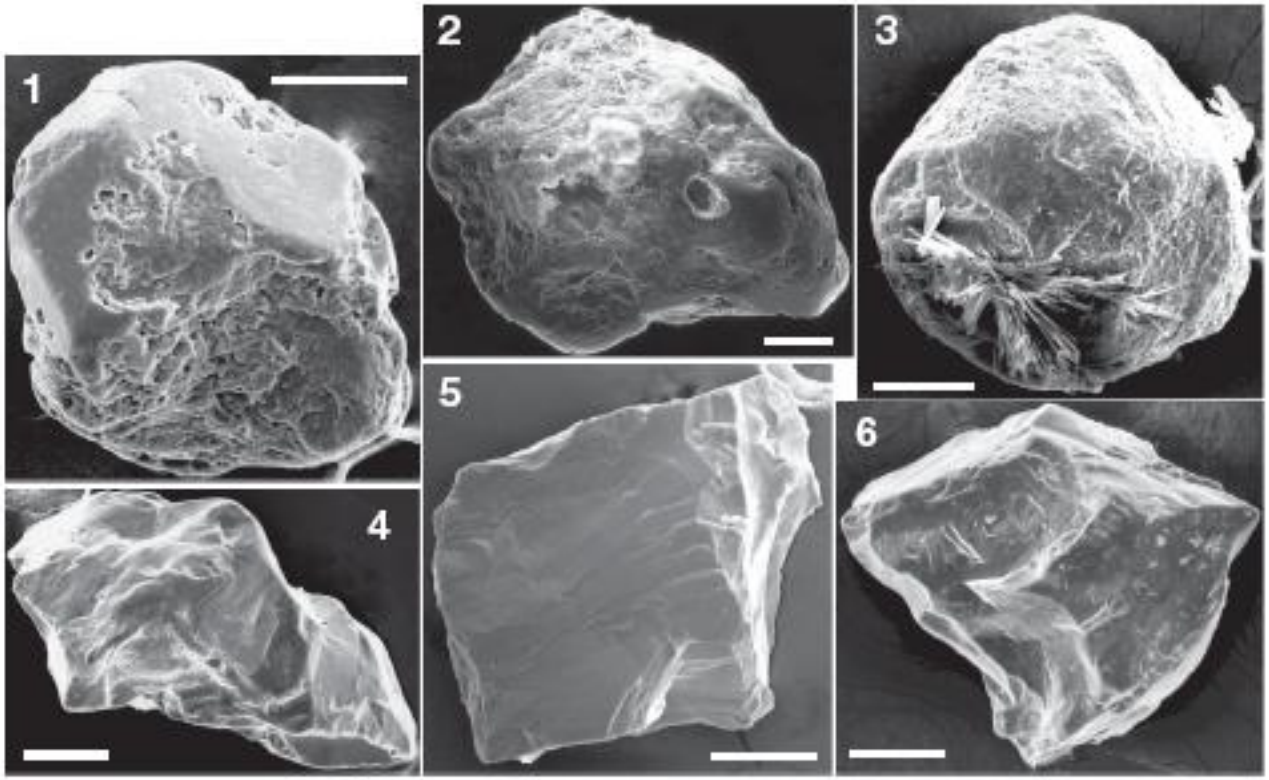




Ice Rafted Debris

Sea ice

Iceberg

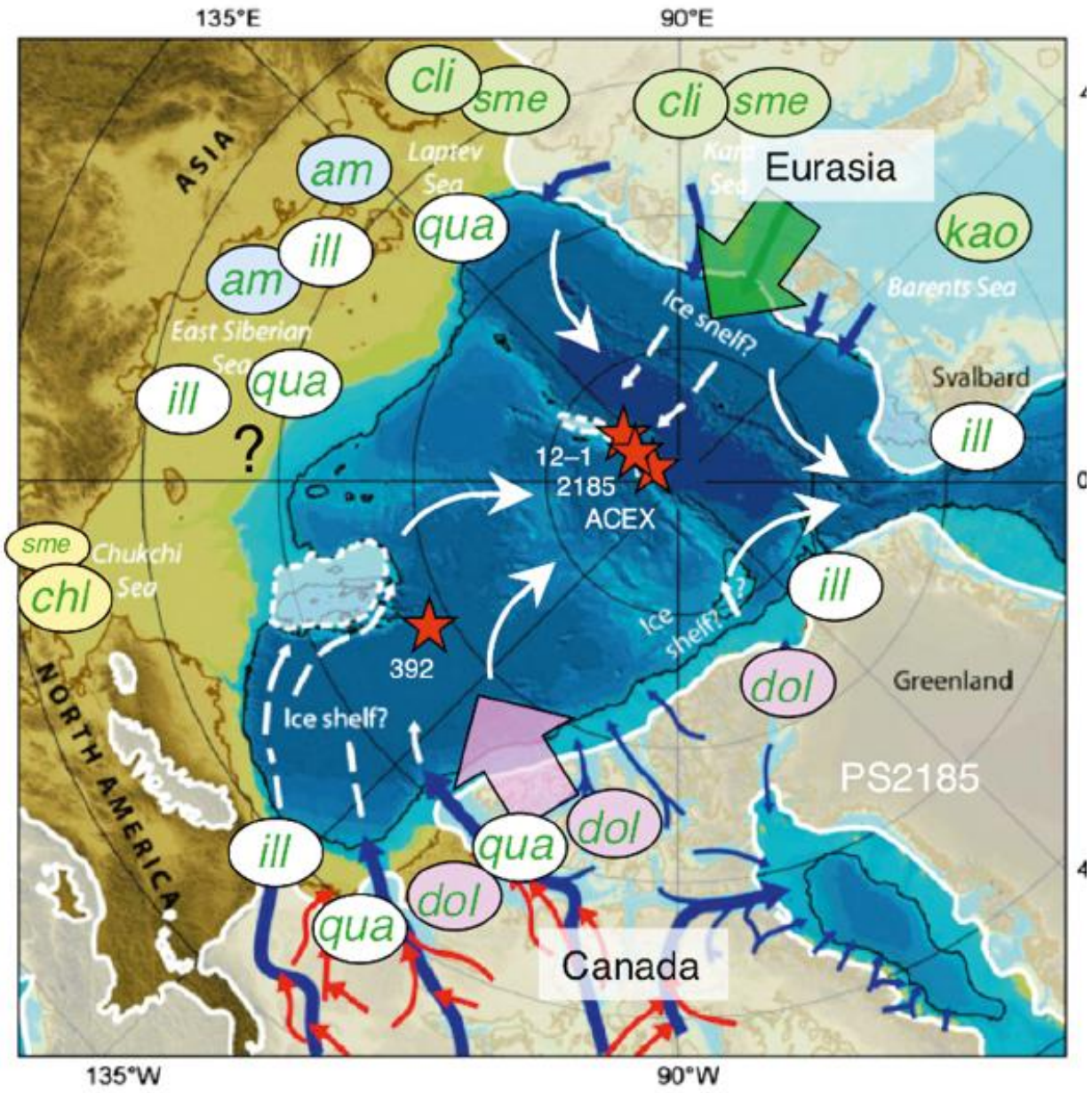


Stickley et al. 2009

How does debris get onto sea ice?

- Talus debris from mountain slopes/coastal cliffs
- Blown by wind
- Early spring melt of rivers

Ice Rafted Debris

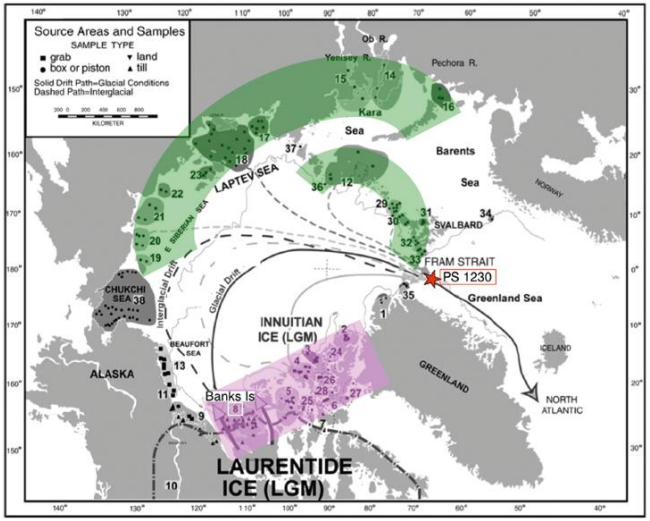


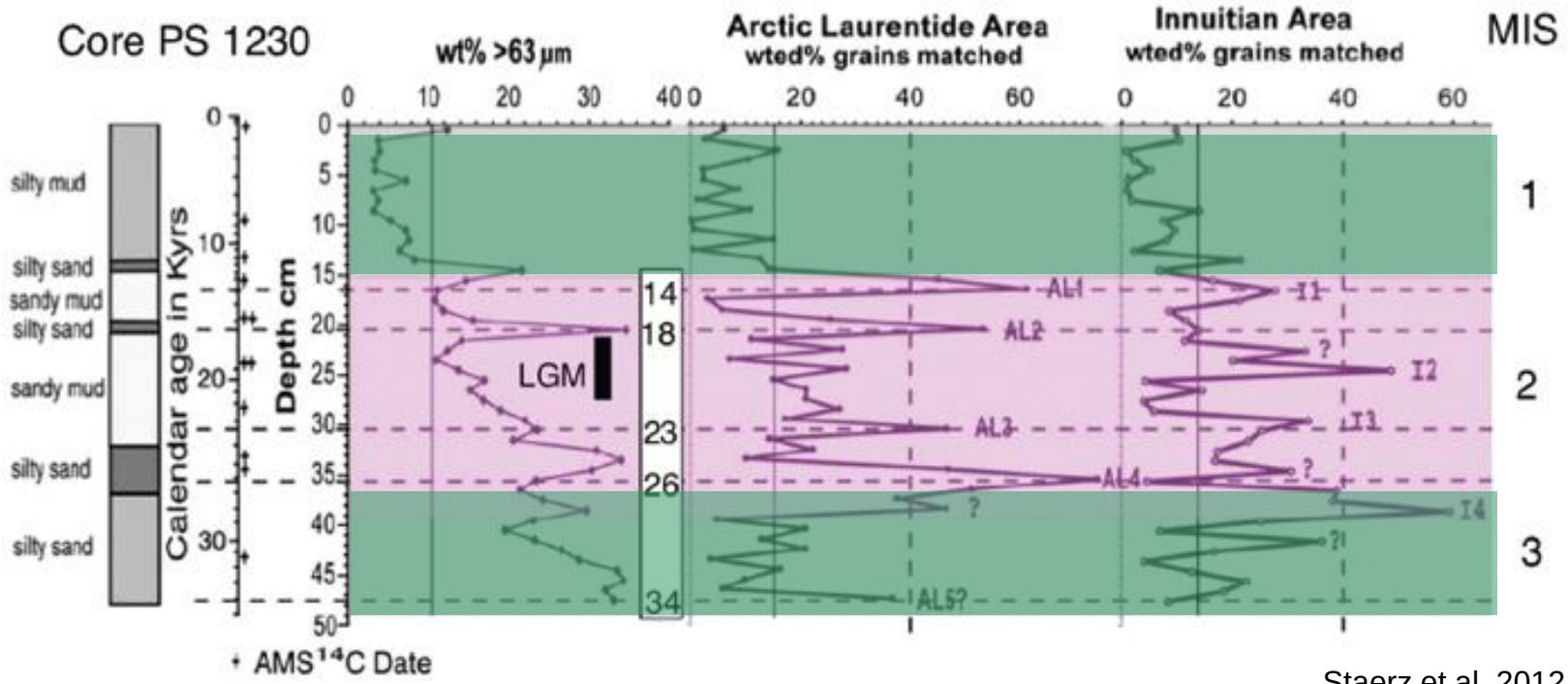
- Provenance Studies

Stein et al. 2012

Ice Rafted Debris

- Different source regions during cold/warm intervals

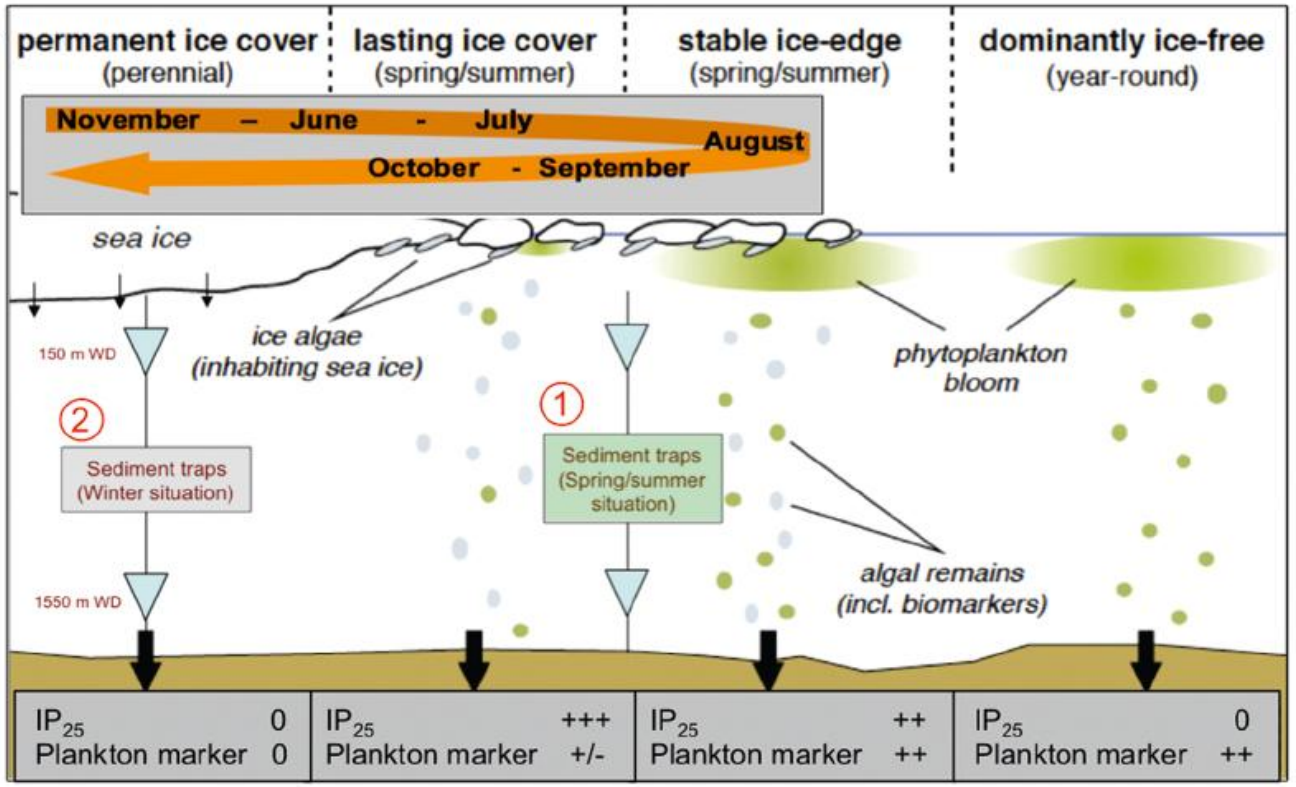




Staerz et al. 2012

IP_{25} Biomarker

- Organic geochemical lipid derived from sea ice diatoms
- Preserved in marine sediments
- IP_{25} content on its own cannot be used as direct measure for sea-ice
- Additional use of phytoplankton-derived, open-water biomarkers

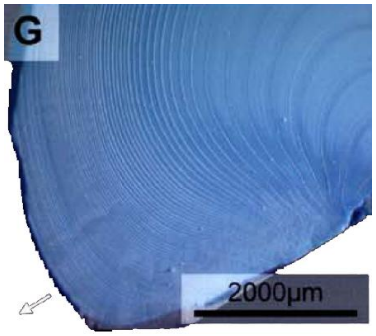


Mueller et al. 2011

High-resolution - Bivalves

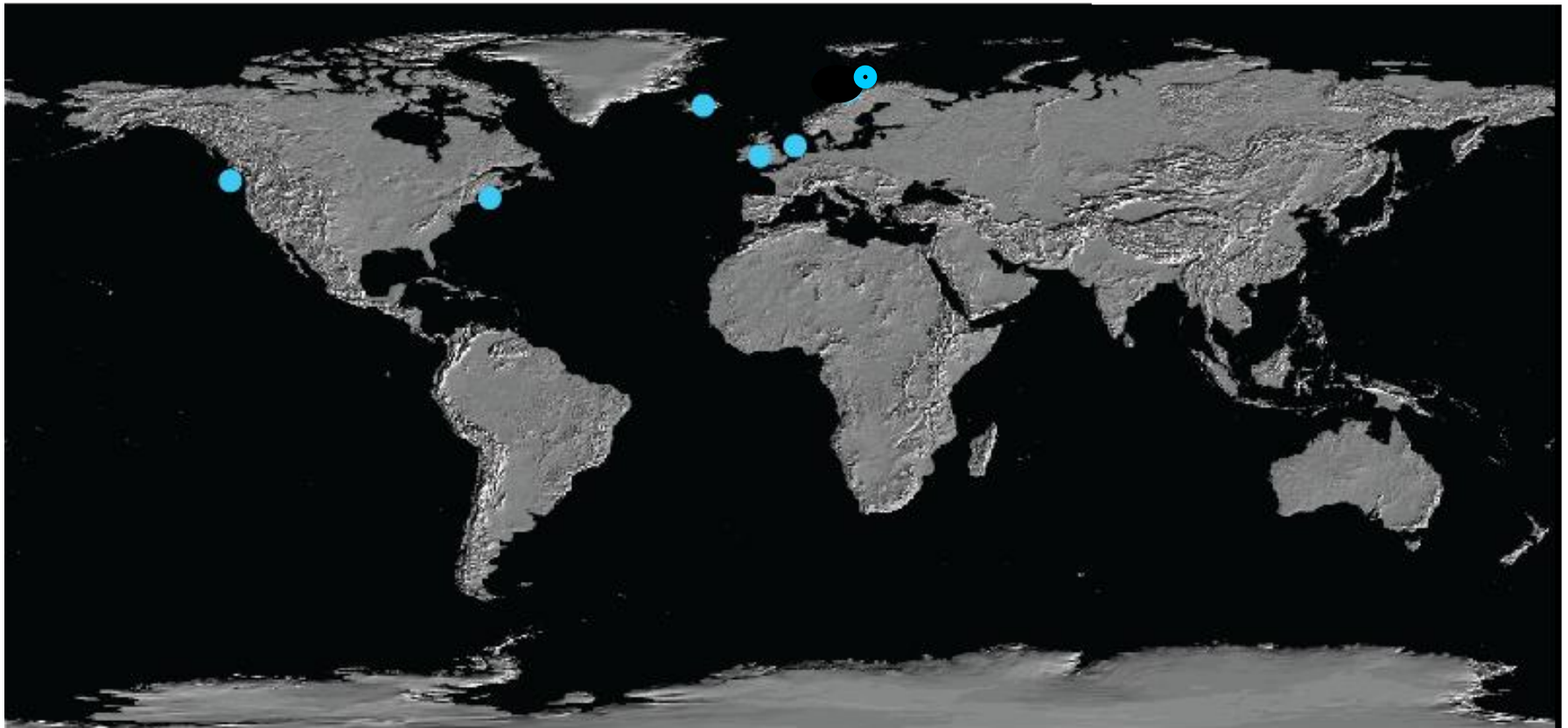
Arctica islandica

Wanamaker et al. 2008



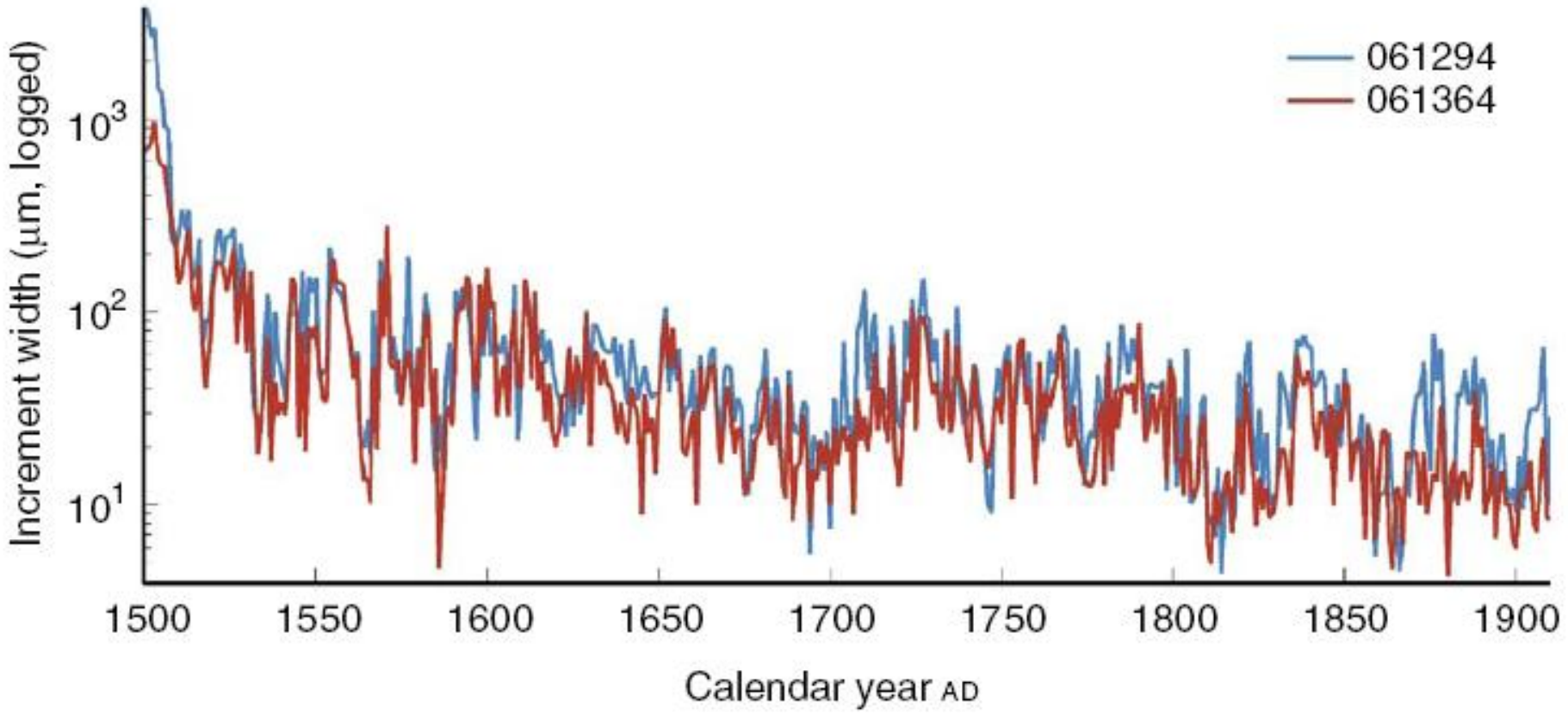
Schoene et al. 2005

Regions with >100-year marine records from bivalves (blue)



High-resolution - Bivalves

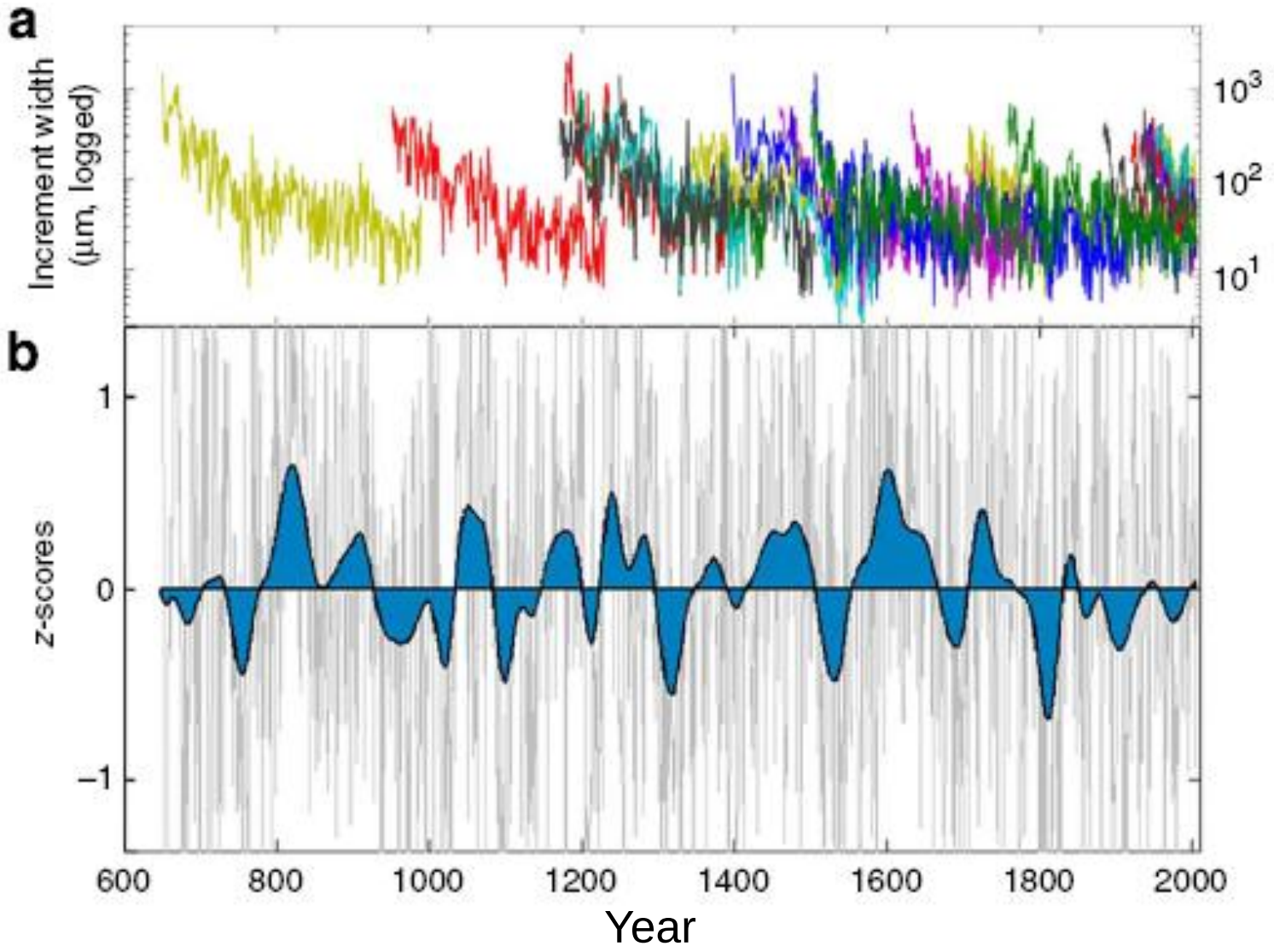
- Increment width measurements



Wanamaker et al. 2012

High-resolution - Bivalves

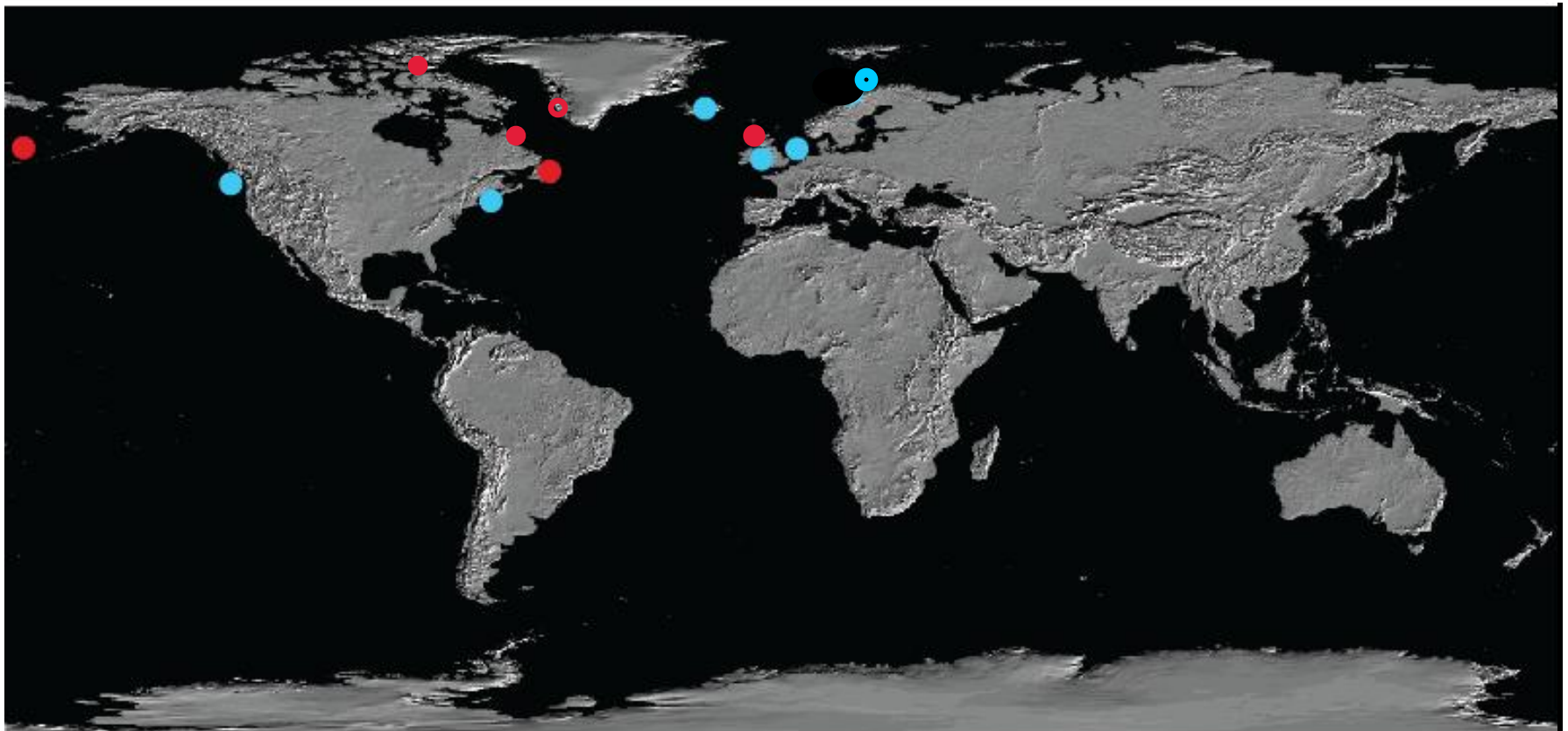
- Master chronologies



Wanamaker et al. 2012

High-resolution – Coralline Algae

Regions with >100-year marine records from bivalves (blue) and coralline algae (red)



High-resolution – Coralline Algae

Clathromorphum nereostratum

Arctic and Subarctic *Clathromorphum* buildups in the Northern Hemisphere

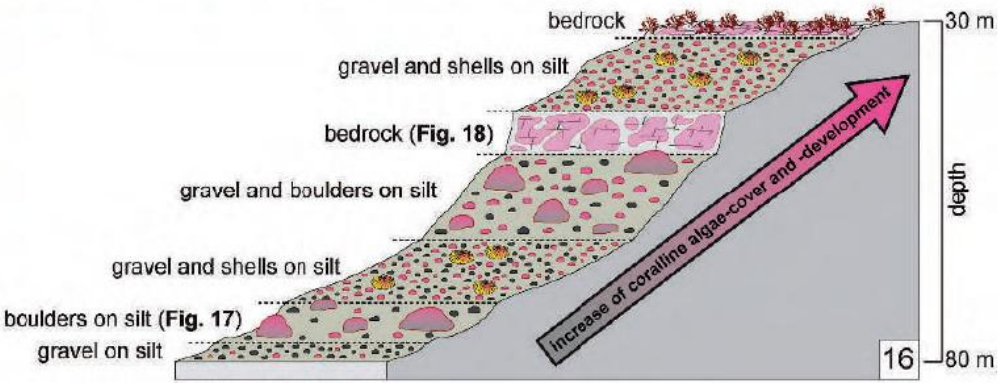
Arctic and Subarctic *Clathromorphum* buildups in the Northern Hemisphere

Rhodolith beds (Corallinales, Rhodophyta) and their physical and biological environment at 80°31′N in Nordkappbukta (Nordaustlandet, Svalbard Archipelago, Norway)

SEBASTIAN TEICHERT[1]*, WILLIAM WOELKERLING[2], ANDRES RÜGGEBERG[3], MAX WISSHAK[1], DIETER PIEPENBURG[4], MICHAEL MEYERHÖFER[5], ARMIN FORM[5], JAN BÜDENBENDER[5] AND ANDRÉ FREIWALD[1,6]

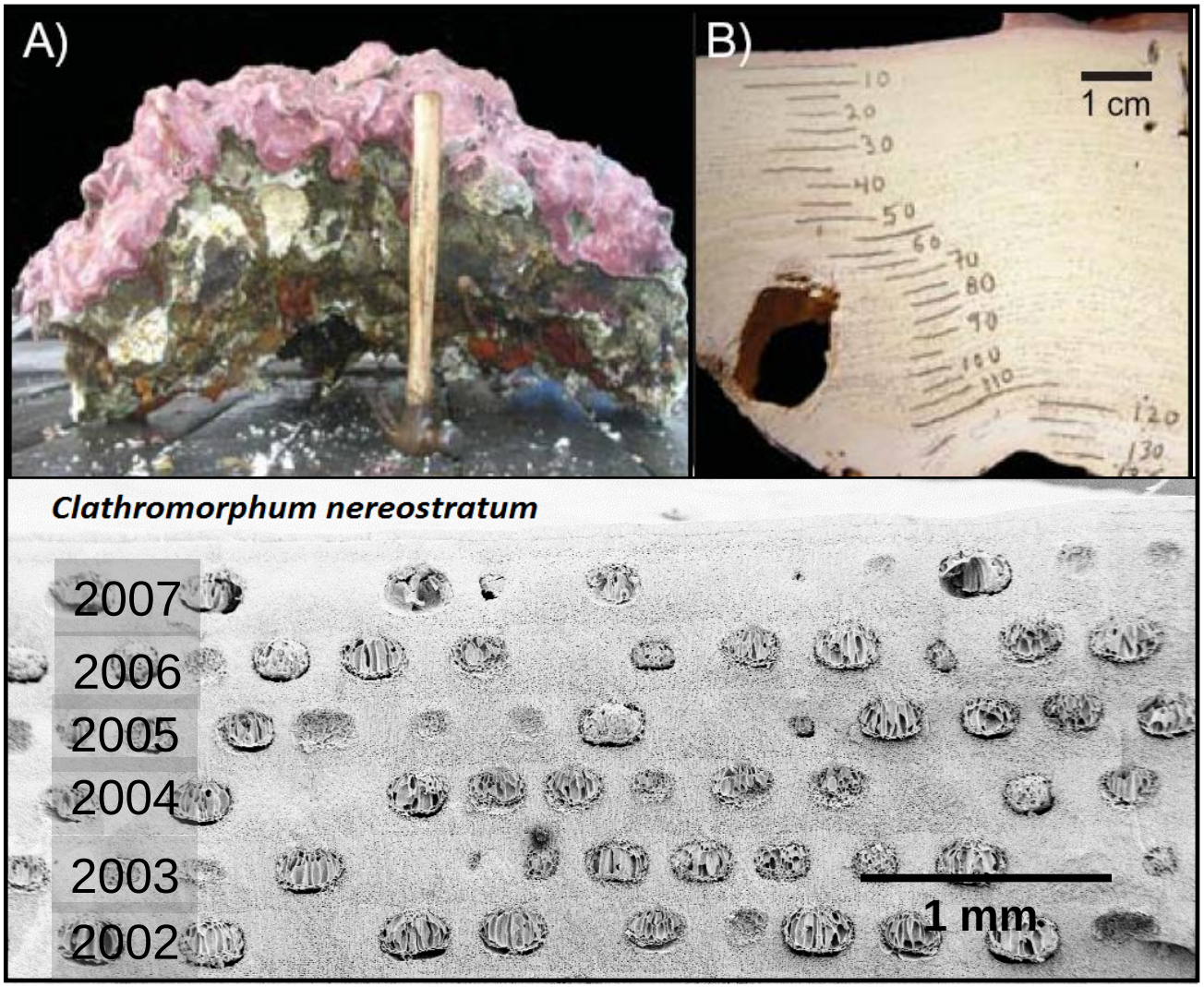
[1]*Senckenberg am Meer, Abteilung Meeresforschung, Südstrand 40, D-26282 Wilhelmshaven, Germany*

Phycologia (2012) Volume 51 (4), 371–390

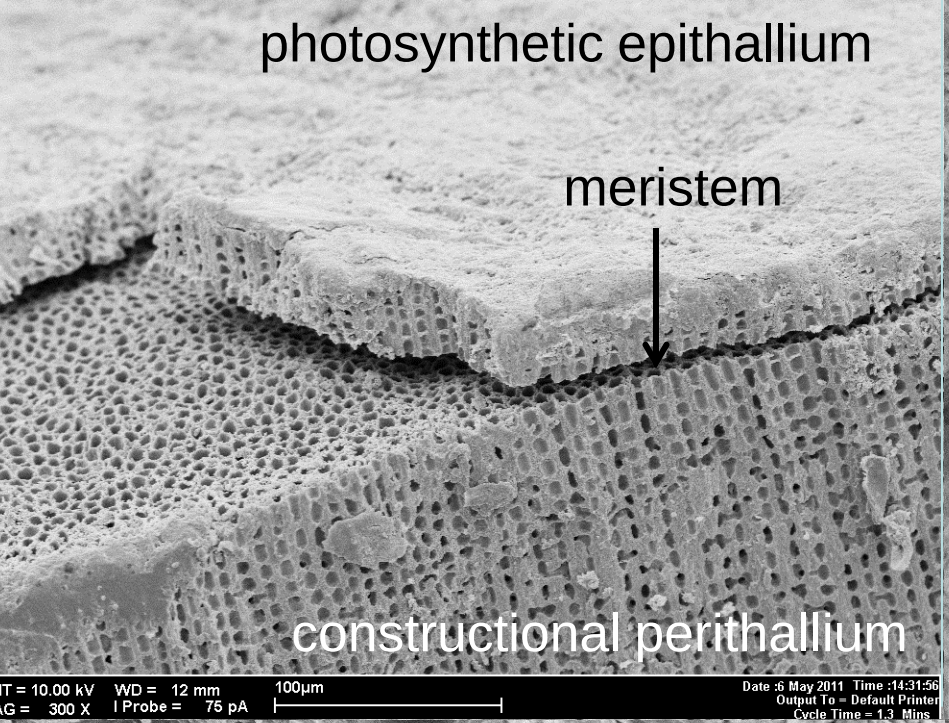


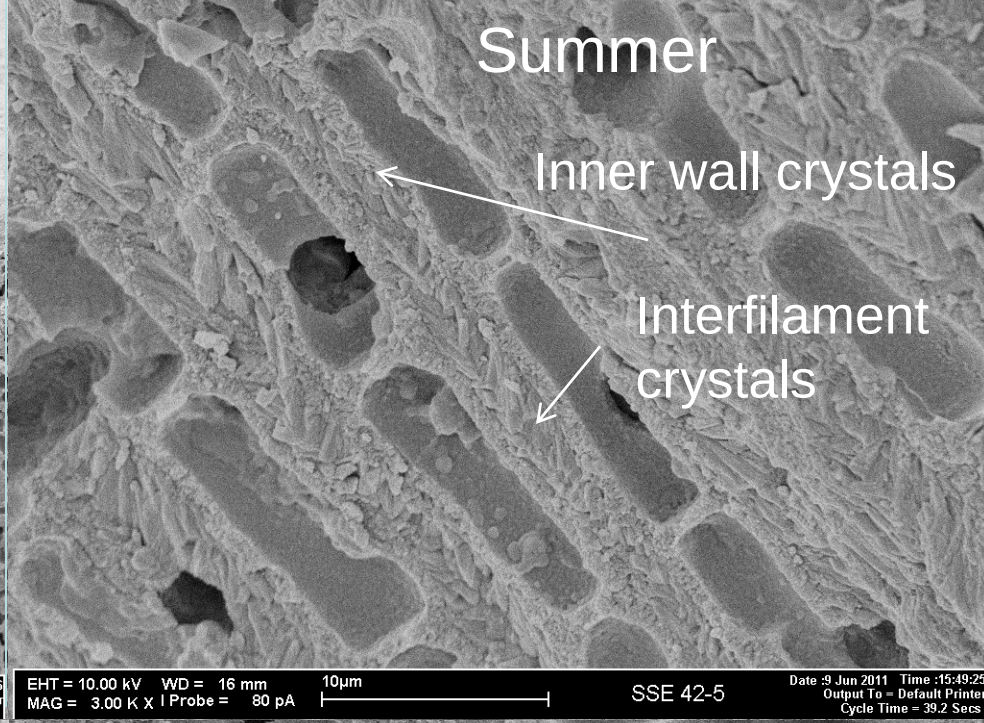
Characteristics of *Clathromorphum*

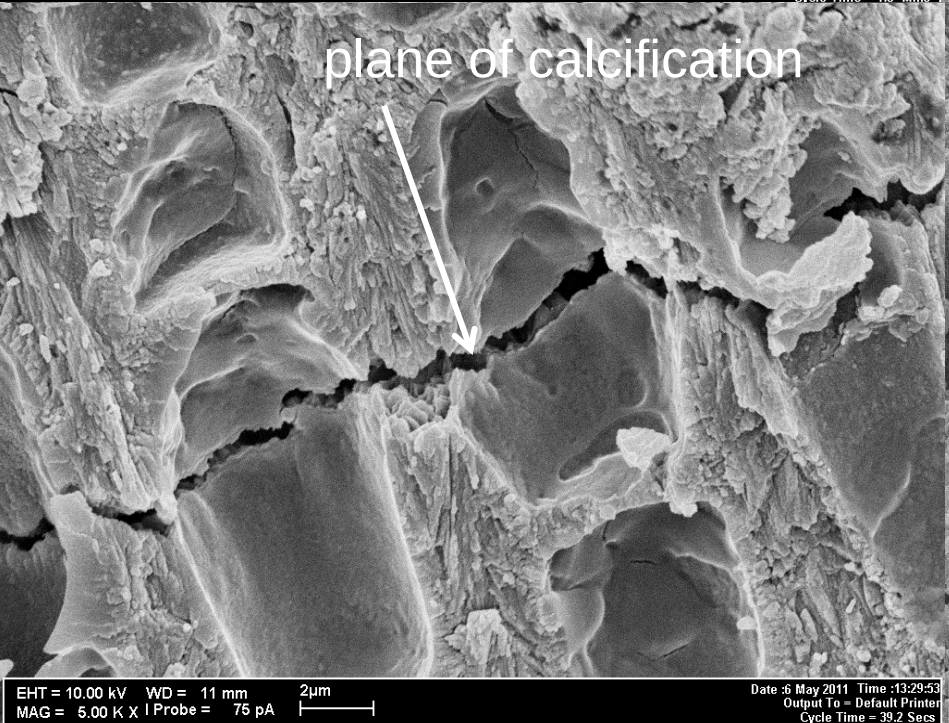
- Well developed annual growth increments in High-Mg Calcite Skeleton

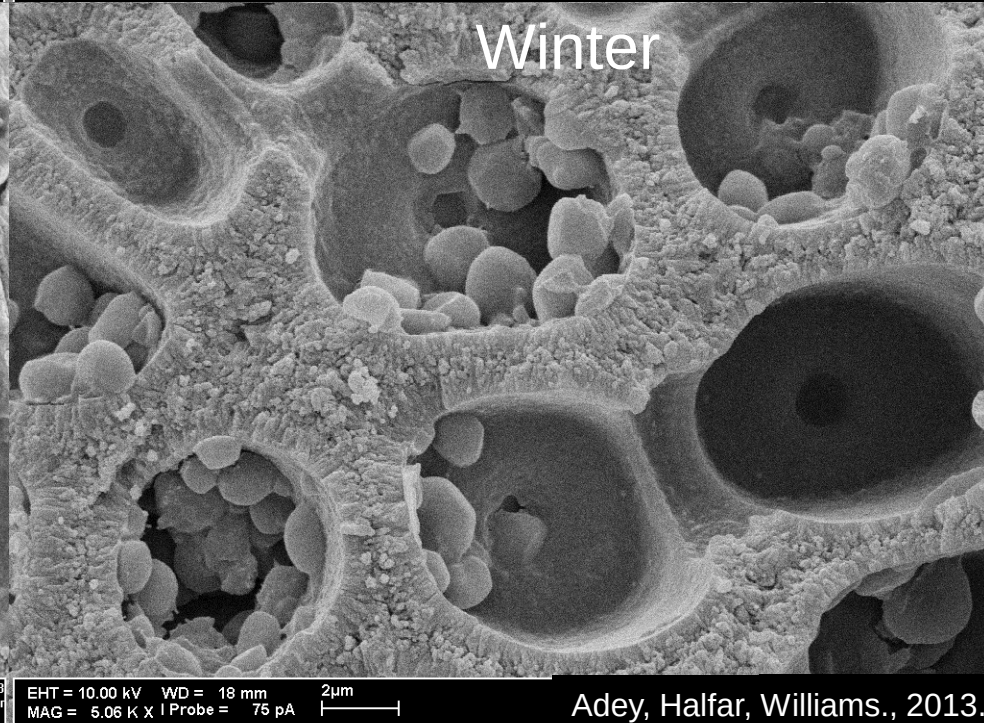


from Halfar et al. 2011, Geology









Adey, Halfar, Williams., 2013.

Coralline algae are not:

- Glibbery
- Slimy
- Soft
- Corals

- High-Magnesium Calcite skeleton

  $(Ca,Mg)CO_3$

Halfar et al. 2008

- High-Magnesium Calcite skeleton

  $(Ca,Mg)CO_3$

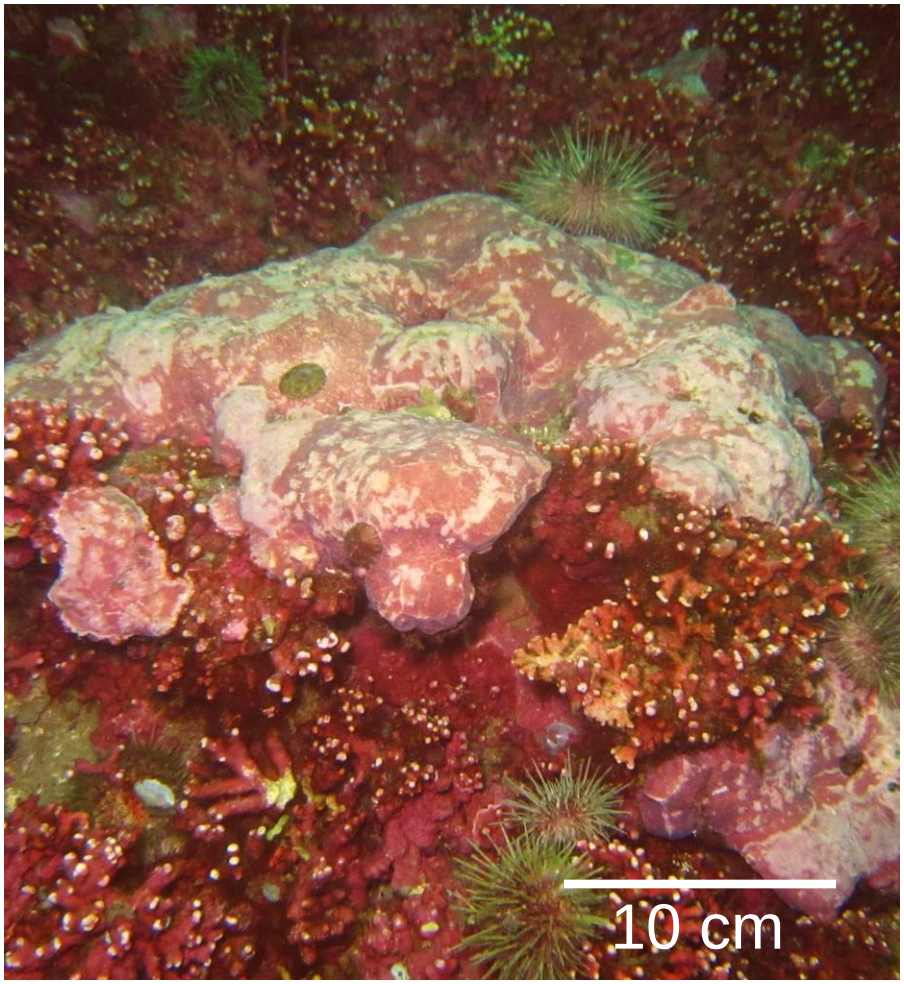
Mg/Ca ratio = Paleotemperature Proxy

Halfar et al. 2008

> Magnesium = warm water temperatures

Characteristics of *Clathromorphum*

- Forms extremely long-lived buildups on shallow seafloor

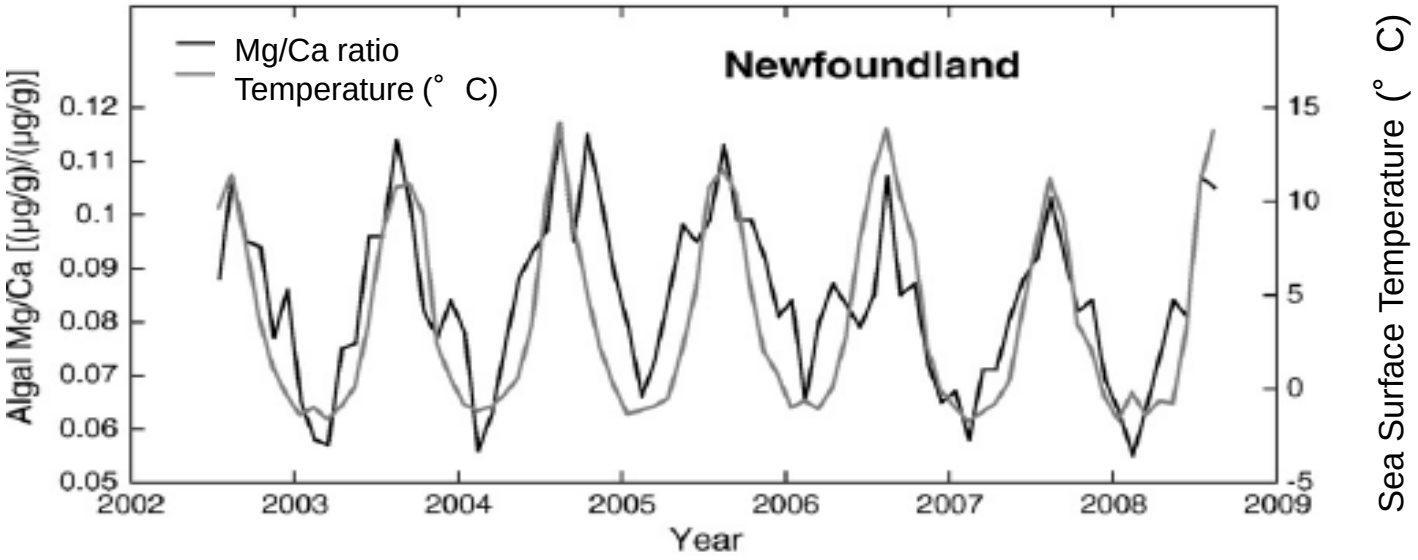


Live-collected specimen dated at 850 years

Halfar et al. 2007. GRL

Clathromorphum meets requirements for climate archive

- Exhibit high temporal climate recording resolution
- Multicentury-scale lifespan
- Abundant in Arctic and Subarctic
- Accurately records climate information



Hetzinger, Halfar et al. 2011

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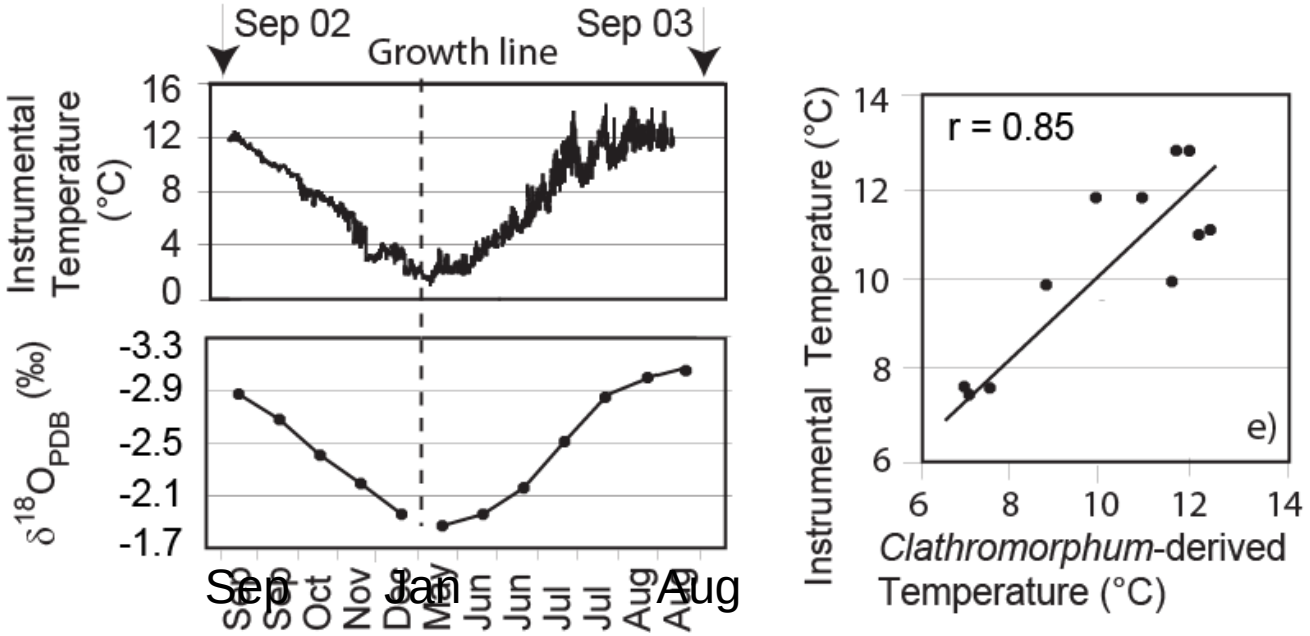

Halfar et al. 2008, Geology