



Università di Trieste
Corso di Laurea in Geologia

Anno accademico 2018 - 2019

Geologia Marina

Parte III

Modulo 3.3 Sistemi deposizionali polari

Docente
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OUTLINE

- River-dominated marine sedimentary systems
- River versus ice sheet sediment source
- Ice sheet-dominated sedimentary systems
 - **Ice streams**
 - **Paleo ice streams**
 - Onshore evidence
 - Offshore evidence
 - **Trough-mouth fans**
 - Two main sedimentary agents
 - Ice stream push: Glacial maxima debris flows
 - Melt water
 - Tunnel valleys
 - Meltwater plumes and plumites
 - **Grounding-zone wedges**
- Sea ice sediment transport
- Contourites
- Turbidites
- Mass transport deposits

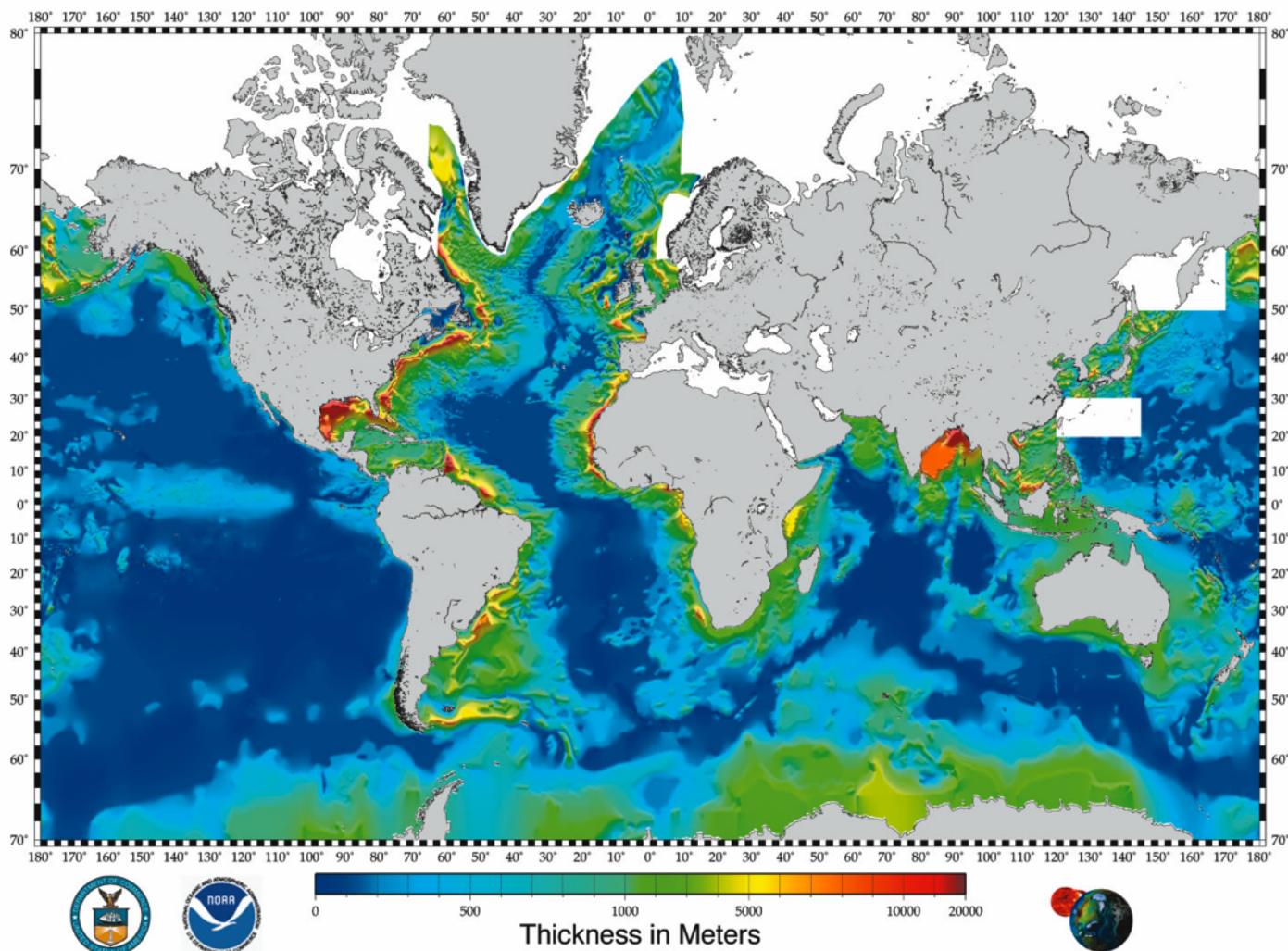


RIVER-DOMINATED MARINE SEDIMENTARY SYSTEMS

Rifted ma
Shetland

outh

Total Sediment Thickness of the World's Oceans & Marginal Seas



A digital total sediment thickness database for the world's oceans and marginal seas is being compiled by the National Geophysical Data Center (NGDC), Marine Geology & Geophysics Division. The data are gridded with a spacing of 5 arc-minutes by 5 arc-minutes. Sediment thickness data were compiled from three principle sources: previously published isopach maps; ocean drilling results, both ODP and DSDP; and seismic reflection profiles archived at NGDC as well as seismic data and isopach maps available as part of the IOC's Geological/Geophysical Atlas of the Pacific (GAPA) project.

The distribution of sediments in the oceans is controlled by five primary factors:

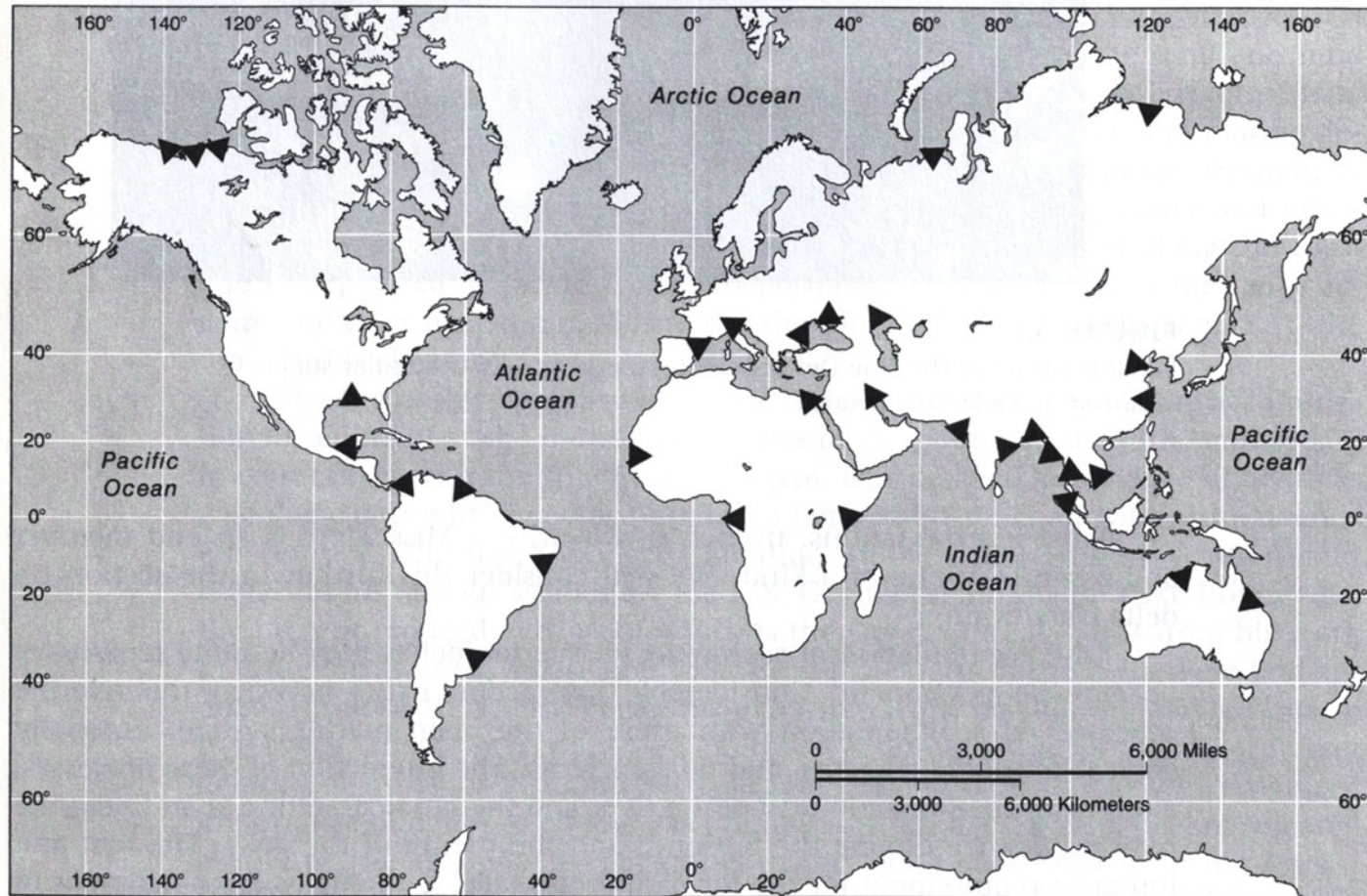
- 1) Age of the underlying crust
- 2) Tectonic history of the ocean crust
- 3) Structural trends in basement
- 4) Nature and location of sediment sources, and
- 5) The nature of the sedimentary processes delivering sediments to depocenters

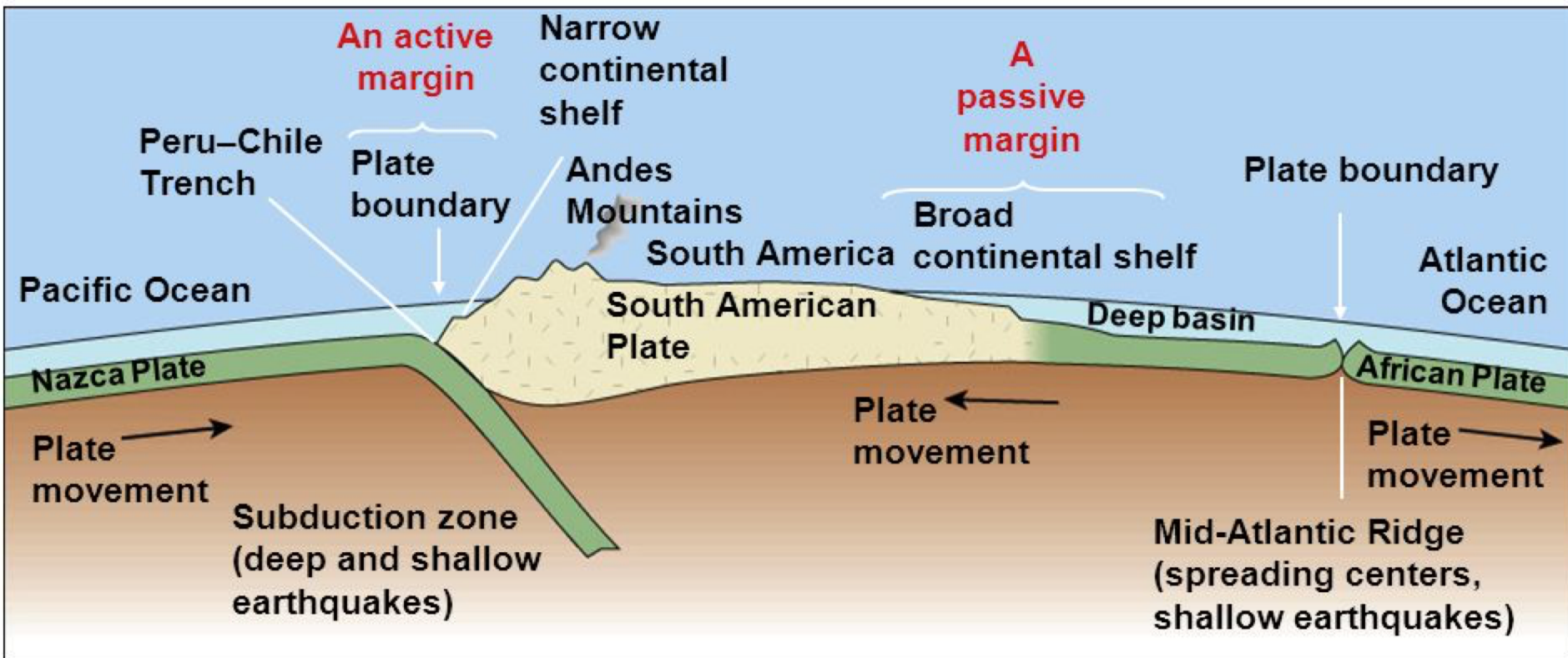
The data values are in meters and represent the depth to acoustic basement. It should be noted that acoustic basement may not actually represent the base of the sediments. These data are intended to provide a minimum value for the thickness of the sediment in a particular geographic region.

<http://www.ngdc.noaa.gov/mgg/sedthick/sedthick.html>



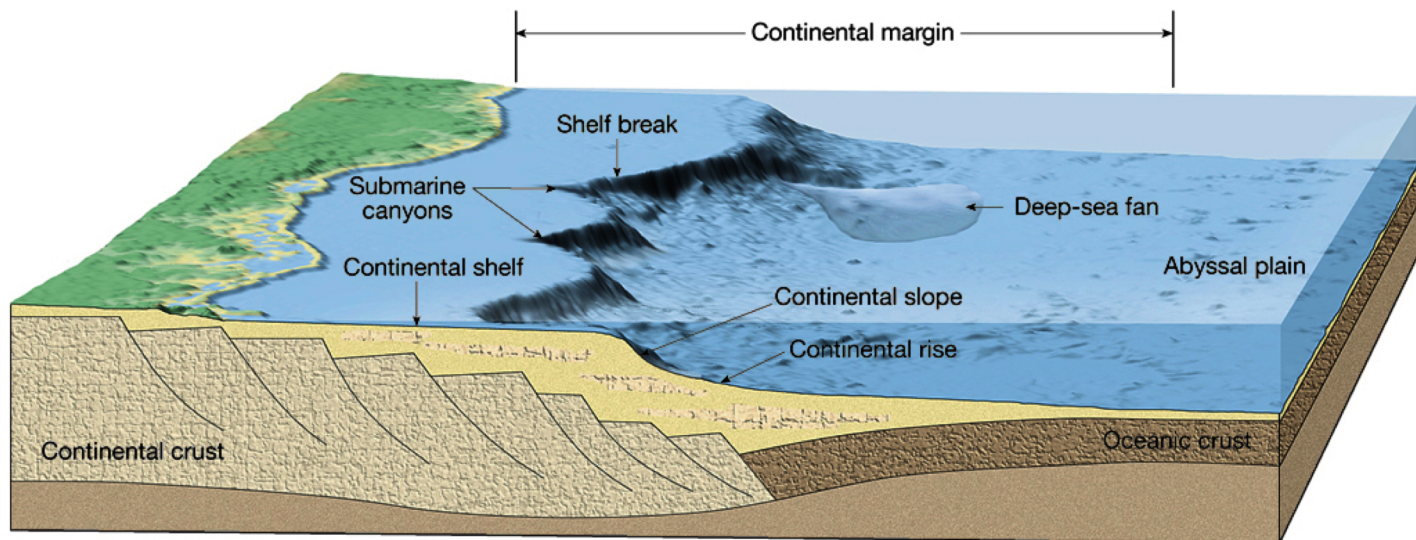
Global Distribution of Deltas





RIFTED PASSIVE MARGINS

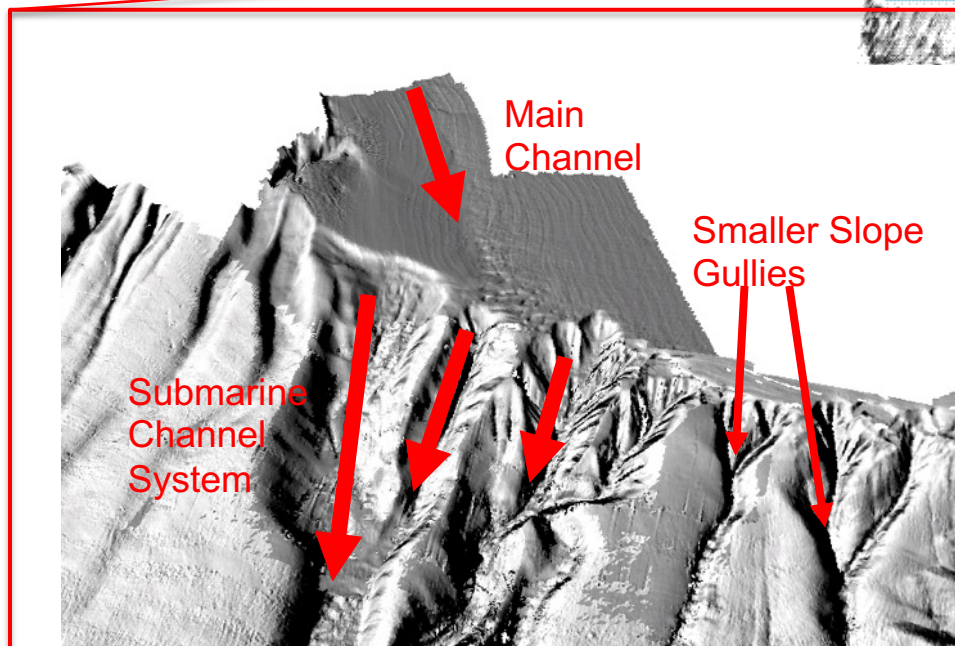
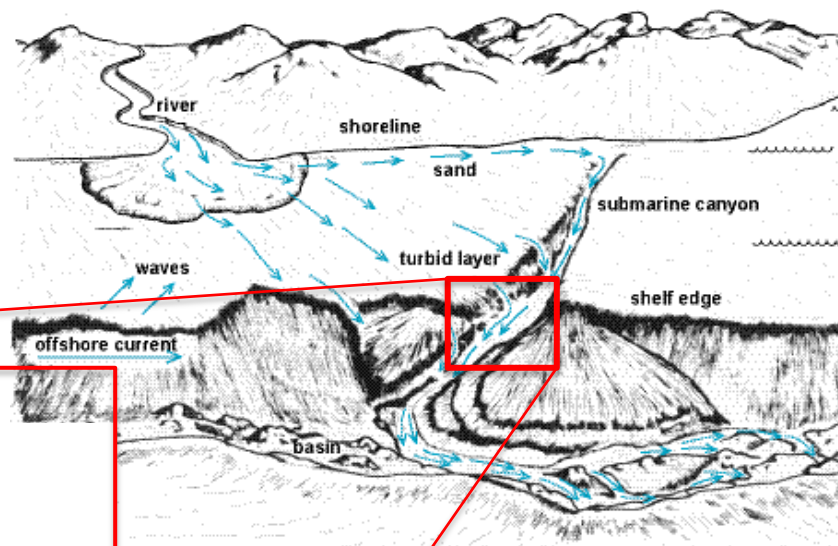
Rifted passive margin create the accommodation space for hosting the largest sedimentary accumulations in the world oceans, including the river-dominated Arctic Ocean



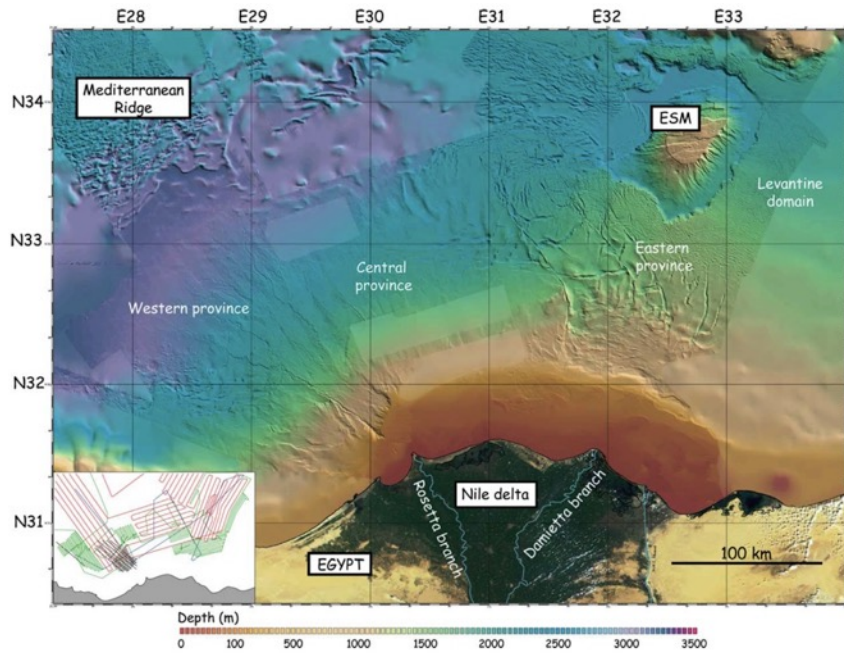
TASA Graphic Arts, 2002

RIVER DOMINATED marine sedimentary systems

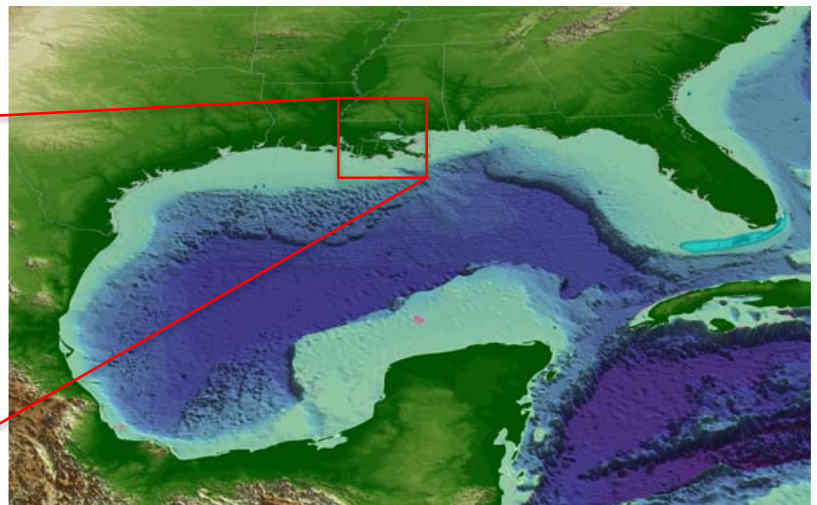
- Rivers are point-source
- Sediment transport and deposition controlled primarily by sea level changes
- River deltas
- Deep Sea Fans
- Submarine Canyons
- Deep Sea Channels



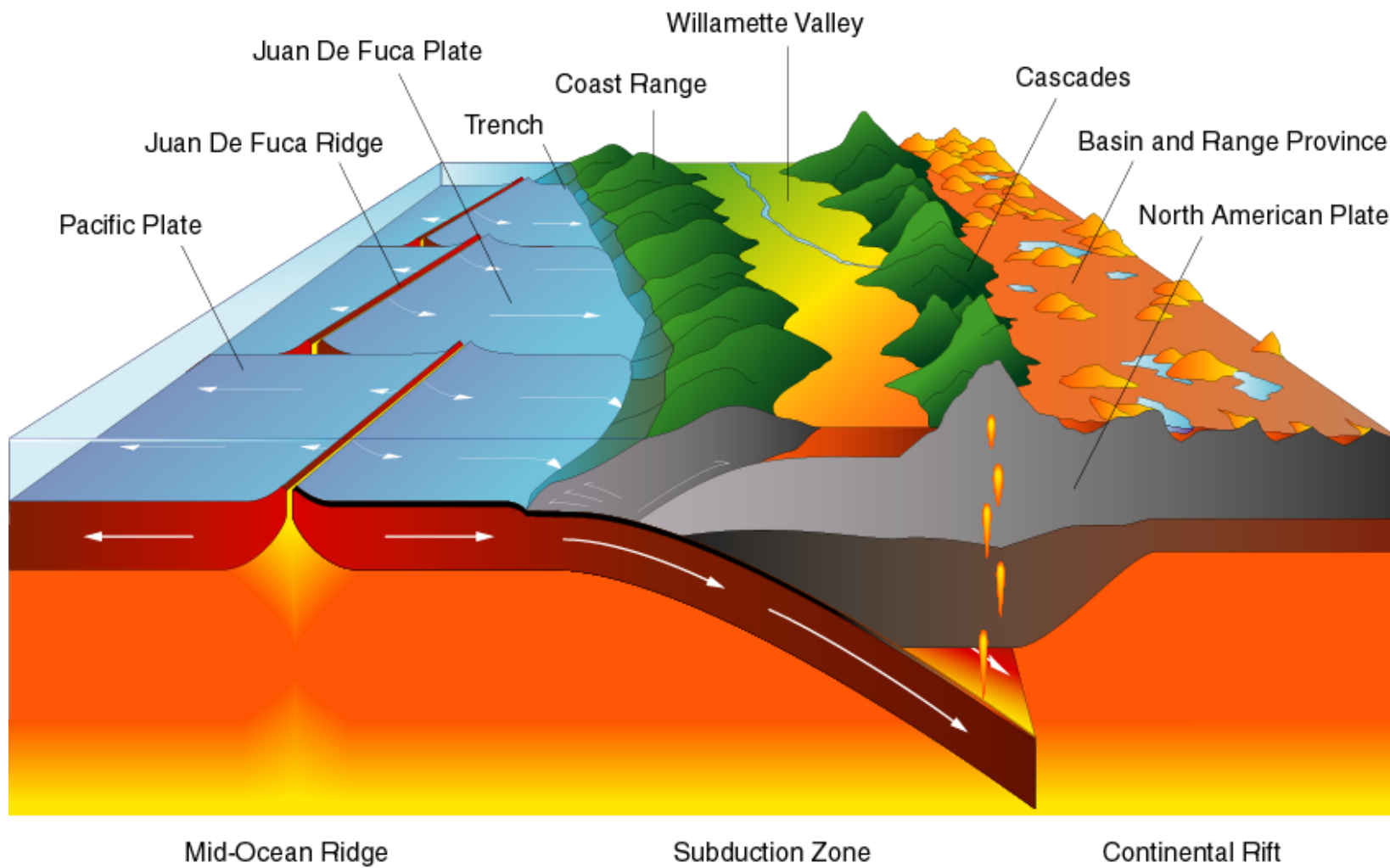
Deep sea fans



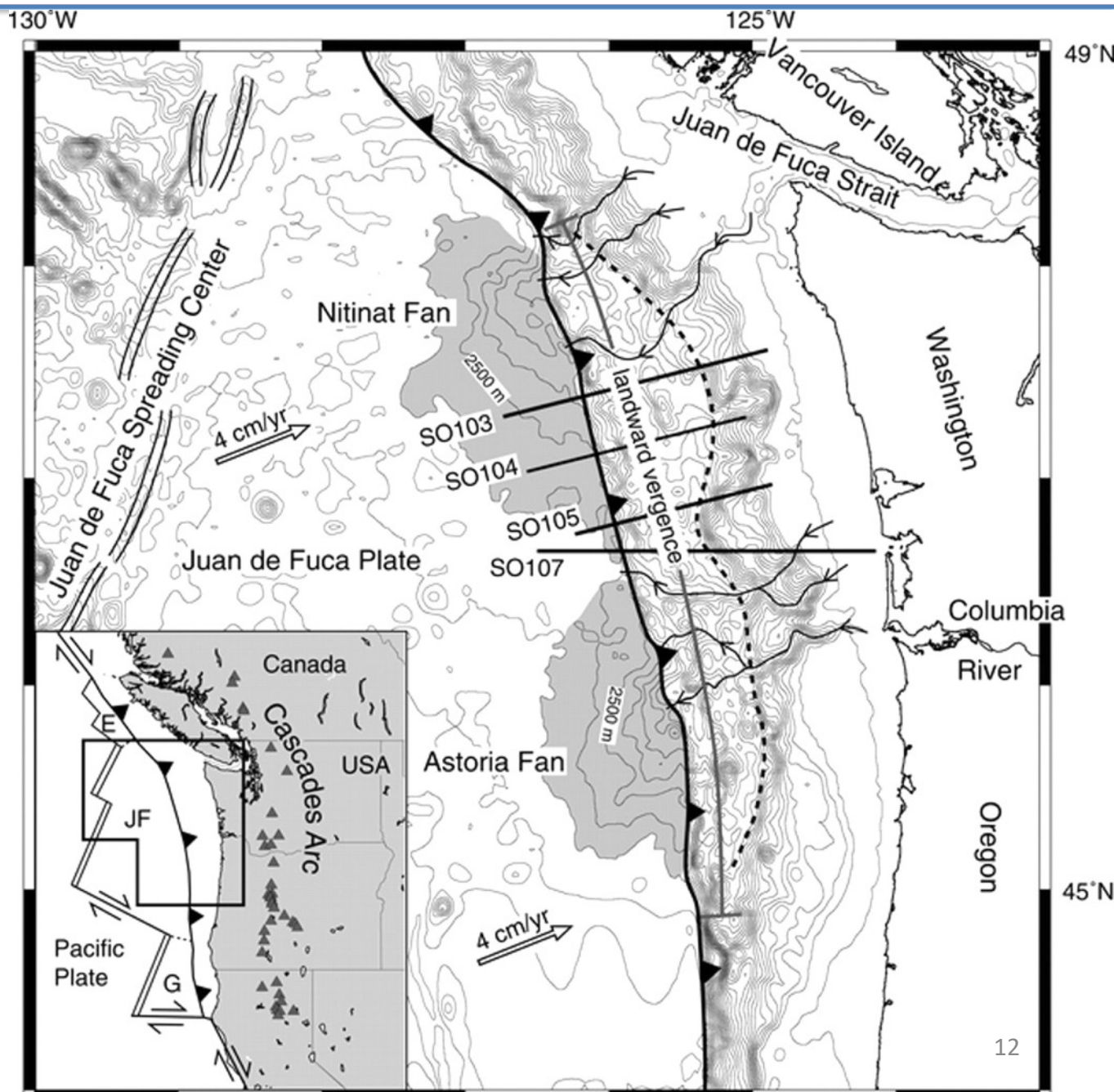
Nile, Loncke et al., 2006



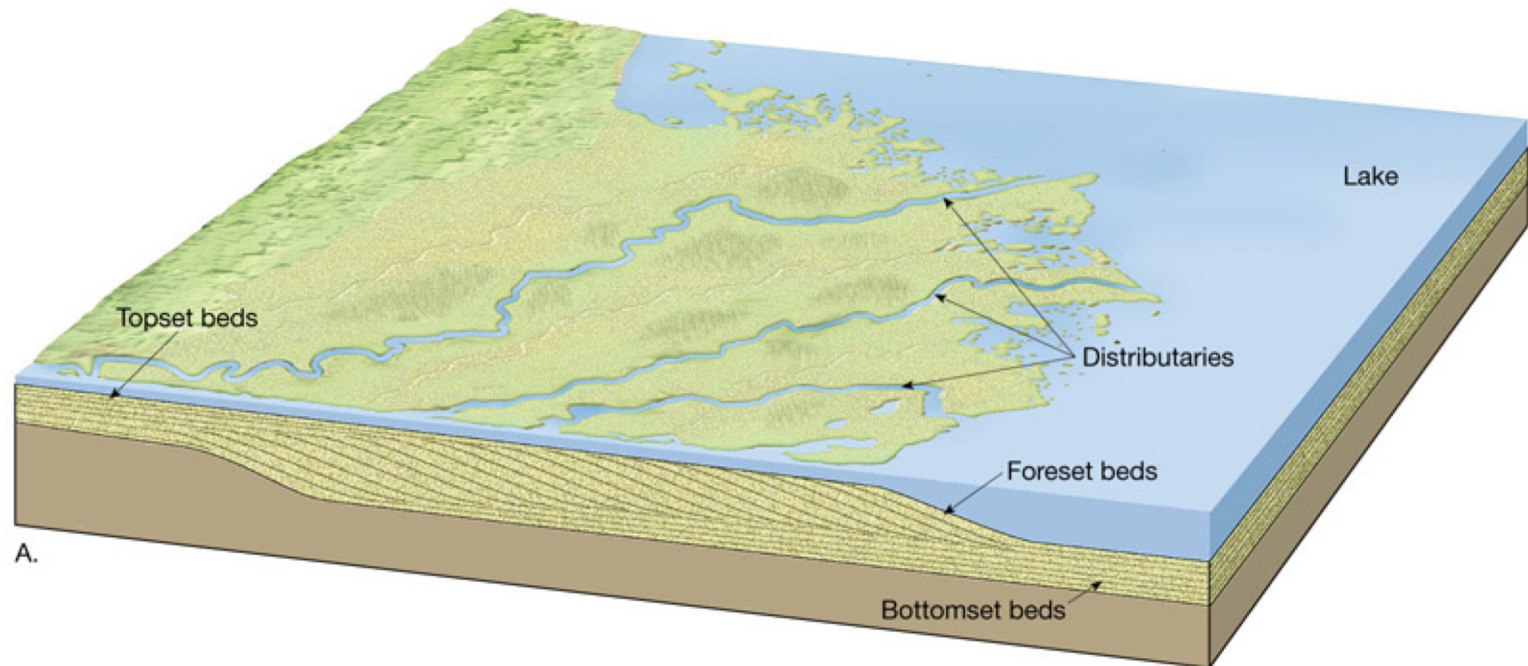
Mississippi



ALSO ON ACTIVE MARGINS



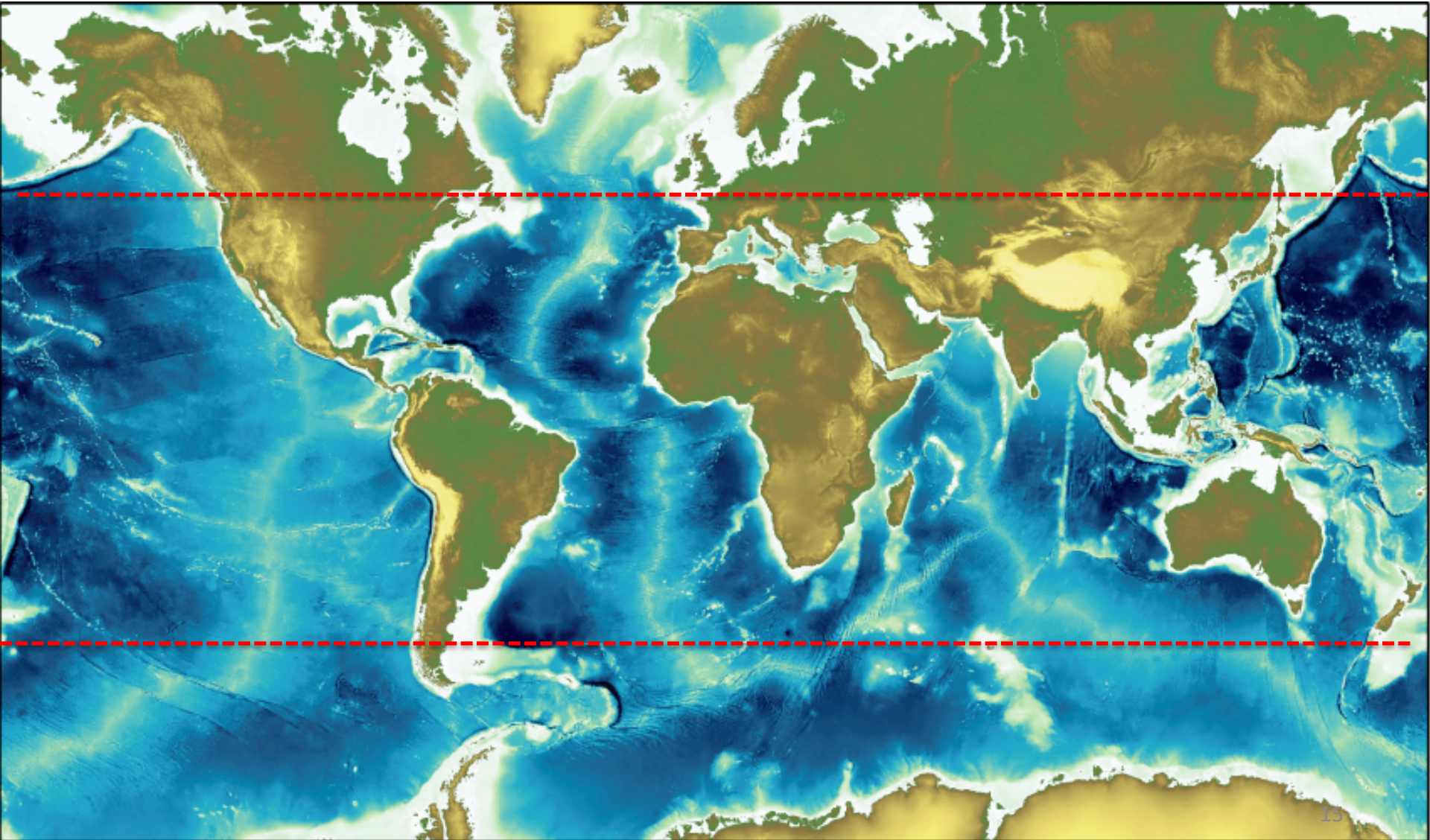
IN RIVER-DOMINATED MARINE SEDIMENTARY SYSTEMS SEDIMENTS ARE MOSTLY **SAND**





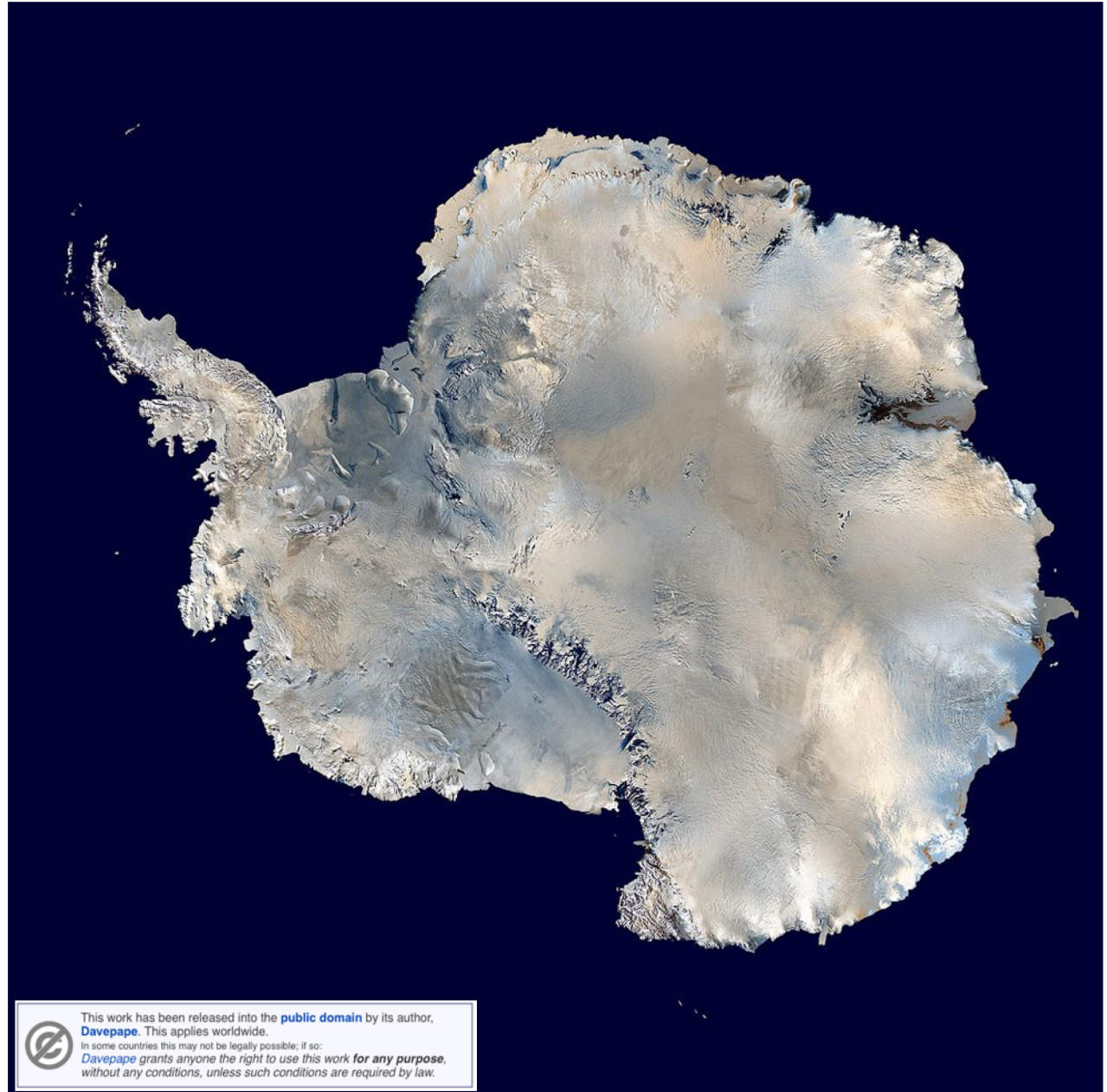
RIVER VERSUS ICE SHEET SEDIMENT SOURCE

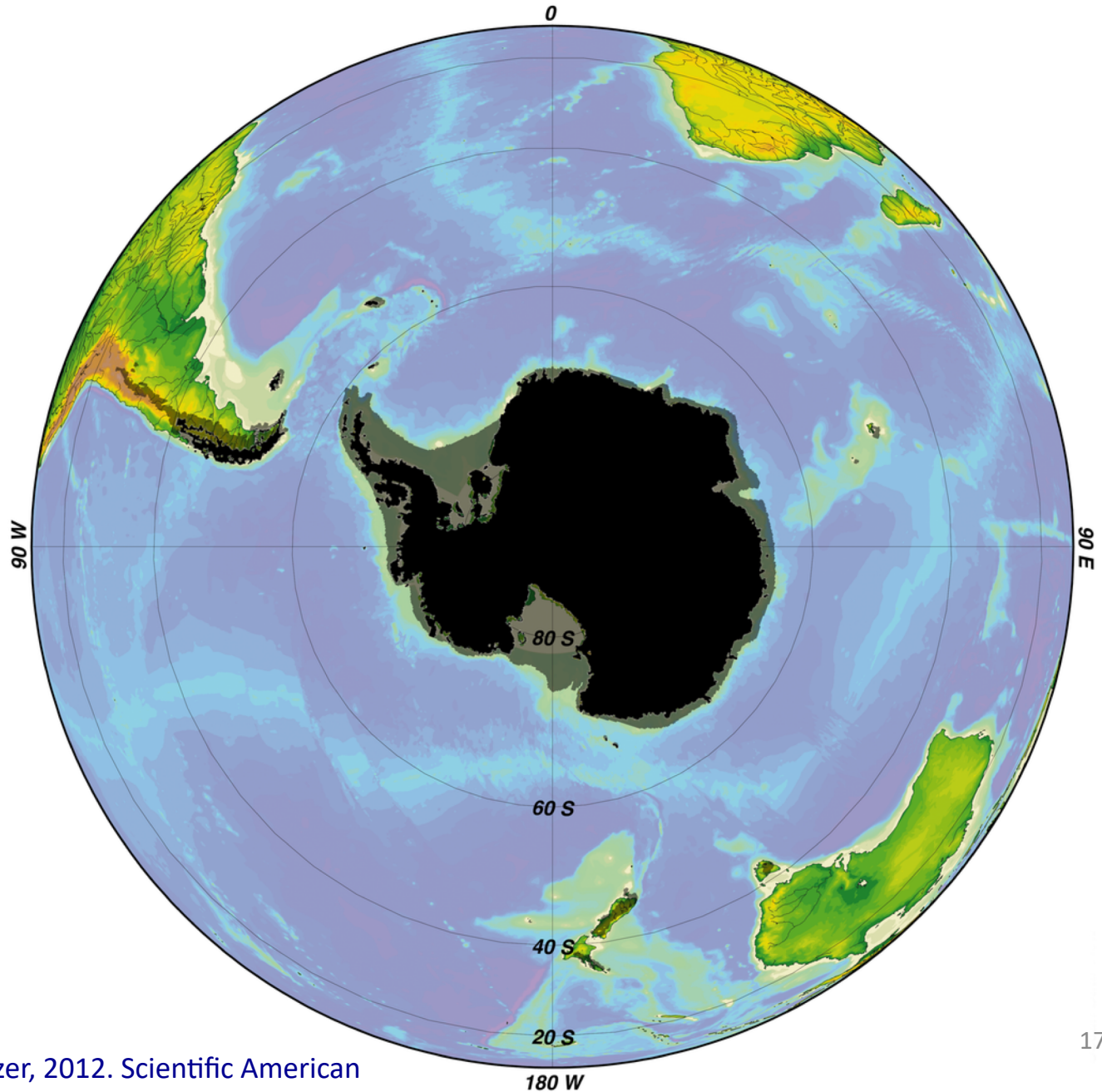
Rifted margins are found in the Entire Atlantic Ocean (except Barbados and South Shetland subduction zone), Antarctica, Arctic, and Indian Ocean



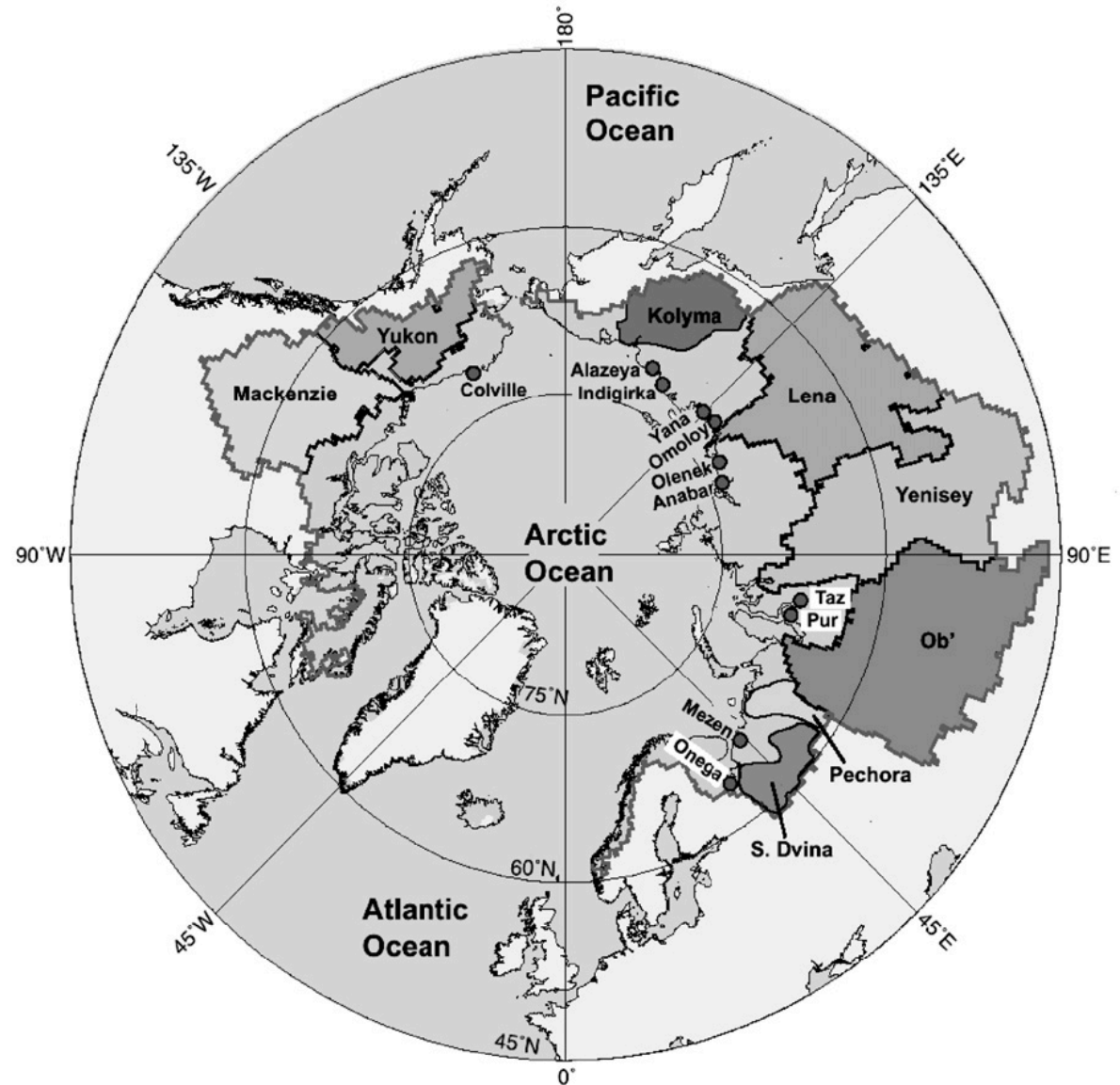
**Antarctica:
No rivers**

**Only ICE-SHEET
DOMINATED
Sedimentary input
to the oceans**

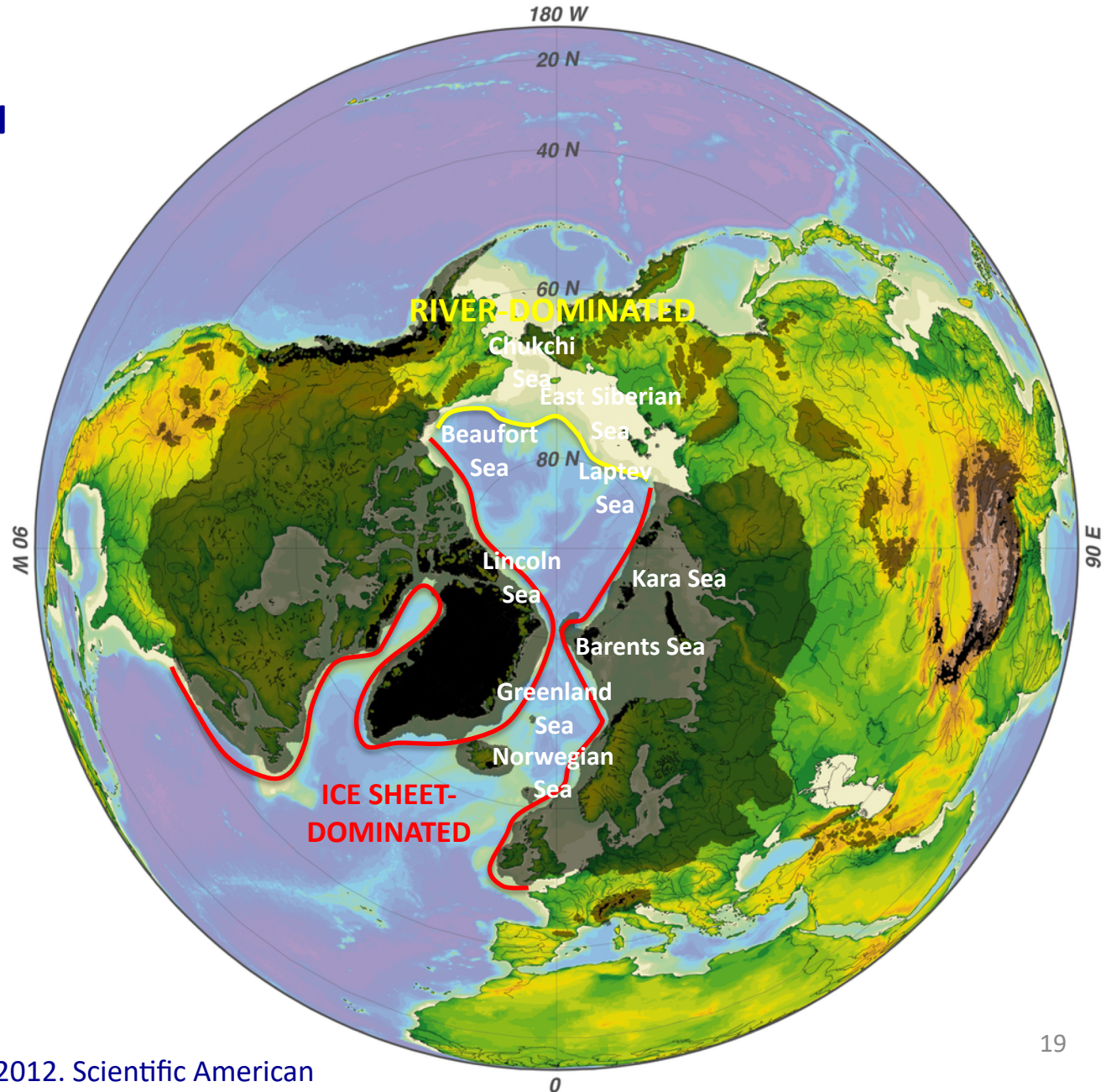




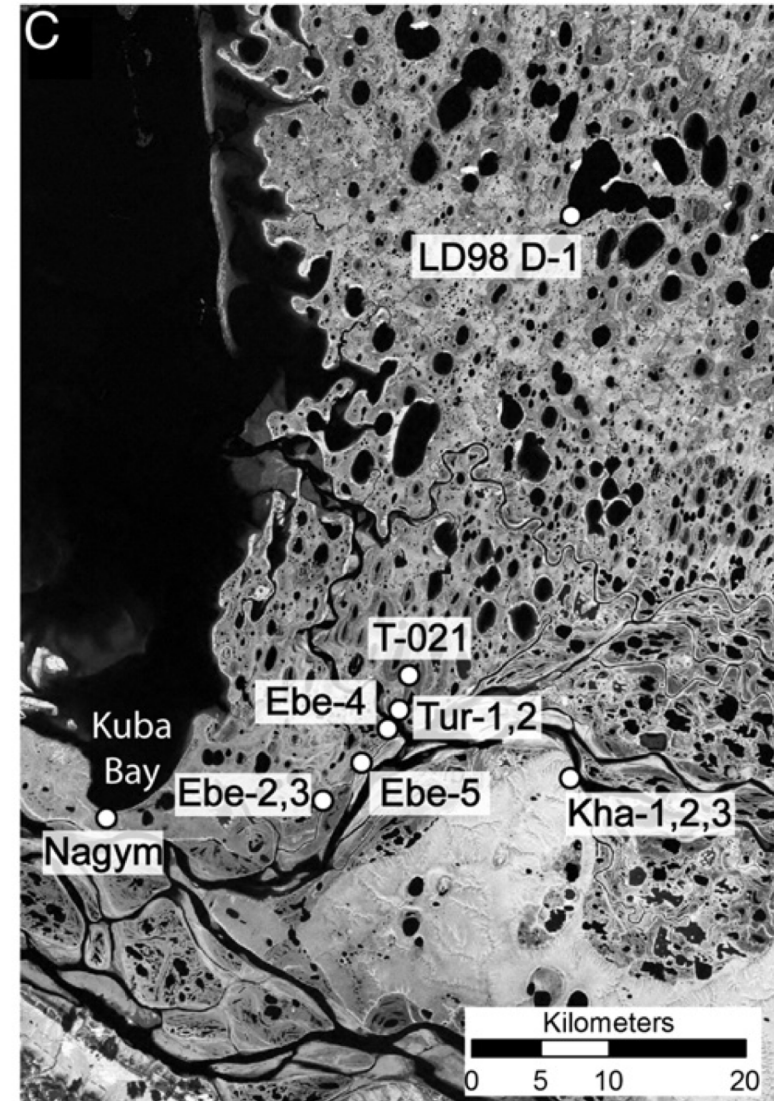
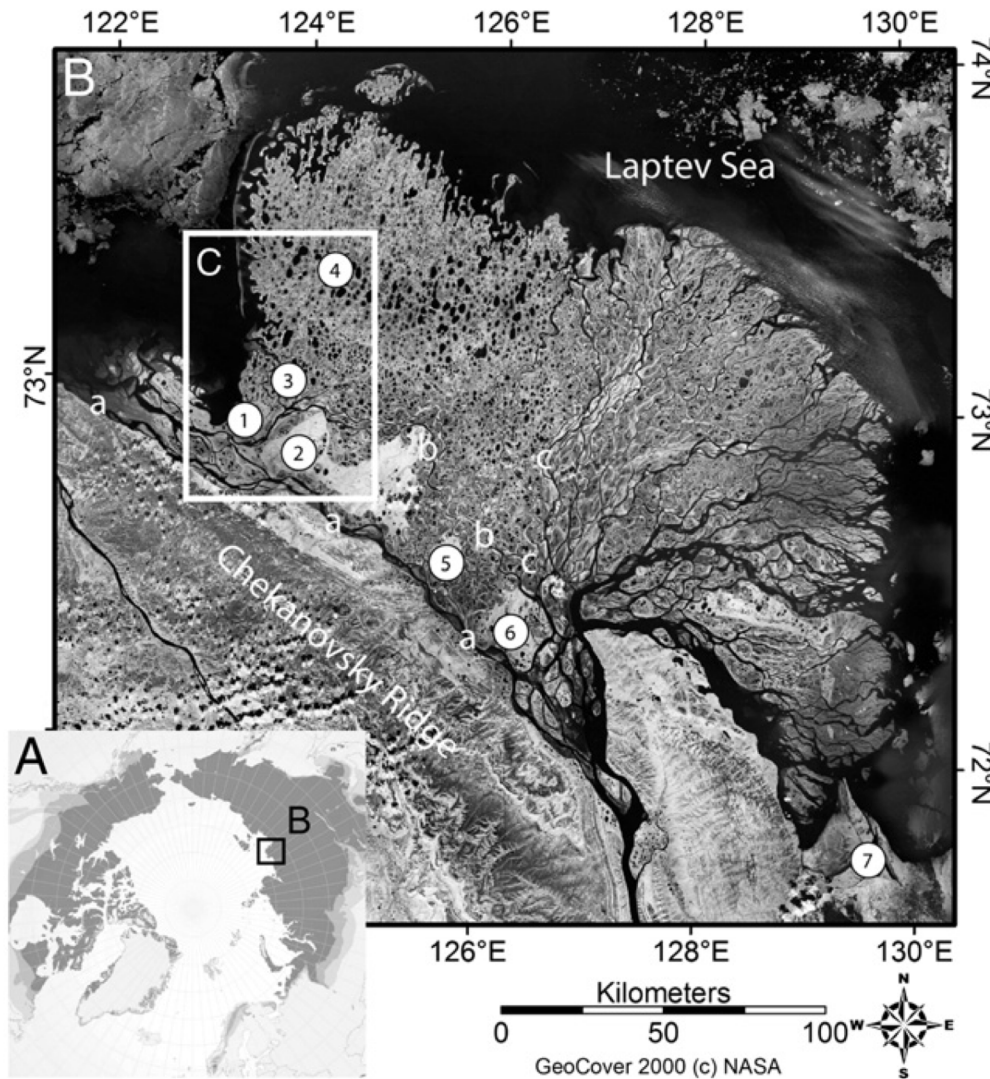
RIVERINE INPUT IN THE ARCTIC OCEAN (During interglacials)



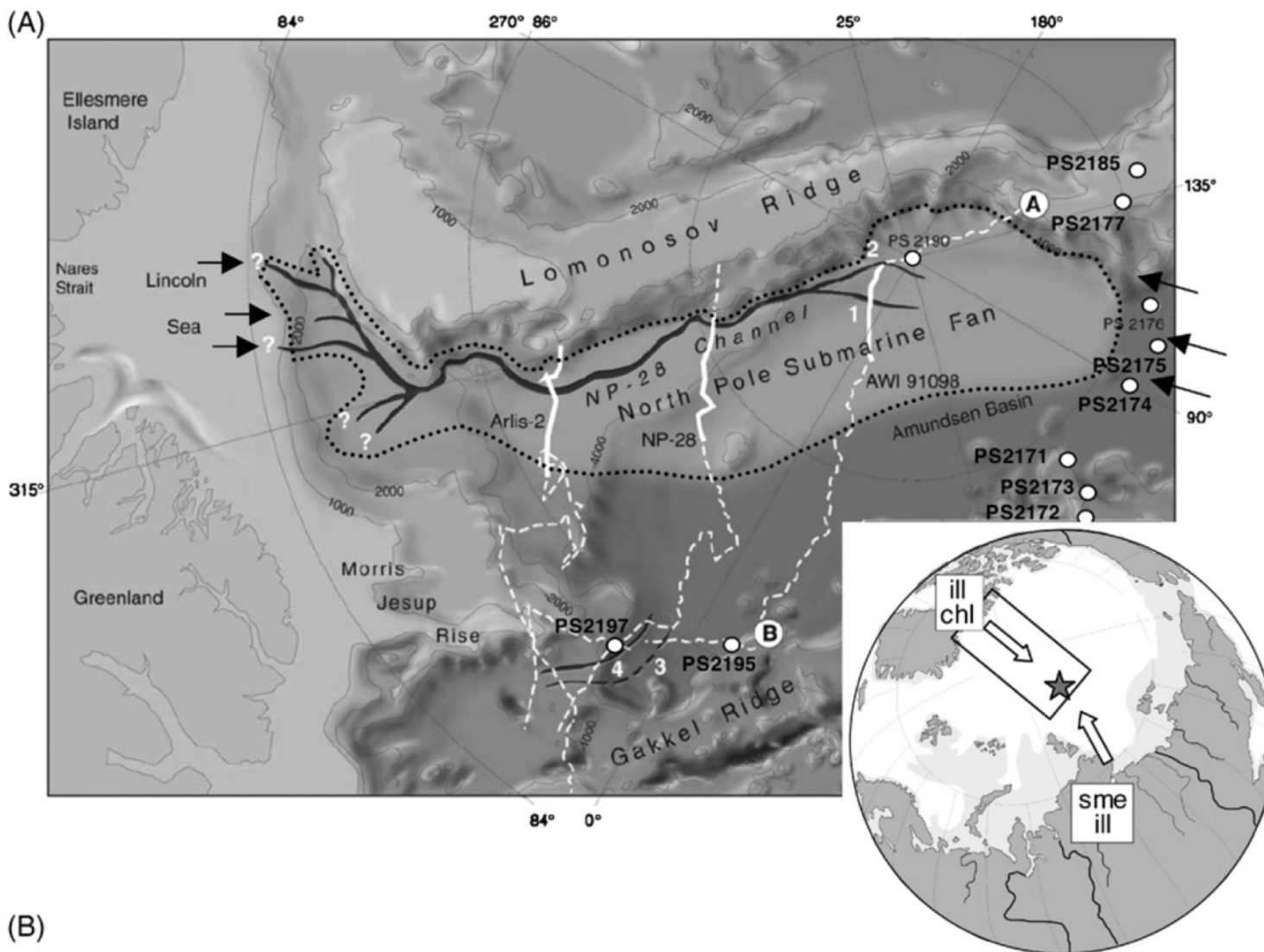
RIVERINE INPUT IN THE ARCTIC OCEAN (During glacials)



Lena Delta Today

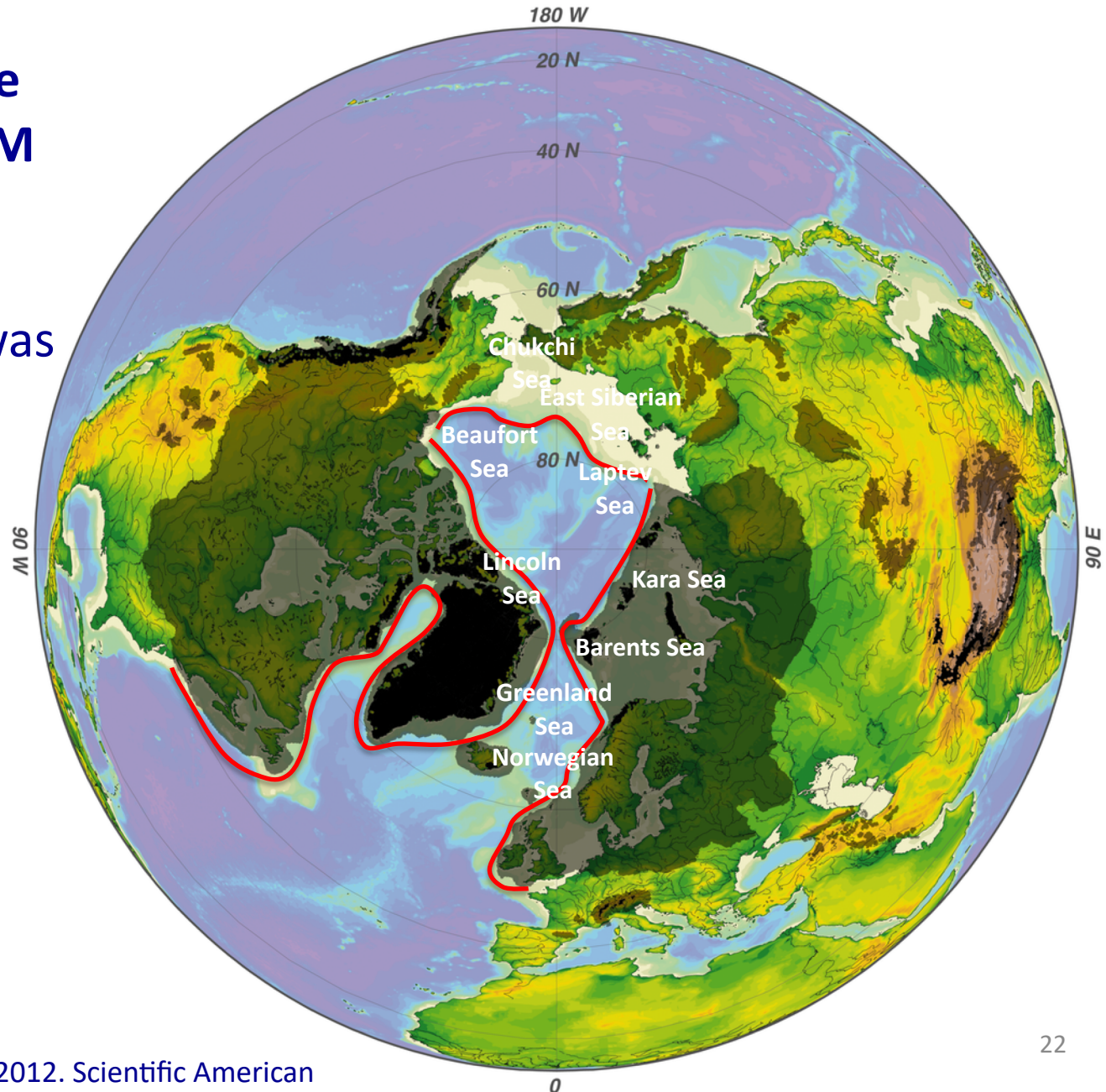


Evidence of Deep Sea fan deposition in the deep Arctic Basin (likely river induced by riverine sedimentary input)



Approximate shore line during the LGM

Not all the Arctic continental shelf was covered by the ice sheet



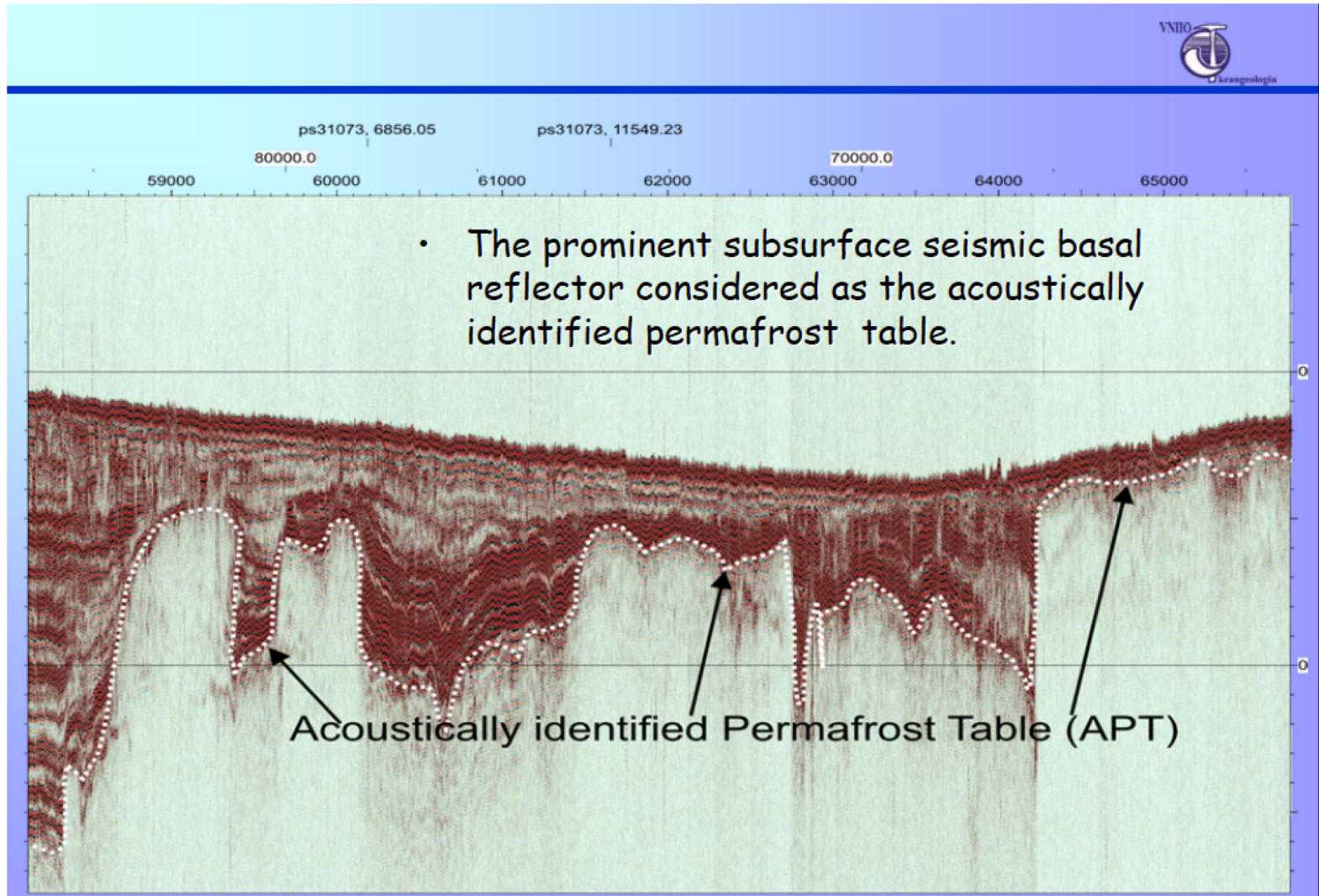


Explanation

- Offshore relic permafrost
- Continuous permafrost (NSIDC)
- Greenland Ice Sheet (NSIDC)

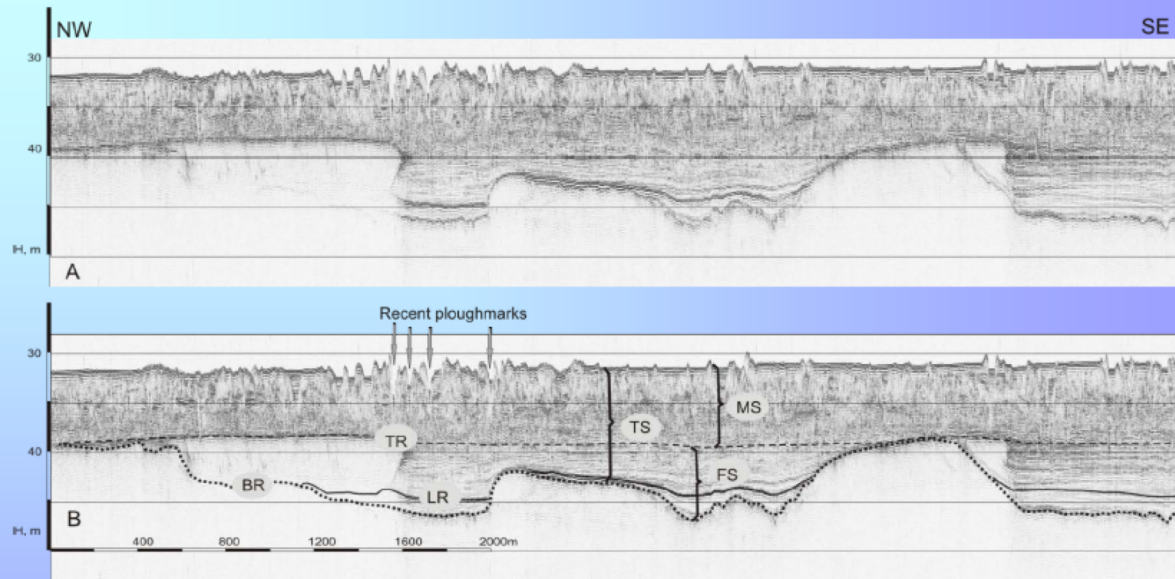
The e continental shelf not covered by ice sheets was exposed to cold temperatures = **Permafrost.**

With deglaciations, these permafrost-bearing shelves were flooded by seawater (+120m sealevel rise) leaving a **relict permafrost** layer below the seabed. Still present today, though slowly thawing





Further study



General seismic facies pattern:

Basal Reflector (**BR**) is clearly seen in the lower part of the seismic-acoustic section. Stratified Transgressive Sequence (**TS**) is bedded on top and divided by the Top Reflector (**TR**) into the Fill Sequence (**FS**) of the depression and Marine Sequence (**MS**). A distinct reflector (**LR**) in the lower part of FS, related to the peat horizon within thermokarst lake deposits



P. Rekant. et al., 2009. In: System of the Laptev Sea and the Adjacent Arctic Seas : Modern and Past Environments





Methane fluxes from the terrestrial environment

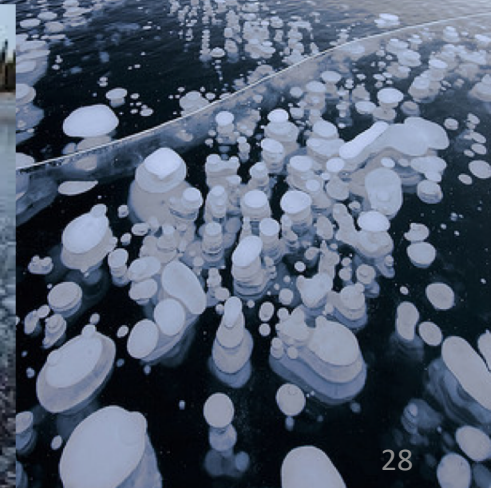
Torsten Sachs

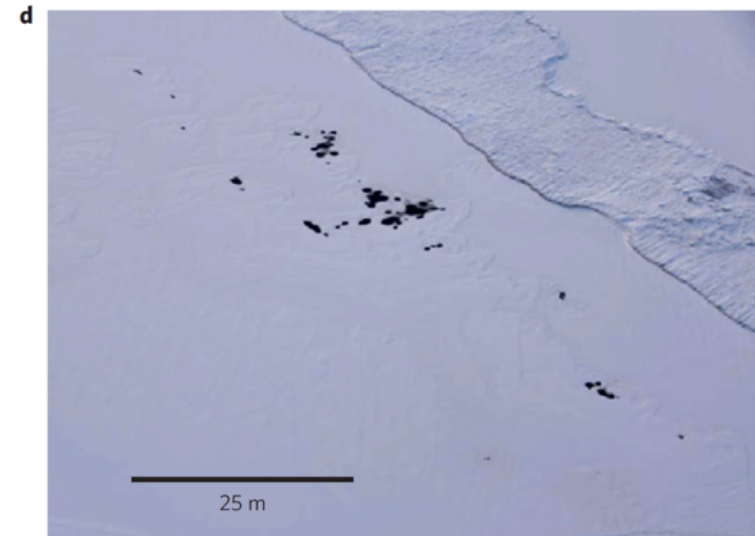
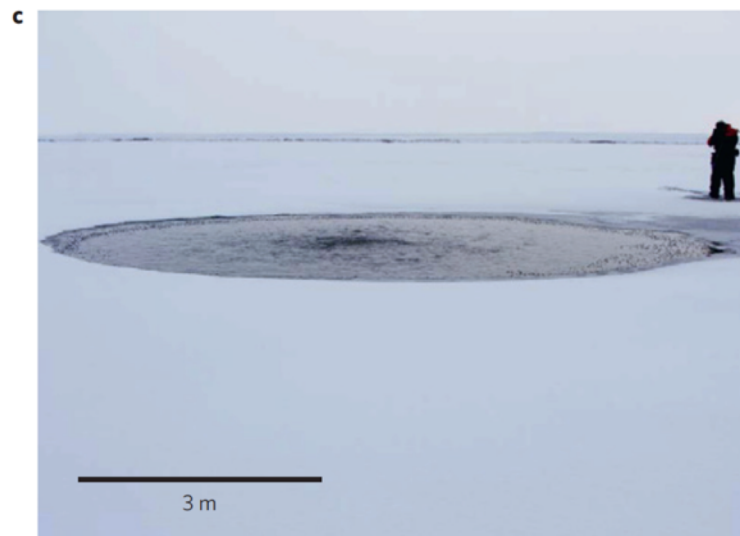
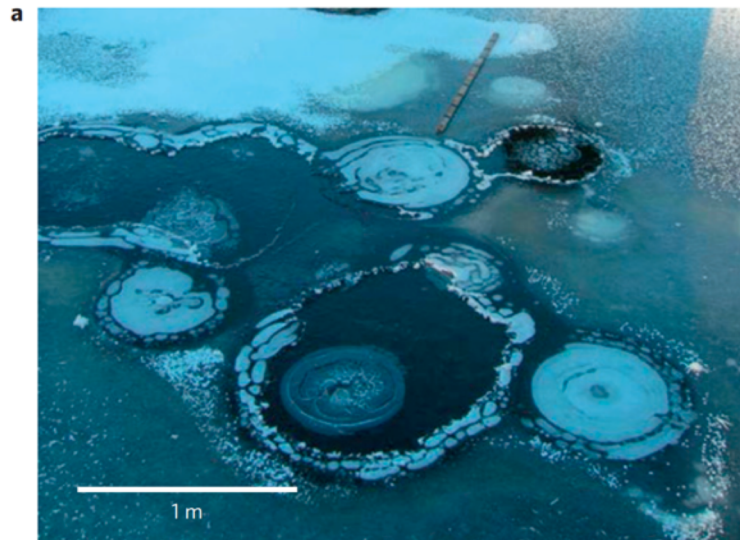
Helmholtz Young Investigator Group TEAM

GFZ German Research Centre for Geosciences, Potsdam

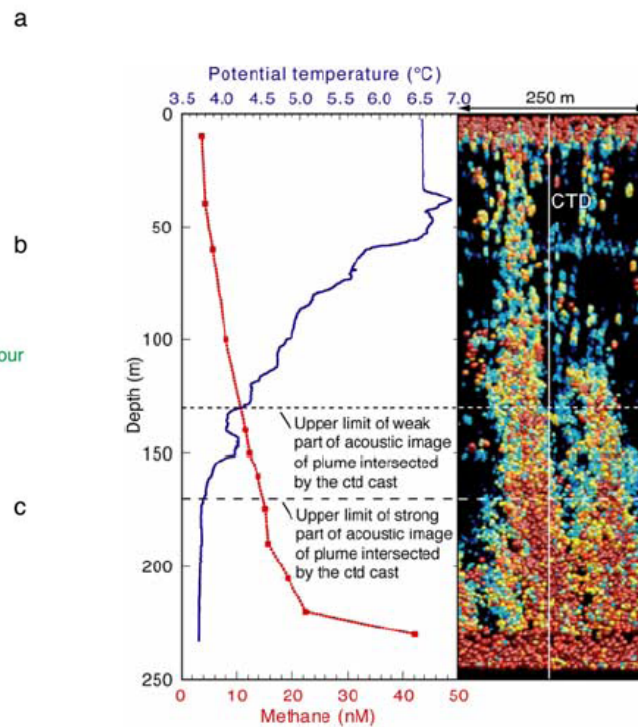
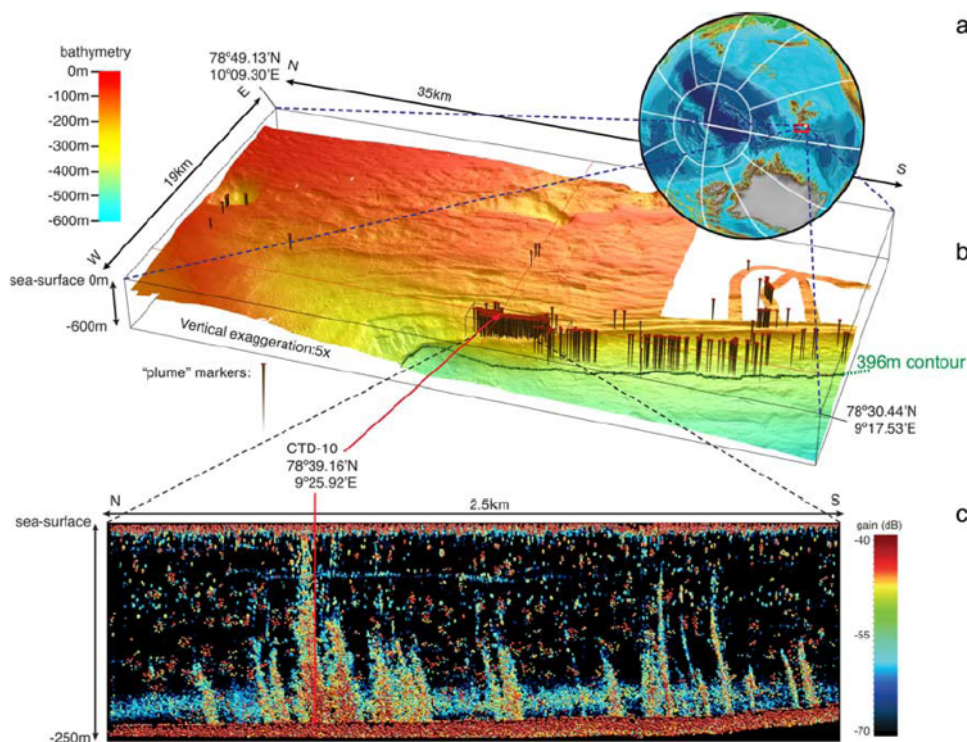


Ice on an Alaskan lake captures methane
Marianne Lavelle, *The National Geographic*. December 2012
Photo Mark Thiessen





DEEP WATER METHANE RELEASE FROM GAS HYDRATES RESERVOIRS



Westbrook et al., 2009, GRL

RIVER DOMINATED:

- Continental shelf edge modulated by sea level
- Deep Sea Fans
- Sand dominated
- Gentle slope
- Sub-sea permafrost

ICE SHEET DOMINATED:

- Continental shelf edge modulated by Ice sheets at glacial maxima
- Trough-mouth fans
- Clay dominated
- Steep slope
- No subsea permafrost