PALEOCEANOGRAPHIC TIME SERIES FROM ARCTIC SEDIMENTS

ISTAS workshop session :

Paleo-Reconstruction and Biological Archives: Decade to Millenium

Authors

Matt O'Regan (matt.oregan@geo.su.se)[1], Katharine Hendry[2], Anna Pienkowski[3], Dayton Dove[4], Christian März[5], Juliane Müller[6] and Kirstin Werner[7]

Overview

Reconstructing past climatic and oceanographic changes in the Arctic significantly contributes to our understanding of the long-term feedback mechanisms in the Arctic Ocean, and their relationship to global change. Arctic climate excursions during the present (Holocene) and earlier interglacials are crucial references for recent and future climate changes.

Fig. 1: Sediment core (Kastenlot) from eastern Fram Strait onbard the German research vessel Maria S. Merian (Photo: Nicolas V. Nieuwenhove)

Studying sediment cores from the Arctic poses two fundamental challenges. The first is comparatively poorly constrained age models. The second is a lack of temporal resolution in slowly deposited Arctic sediments (Fig. 1).

Overcoming these obstacles is a key research priority in the near future, and can be met by the acquisition of sediment records from high sedimentation areas, marginal settings, and through the application of advanced seafloor drilling technologies. A third challenge is understanding and calibrating proxies to reliably reconstruct environmental parameters from sediments (see ART priorities 'Proxy Calibration and Evaluation'). This can be improved by 'ground-truthing' proxies with modern data, e.g., the distribution of microfossils in relation to environmental factors.

Summary

- Improving the **chronological control** of Arctic sedimentary records in order to correlate geological features of the Arctic Ocean to the global ocean.
- Focus on **high-resolution sedimentary records** from the shelves and margins of the Arctic Ocean
- Find **analogues to present and future** warm climate in Arctic geologic history
- Integration of marine and terrestrially-derived datasets to reconstruct **past land-ocean linkages**
- **Acoustic mapping of seabed and shallow sub-seabed** combined with chronological and proxy data
- Utilization of **ground-truthing technologies**

The ISTAS interdisciplinary and international workshop (Integrating spatial and temporal scales in the changing Arctic System: towards future research priorities) was organized in October 2014 by the Arctic in Rapid Transition (ART) network at the IUEM in Plouzané, France. The overarching objective of the workshop was to bring together Arctic scientists of different areas of expertise and experience level in order to discuss future research priorities for the Arctic Ocean and adjacent coasts from an early and mid career researchers' perspective. This set of priority sheets summarizing the workshop's discussions is one of the contributions of the ART network to the 3rd International Conference on Arctic Research Planning (ICARP III) in Japan.

PALEOCEANOGRAPHIC ARCTIC TIME SERIES

RESEARCH PRIORITIES
APPROACHES AND RECOMMENDATIONS

▶ Chronology and Age Control
- Development of rigorous age models for geological archives to allow robust cross-comparison of records within the Arctic and to the global ocean.
- Find appropriate sediment material for AMS radiocarbon dating.
- Determination of appropriate regional reservoir ages.

▶ High-resolution Time Series
- Develop high-resolution time series of a range of proxy archives (see ART priorities 'Proxy Calibration and Evaluation').
- Capture millennial-scale climate and oceanographic variability in sediments in order to reconstruct past response of the Arctic marine system to abrupt climate changes.
- Incorporation of Arctic proxy data into high-resolution climate models.

▶ Land-Ocean Linkages
- Integration of marine- and terrestrially-derived multiproxy datasets from key geographical areas (e.g., incorporation of terestrially-derived sea-level curves and deglacial dating into marine; see also ART priorities 'Arctic Land-Ocean Interactions').
- Comparison of marine data with terrestrially based climatic episodes.

▶ Past Periods of Warmth
- Find past analogues to present climate conditions (e.g., by using modern analogue techniques and multiproxy approaches) from key periods in Earth's history, e.g.:
- Holocene Thermal Maximum (8 to 10,000 years ago)
- Last Interglacial (~120,000 years ago)
- Pliocene (2 to 5 million years ago)
- Miocene Climate Optimum (16 to 18 million years ago)
- Early Cenocoic Warming event (e.g. Paleocene/ Eocene Thermal Maximum 54 million years ago)

▶ Acoustic mapping of Seabed and Shallow Sub-Seabed
- Detailed and accurate mapping of seabed and shallow sub-seabed environments underpins multiple disciplines (e.g., benthic ecology, geomorphology).
- Seabed geomorphology characterizes processes which form and actively govern seabed environment.
- Shallow sub-bottom profiler and seismic data provide 3D characterization of sub-seabed environments in order to correlate sedimentary records.
- Combination of bathymetric and seismic data together with chronological and proxy data extracted from core analysis provides a powerful tool for reconstructing paleo environments.

▶ Ground-truthing Technologies
- Coring (ship-based, e.g. piston cores) can be deployed from most research vessels.
- IODP-drilling (e.g. advanced piston coring (hundreds of meters) or seabed drills (up to ~80m)) may require specialized vessels.
- Downhole logging (e.g., spectral gamma) used for stratigraphic correlation and core-seismic correlation.

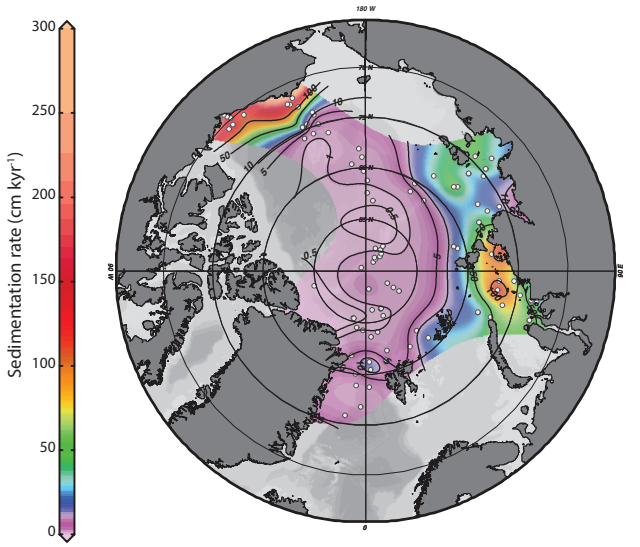

Fig. 2: Holocene sedimentation rates derived from radiocarbon dated sediments (gridded in Ocean Data View; Wegner et al., 2015, Polar Research)

Affiliations:
[1] Stockholm University, Sweden; [2] University of Bristol, UK; [3] Bangor University, UK; [4] British Geological Survey, UK; [5] Newcastle University, UK; [6] Alfred Wegener Institute, Germany; [7] Byrd Polar and Climate Research Center, USA

Contributors:
Natalia Barrientos, Martin Bartels, Nikolai Pedentchouk