How does increased paleosurface reconstruction contribute to understanding of the Arctic?

Developing a deep time paleoclimate field laboratory in Svalbard

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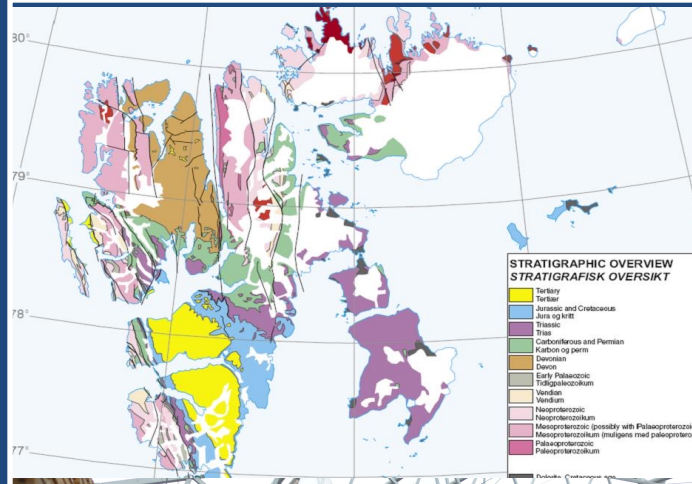
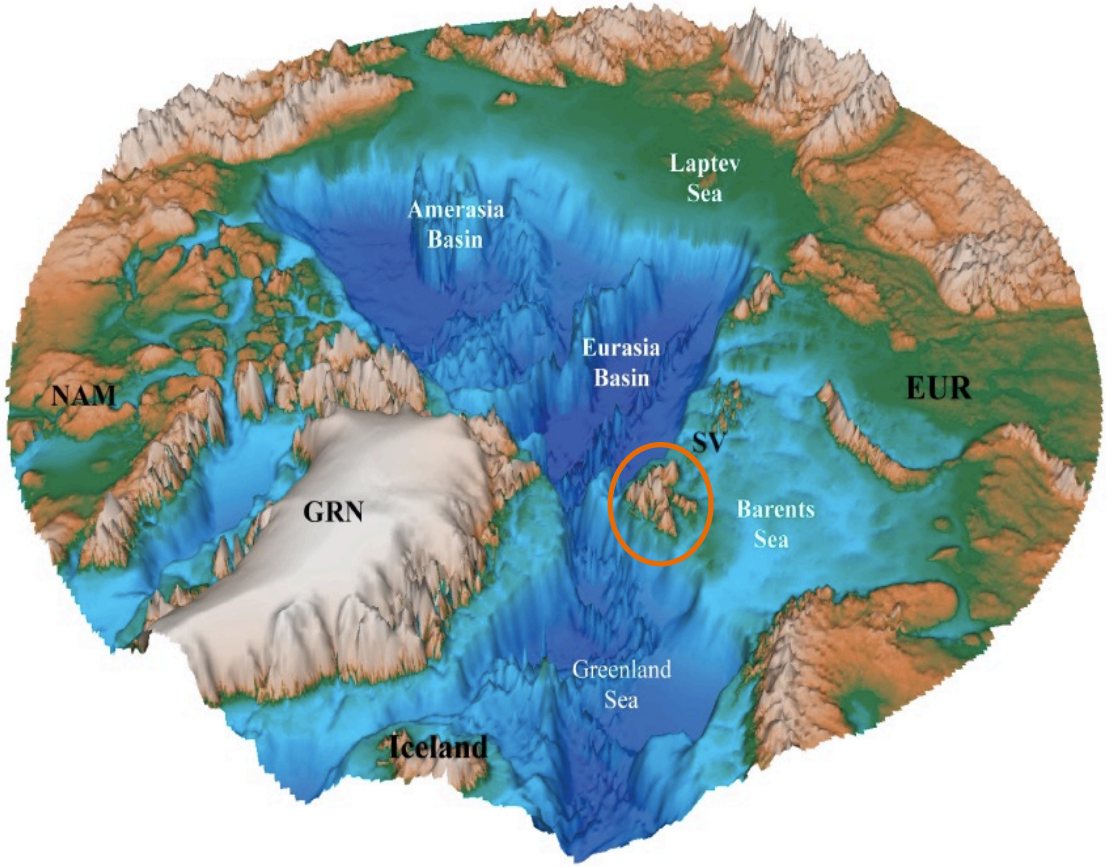
And contributions from Kim Senger, Aleksandra Smyrak-Sikora and colleagues and students from the Arctic Geology department at UNIS

Key Points

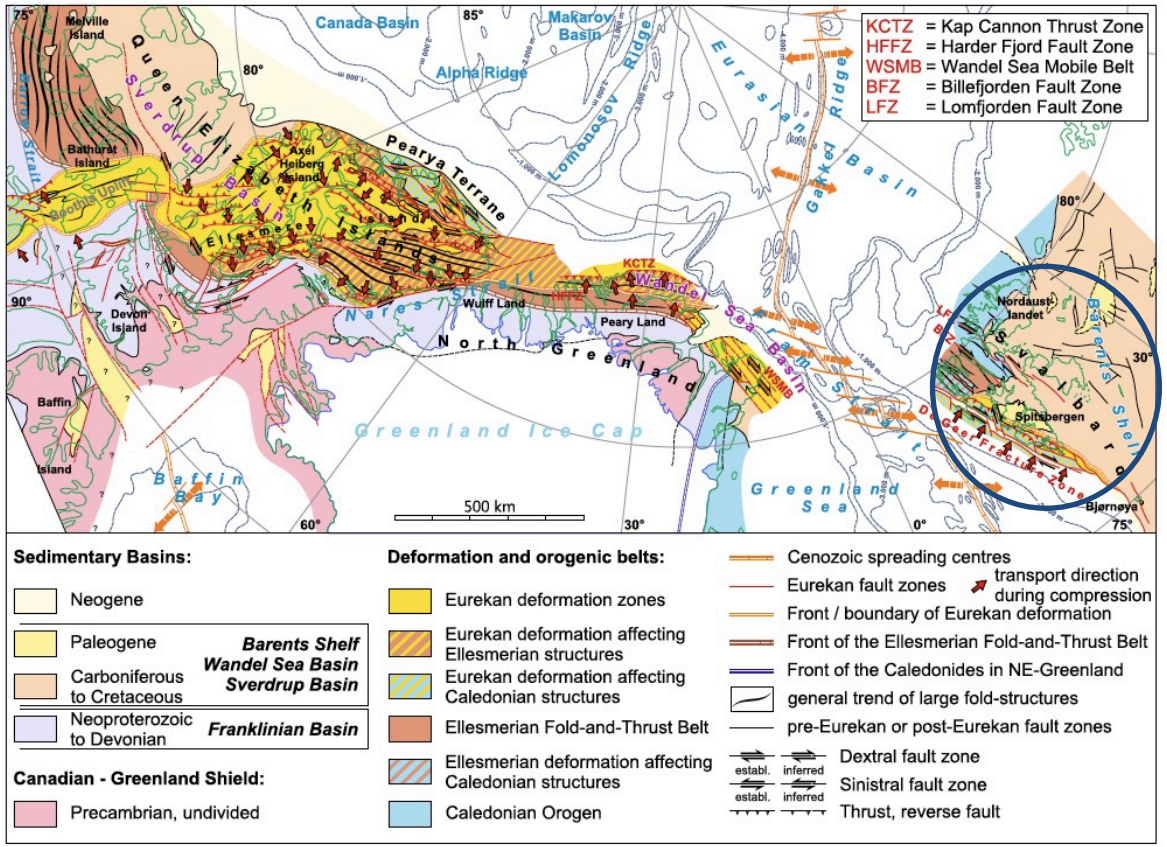
- The Svalbard archipelago represent geological history ranging from the Precambrian to the Holocene with outcrops and core material available through major tectonic and climatic events from the Marinoan snowball earth glaciation (650 mio yrs) to PETM and Quaternary glaciations.
- Extensive coal exploration, onshore petroleum drilling and CCS-research initiatives provide a (for the high-Arctic) unique amount of well-documented cores and boreholes ideal for palaeoclimate research. Coupled with increasing precision of palaeogeographic models palaeoclimatic proxies can also be put in context of landscape development.
- The permanent settlement in Longyearbyen, well-developed infrastructure and location of the University Centre in Svalbard with year-round presence of staff and students provides competence, access and high potential for synergy between palaeoclimate data collected here.



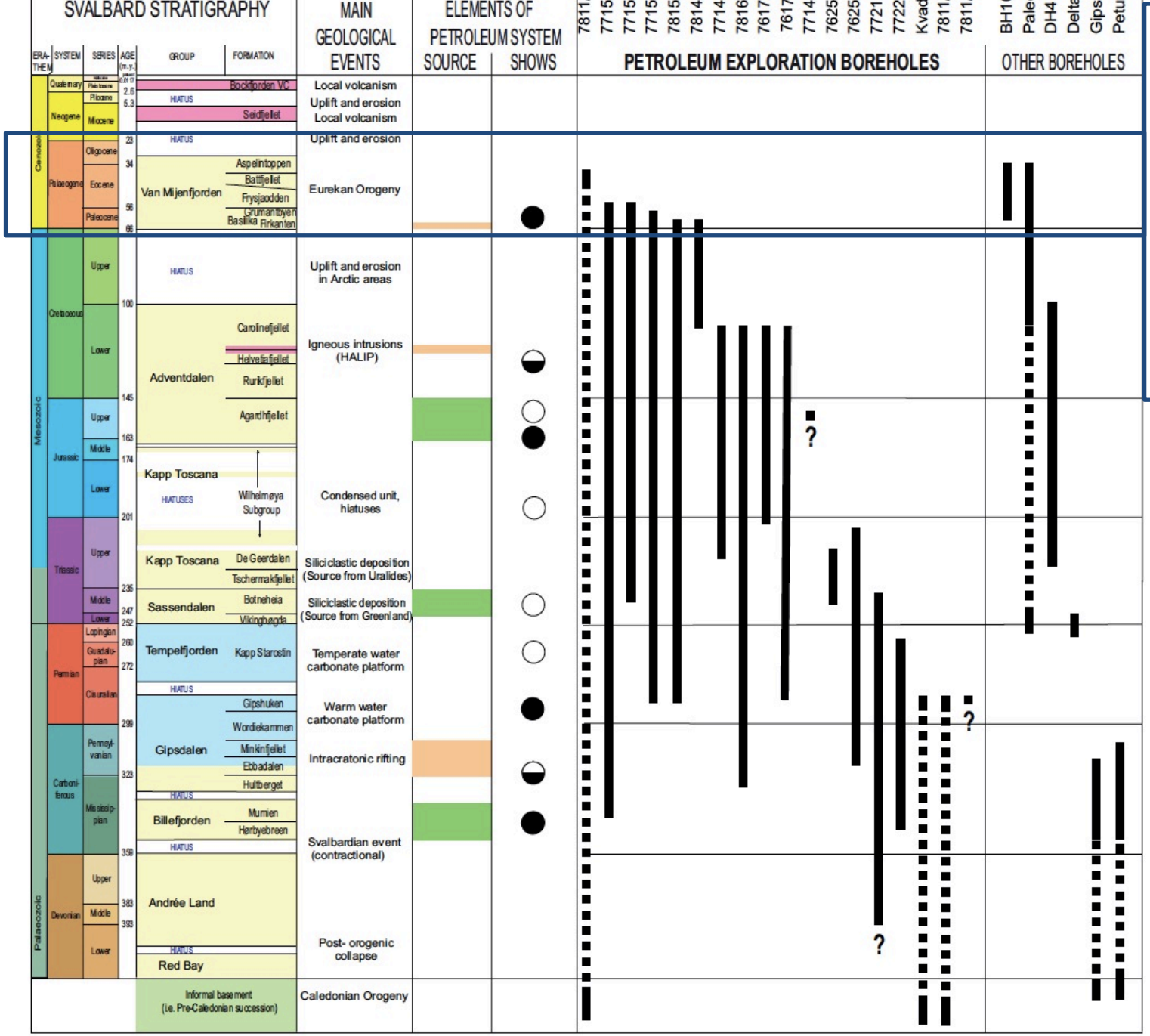
Svalbard is located at the margin of the Eurasian basin and the north Atlantic spreading zone
Svalbard is connected tectonically to northern Greenland through the Ellesmerian orogeny (earliest Carboniferous) and the Eurekan orogeny (Eocene) and to the spreading zones in the arctic through HALIP (outcrops) and Paleocene bentonites.



(Mandea & Gaina 2012)



(Piepjohn et al 2015)



Additional boreholes from the Cenozoic:

More than 400 exploration and technical drill cores from coal exploration.

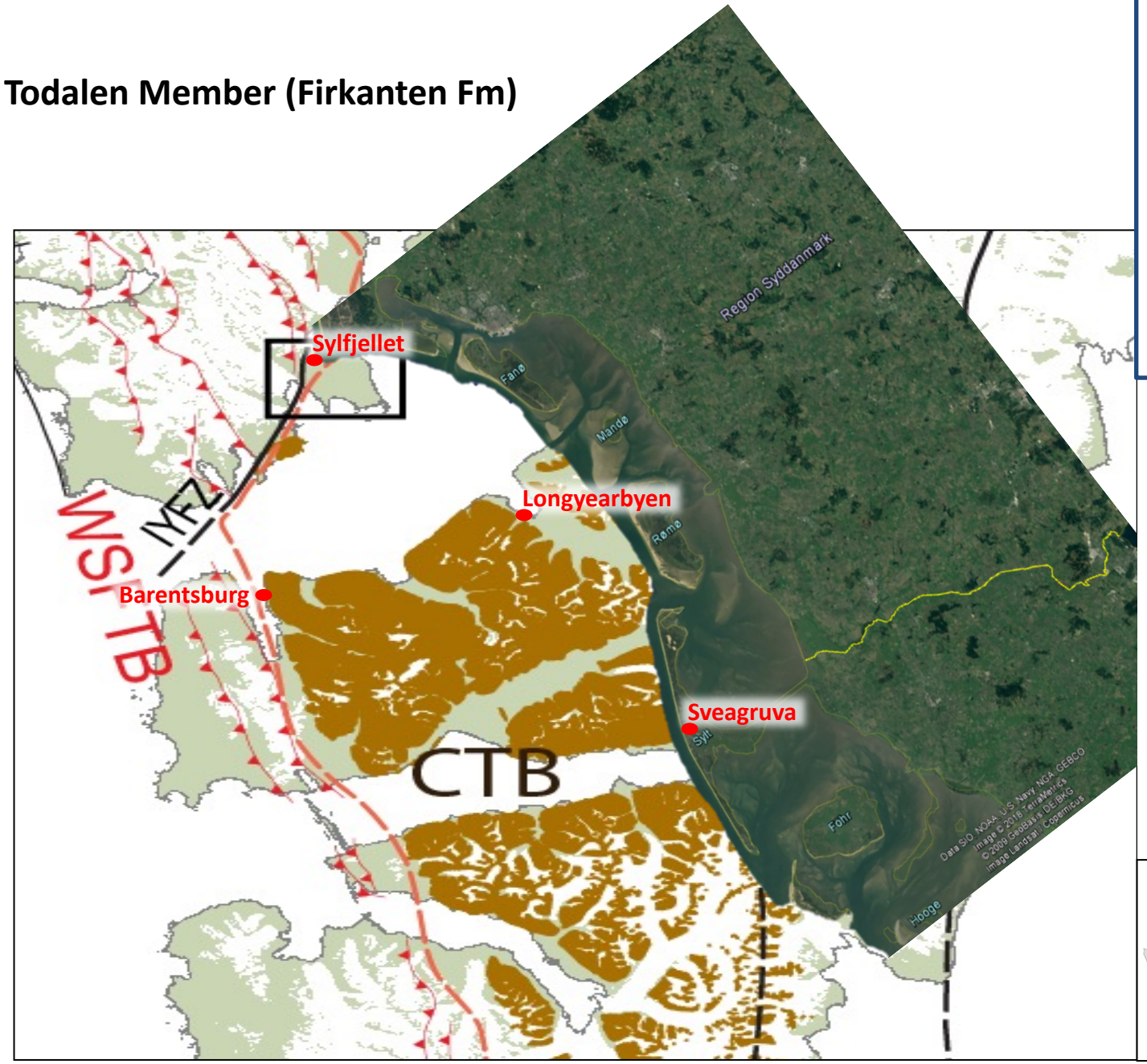
Detailed archive of a nearly complete Foreland basin succession during the Eurekan orogony

LEGEND

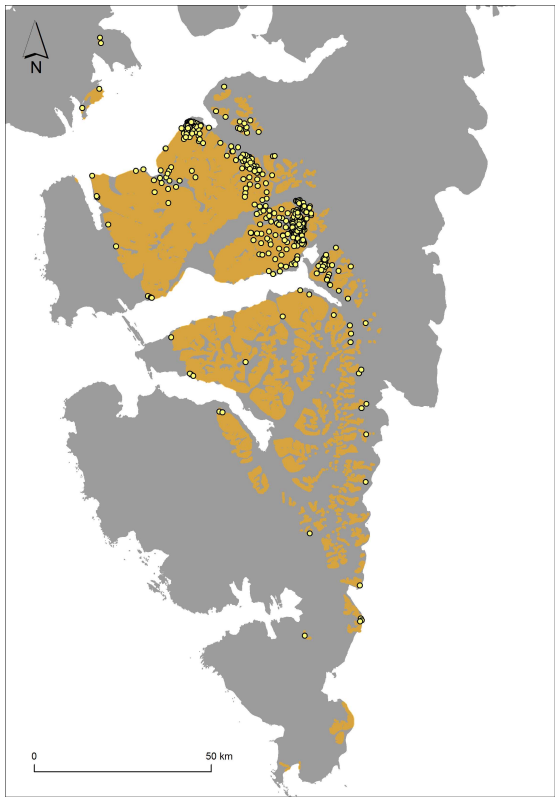
- Volcanic/igneous rocks
- Siliciclastics dominated strata
- Carbonate- and evaporite- dominated strata
- Metamorphic rocks
- Potential source rock
- Confirmed source rock
- Gas shows
- Oil shows
- Stratigraphy covered in well
- Stratigraphy missing in well

(Senger et al. 2019: Petroleum, coal and research drilling onshore Svalbard – a historical perspective)

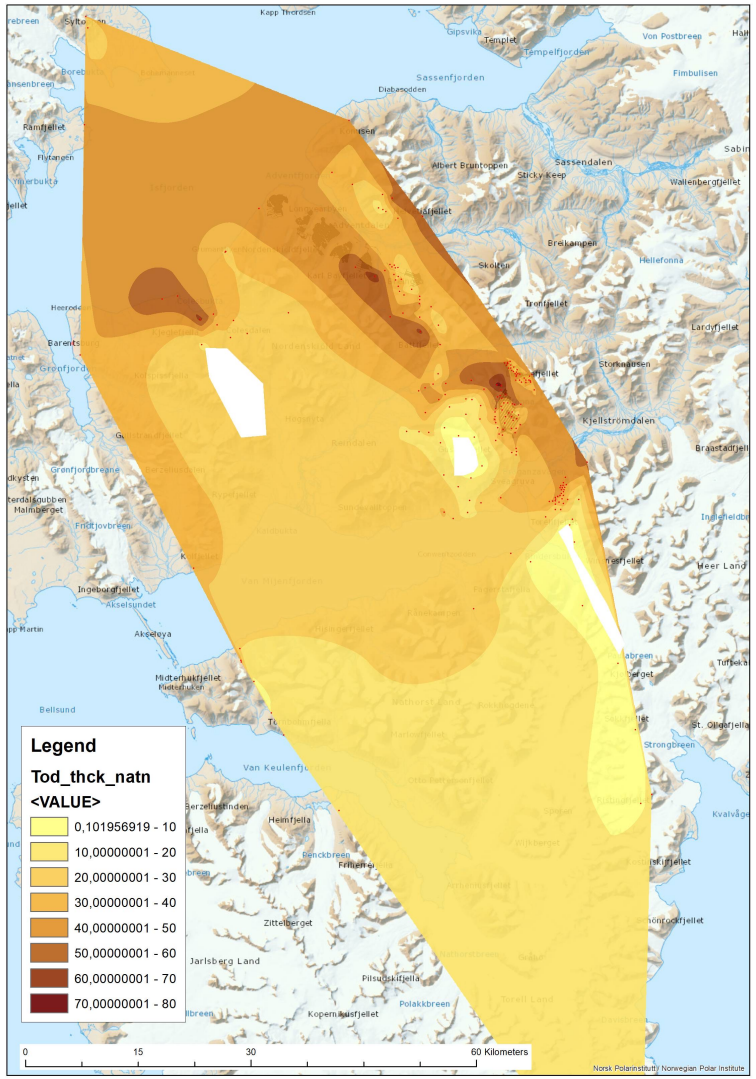
Todalen Member (Firkanten Fm)



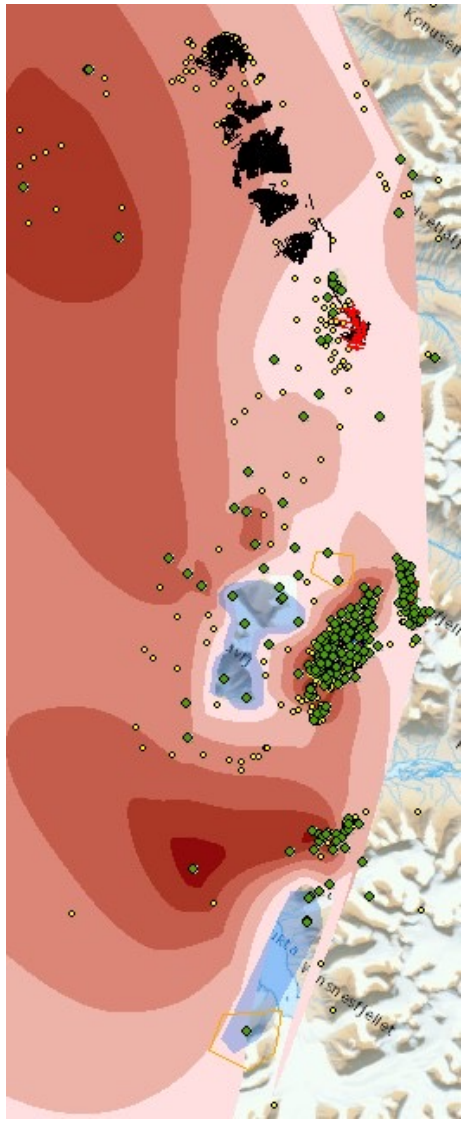
- Bentonite as isochron gives excellent correlation
- Isochronous paralic belt of more than 150 km is reconstructed in high detail
- Great field lab to study paralic deposits in high detail



Todalen Member

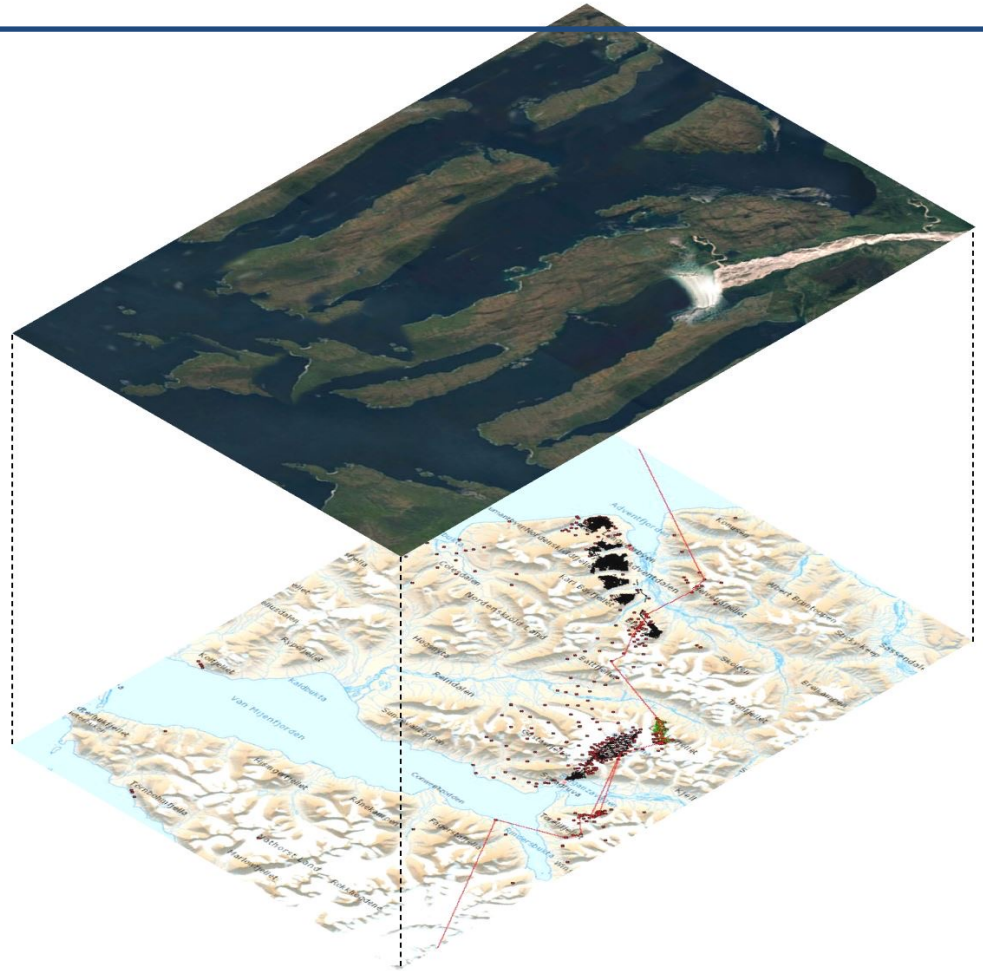


Above bentonite

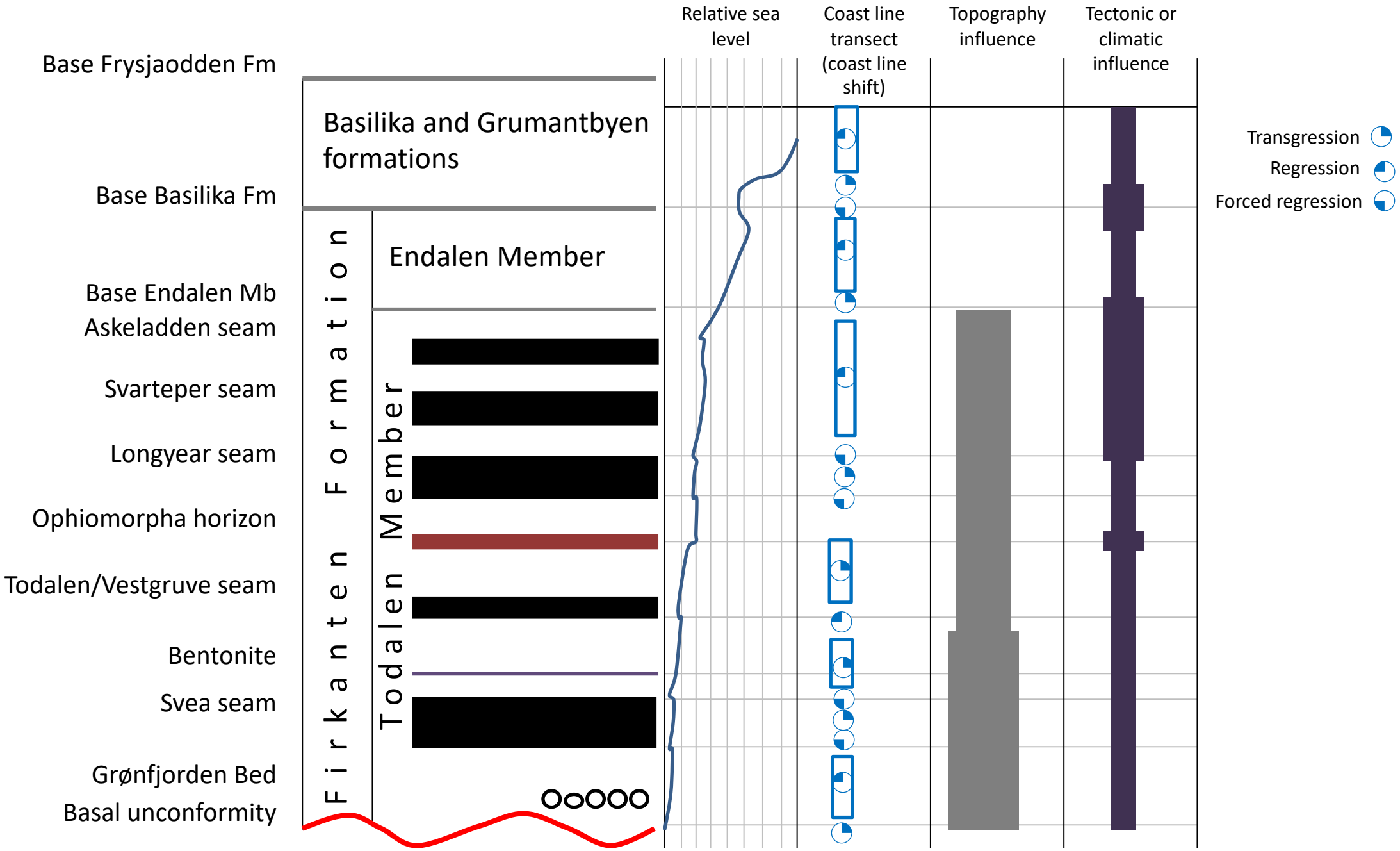


Thickness maps, bentonite as an isochron and high resolution lateral control yields palaeotopography

Detailed understanding of where landform elements develop (peatlands, rivers, barrier island and how the coastline develop during transgression



Data from ongoing PhD project (Jochmann et al. in prep)



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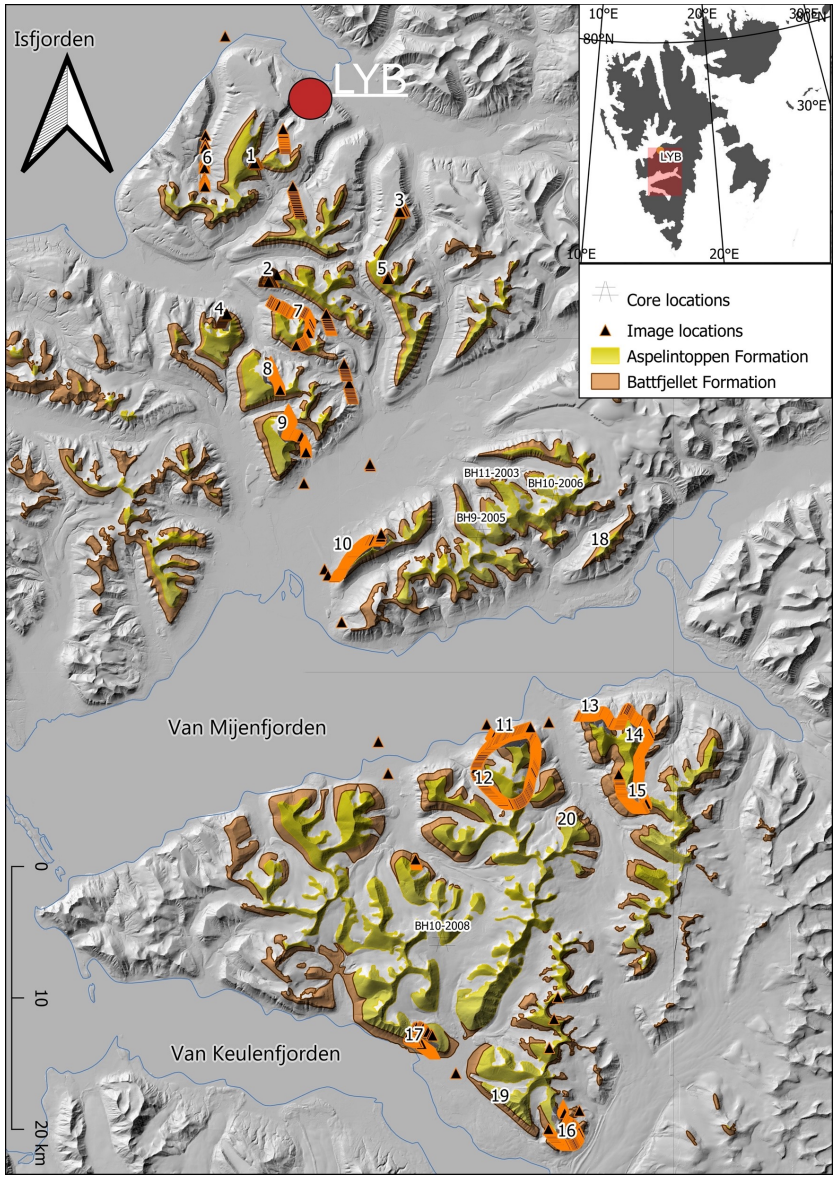
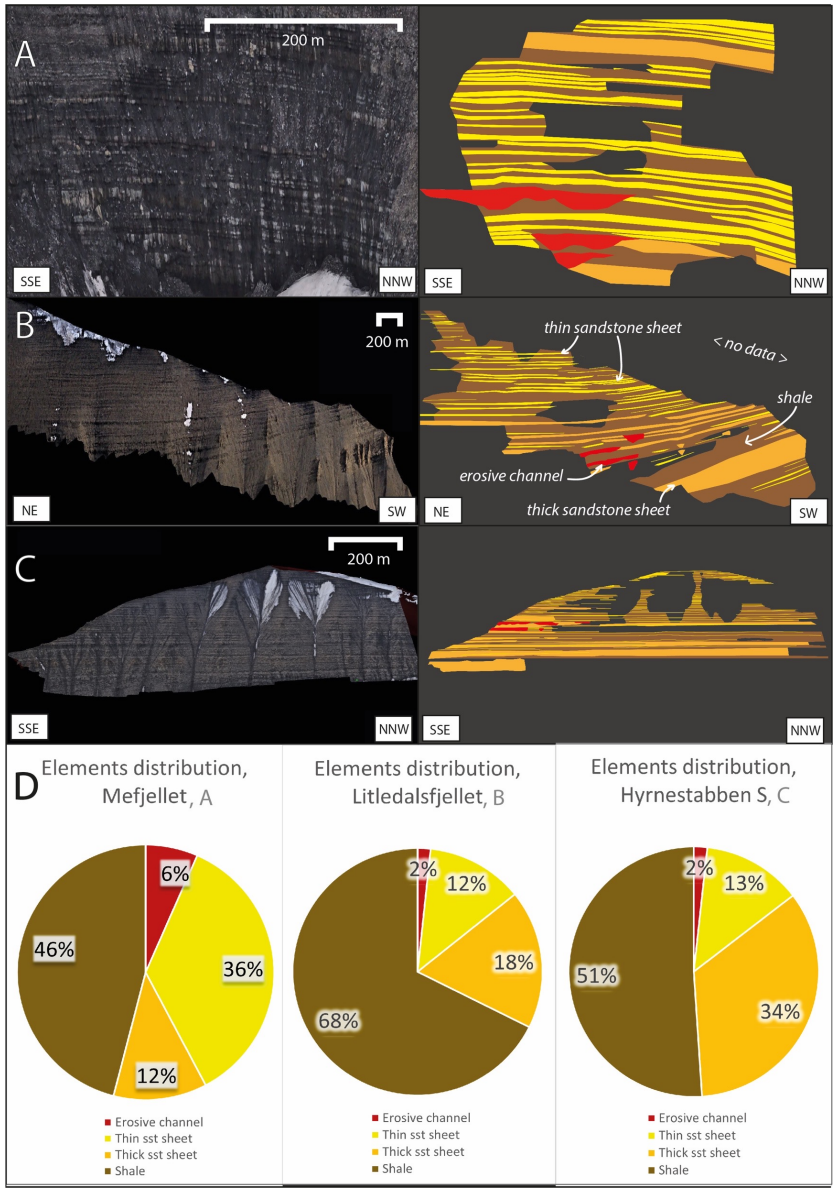




In addition to core material, outcrops and virtual outcrops are used for improved understanding of landscape elements and terrain.

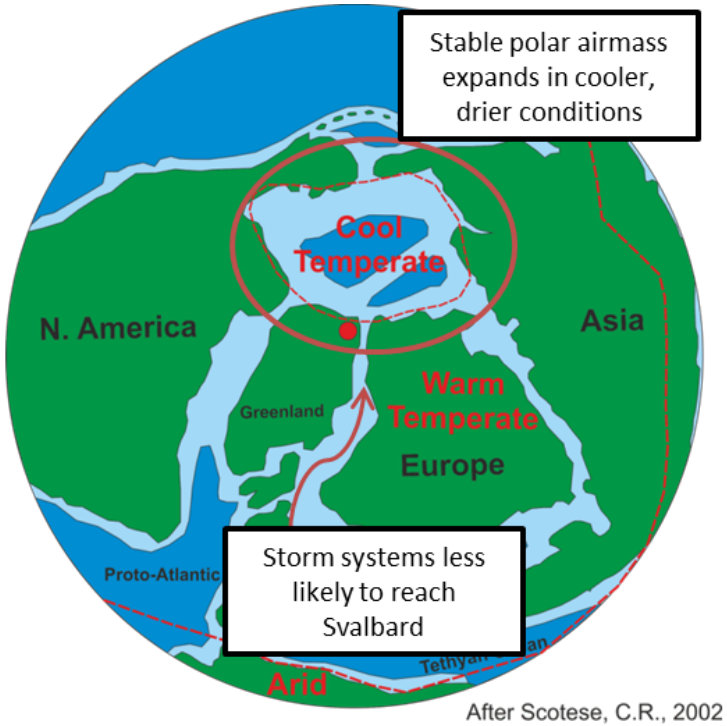
3D reconstruction of Floodplain strata from the Aspelintoppen Fm. Sedimentation distribution and storage patterns during the Eurekan orogeny.

Made possible through virtual outcrops

Data from ongoing MSc project (Mannerfelt MSc Thesis)

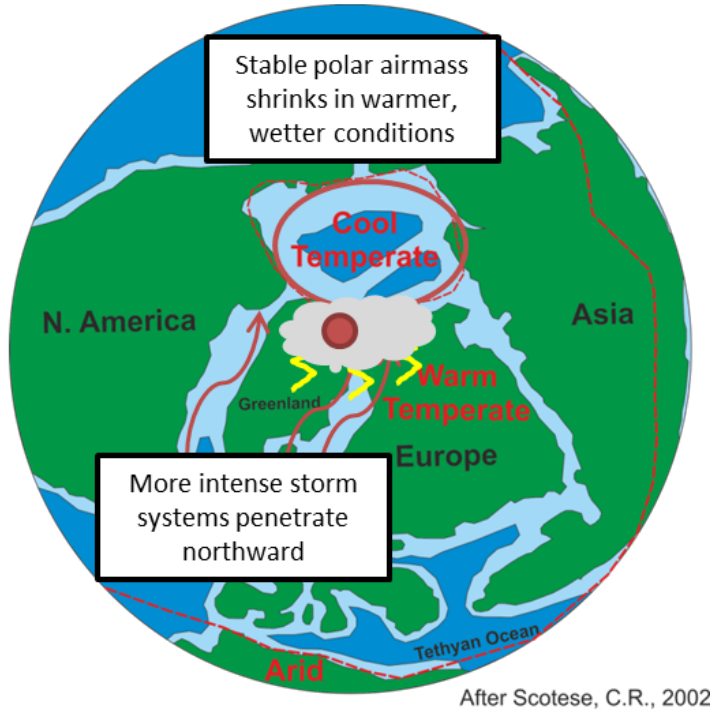
Palaeogene coal seams as a key to high-resolution palaeoclimate

In addition to being marker horizons – the Paleocene coal seams contain High-resolution palaeoclimate proxies.



After Scotese, C.R., 2002 and Weijers *et al.* 2007

Dry Conditions

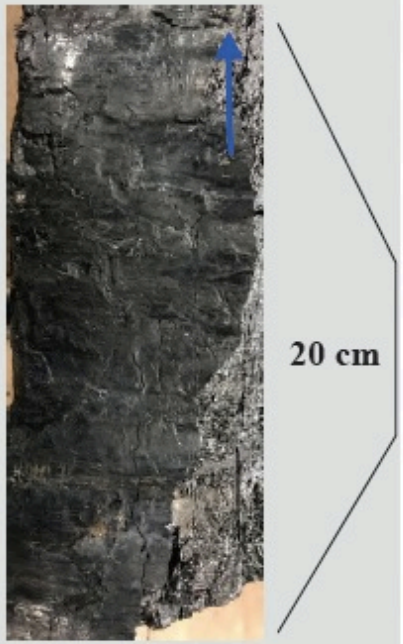


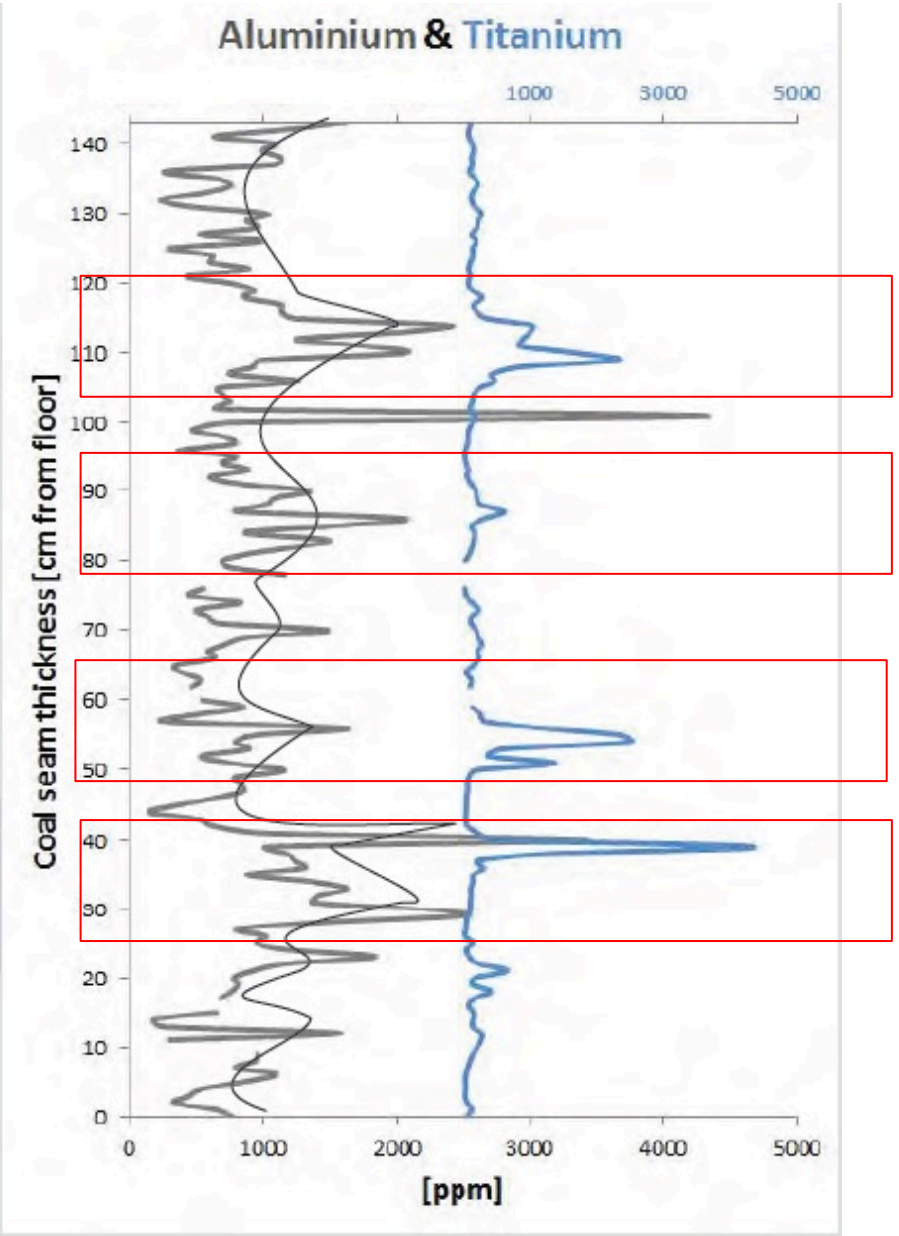
After Scotese, C.R., 2002 and Weijers *et al.* 2007

Wet Conditions

(Marshall 2013)

Examples of XRF data from the Longyear coal seam in mine 7 (ca. 100 kyr of palaeoclimate variation in the Palaeocene. This is a time, where we have high-resolution knowlege of the lateral distribution of topography and palaeogeography. This provides **a unique high-resolution record of Palaeogeography and Palaeoclimate interaction in the Arctic**





Dry?

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