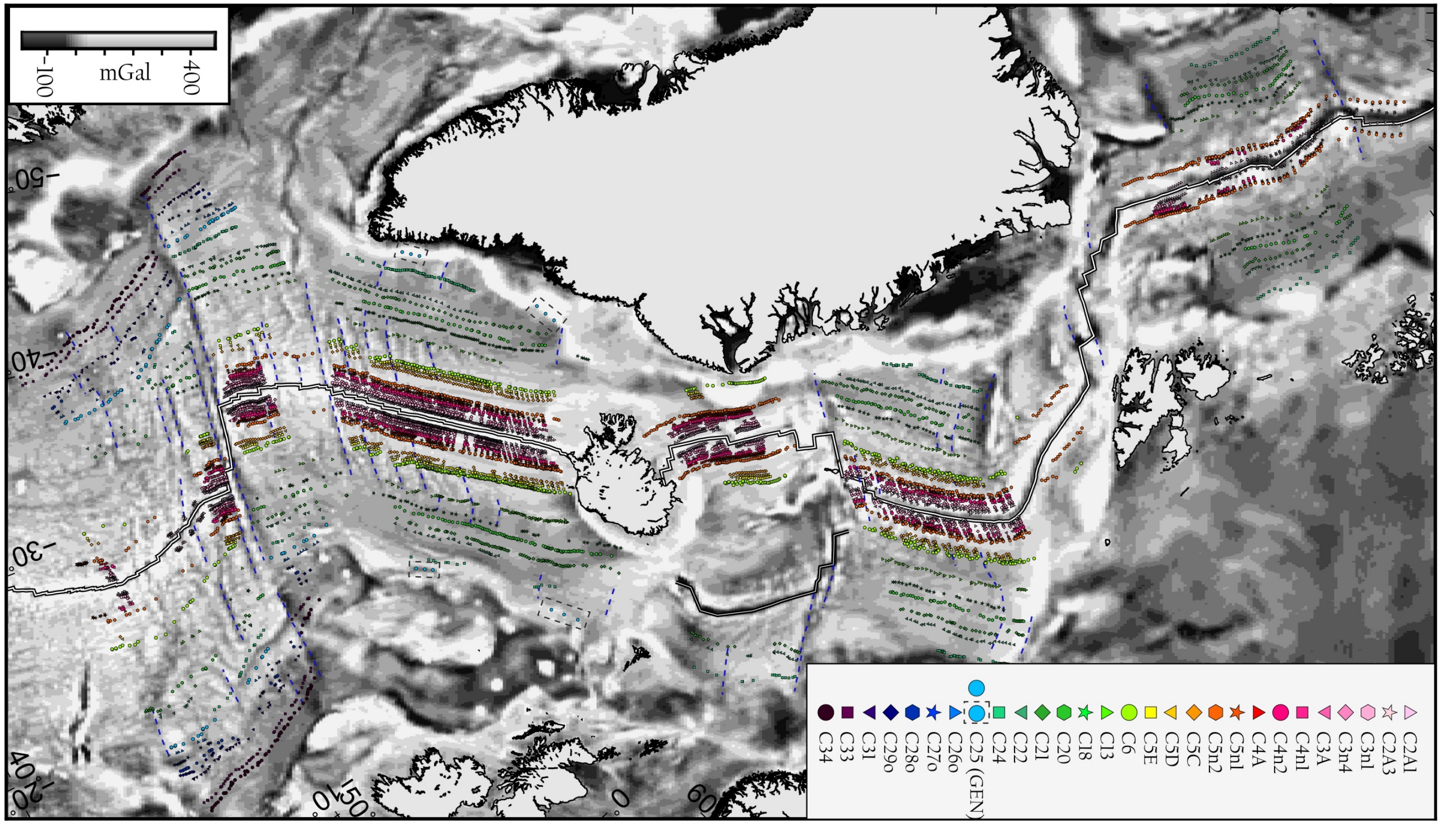
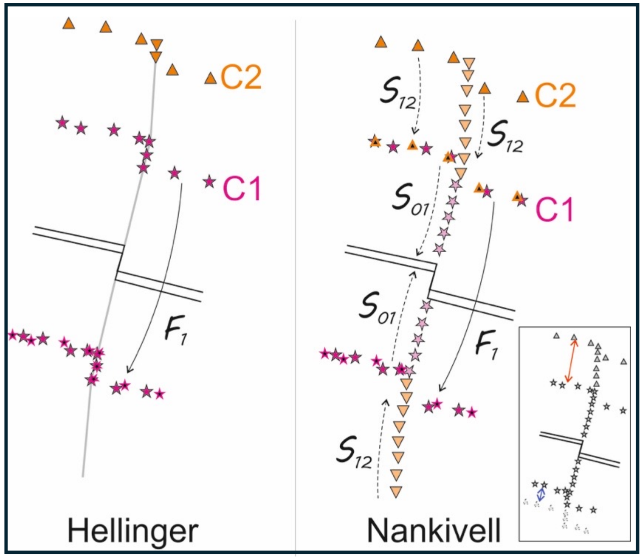
1/13: A new relative plate motion context for post Santonian development of North Atlantic and Arctic plate boundary zones

Eagles, G.[1], Adam, J.[2], Pérez Díaz, L.[3], Geissler, W.H.[1], Klitzke, P.[4], Ruppel, A.[4], and Causer, A.[2]
[1]Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Germany [2]Royal Holloway University of London, UK [3]Oxford University, UK [4]Federal Institute for Geosciences and Natural Resources, Germany

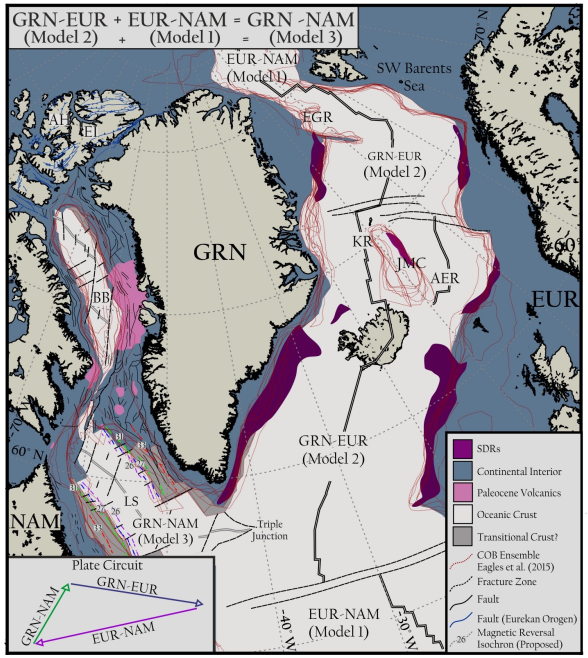


Parts of this presentation are described in *Cenozoic relative movements of Greenland and North America by closure of the North Atlantic-Arctic plate circuit: The Labrador Sea, Davis Strait, Baffin Bay, and Eurekan Orogen,* by Annie Causer and co-authors, Tektonika, in press. Tektonika is a diamond open access journal for tectonics and structural geology.

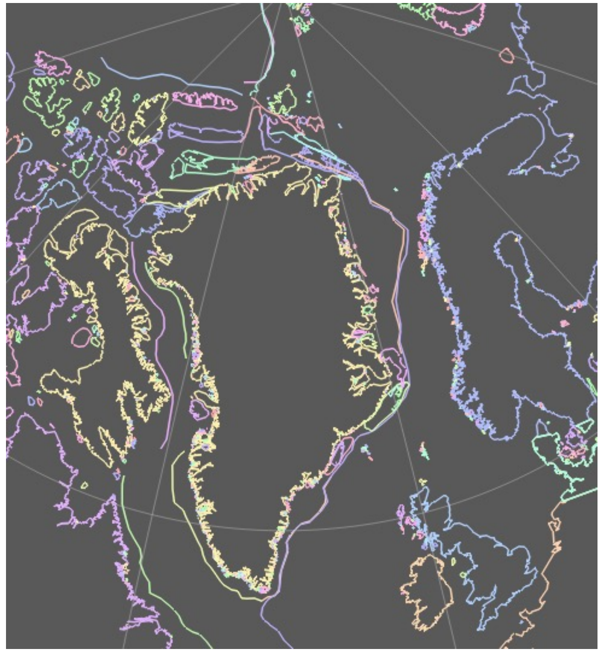
2/13: About this work



1: Two Nankivell inversions to optimize use of tectonic flowline data from Greenland/Eurasia and Eurasia/North America oceanic crust

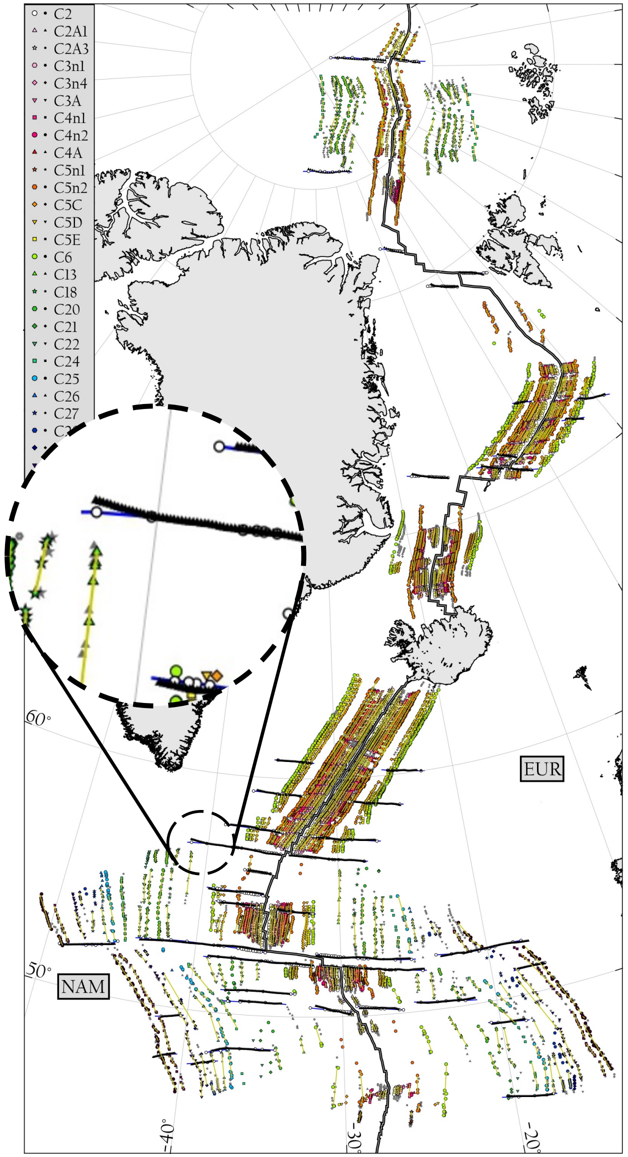


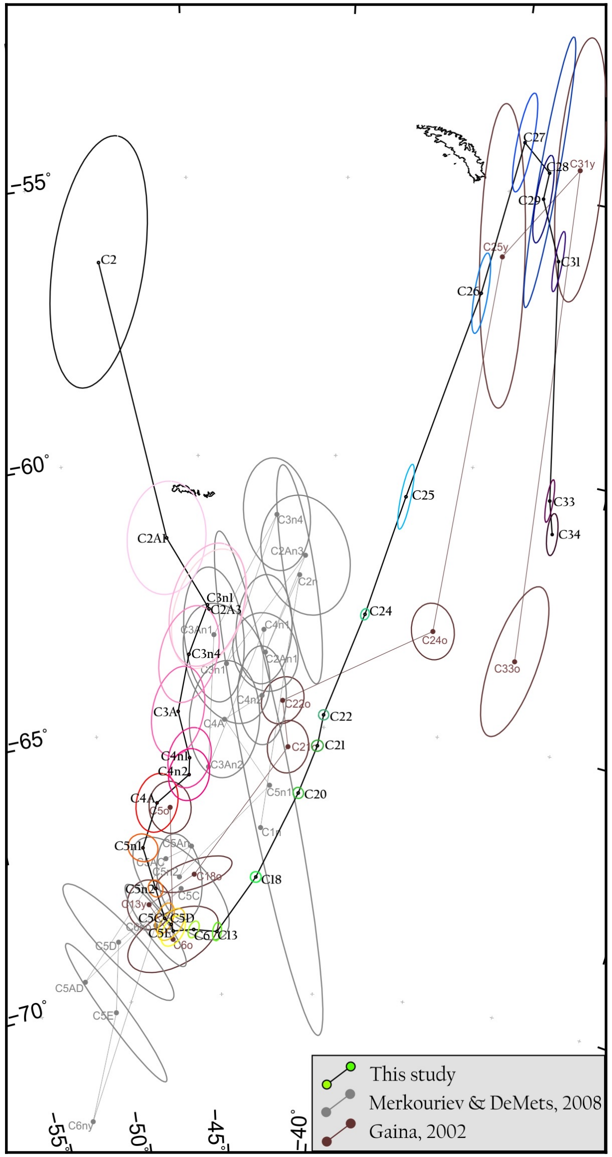
2: Greenland/North America rotations by plate boundaries by addition of inversion results



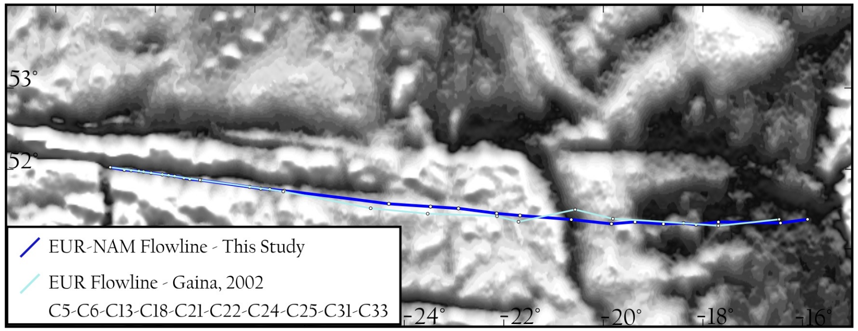
3: GPlates - apply constrained stage rotations as estimated strain histories in remote or poorly understood plate boundary zones

3/13: Results of the North America-Eurasia inversion

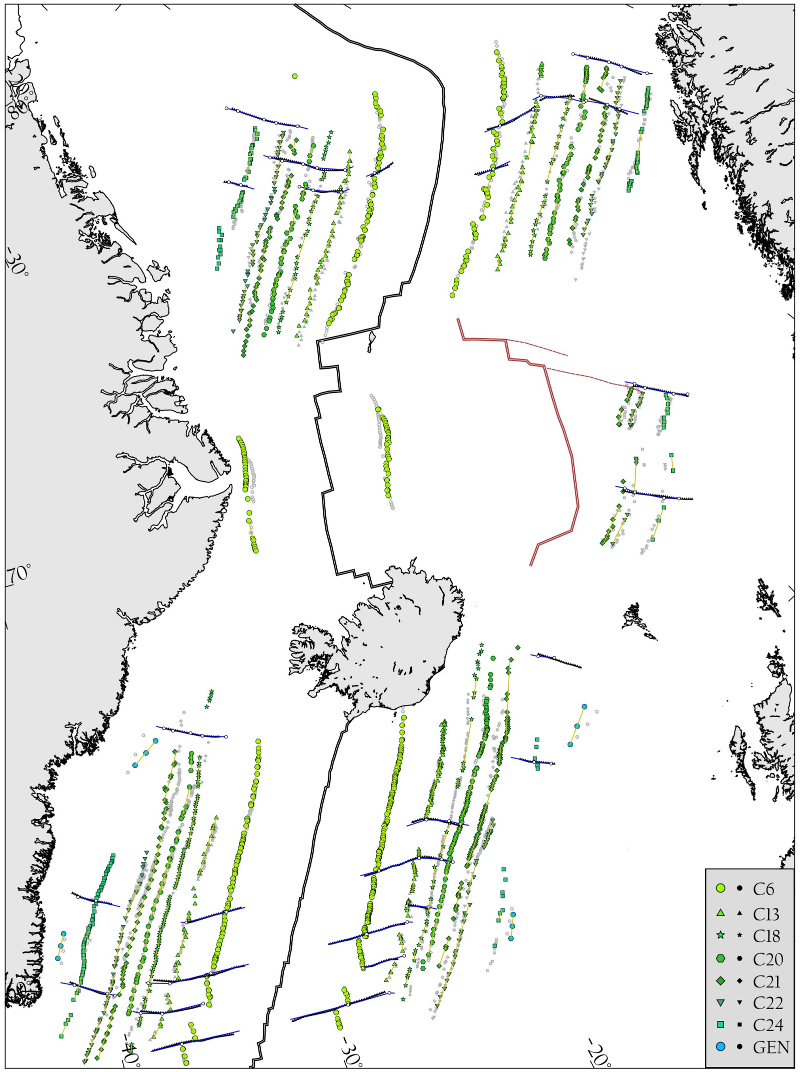


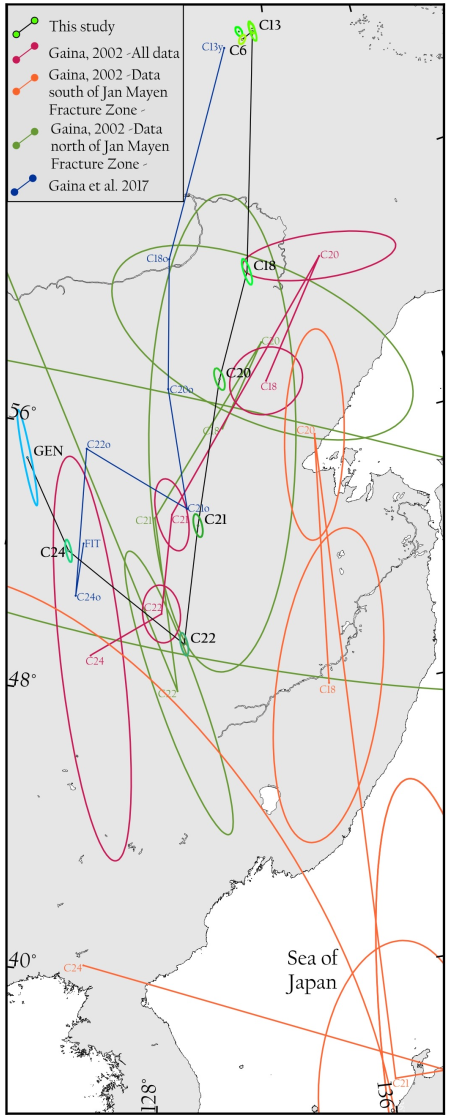


- 29 sets of rotation parameters
- 1743 flowline crossings – 2 orders of magnitude increase in use
- Misfit standard deviations 5.0 km (isochrons) and 3.7 km (flowlines)
- Statistical confidence is much greater than in earlier Hellinger-style inversions
- Smooth implied divergence history

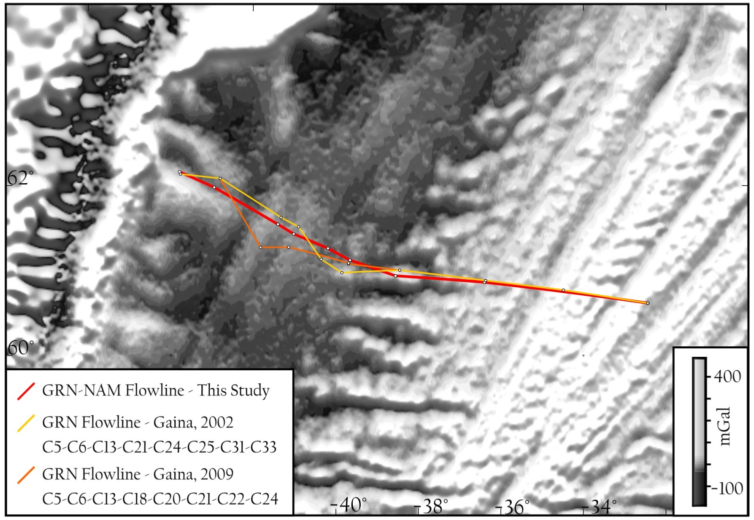


4/13: Results of the Greenland-Eurasia inversion

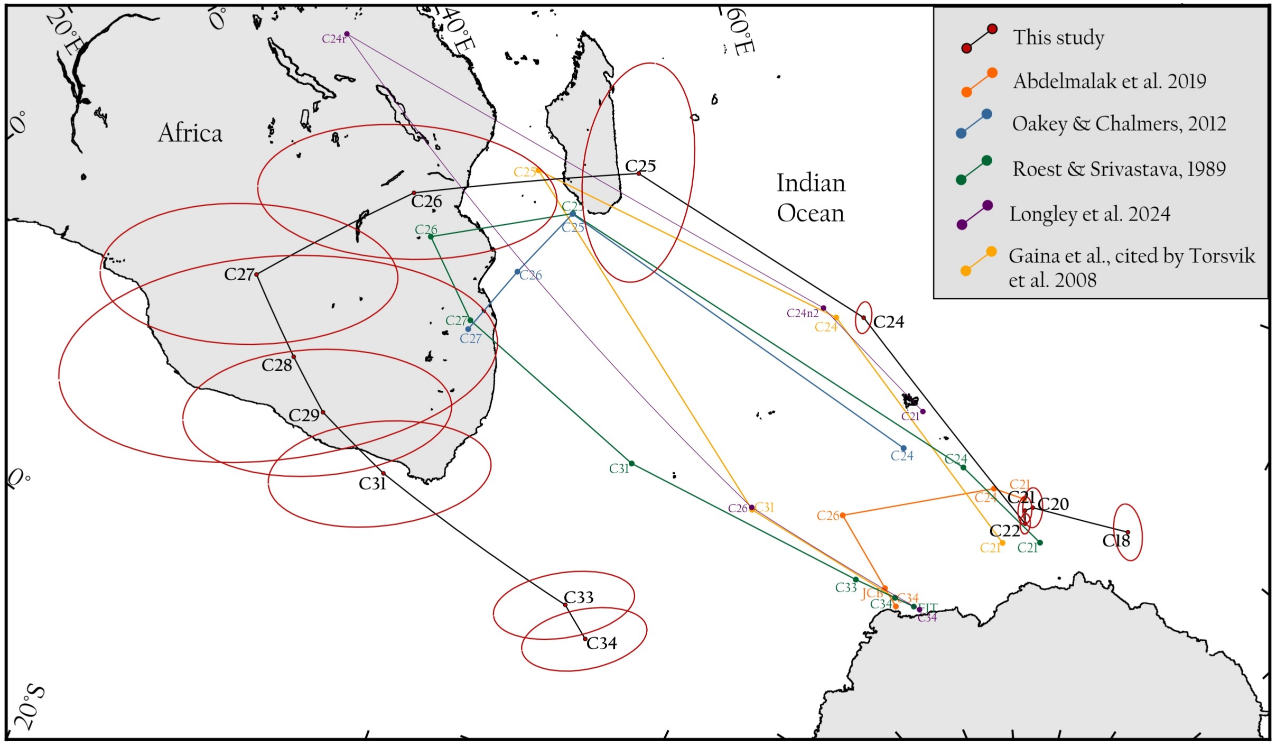


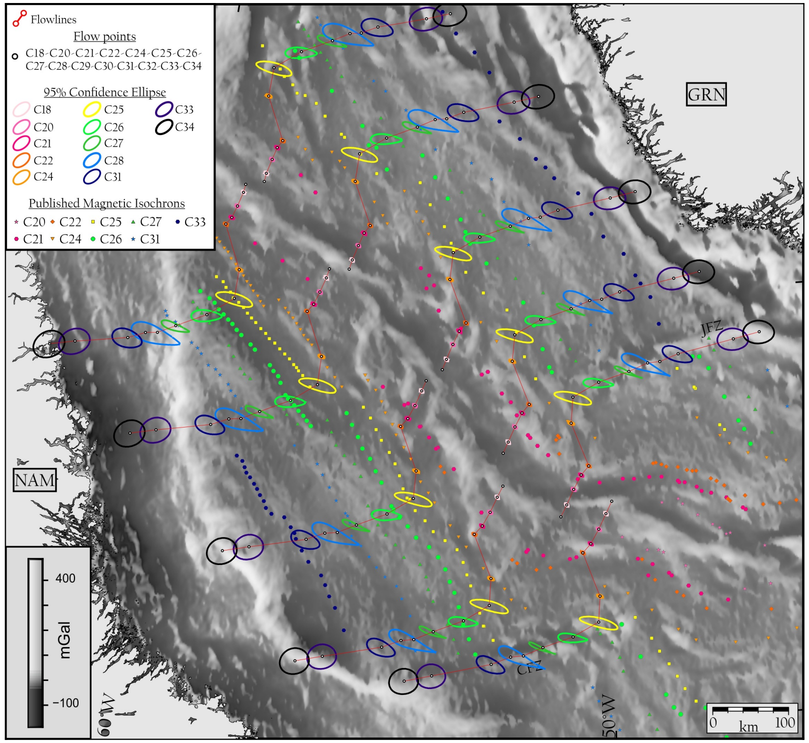


- 8 sets of rotation parameters
- 754 flowline crossings – 2 orders of magnitude increase in use
- Misfit standard deviations 8.3 km (isochrons) and 2.8 km (flowlines)
- Statistical confidence is much greater than in earlier Hellinger-style inversions
- Smooth implied divergence history



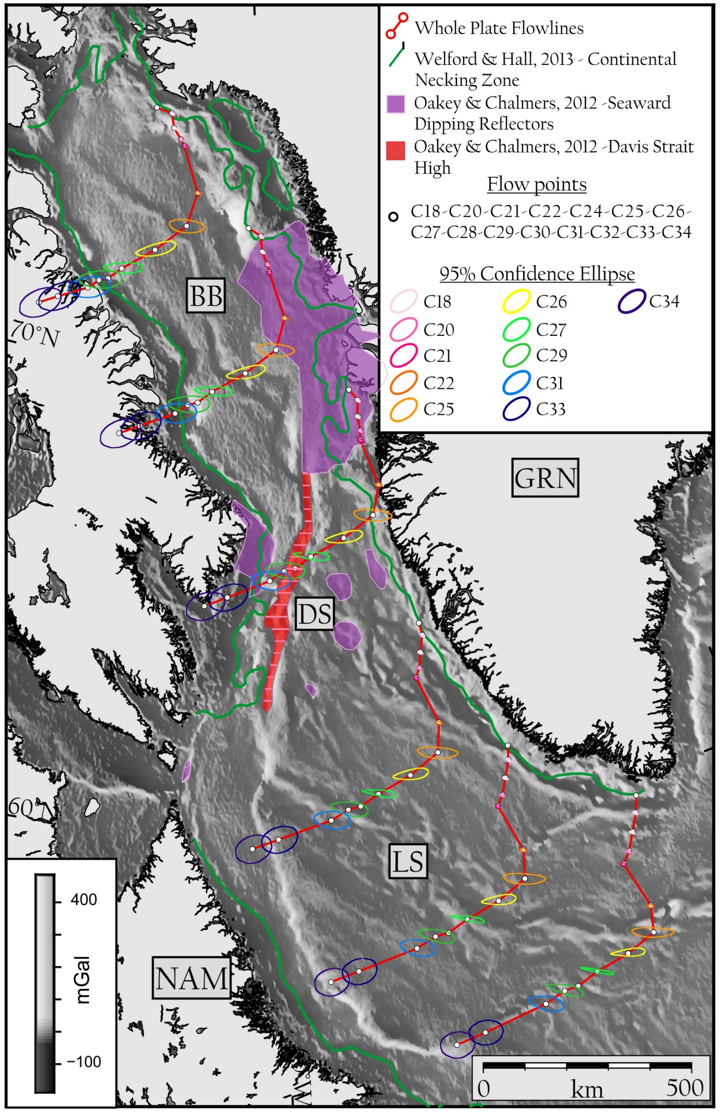
5/13: Results of the summation for Greenland-North America rotations



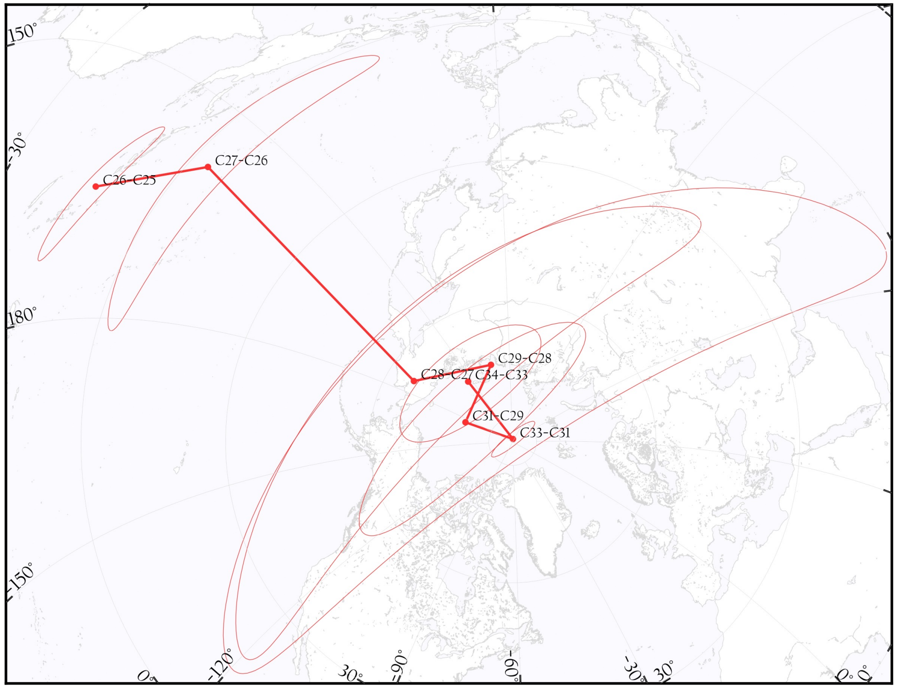


- 13 sets of rotation parameters, loose U-shaped progression
- Rotations constrained within 95% confidence estimates
- Close resemblance at 95% to consensus (post-C26) Labrador Sea markers
- Basis for confident predictions of pre-C26 phase of Labrador Sea & more remote and less well understood settings on GRN-NAM boundary

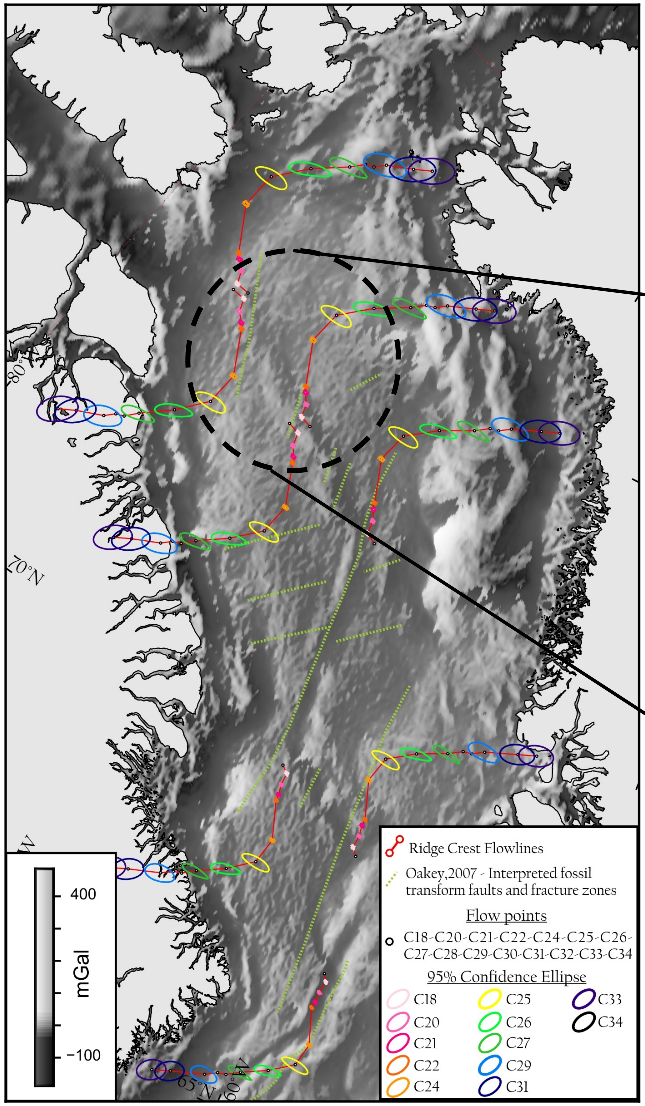
6/13: Labrador Sea & Baffin Bay #1



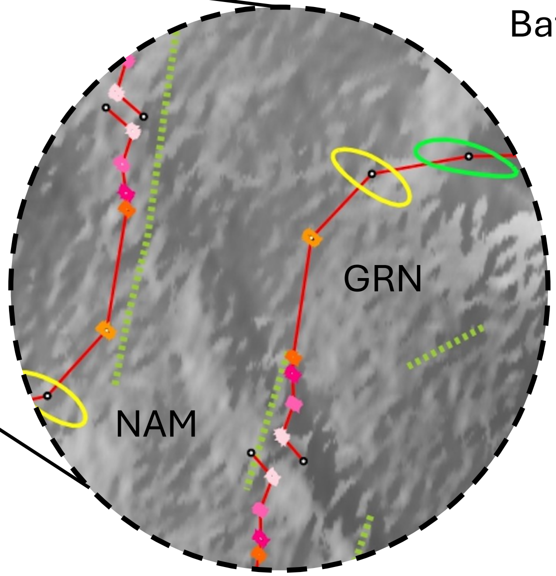
- Observe where divergence flowlines seeded from GRN necking zone cross the NAM necking zone.
- Implied breakup propagates northwards: ~90 Ma in southern Labrador Sea, 68-65 Ma in Baffin Bay
- Stage rotations: propagation more rapid after C27 (63 Ma): softening of propagation path by plume-sourced melt addition?



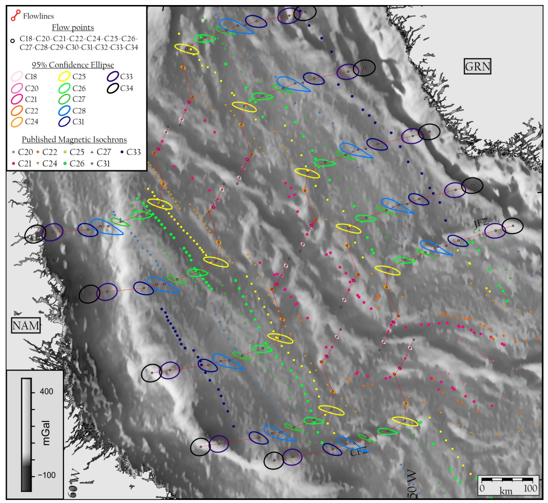
7/13: Labrador Sea & Baffin Bay #2



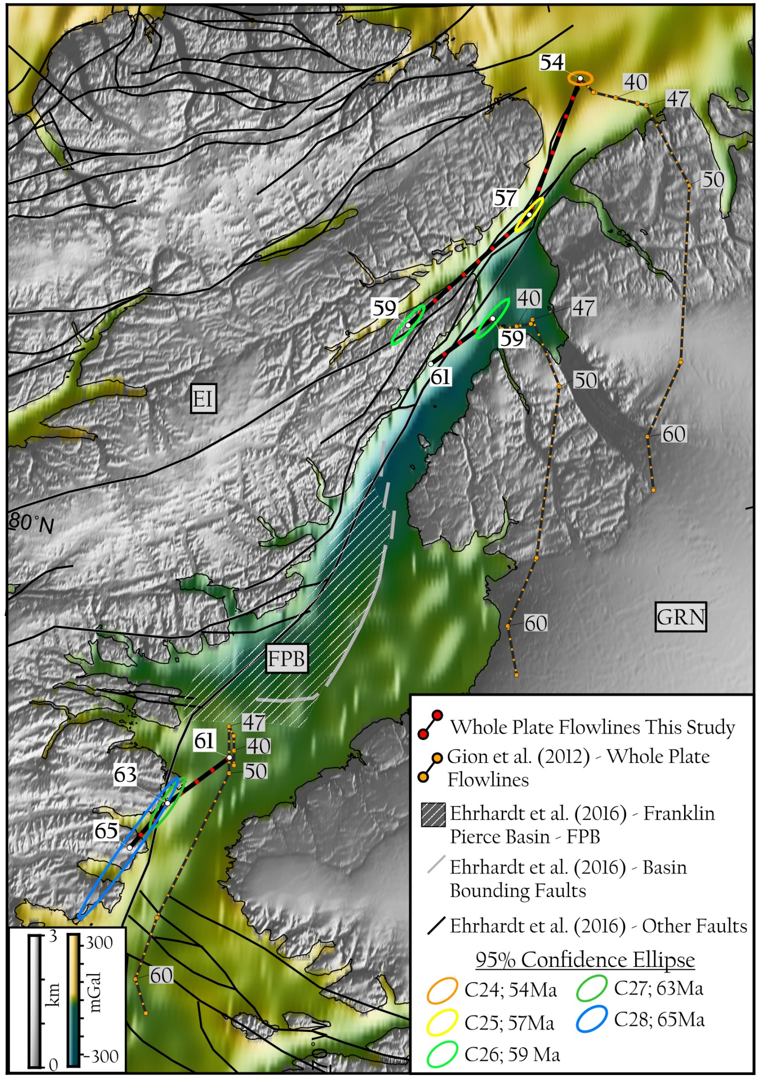
- Model symmetrical accretion between Greenland and North American plates in Baffin Bay
- Flowlines seeded from axial gravity anomaly (extinct ridge?) parallel to transform fault- and fracture zone-like features
- Post-C18 flowline segments imply northern Baffin Bay divergence ended ~40 Ma

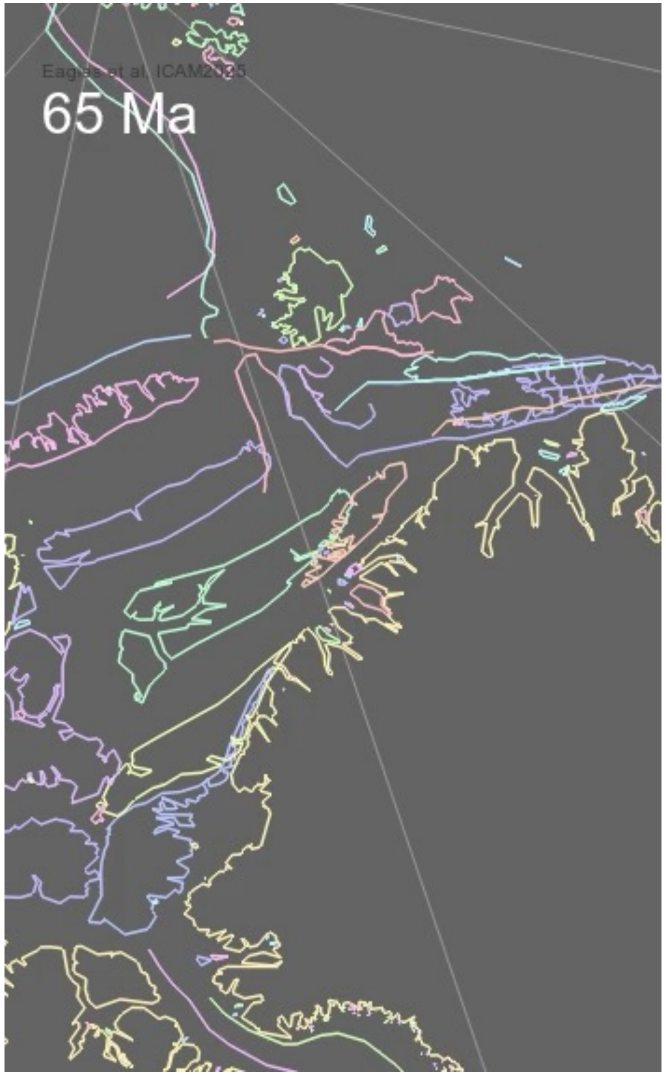


- Compare: Labrador Sea divergence until extinction at ~33 Ma



8/13: Nares Strait

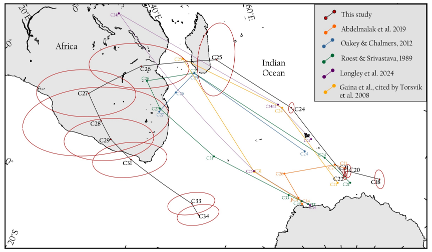




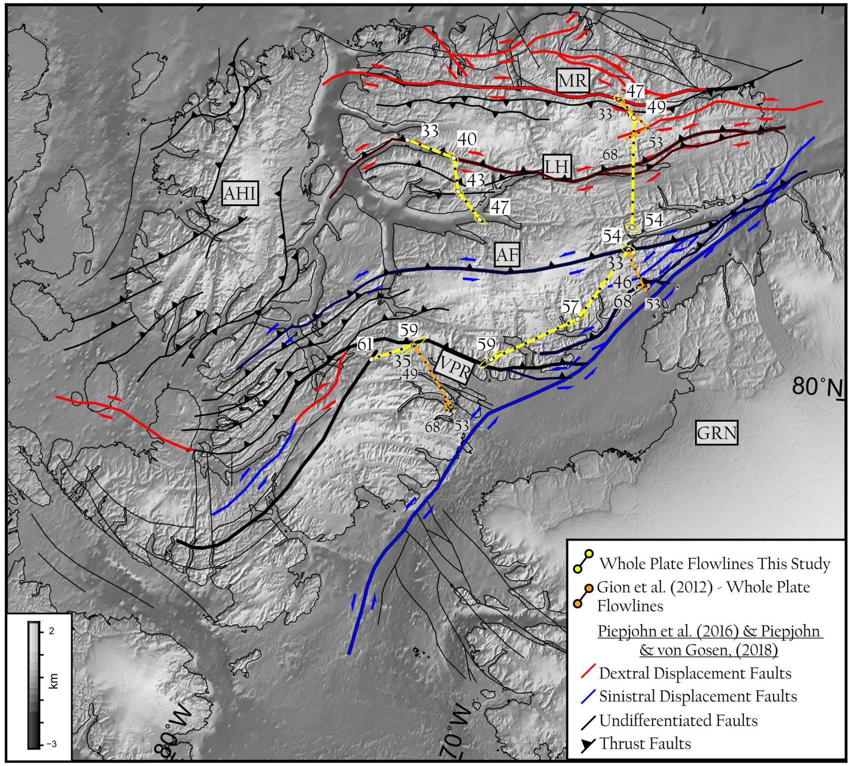
Animation: GPlates, https://www.gplates.org/ & ffmpeg, https://www.ffmpeg.org/

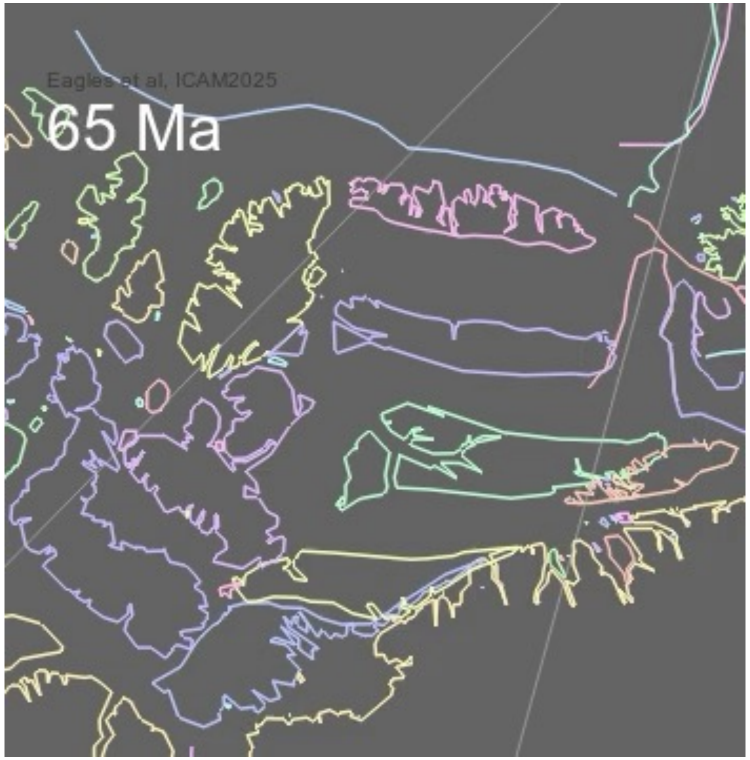
- Model focussed GRN-NAM motion in Nares Strait after 65 Ma (cf. breakup in Baffin Bay).
- Divergent component – e.g. Kane/Franklin Pierce Basin, alkali basalt pebbles (Ehrhardt et al, 2016; Estrada et al, 2009).
- Convergent component further east until 54 Ma
- Variable strike-slip offsets wrt individual Ellesmere Island blocks
- All left-handed offset estimates consistent with very large range in geological-based estimates (e.g. Judge Daly Peninsula)
- No implied sub-ice shortening of N. Greenland (contrast Gion et al 2017)

9/13: Eurekan Orogeny



U-shaped GRN-NAM rotation pole sequence implies multiple contrasting phases of deformation

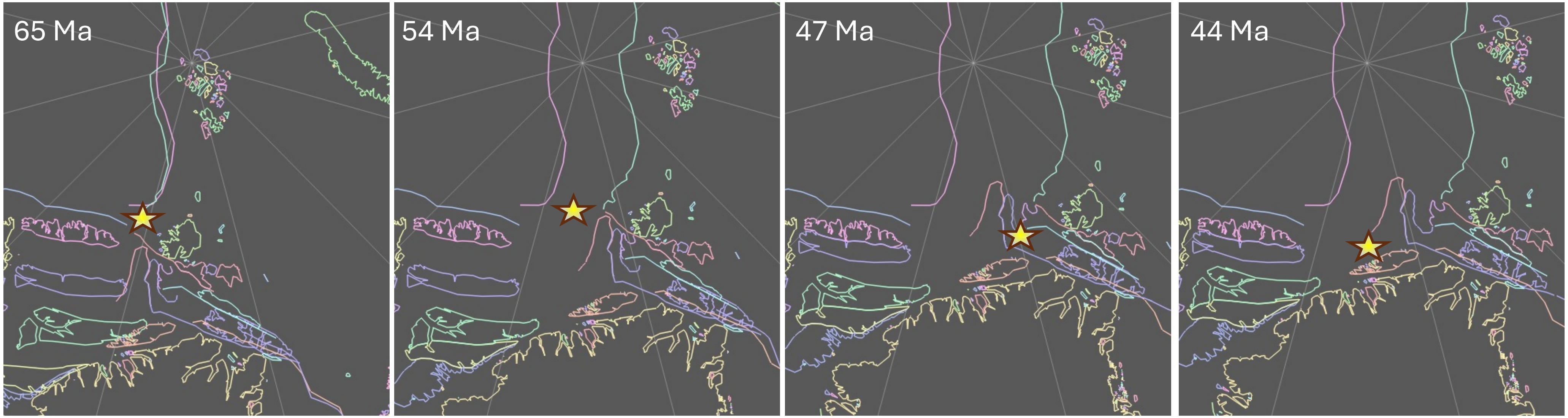




Animation: GPlates, https://www.gplates.org/ & ffmpeg, https://www.ffmpeg.org/

- Model subdivision of Ellesmere Island updated according to Piepjohn et al (2016) and Piepjohn & von Gosen (2019)
- (i) dextral accompanying Nares Strait history
- (ii) orthogonal convergence
- (iii) sinistral
- All implied phases are represented on island
- Solution is not unique

10/13: Spitsbergen, Morris Jesup Rise and Yermak Plateau #1



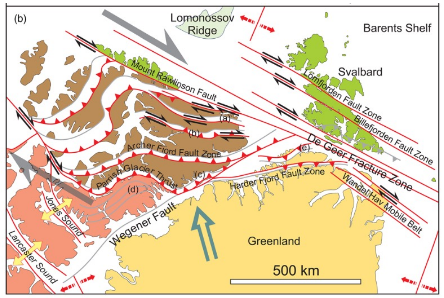
Still frames from GPlates animation

- Shortening Ellesmere Island, widening Eurasian Basin, imply southwards & eastwards migration of GRN-NAM-EUR triple junction

- Southwards component TJ motion implies sequential activation of Lomfjorden, Billefjorden, Hornsund fault zones (cf. Piepjohn et al 2016).

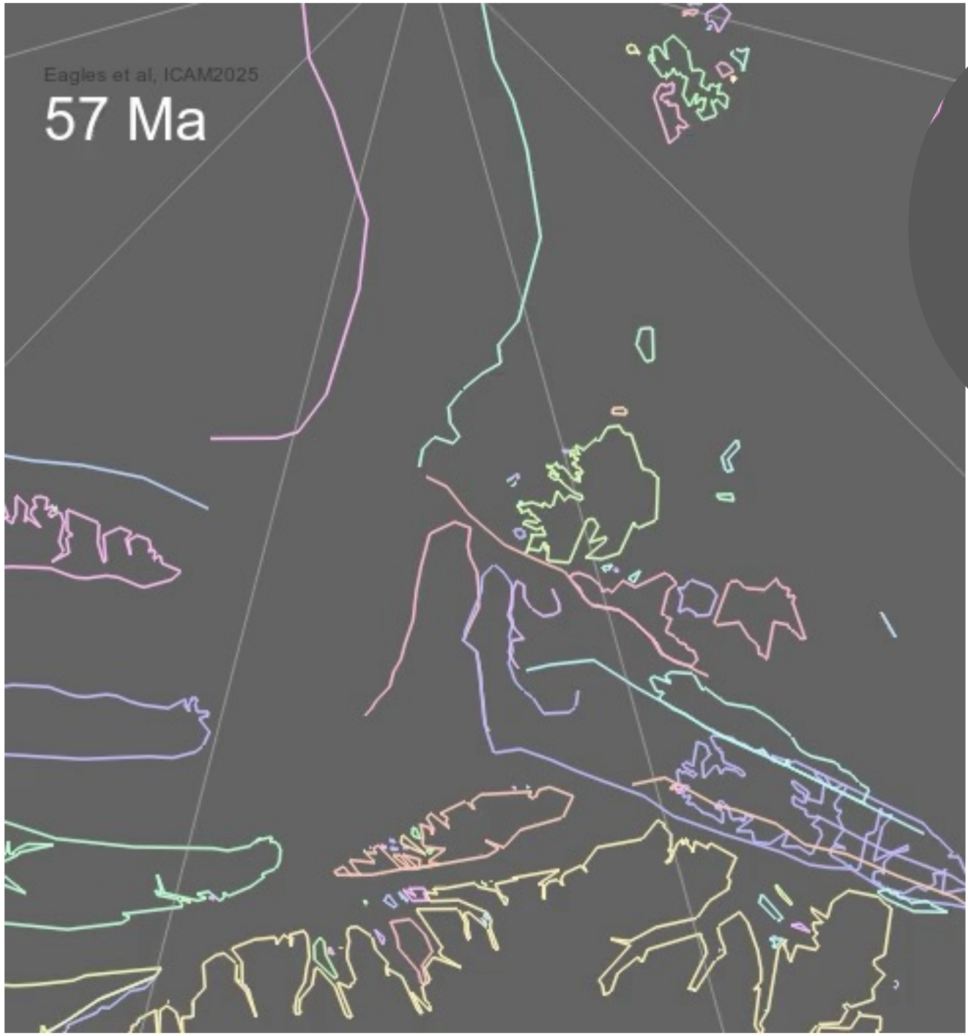
- Slivers of Spitsbergen are passed from Greenland to Eurasian plate.

- Strongest Spitsbergen convergence until 50 Ma, later very slight divergent component

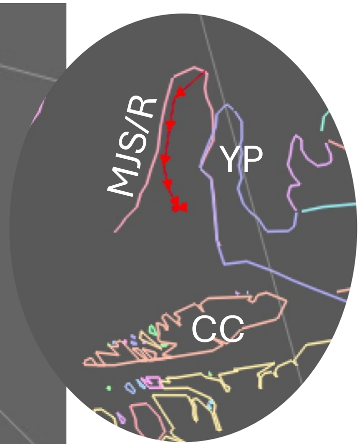


Piepjohn et al (2016)

11/13: Spitsbergen, Morris Jesup Rise and Yermak Plateau #2



Animation: GPlates, https://www.gplates.org/ & ffmpeg, https://www.ffmpeg.org/

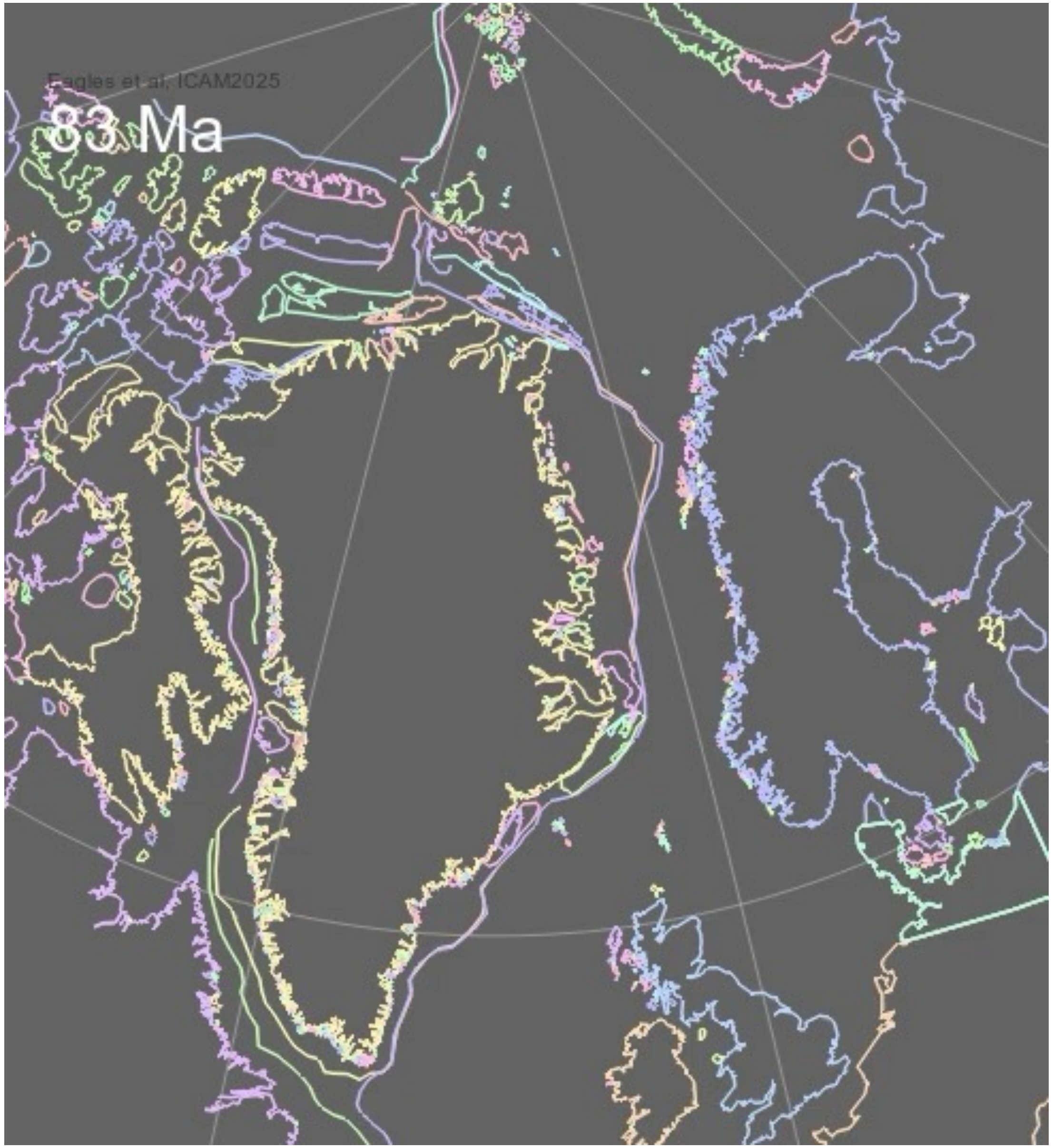


- TJ migration sees Morris Jesup/Yermak Plateau body spend time on GRN plate side of GRN-NAM boundary
- Like Ellesmere Island segments of the same boundary over same period, the orientation of relative motion rotates

- Until ~50 Ma sinistral strike-slip parallel to axis of Morris Jesup Rise
- Post-50 Ma oblique convergence (orthogonal component is ~50 km)
- Post-45 Ma period is divergent

12/13: Summary

- New models of relative motions between North American, Greenland and Eurasian plates since 83 Ma
- High resolution; low statistical uncertainty
- No independent motions of ‘blocks’ or ‘microplates’.
- Major moderately well-known structural phases in Eurekan orogeny in Spitsbergen and Ellesmere Island reproduced by stage rotations calculated from GRN-NAM history
- Potential for predictive understanding of less well understood phases – e.g. convergence at Yermak Plateau and Morris Jesup Rise; opening of Sophia Basin



Animation: GPlates, https://www.gplates.org/ & ffmpeg, https://www.ffmpeg.org/

13/13: Did I mention Tektonika?