Global Magnetic Mapping of LIPs from EMAG2 version 3

T166. Large Igneous Provinces (LIPs) in the Solar System

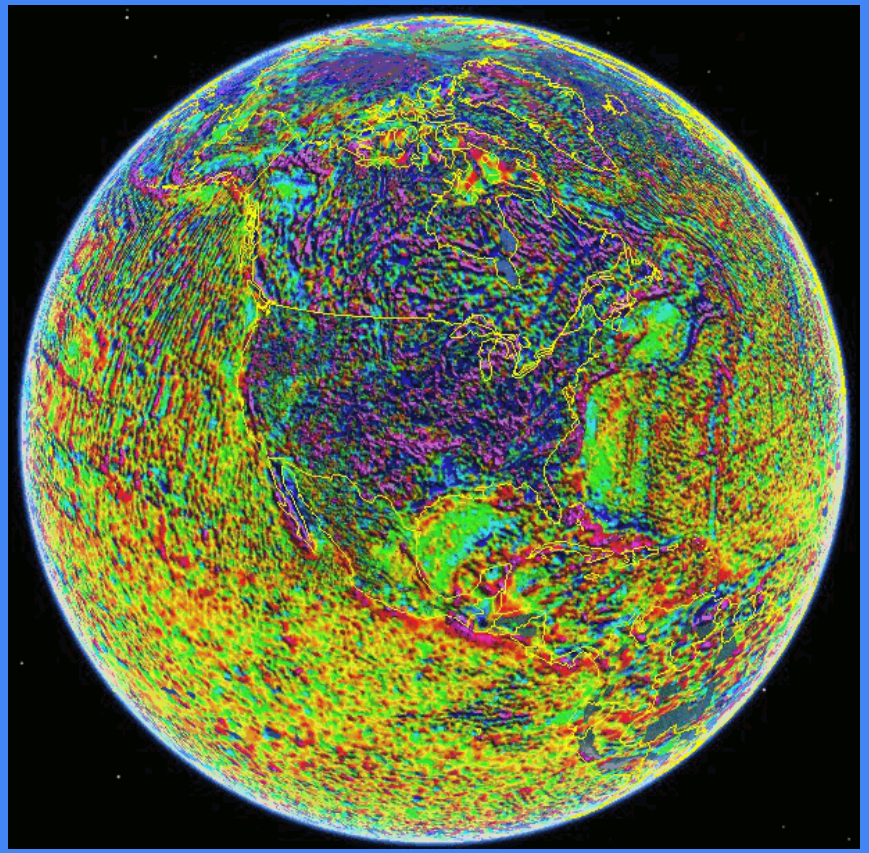
Rick Saltus (rick.saltus@noaa.gov)
Gordi Oakey (gordon.oakey@canada.ca)
Brian Meyer (brian.meyer@noaa.gov)

Outline

- **EMAG2 version 3 (2016) – Global compilation of lithospheric magnetic anomalies**
- **Arctic magnetic anomalies and the High Arctic Large Igneous Province**
- **Other notable LIPs and their magnetic expression**
- **A first look at the global magnetic expression of LIPs**
- **Audience participation – Yes/No/Maybe vote**

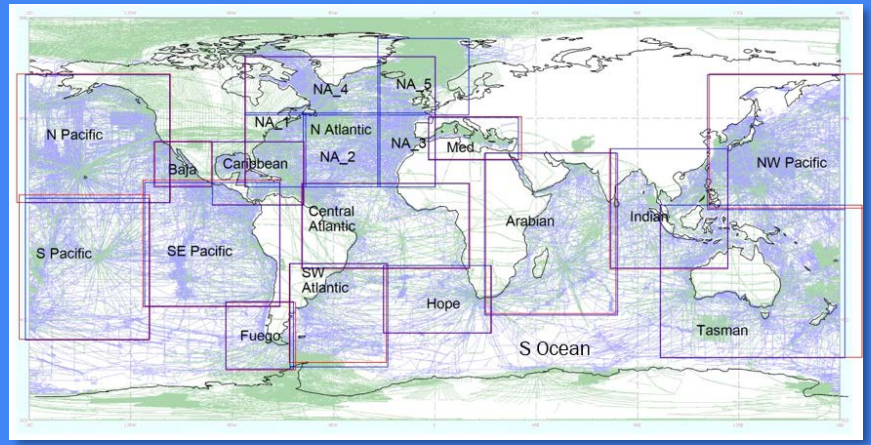
EMAG2 – Version 3

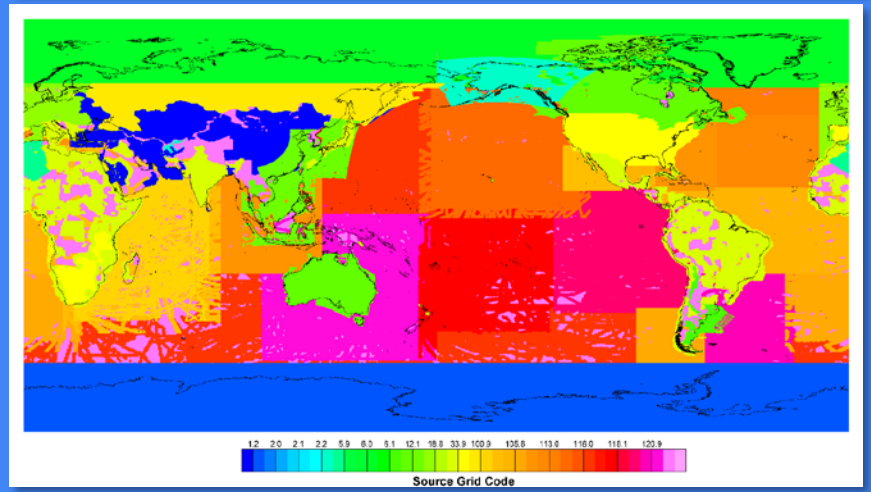
- 2-Arc Minute (~4 km) resolution
- Leveled to MF7 (long wavelength crustal anomaly field from satellite data)
- No *a-priori* ocean age model included
- Arctic from IPY CAMP-GM grid
- Antarctic from ADMAP



- www.ngdc.noaa.gov/geomag/emag2.html

EMAG2v3 – a few details

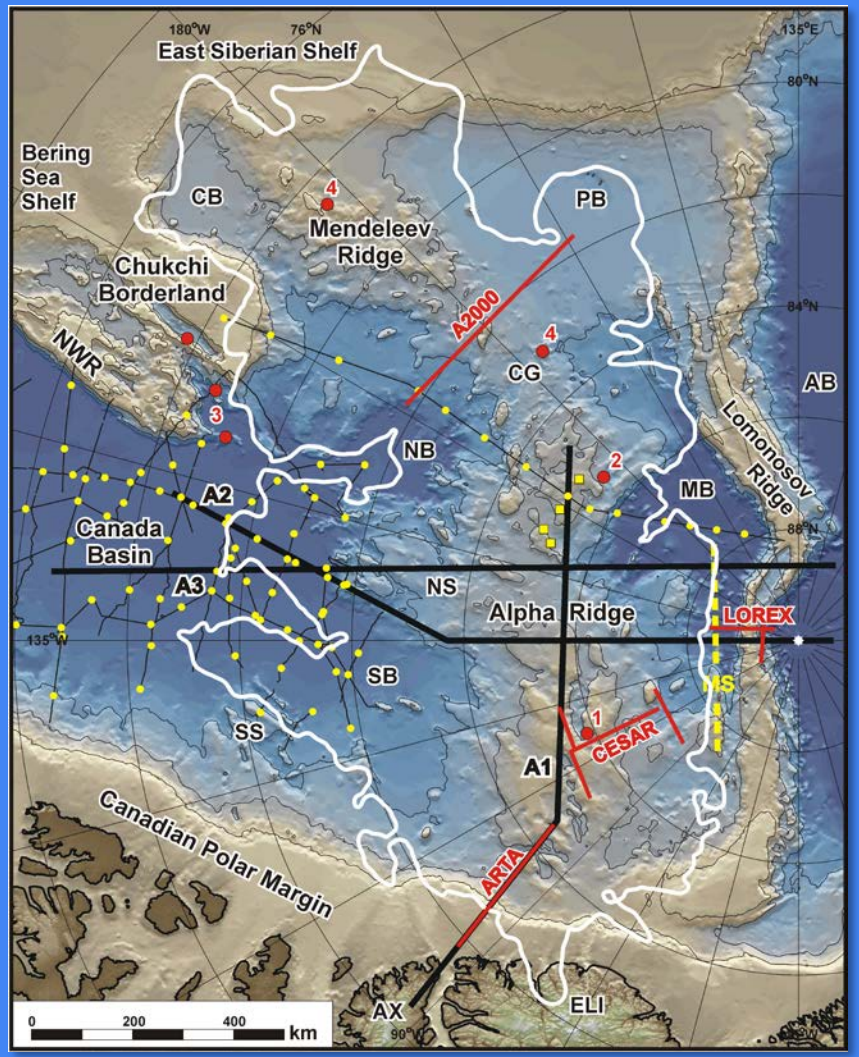




- Ocean coverage from new processing and leveling of NCEI (formerly NGDC) trackline coverage
- Continents from best-available regional compilation grids

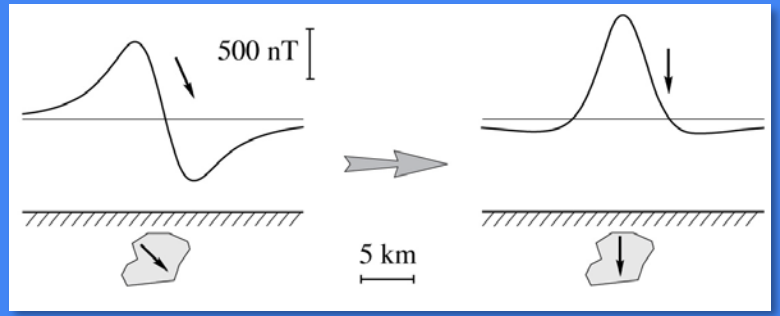
High Arctic location

Oakey and Saltus, 2016



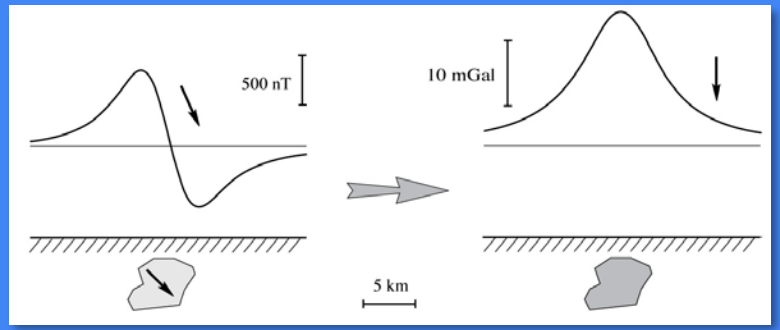
http://dx.doi.org/10.1016/j.tecto.2016.08.005

Magnetic transformations



Reduction to the pole (RTP):

$$F[h_P(x,y)] = F[h(x,y)]\frac{-2\pi}{\theta(k_x,k_y)}$$



Pseudogravity transformation:

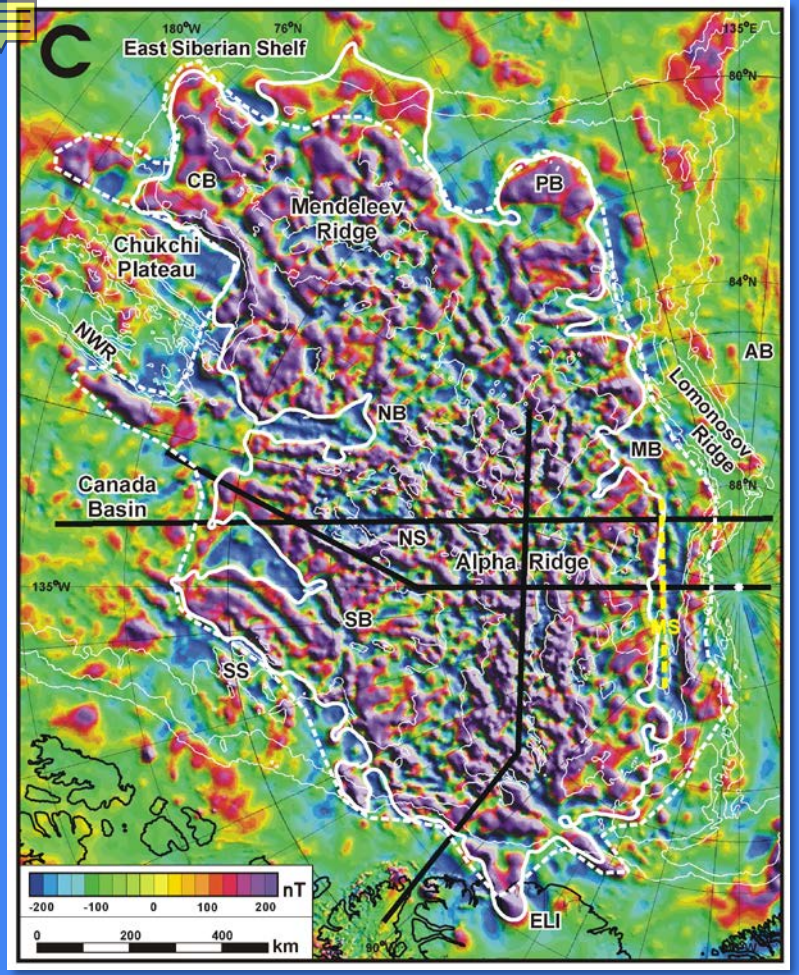
$$F[h_{PSG}(x,y)] = F[h(x,y)]\frac{-2\pi}{\theta(k_x,k_y)}\frac{A}{|k|}$$

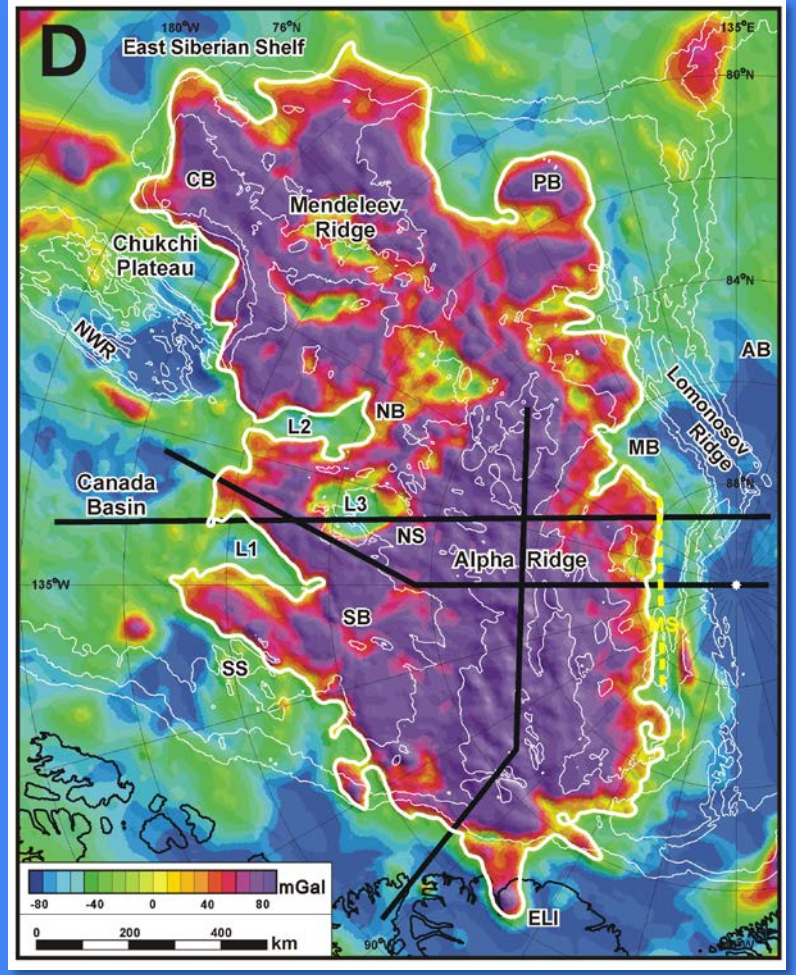
Blakely, 1995

k = wavenumber,

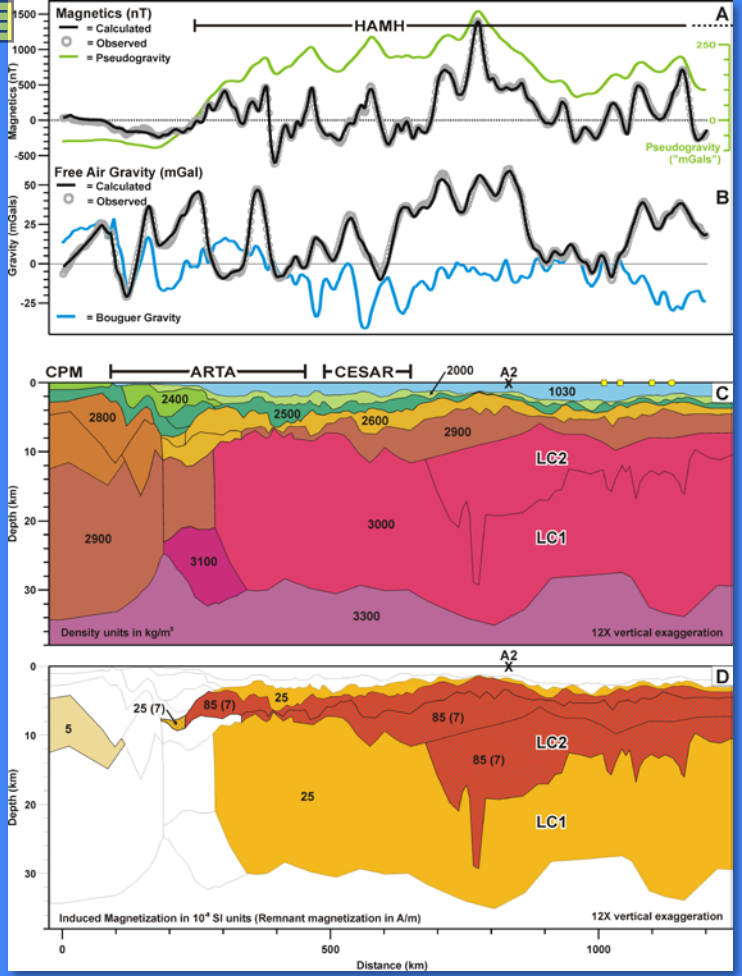
$\theta(k_x,k_y)$ = a complicated function that depends only on the direction and magnitude of the Earth's magnetic field.

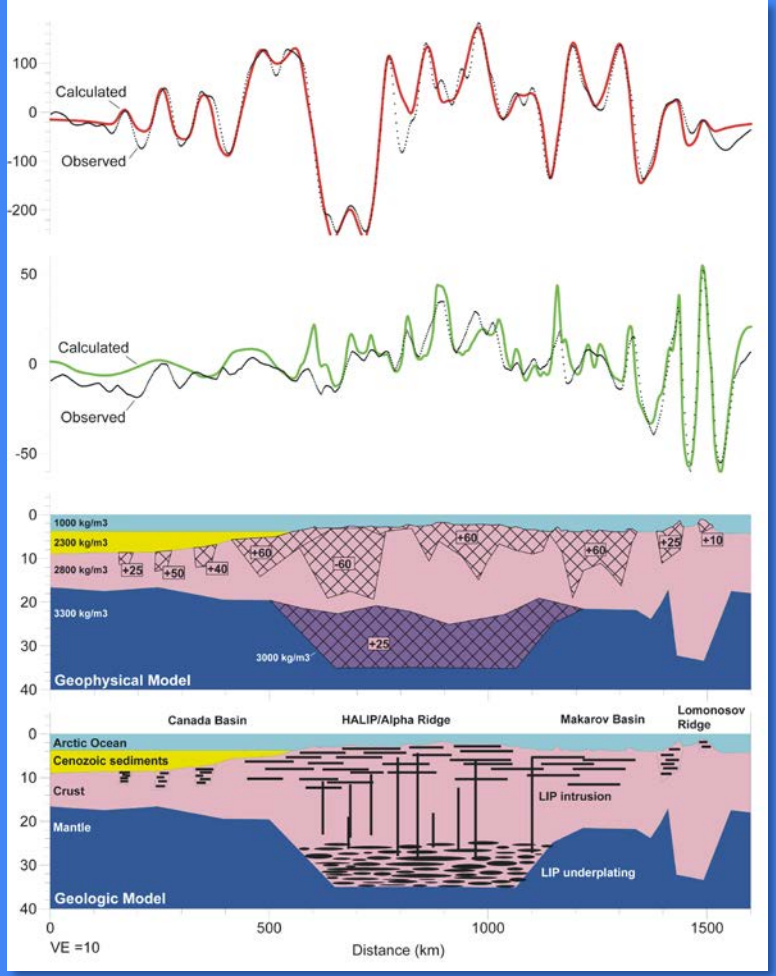
A = a constant based on the expected ratio of pseudo-density to magnetization





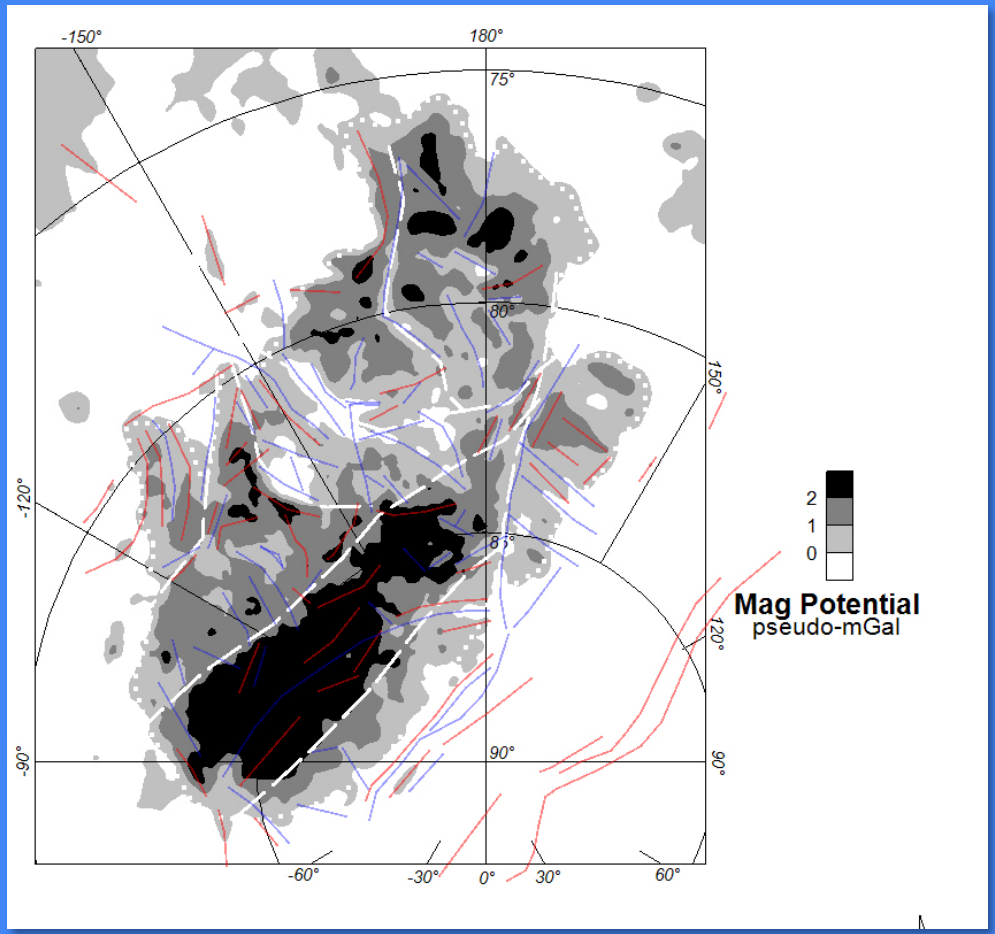
High Arctic Magnetic High (HAMH) – Oakey and Saltus, 2016



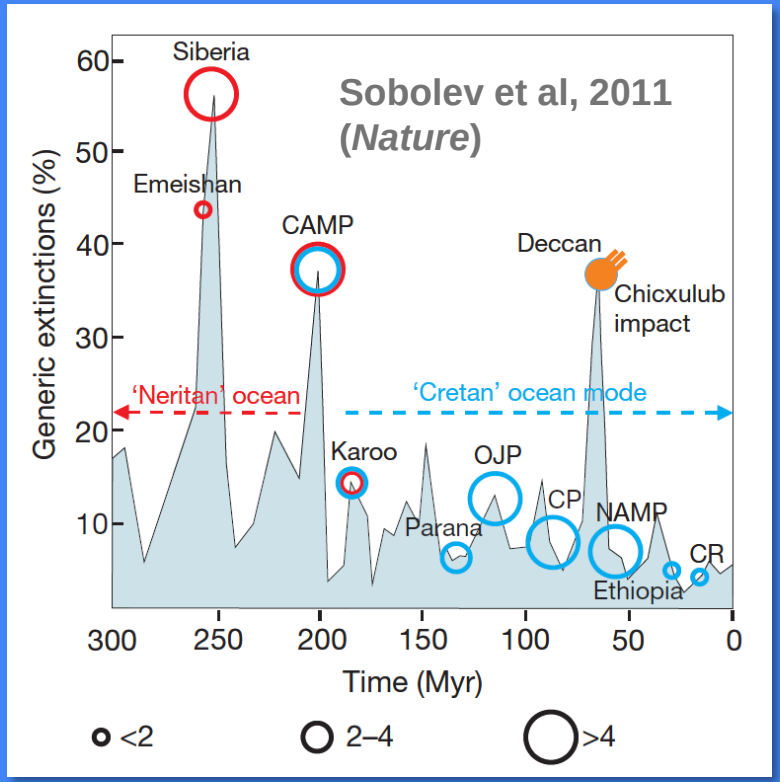


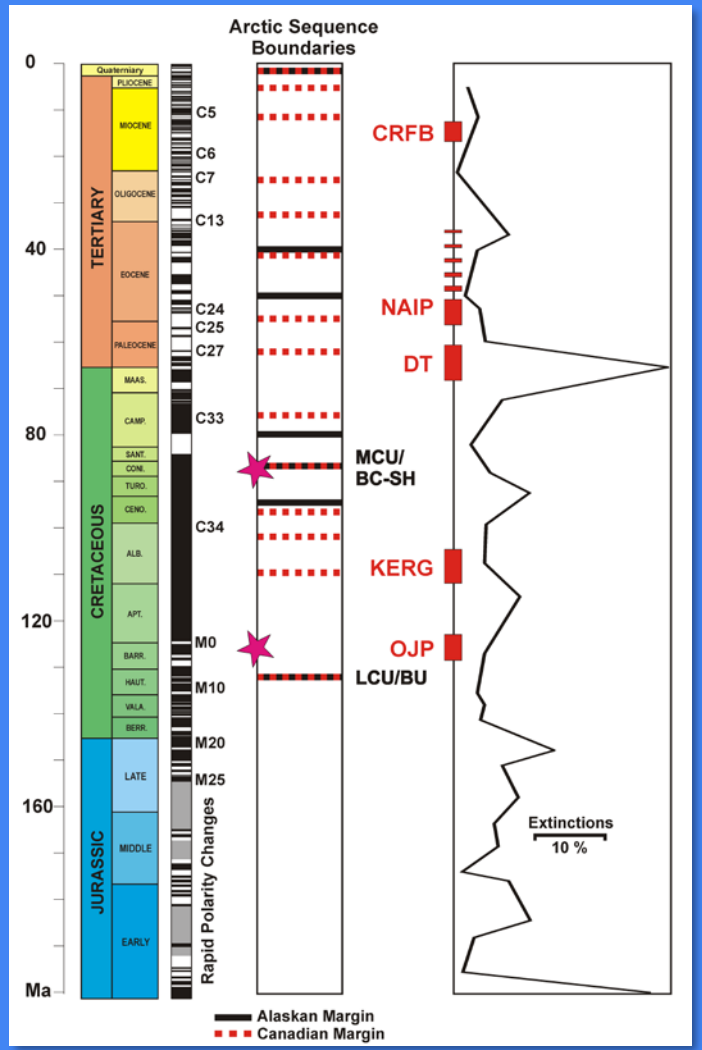
(Oakey and Saltus, 2016)

Magnetic Potential (pseudo-gravity)

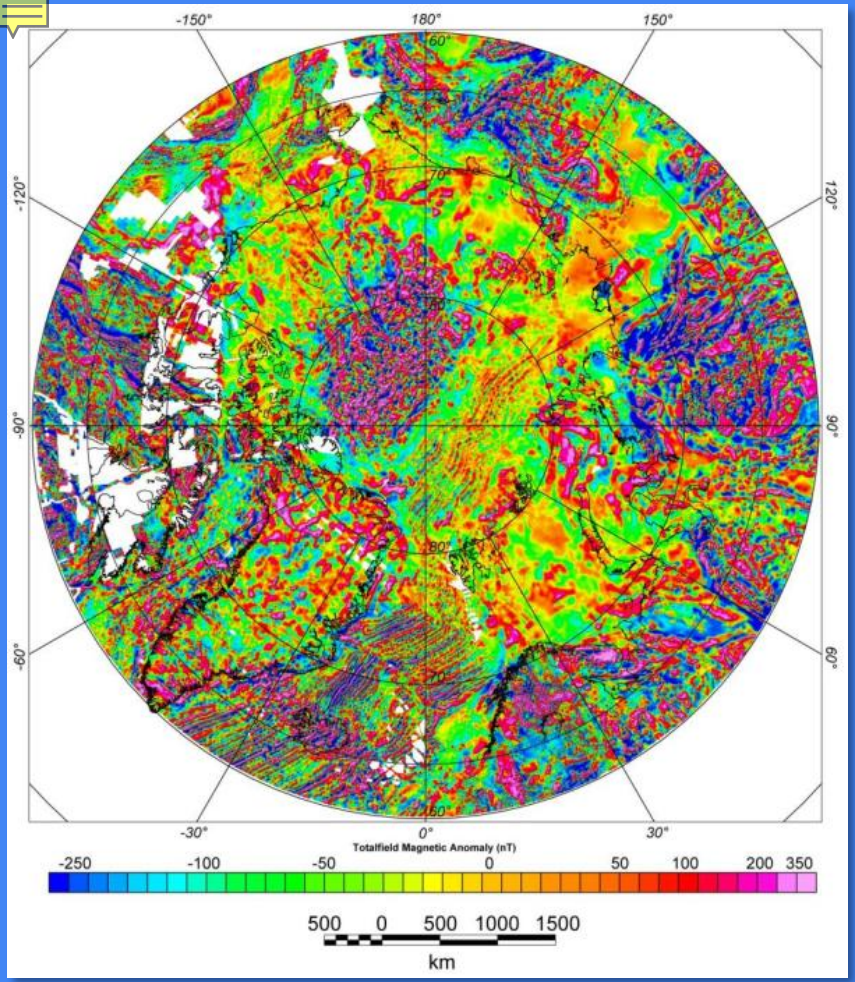


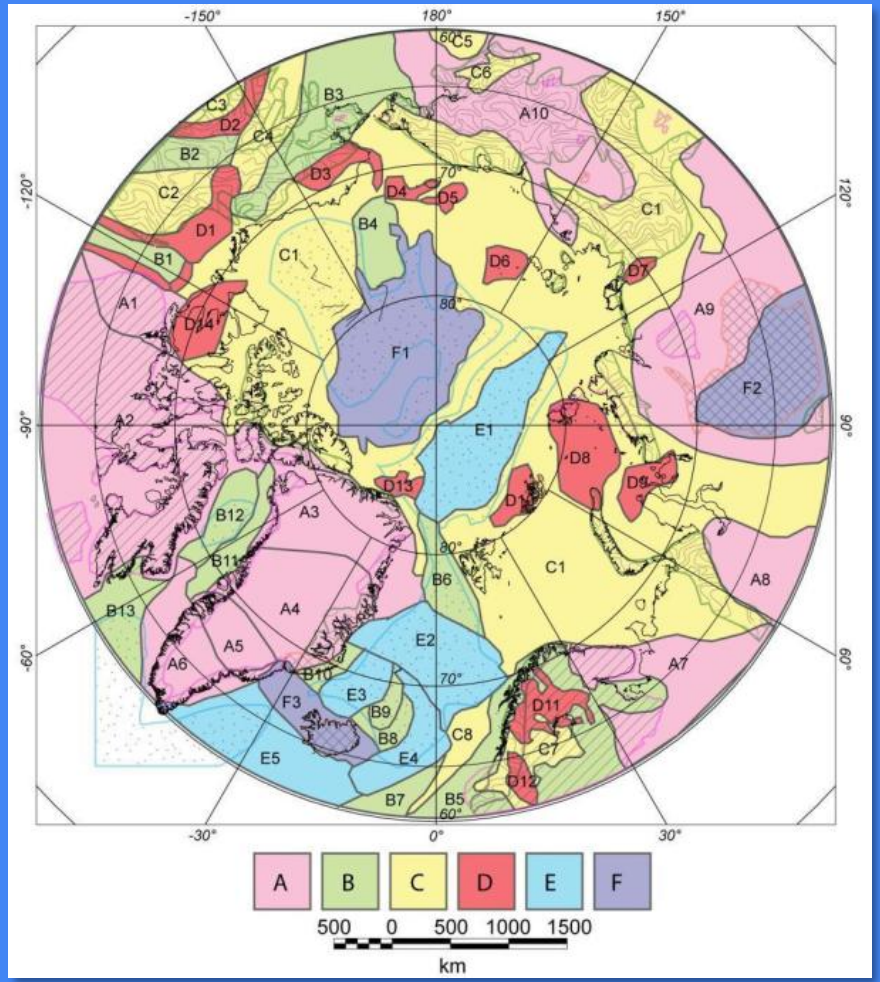
2 Plume Events???



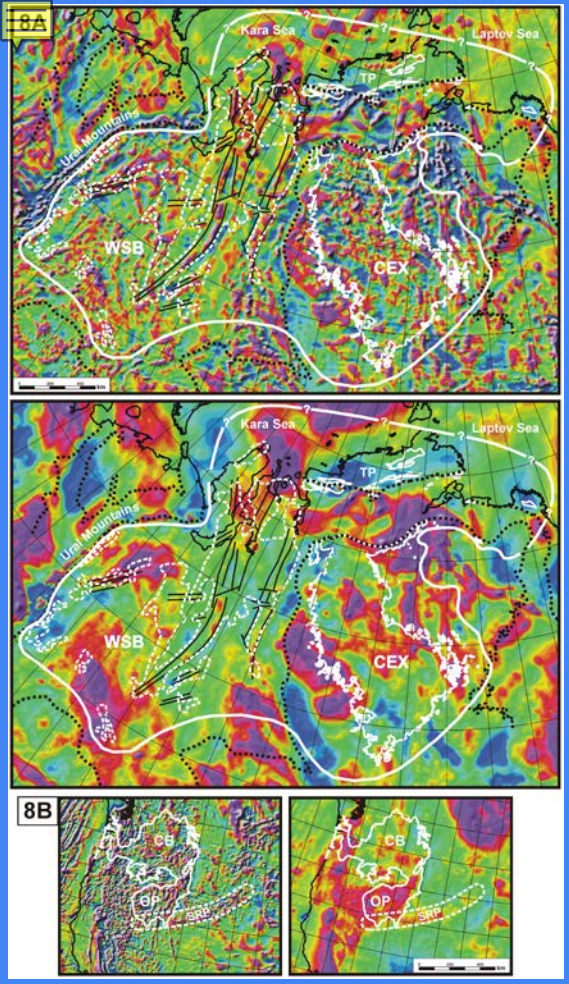


Association of HALIP with extinctions



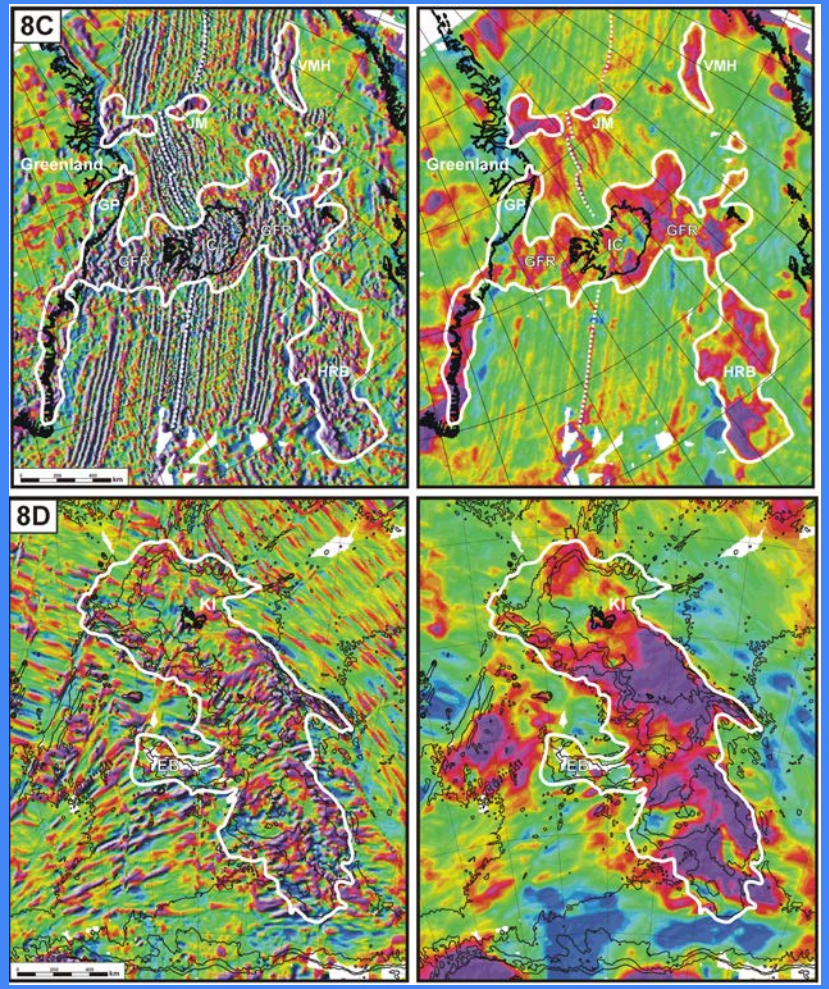


Arctic magnetic domains – F = LIP (Saltus et al, 2011)



Siberia

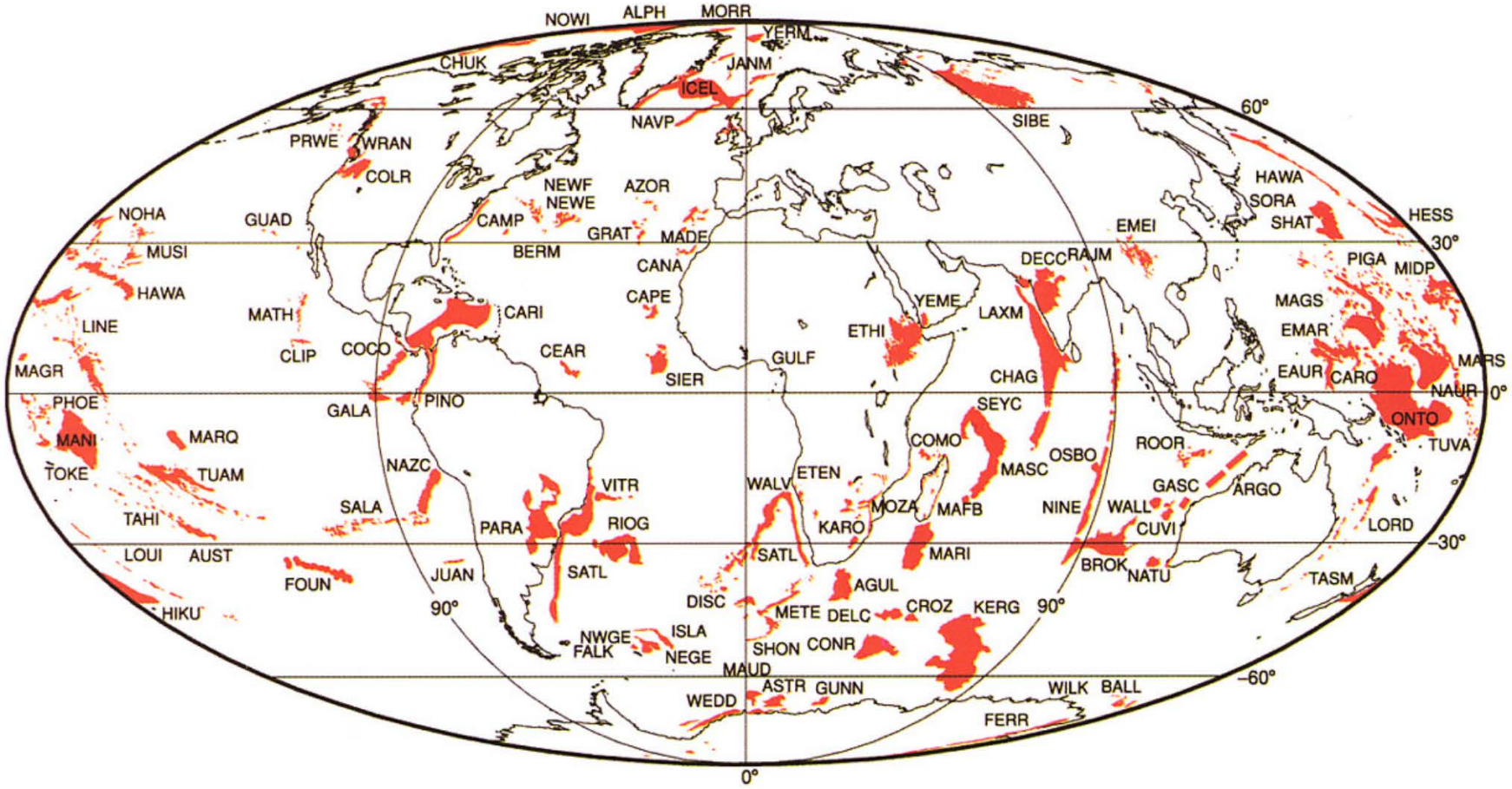
Columbia Plateau



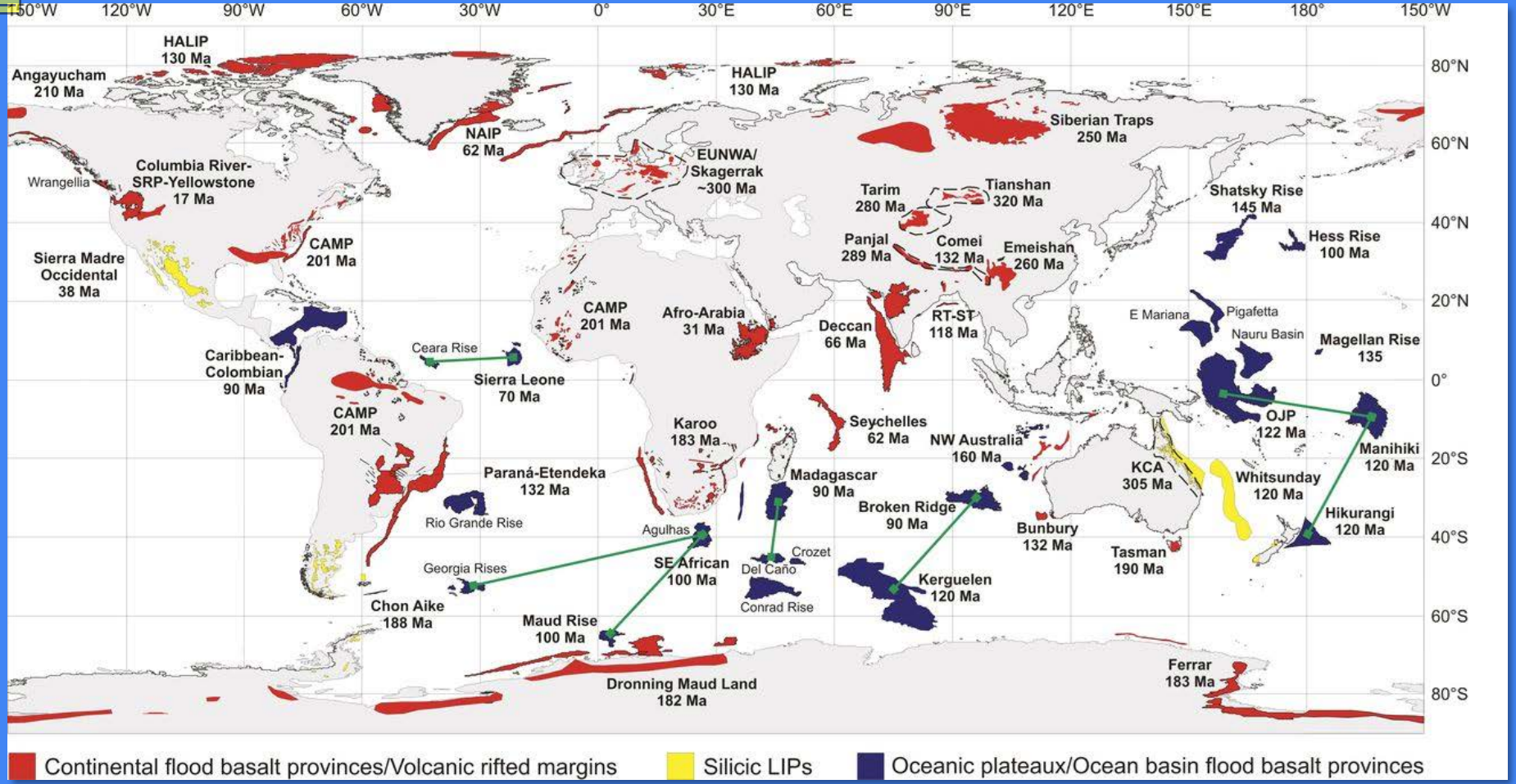
Iceland

Kerguelen

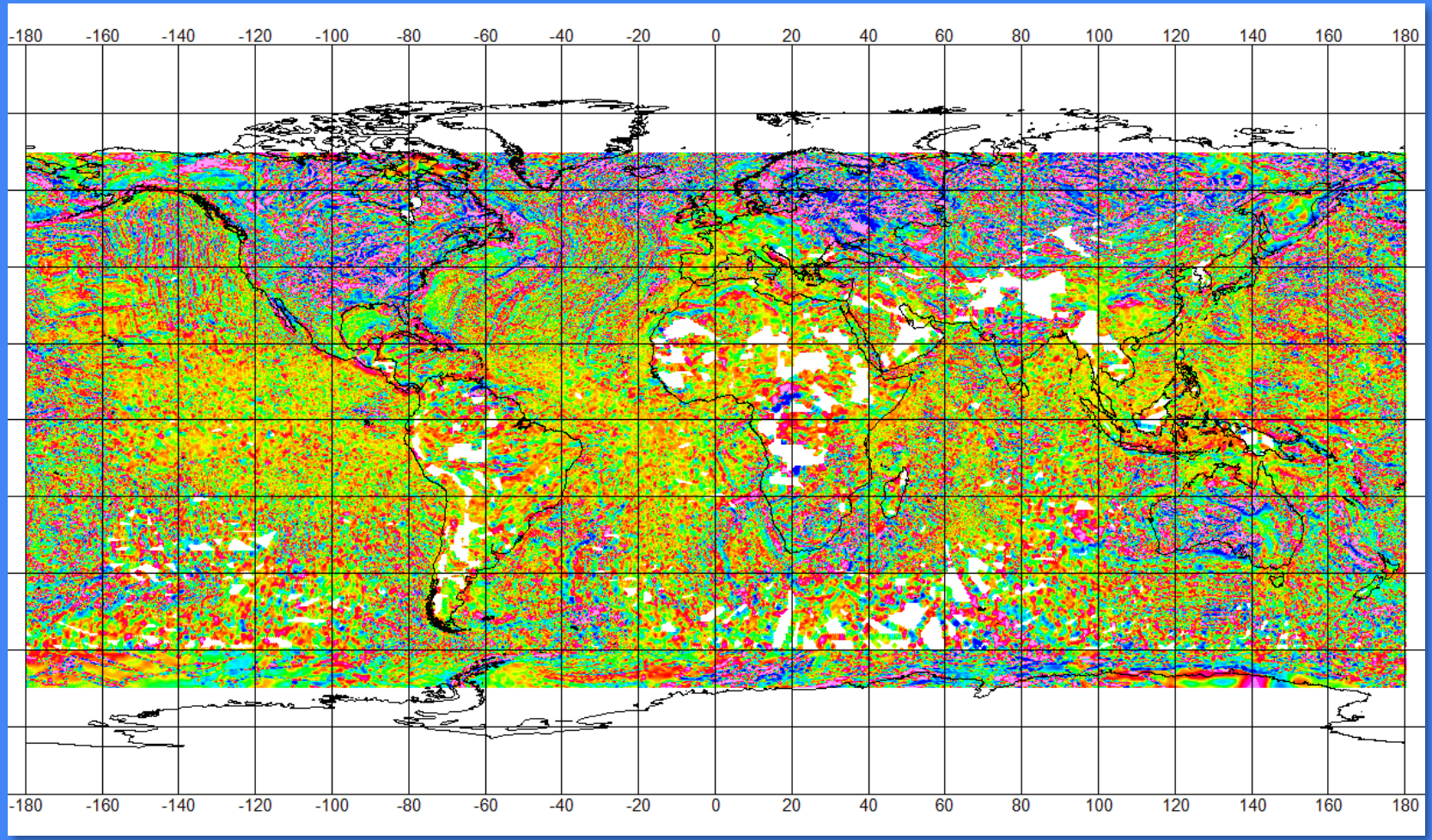
Some global examples based on careful study (Oakey and Saltus, 2016)



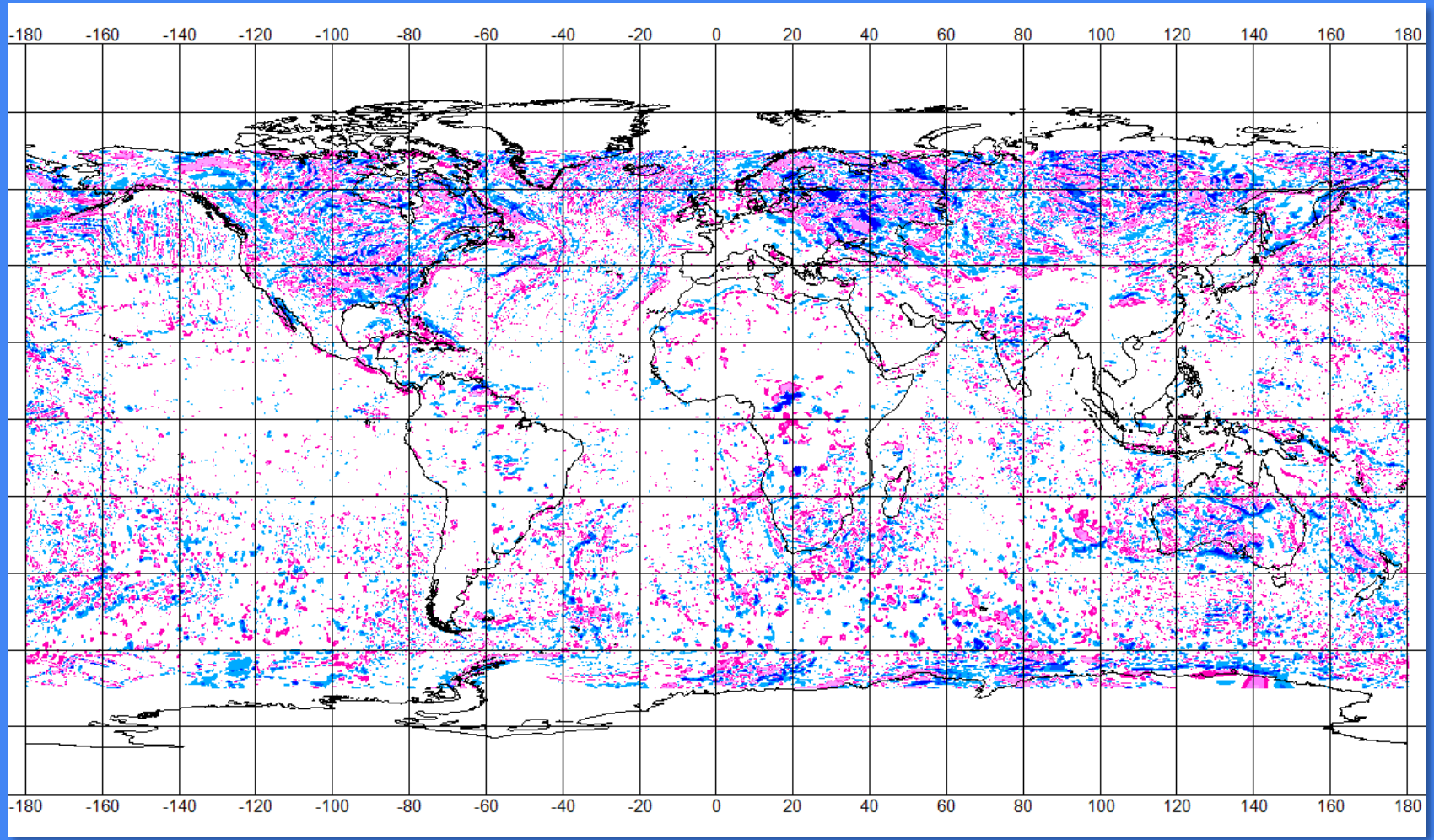
Coffin and Eldholm, 2005



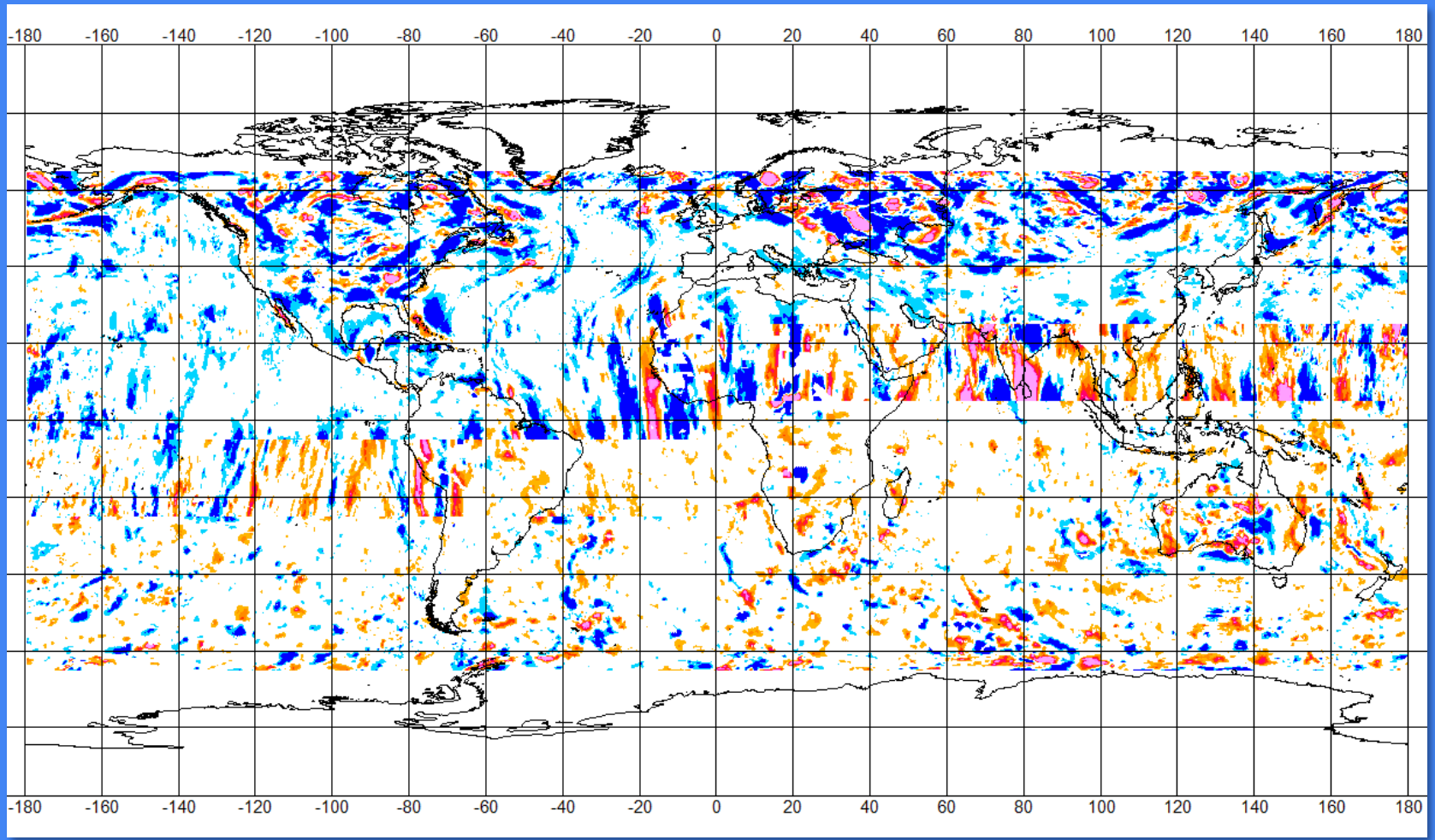
Bryan and Ferrari, 2013


-180 -160 -140 -120 -100 -80 -60 -40 -20 0 20 40 60 80 100 120 140 160 180
-180 -160 -140 -120 -100 -80 -60 -40 -20 0 20 40 60 80 100 120 140 160 180

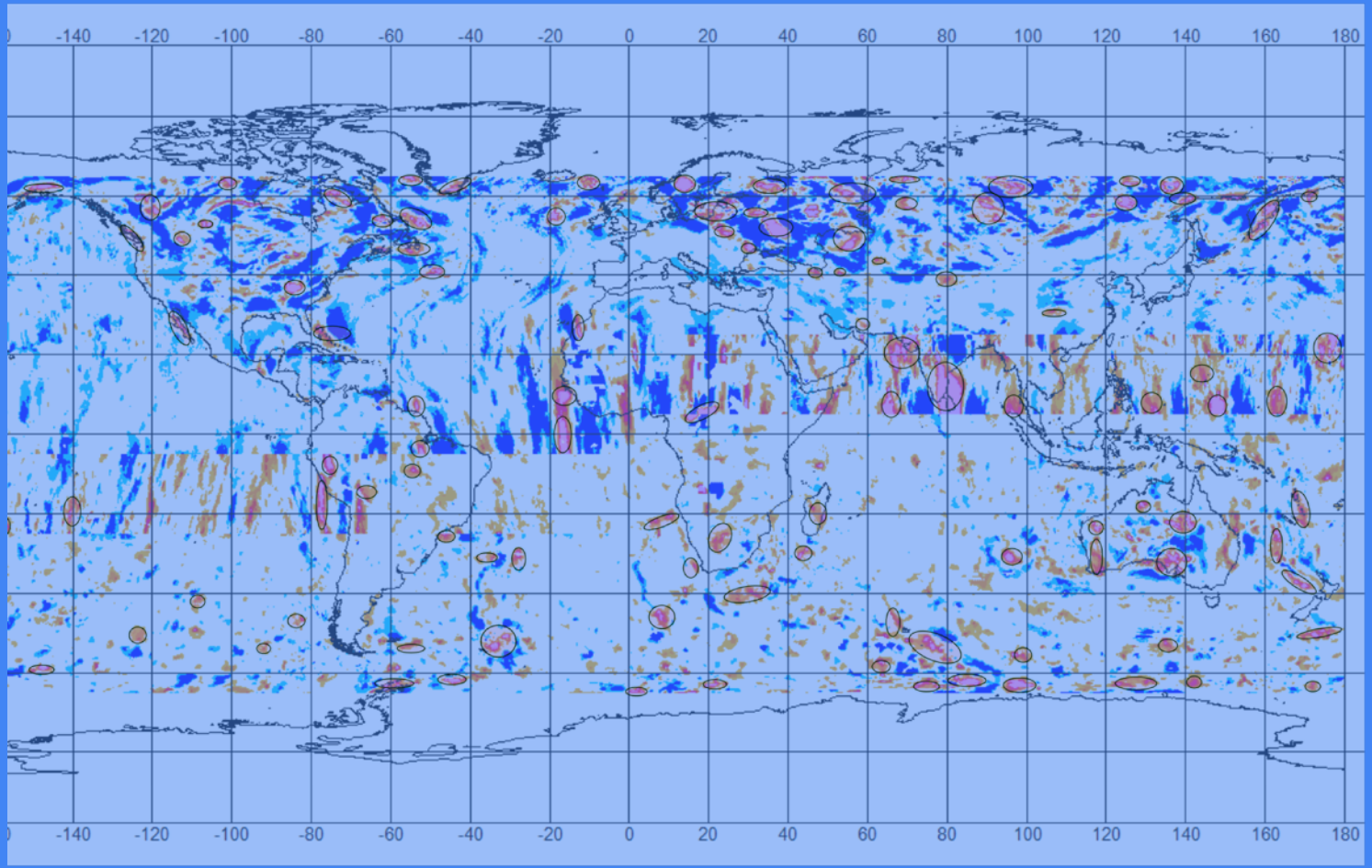
EMAG2v3



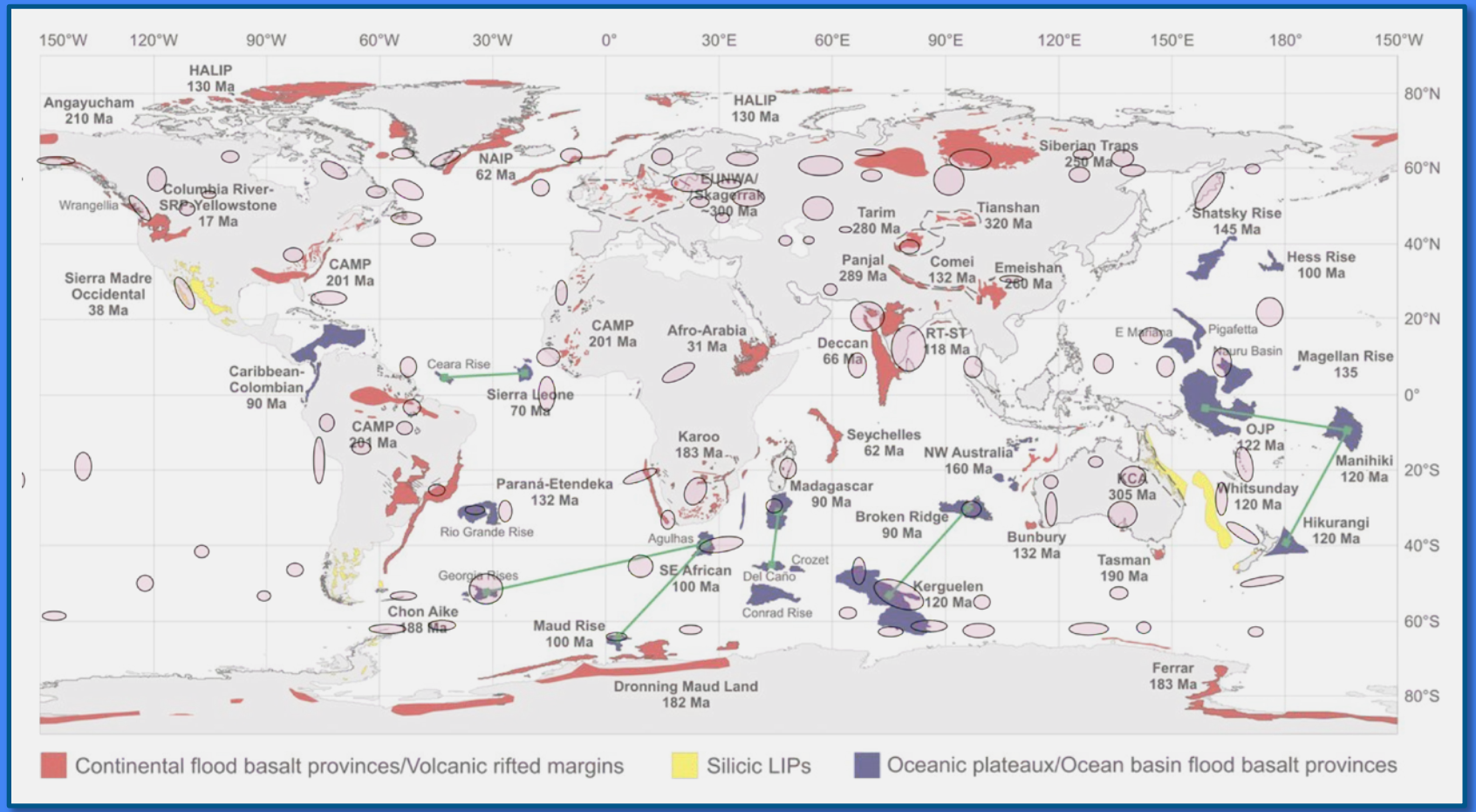
EMAG2v3 Upward Continued 10 km



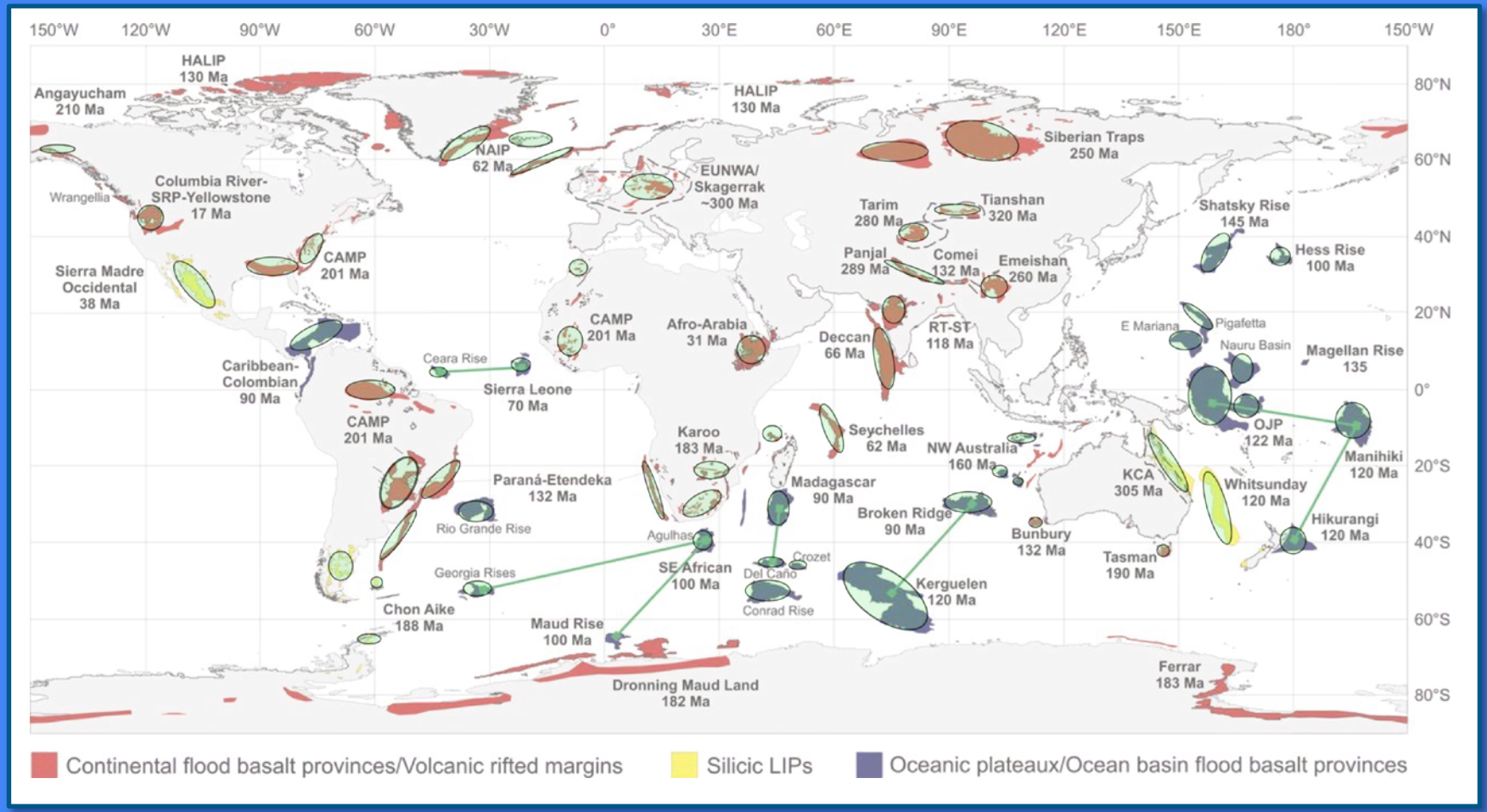
Pseudogravity (Beta version) from EMAG2v3 – Calculated using overlapping 40deg tiles



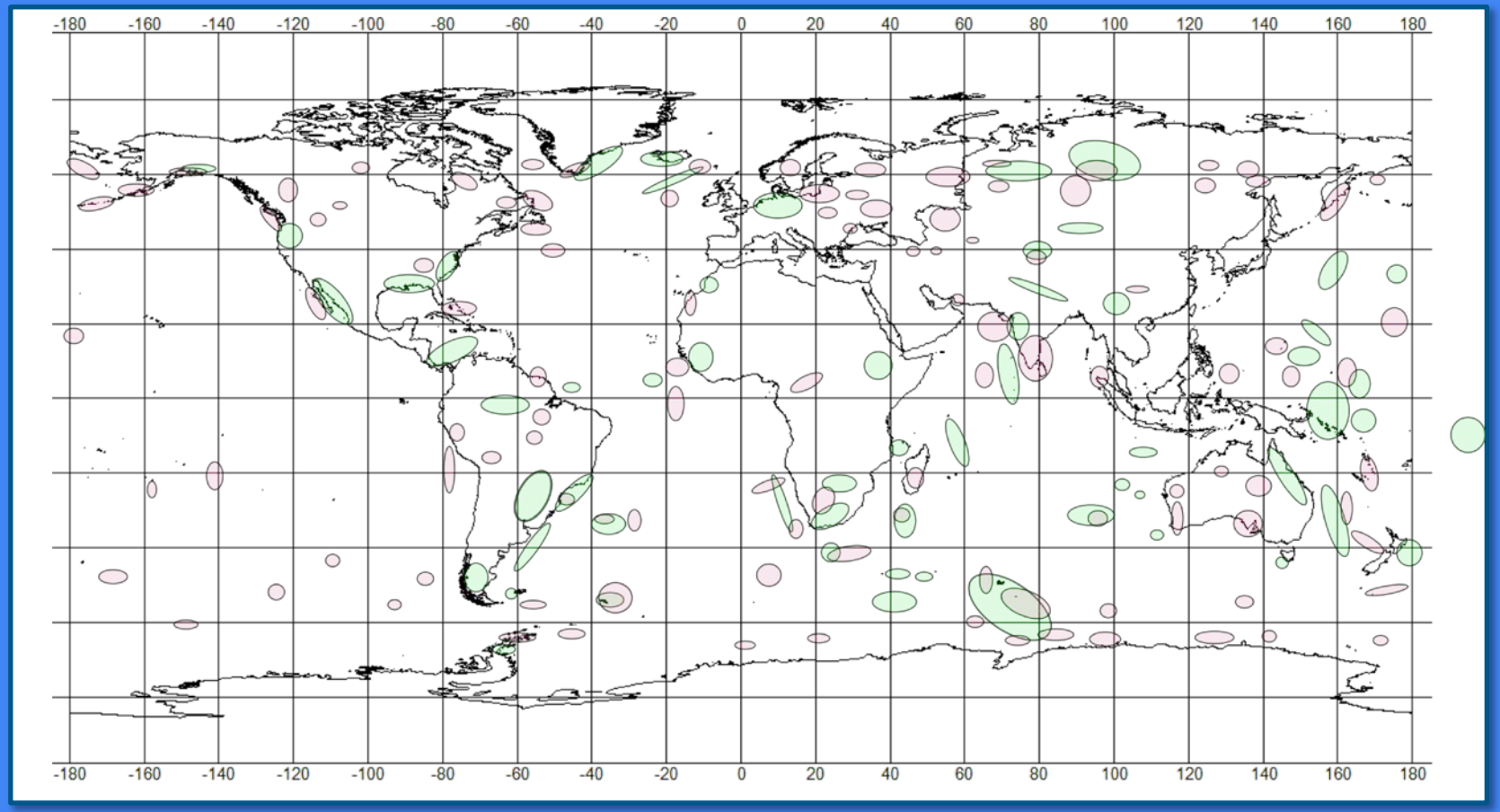
Visual identification of pseudogravity highs (aka “deep magnetic highs”)



Drumroll please… Pseudogravity highs plotted on Bryan and Ferrari 2013 LIP map



Circles marking Bryan & Ferrari LIP locations



Pseudogravity highs and mapped LIPs

Discussion and vote:
Is magnetic anomaly data diagnostic for LIP identification?

YES

- Reasonable expectation based on physical properties and mafic volumes
- Works in a number of well-documented cases
- Maybe it works reliably when you have good quality data

NO

- Not convinced that EMAG2 pseudogravity highs match global LIP polygons very well
- Geology is usually messier than theory would predict
- What about remanence, Curie depth, alteration, etc.?

DON'T KNOW YET

- EMAG2 resolution isn't sufficient yet
- Need a better map of global LIP polygons
- Need a better pseudogravity calculation

CIRES GEOMAGNETIC RESOURCES

geomag.colorado.edu

Magnetic data and models