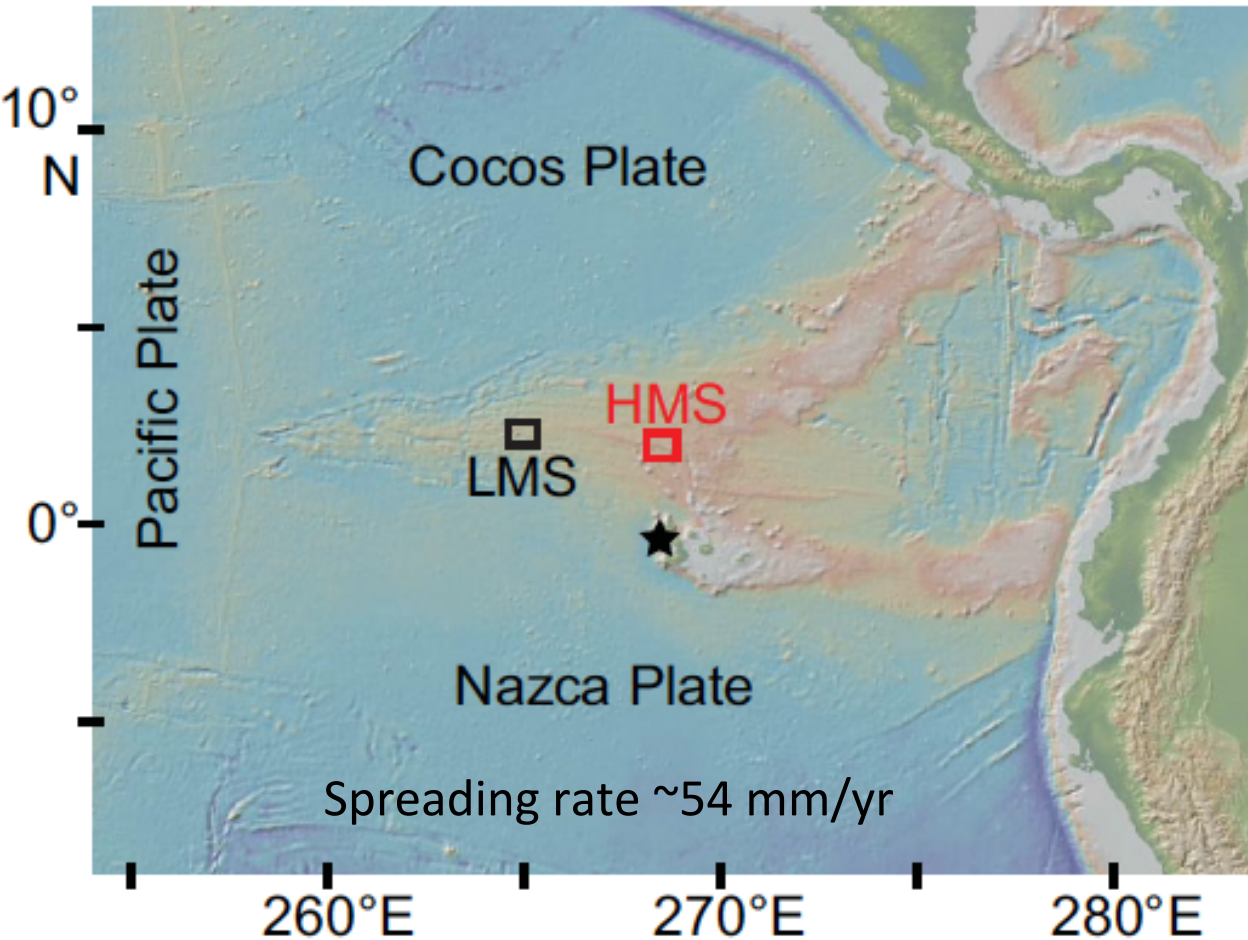


Eruptive timing and 200 year  
episodicity at 92°W on the hot spot-  
influenced Galapagos Spreading  
Center derived from geomagnetic  
paleointensity

Julie Bowles, Alice Colman, Tim McClinton,  
John Sinton, Scott White, Ken Rubin

*Geochem., Geophys., Geosys.*, 15, doi: 10.1002/2014GC005315, 2014.

# Study Area



Use high-resolution swath mapping, submersible and camera-tow observations, sample geochemistry to delineate flow field boundaries.

## Expedition goal:

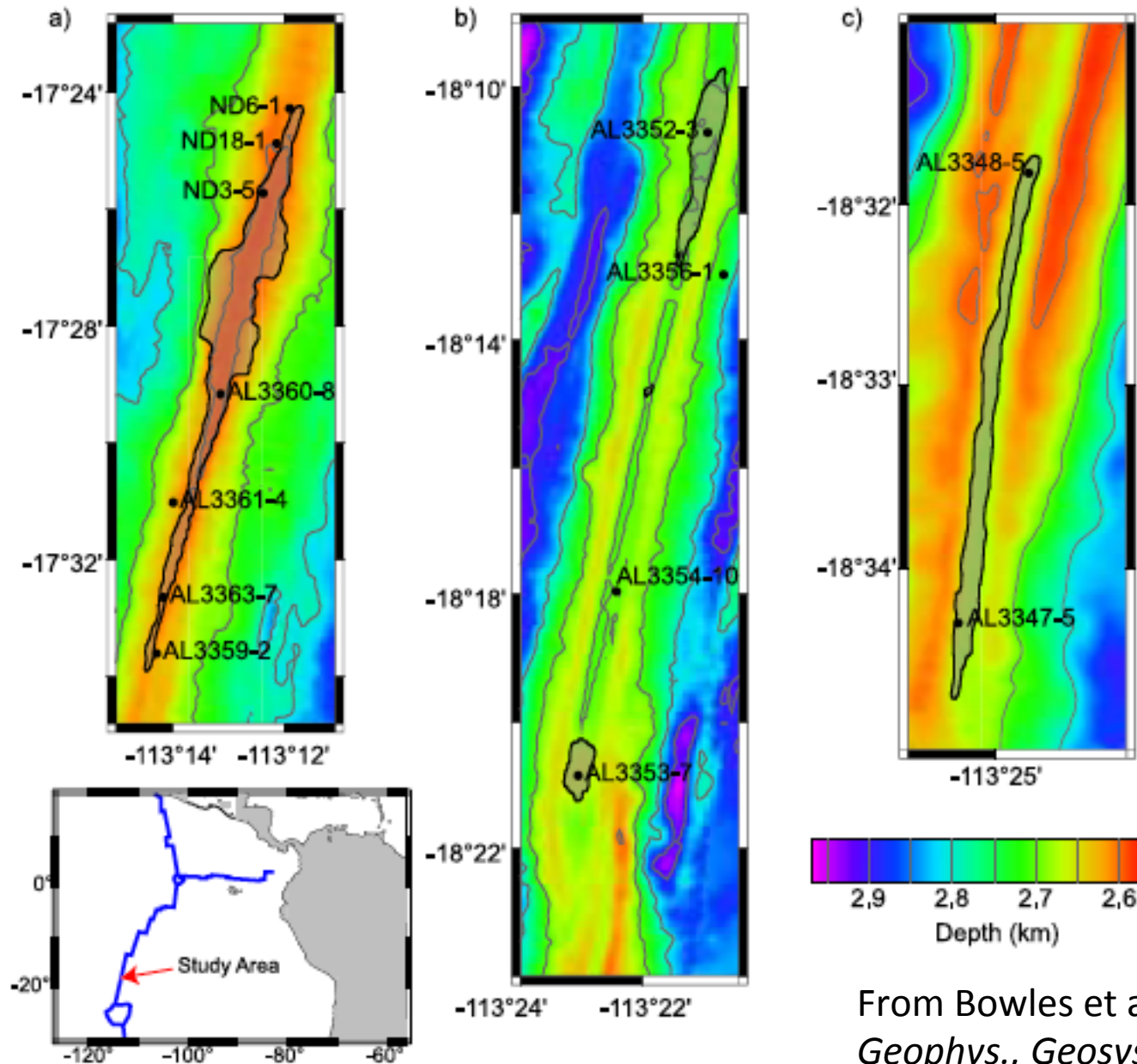
Characterize flow volume, frequency, duration and chemical heterogeneity with increasing magma supply, independent of spreading rate.

## Paleomagnetism goal:

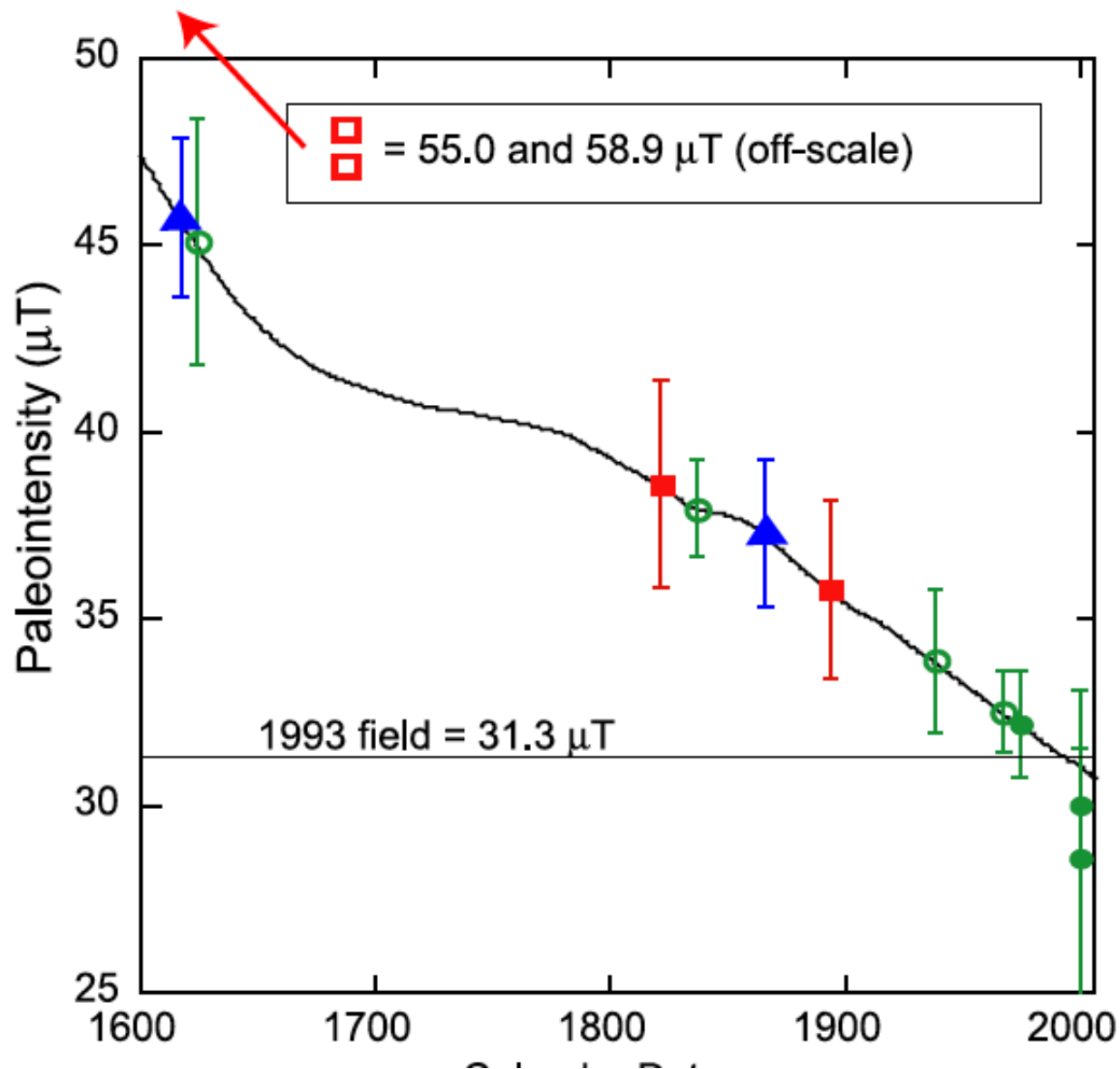
Constrain chronology and estimate eruptive frequency.

Very few absolute eruption chronologies for mid-ocean ridges.

# Earlier Work – S. East Pacific Rise



From Bowles et al., *Geochem., Geophys., Geosys.*, 2005.



Based on geologic evidence, within a given region (north, middle, south):

Solid symbols = younger  
Open symbols = older

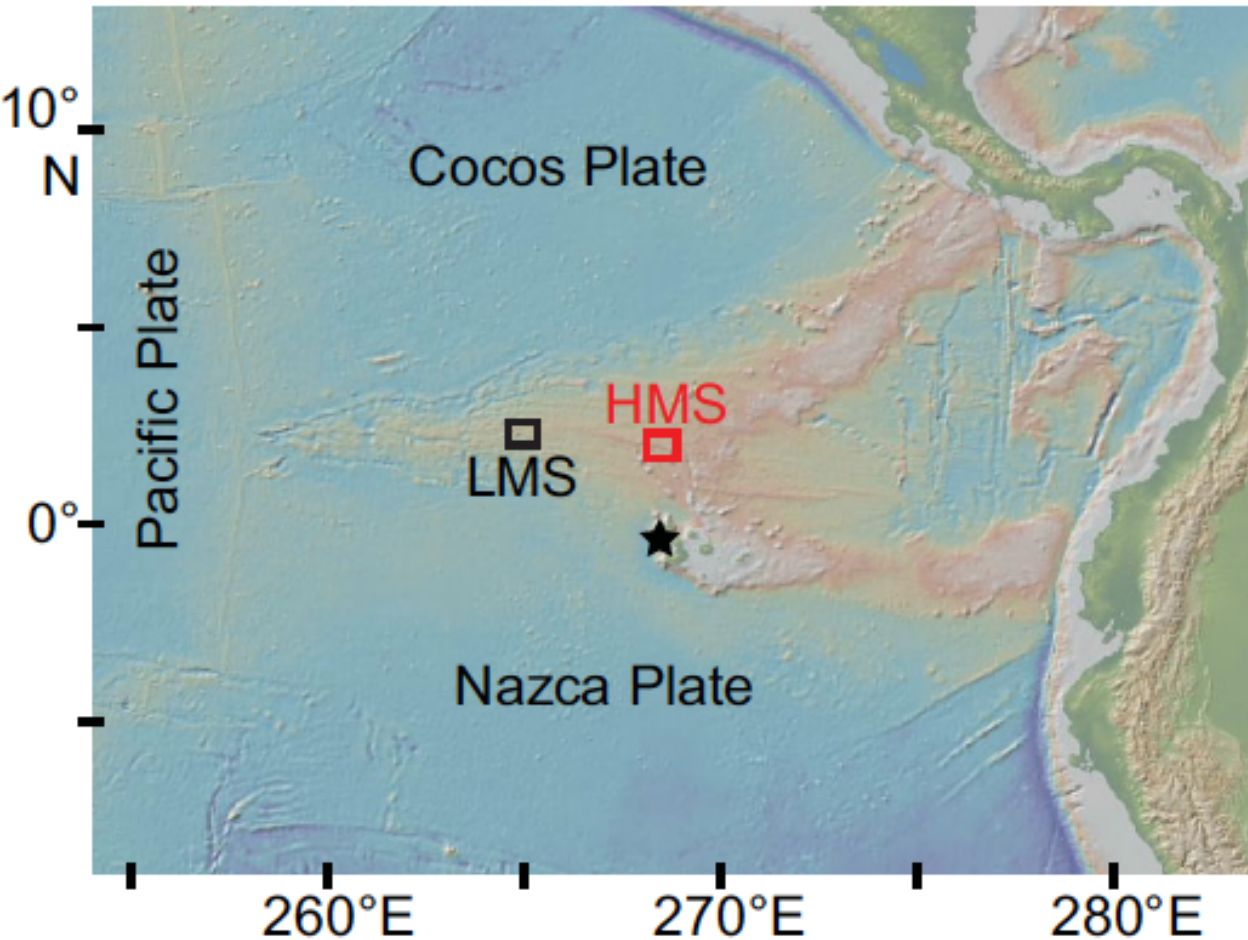
● ○ North (Fig. 1a)

■ □ Middle (Fig. 1b)

▲ △ South (Fig. 1c)

From Bowles et al., *Geochem., Geophys., Geosys.*, 2005.

# Study Area

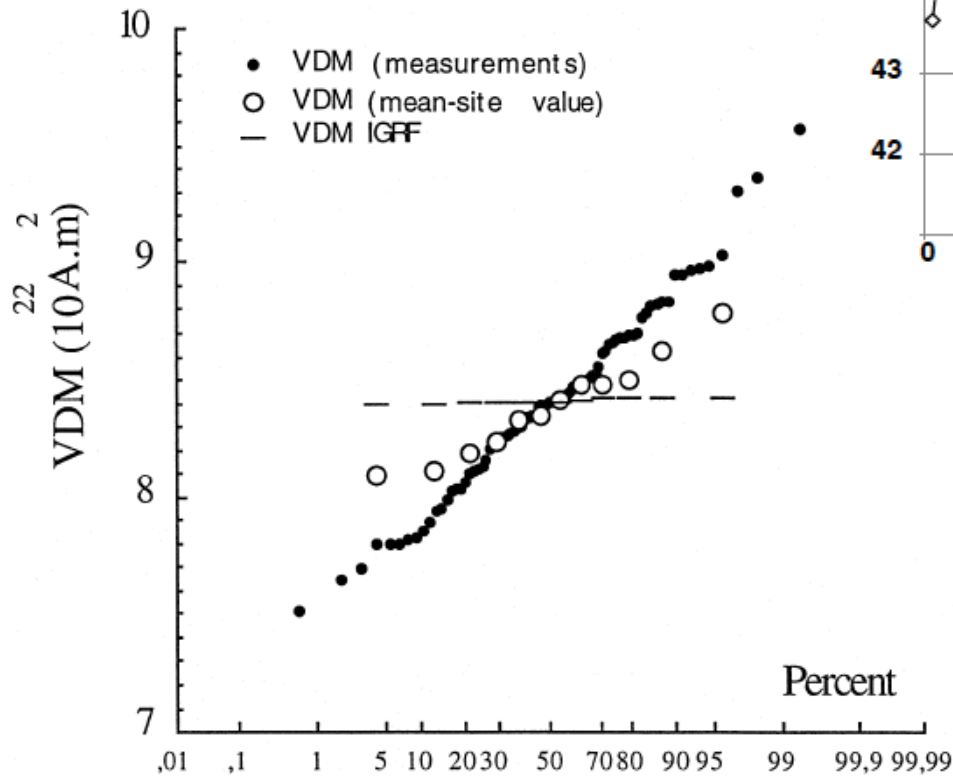


Potential difficulties

Strong local field anomalies due to:

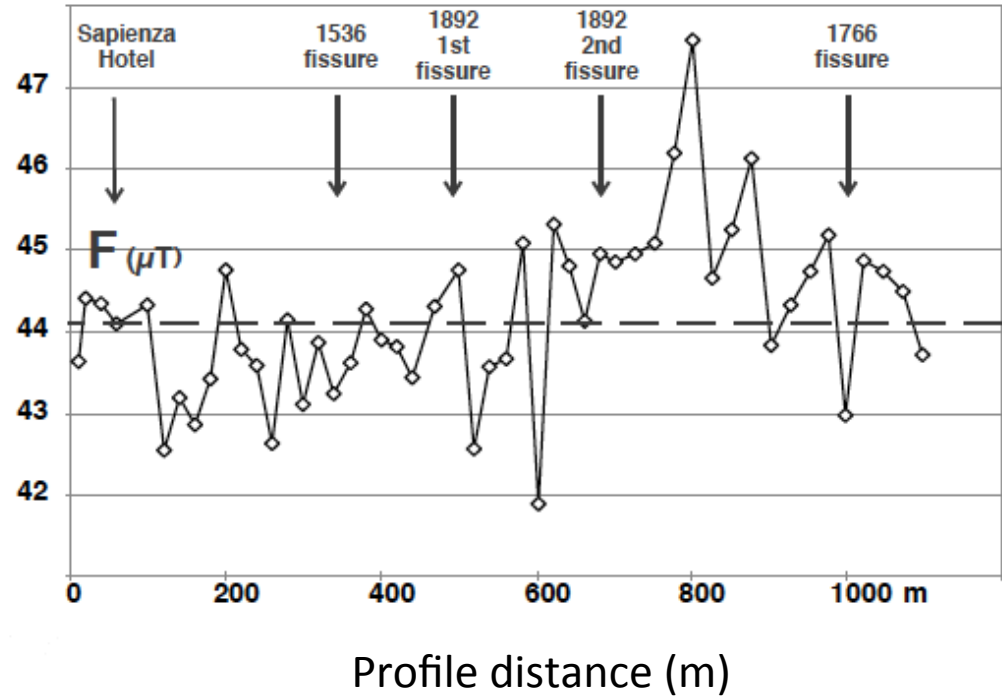
- Fe-rich basalts
- Unfavorable geometry

## Canary Islands



Valet and Soler, PEPI, 1999

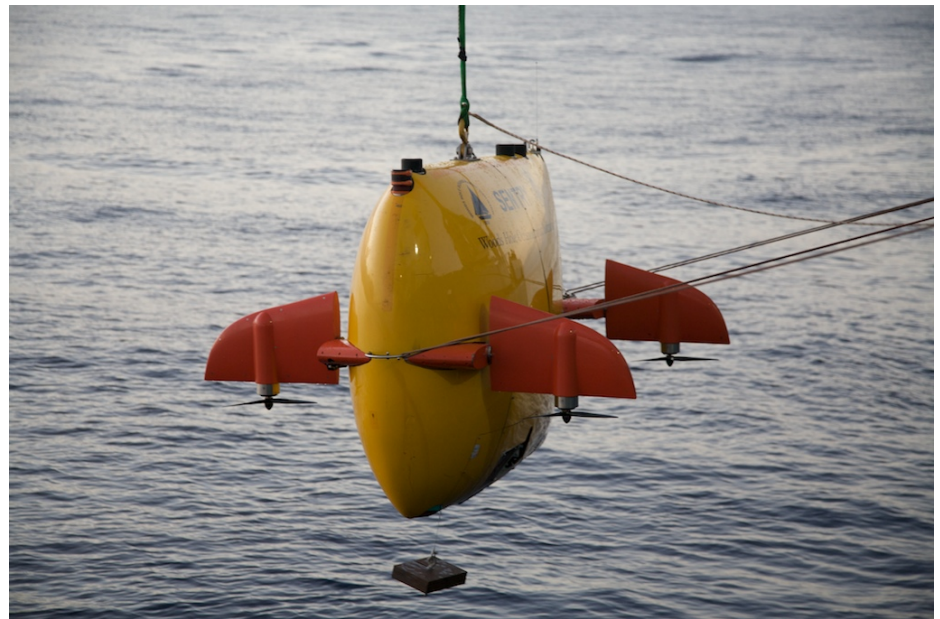
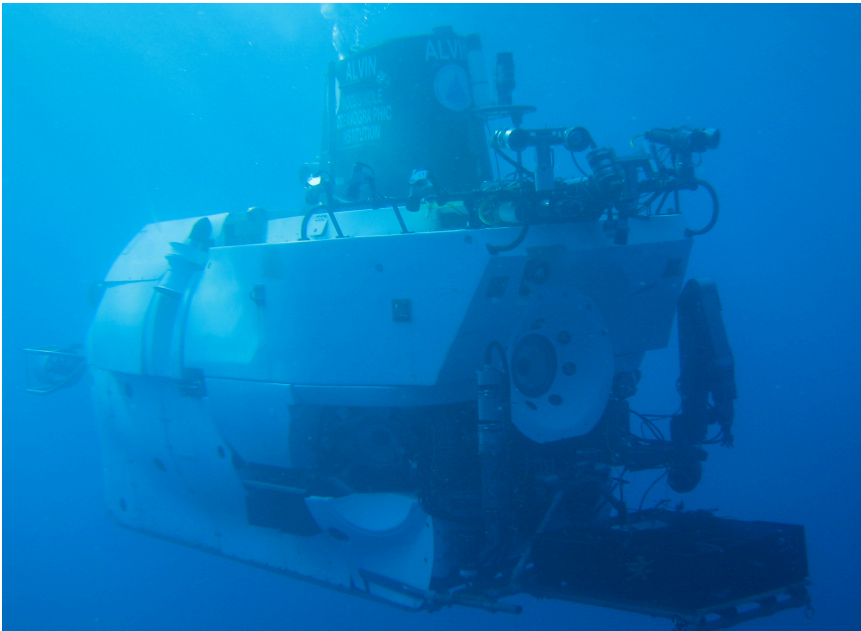
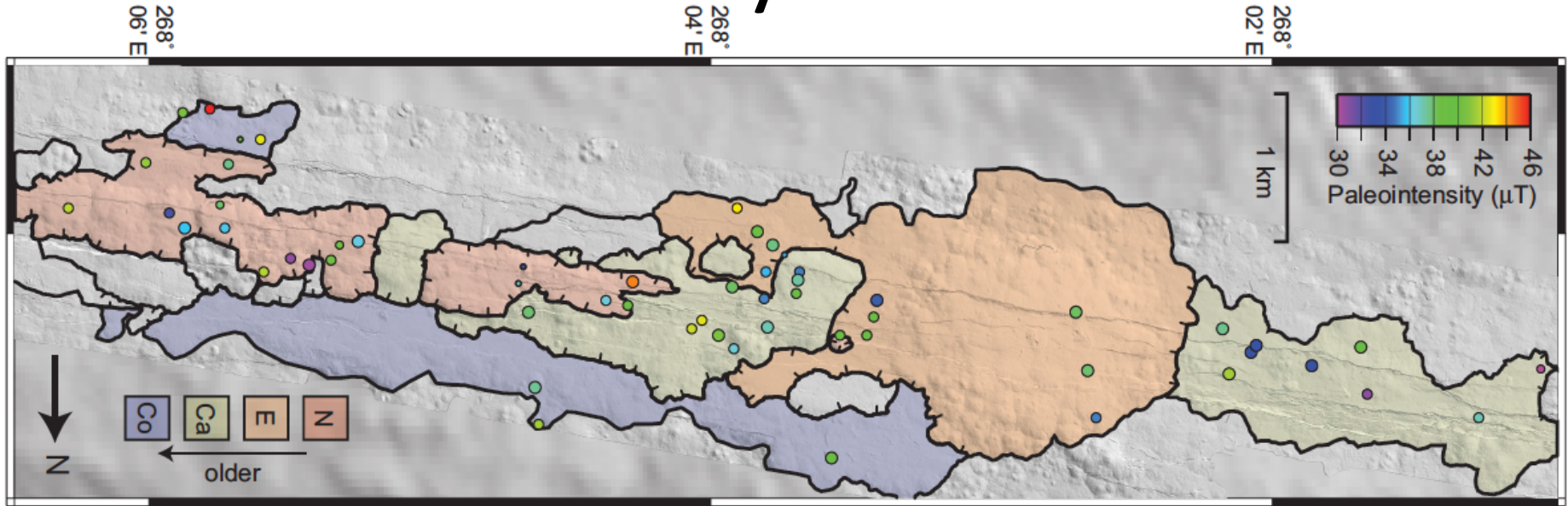
## Etna

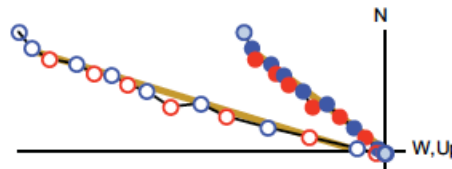
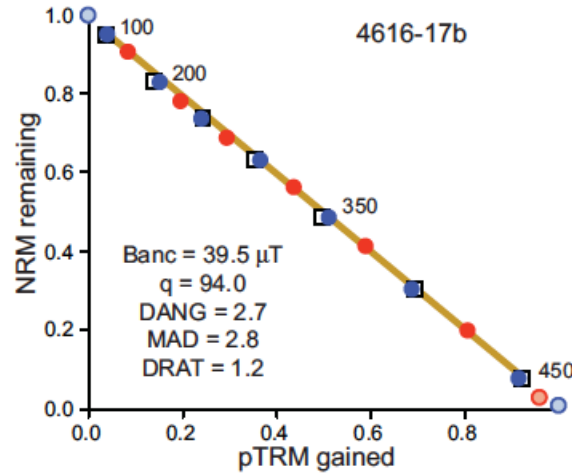
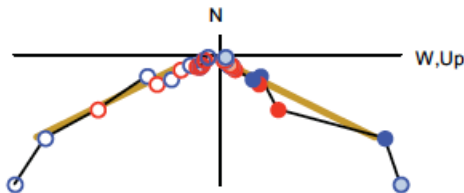
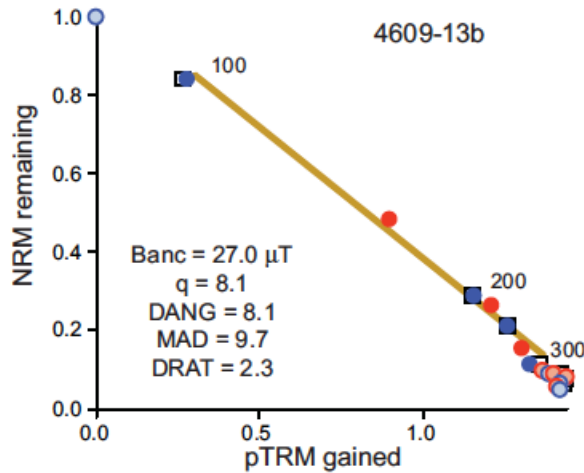
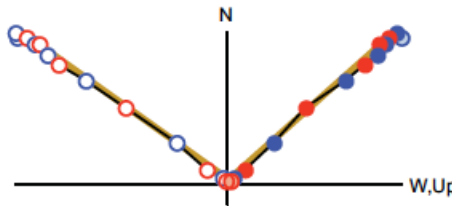
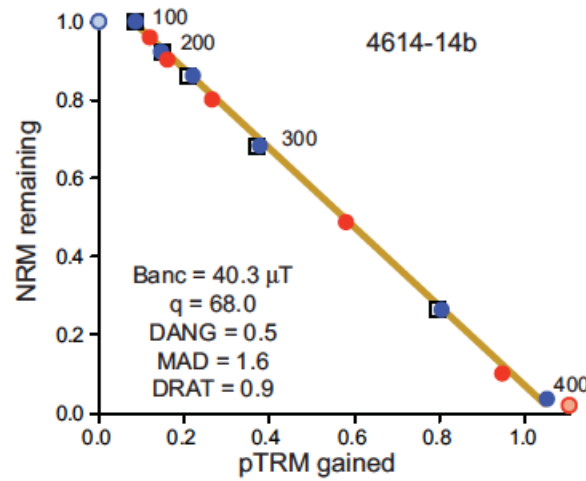
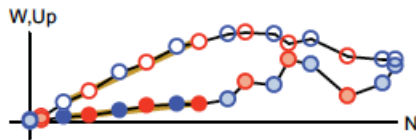
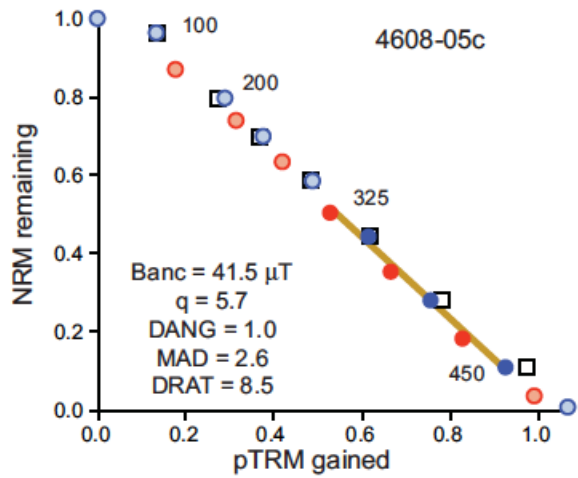


Tanguy and Le Goff, PEPI, 2004

If sufficiently sampled,  
perhaps local field effects  
can be averaged out.

# Study Area





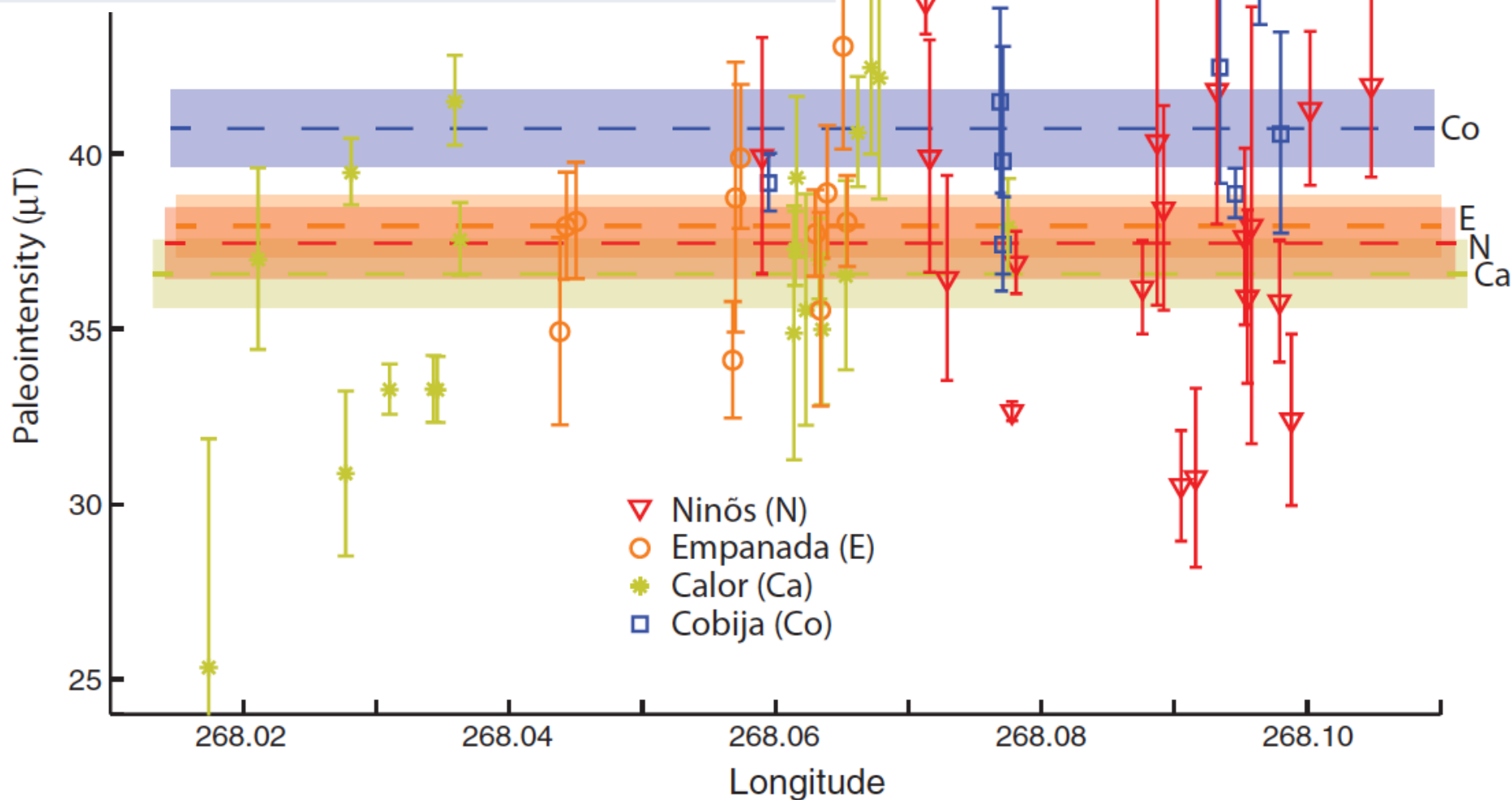
Sample-level results derived from bootstrap resampling of all possible slopes, where  $f > 0.5$  and  $DRAT < 10$

Flow-mean-level results derived from bootstrap resampling in order to propagate sample-level uncertainties into flow mean uncertainties.

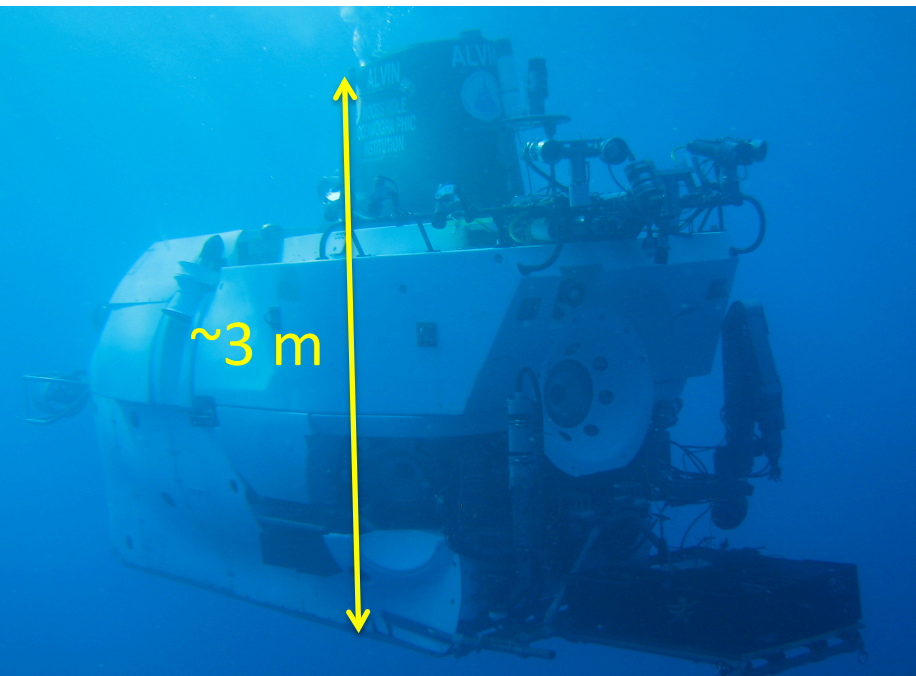
**Table 2.** Flow-Mean Paleointensity

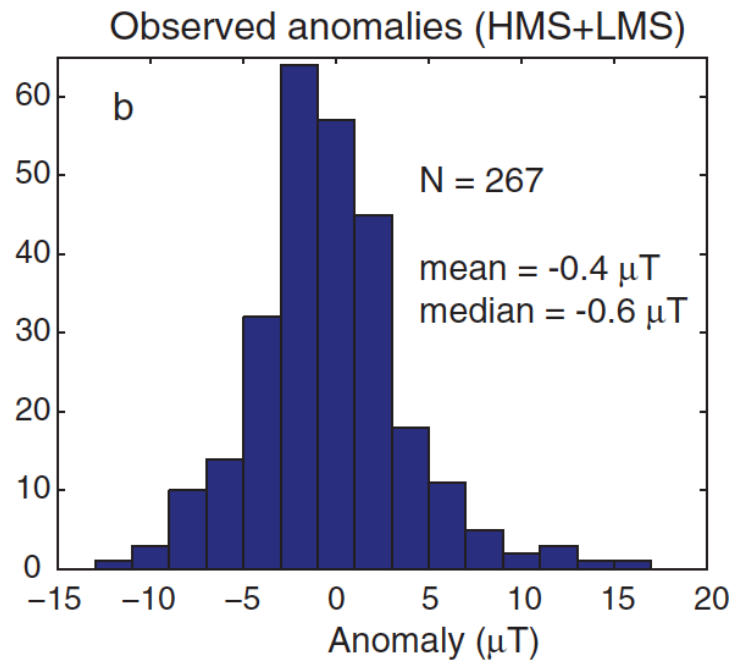
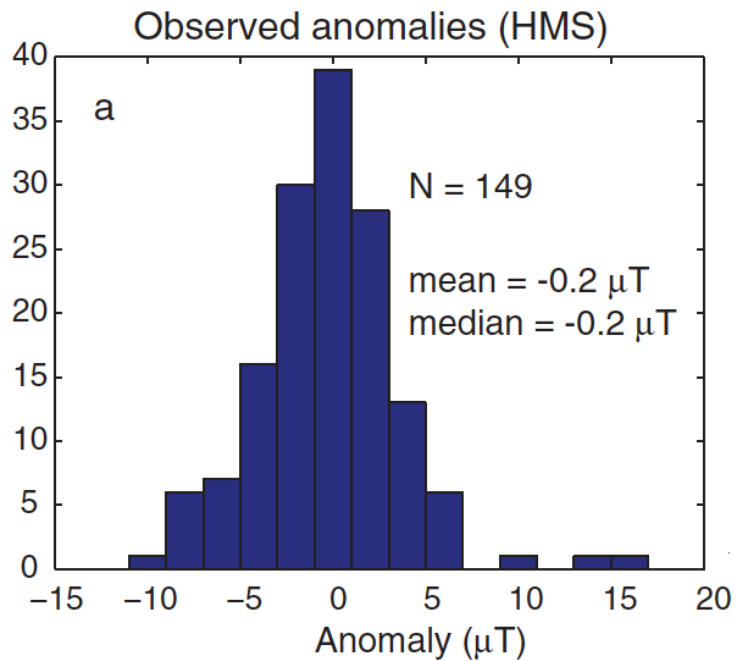
Flow	Mean ( $\mu\text{T}$ )	Standard Error ( $\mu\text{T}$ )	N
Calor (Ca)	36.6	1.0	20
Cobija (Co)	40.7	1.1	8
Empanada (E)	38.0	0.9	11
Ninos (N)	37.5	1.0	19

Error bars 2 standard error

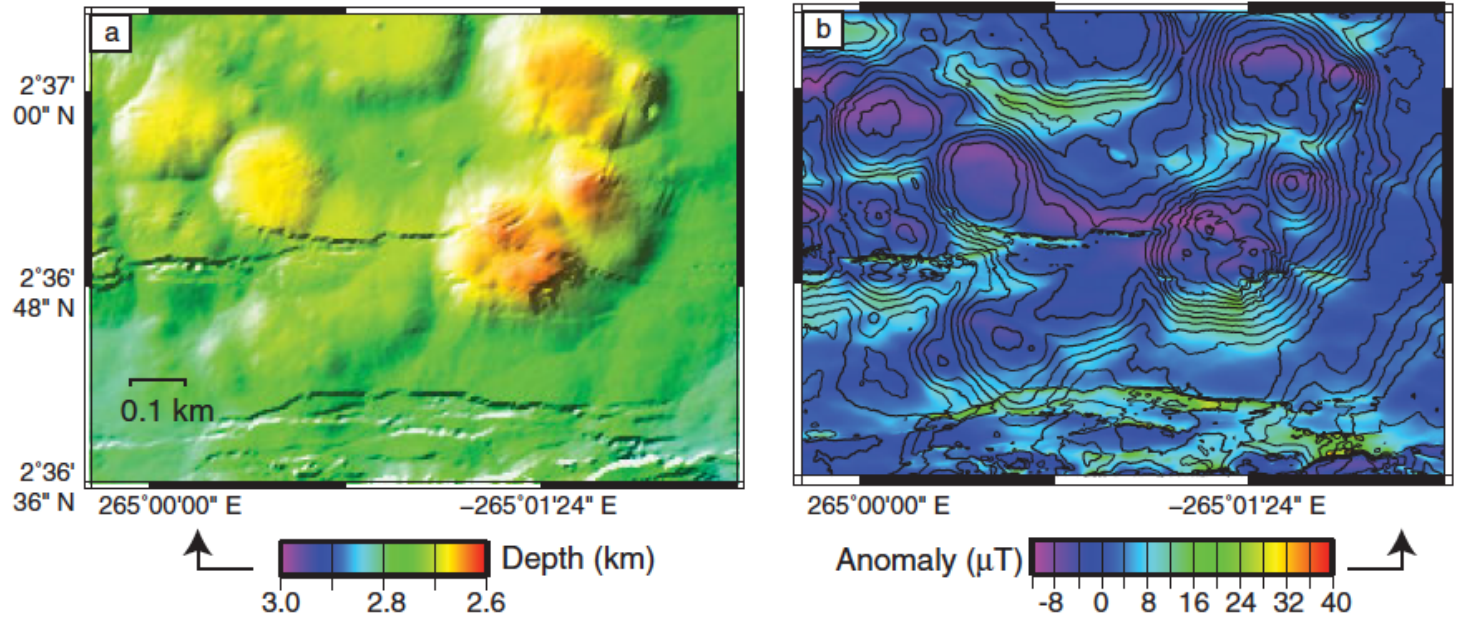


- What accounts for the scatter?
  - Problem with recording medium?
  - Or is there this much variability in the near-bottom field?
- Does the “noise” have zero mean?

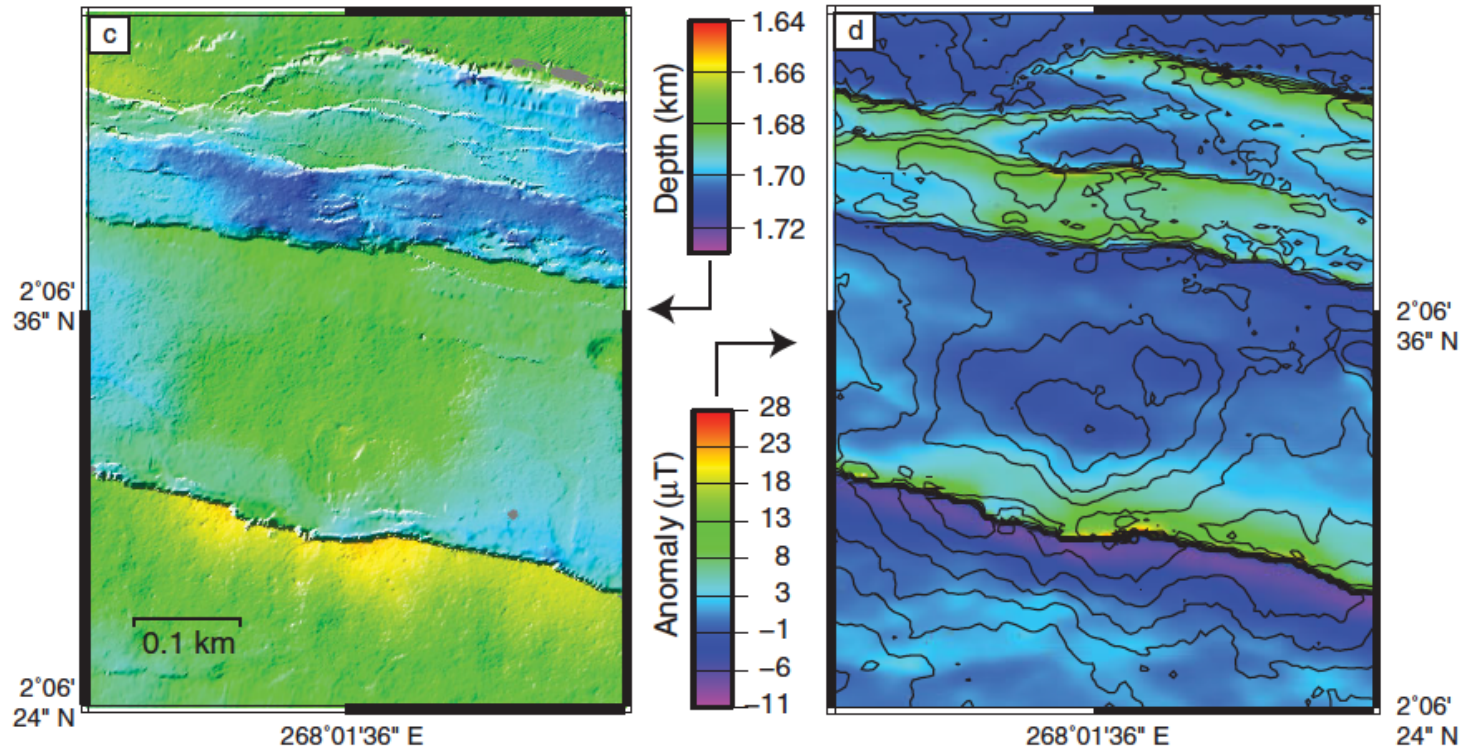


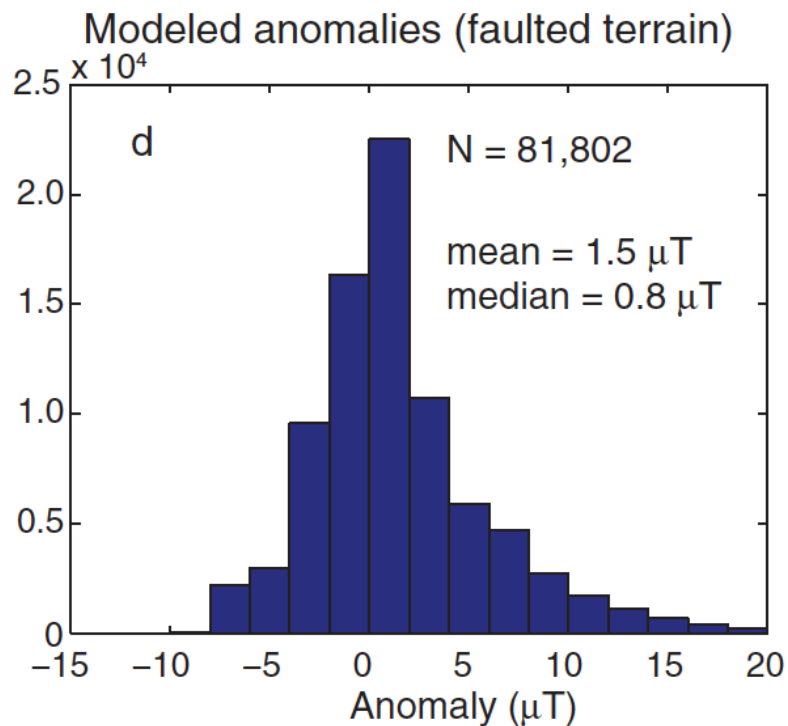
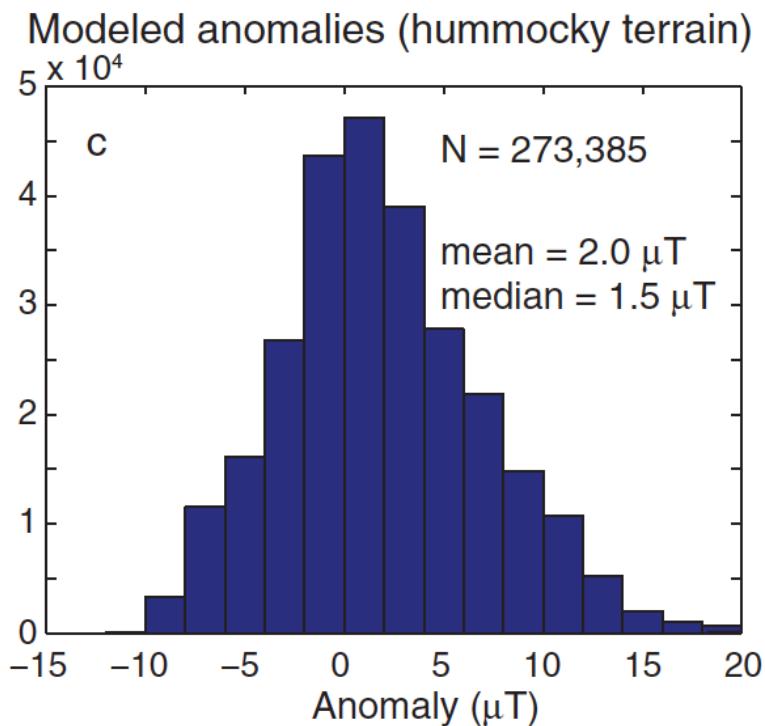
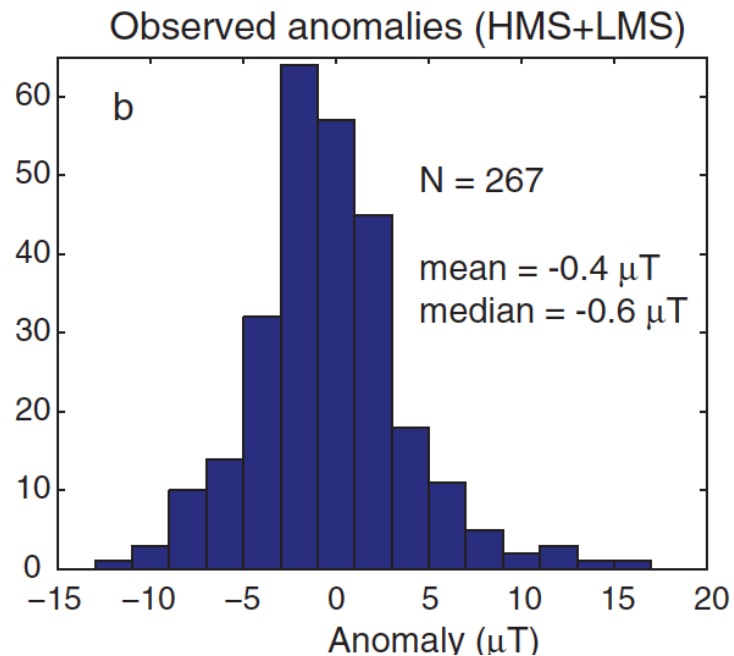
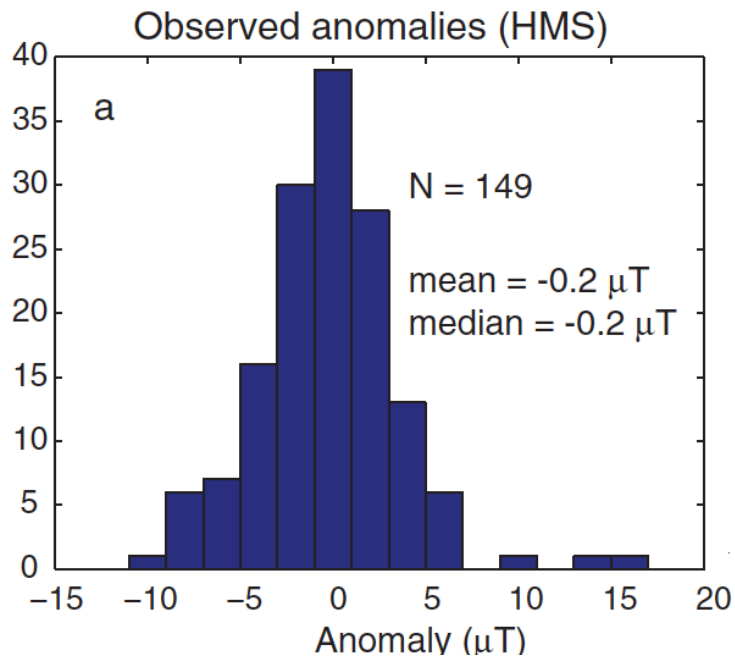


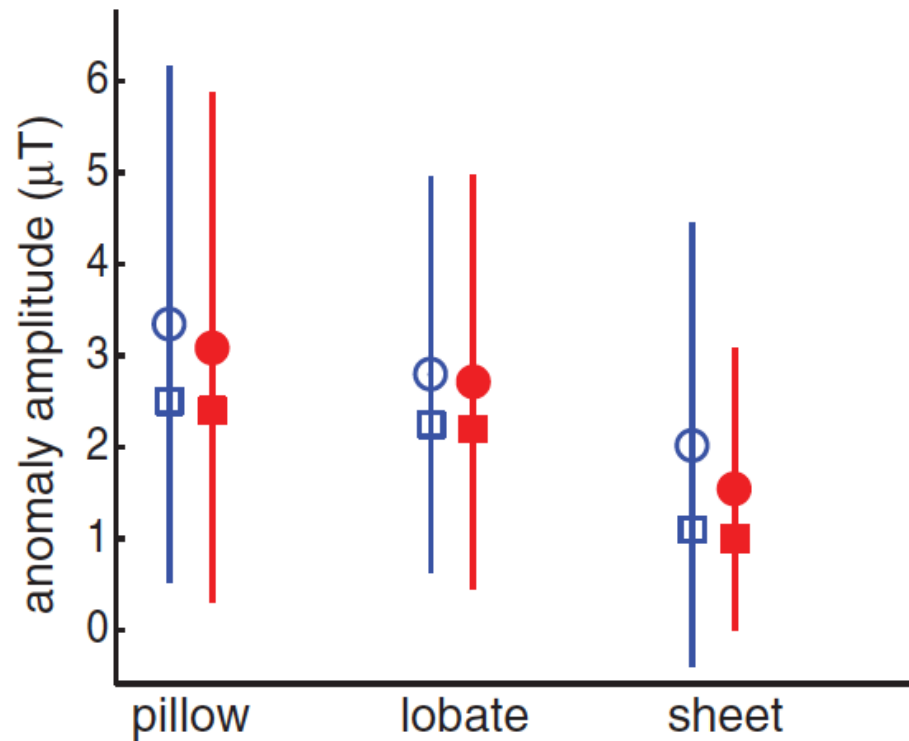
“Hummocky”  
terrain (LMS)



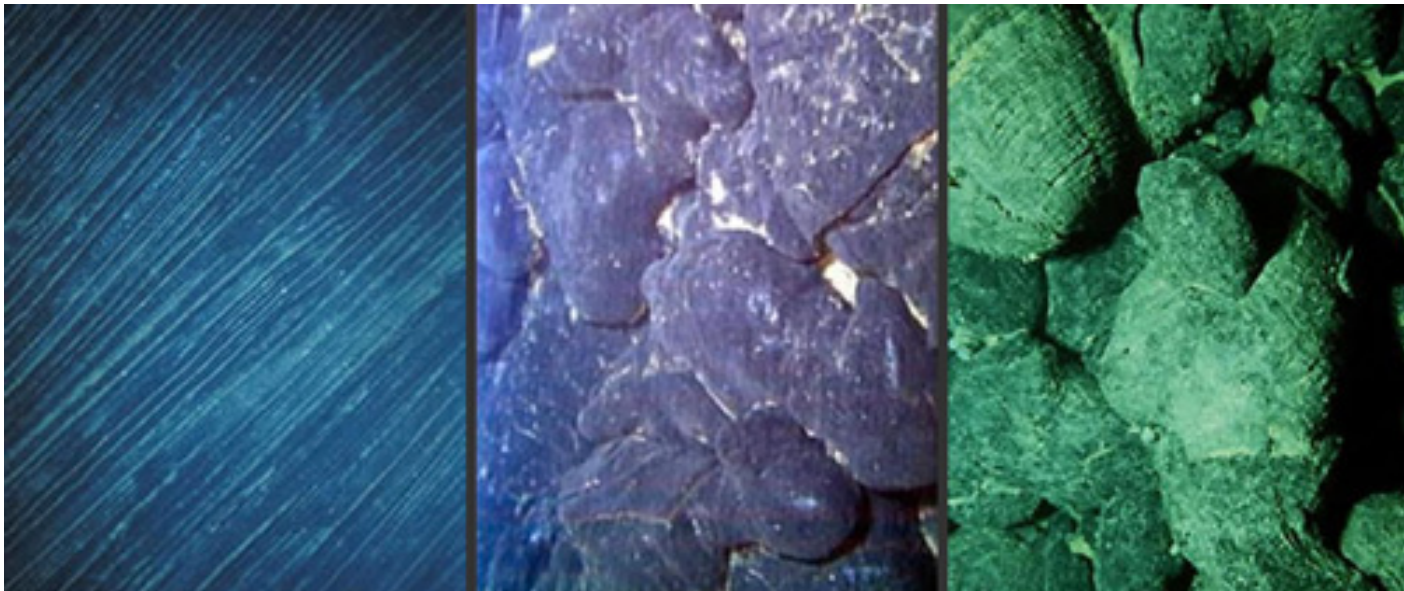
Faulted  
terrain (HMS)

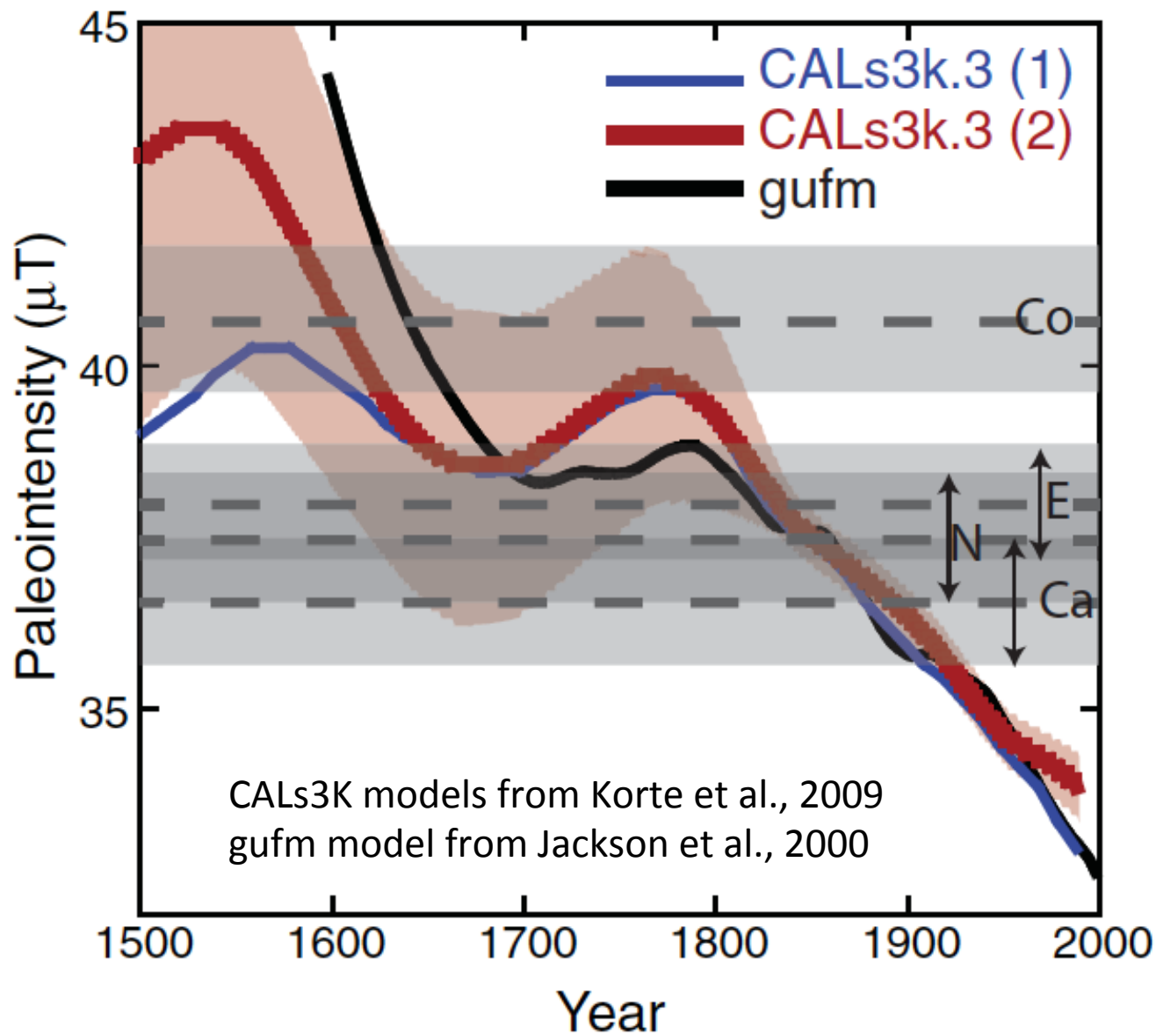






Paleointensity results suggest there *may* be a 1-2  $\mu\text{T}$  positive bias over pillow lavas compared to sheet flows.



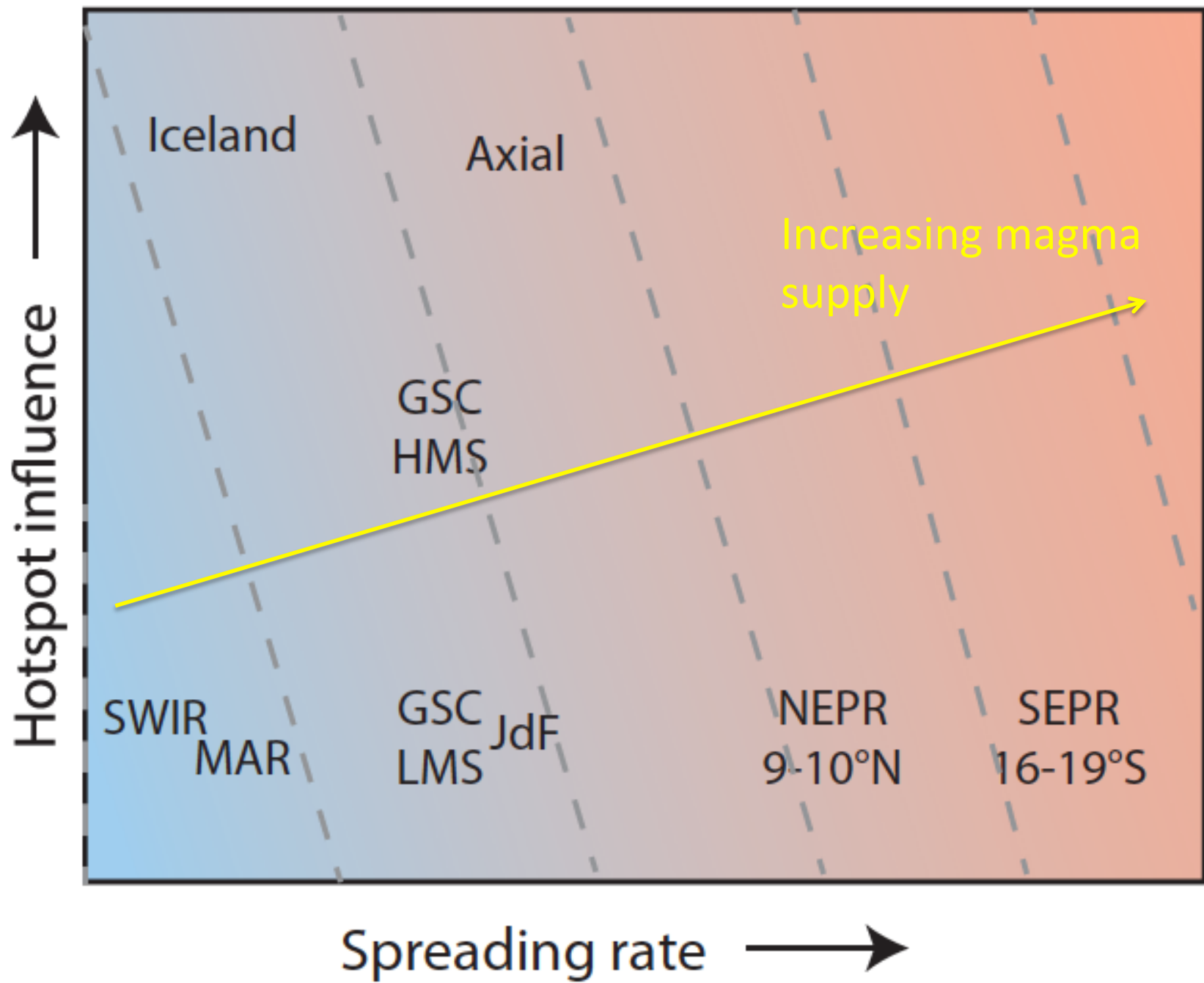


Interpretation:

- 3 youngest flows erupted in relatively close succession between 100-200 years ago.
- Oldest flow may be significantly older – roughly 400 years old

# Interpretation

- Eruptive activity episodic with a quiescent interval of roughly 200-300 years
- “Average” eruptive interval: 25-50 yrs, including other (smaller) mapped flows
- Comparisons:
  - HMS study area: 72 yr eruptive interval based on average extrusive layer thickness and median flow volume estimates (Colman et al., 2012)
  - LMS study area: 360 yrs eruptive interval (Colman et al., 2012)
  - Axial volcano: ~20 year eruptive interval with quiescent phase of ~345 yrs (Clague et al., 2013)
  - Iceland: ~10 year interval for diking events with quiescent phase of ~200-300 yrs (Nooner and Chadwick, 2009)



# Conclusions

- Three relatively large, young flows indistinguishable in age and emplaced in relatively rapid succession in past 100-200 yrs.
- Oldest flow significantly older, roughly 400 yrs
- Possible bias in paleointensity data allows for ages as young as ~50 yrs for young flows and 200-400 yrs for old flow.
- The episodic behavior described aligns with other observations for hotspot influenced spreading centers.
- Paleointensity method has limitations in areas with strong on-bottom anomalies, but with sufficient sampling and characterization of anomalies, it can still be a useful technique.