AT37-08: PMaG Expedition

Pito Deep - Revisiting Pacific Lower Crust, the 3rd Dimension of Magnetic Stripes and Long Lost & New Found Hydrothermal vents

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& others

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NSF National Science Foundation WHERE DISCOVERIES BEGIN

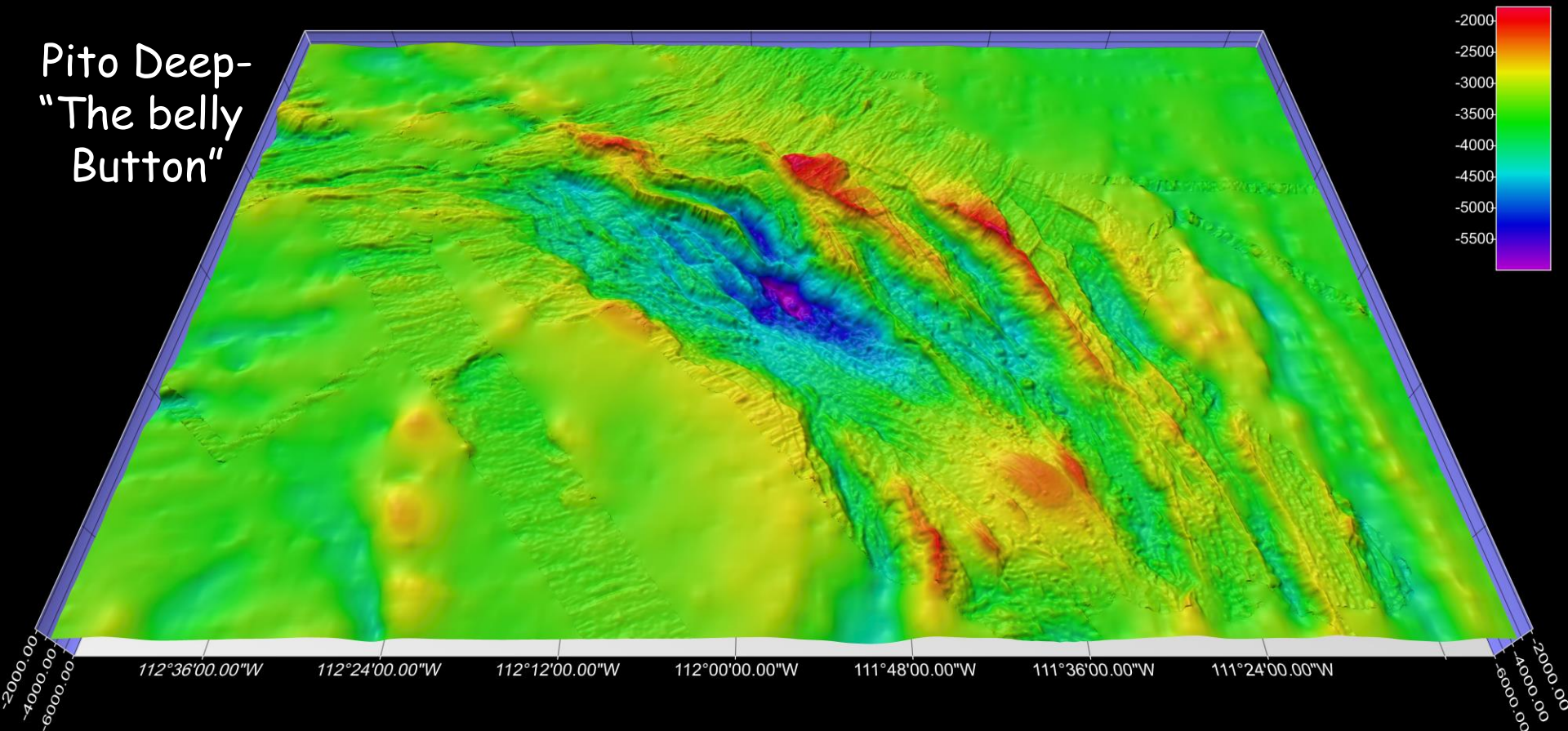
Objectives:

- Report on the AT37-08 Atlantis cruise to Pito Deep (Jan/Feb 2017)
- Present preliminary results: - lateral heterogeneity
- Implications for the size & shape of magma accretion zones & both fast & slow spreading ridges
- New hydrothermal vent discoveries
- Future work

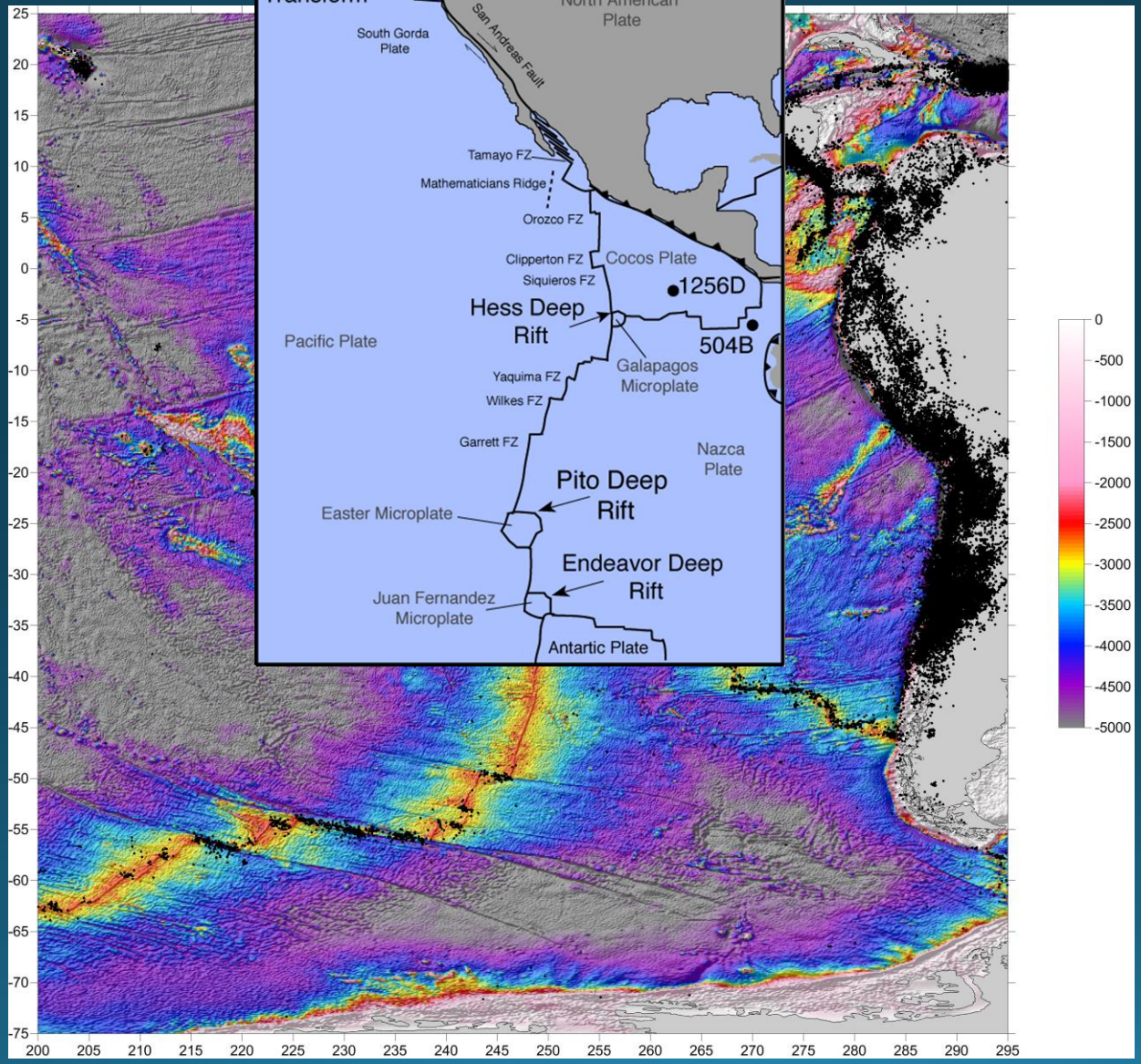
So why did we go to Easter Island?

close to one of the few places in the the Pacific Sea floor that has a crack in the crust that allows access to the interior of oceanic crust

Pito Deep- "The belly Button"

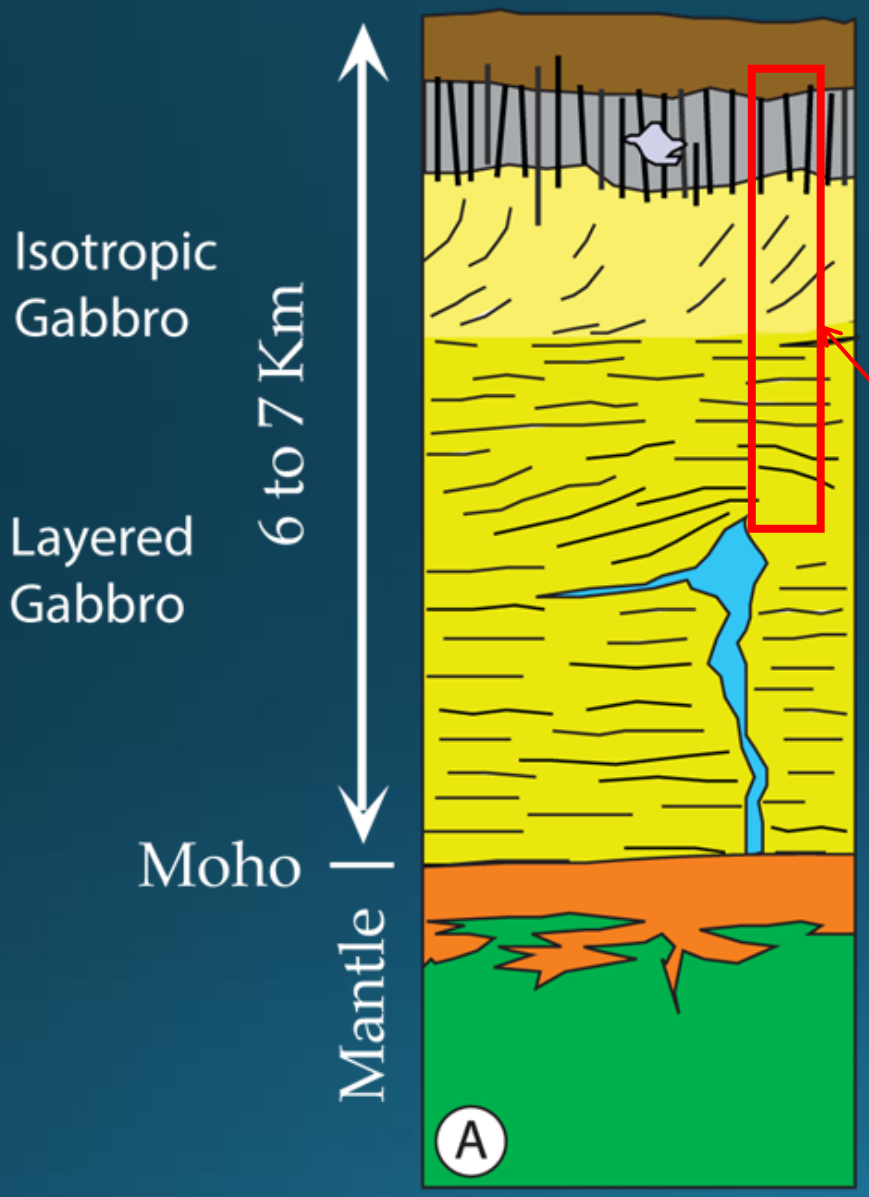


Why is having a crack through the c ant ?



Bathymetry (m)

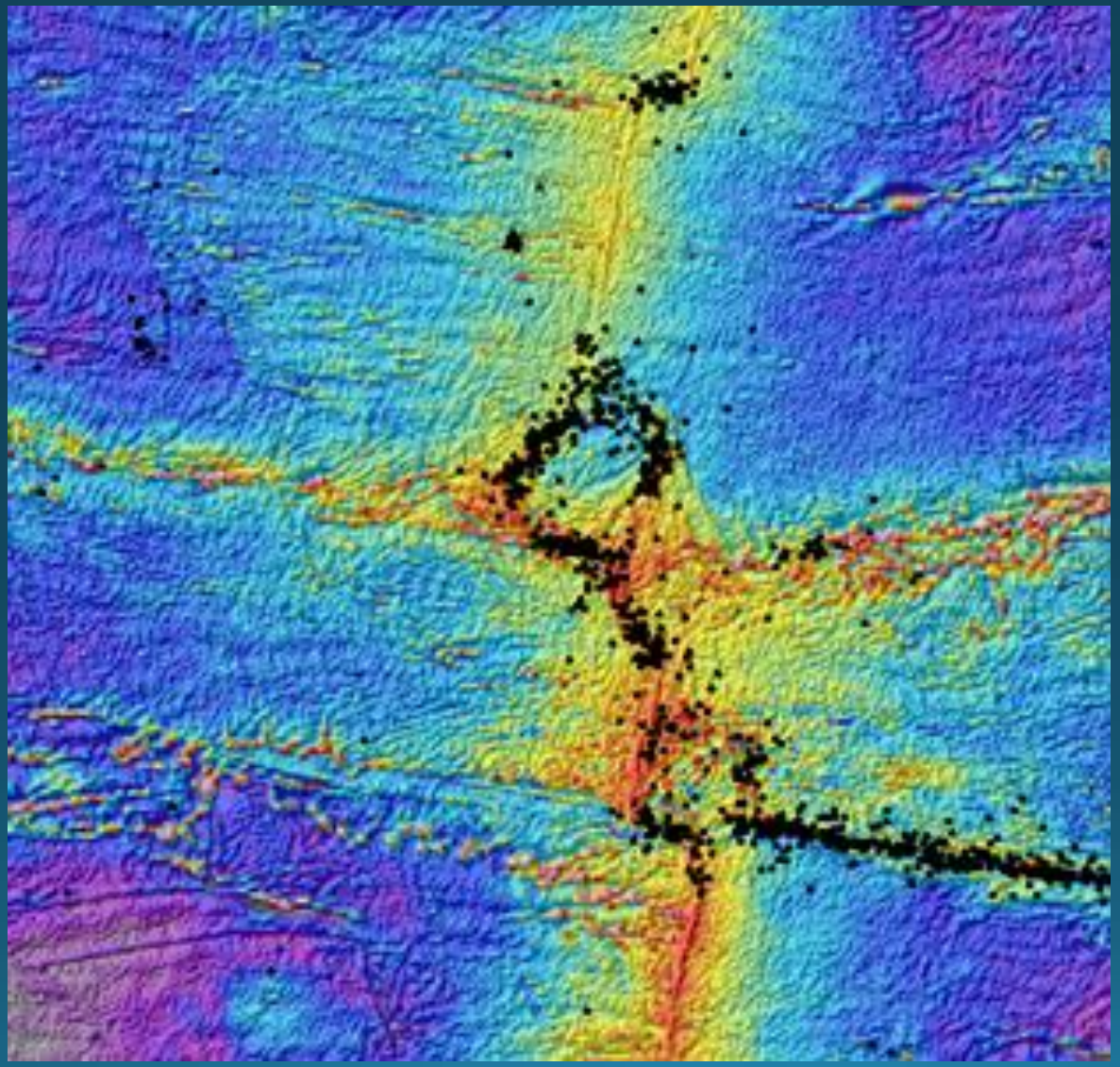
Why - provides section through the crust



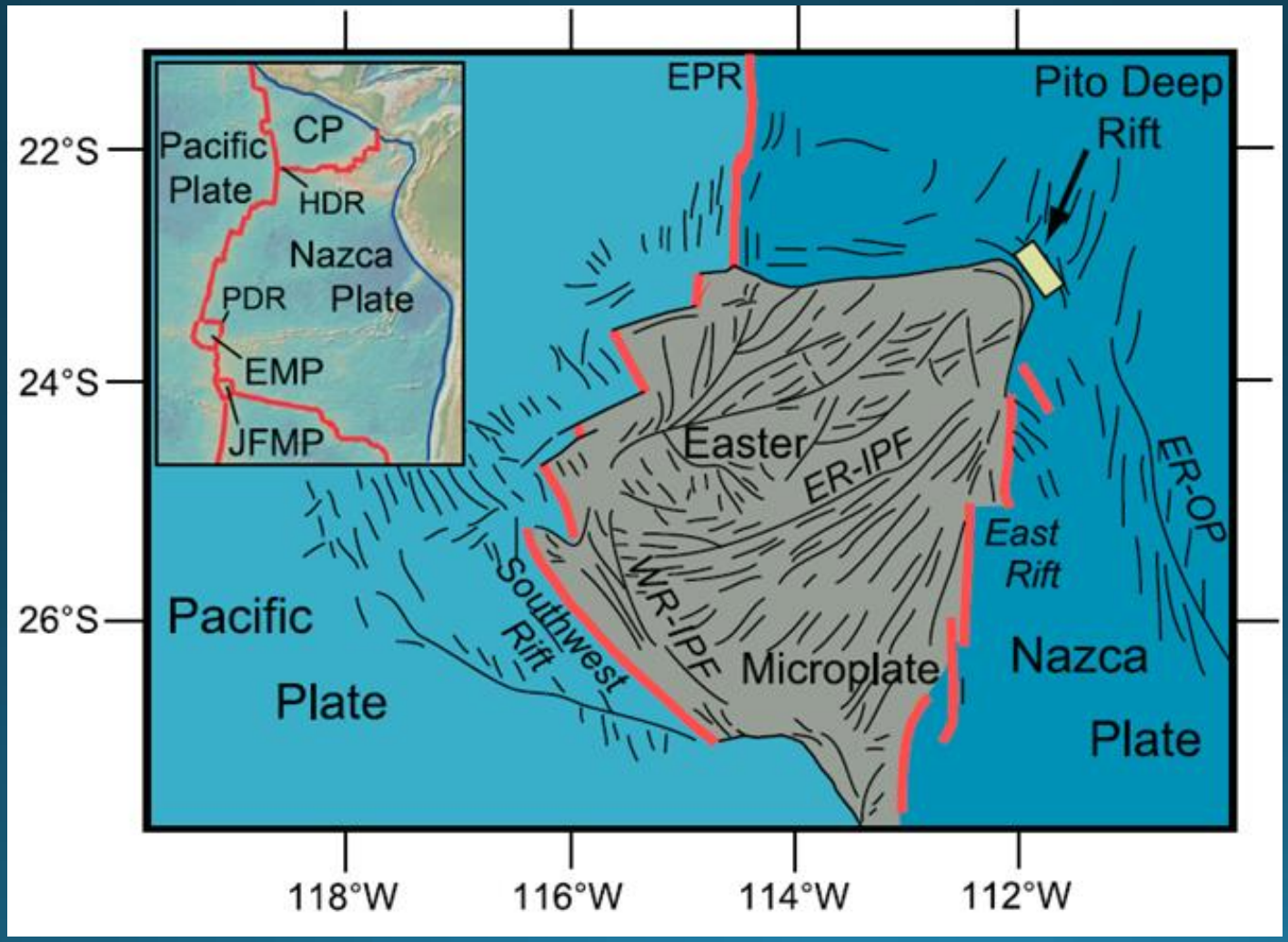
Penrose Model for Ocean Crust

From Chutas (2007)

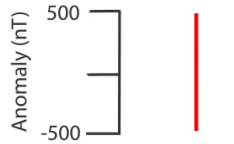
Why does Pito Deep exist?

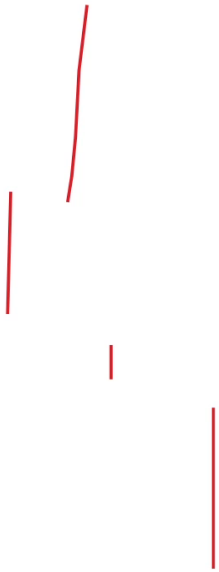


Easter Microplate



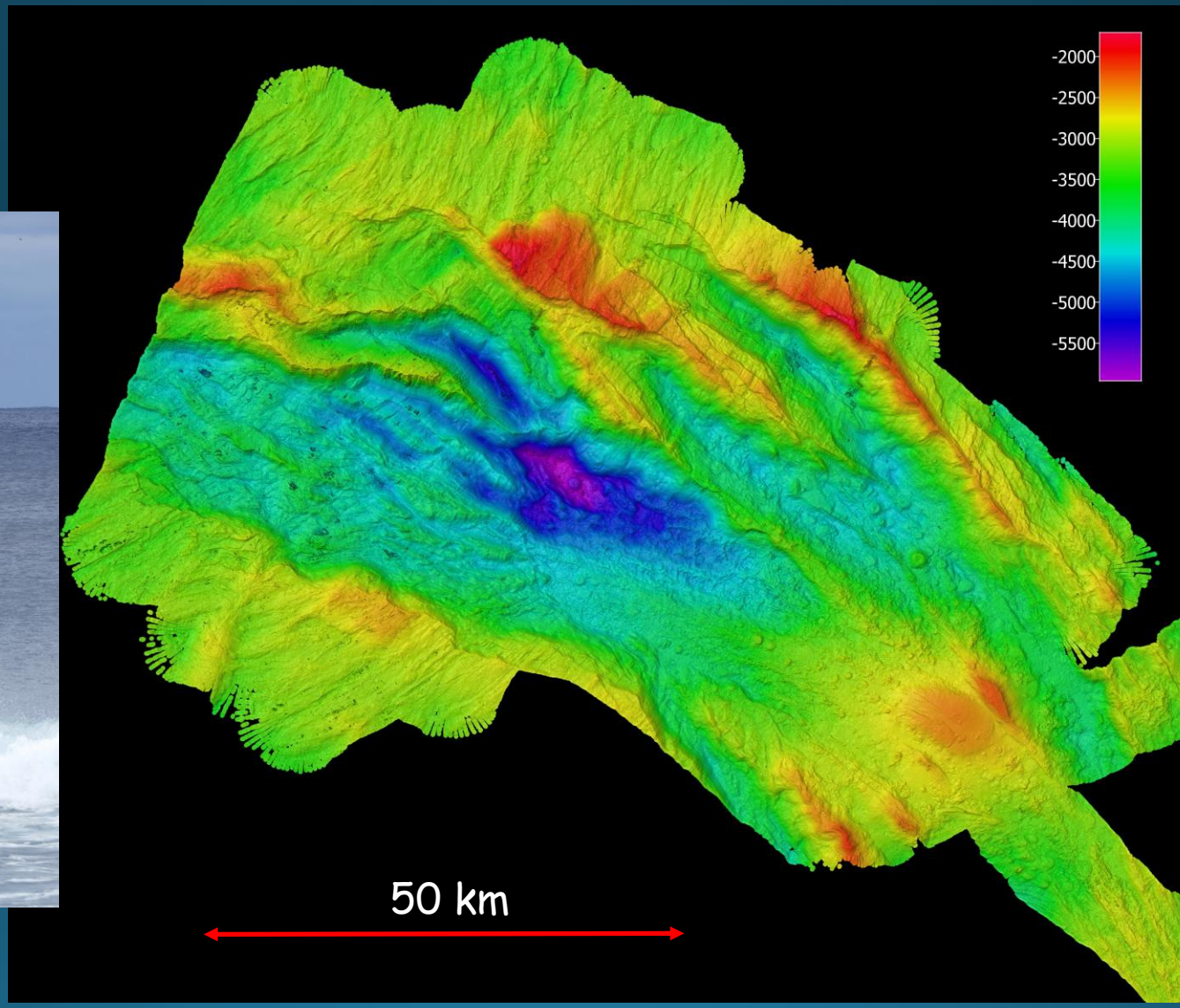
6.56 Million Years Ago





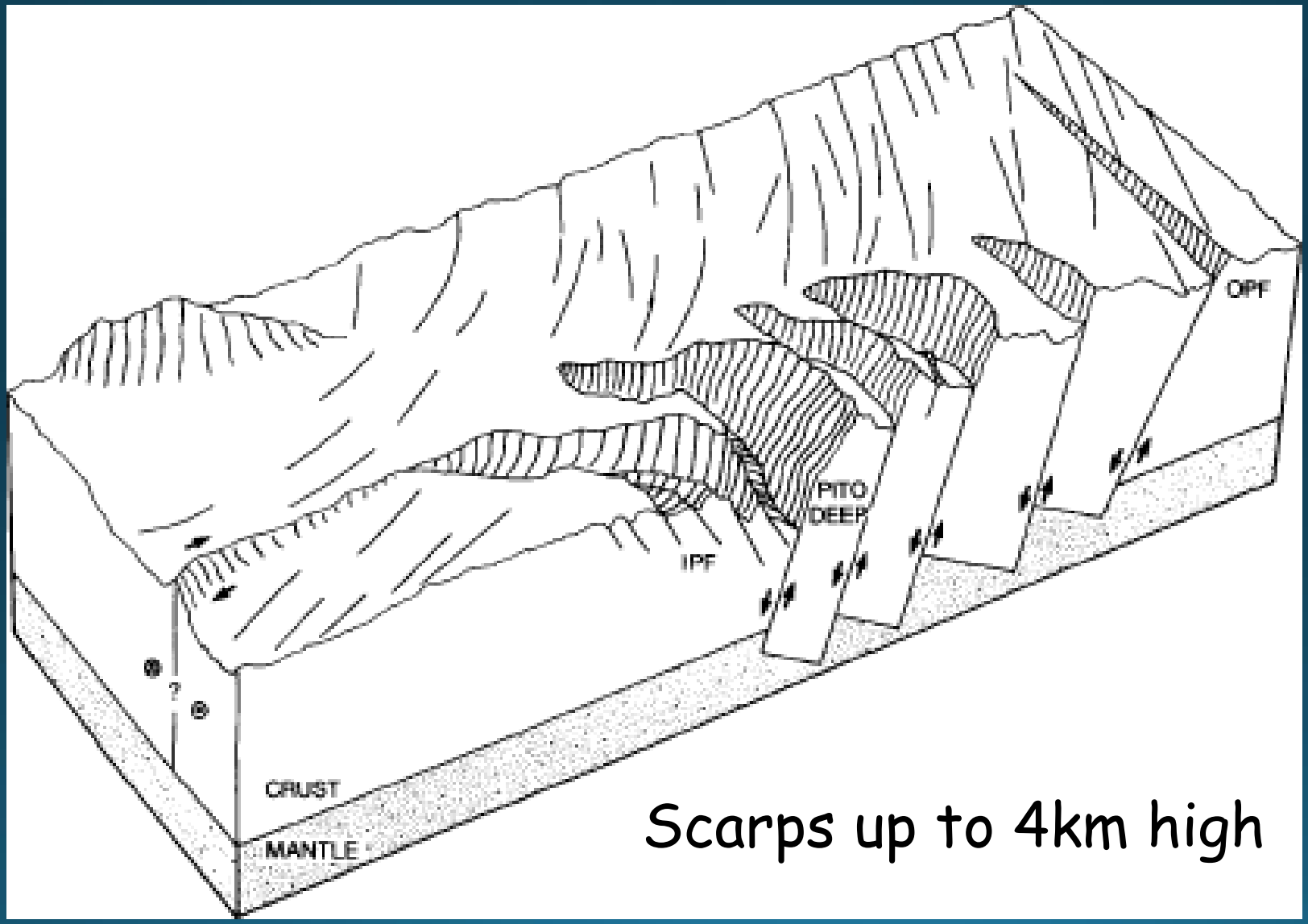
From Kavanagh, Gee, Maher, Doran, Naar

Atlantis: multibeam bathymetry



40m Resolution

Rotated Fault Blocks



Scarps up to 4km high

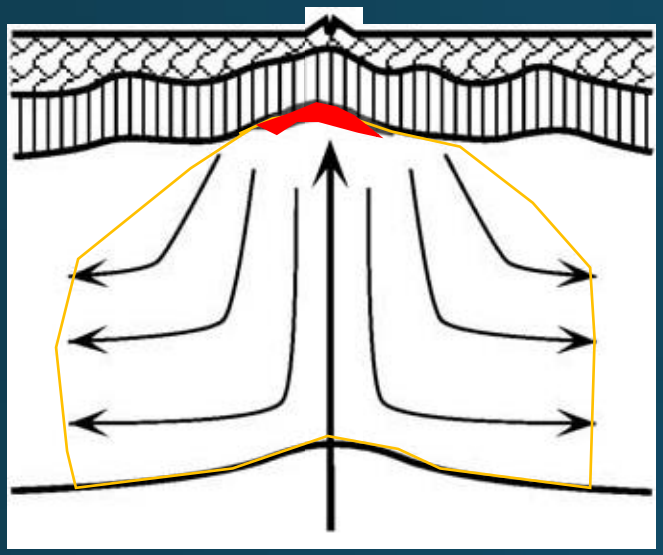
Naar et al., 1991)

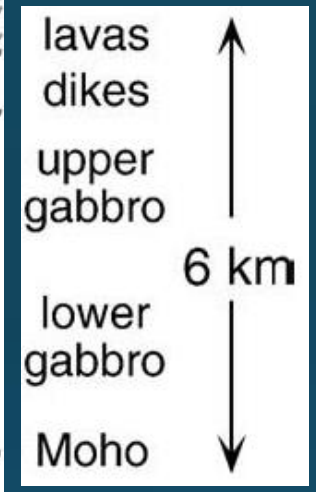
Provides the third dimension:

Helps address the following questions

- The composition & nature of fast spread crust ?
- How does it grow ?
- The third dimension of the magnetic stripes ?
- Constraints on the shape/dimensions of the magma accretion zone

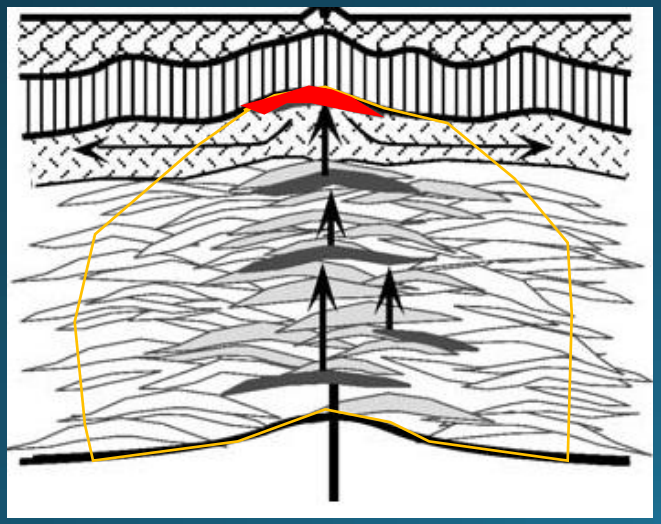
Straw-man models for lower crust (frozen magma chamber) formation





Gabbro-glacier flow

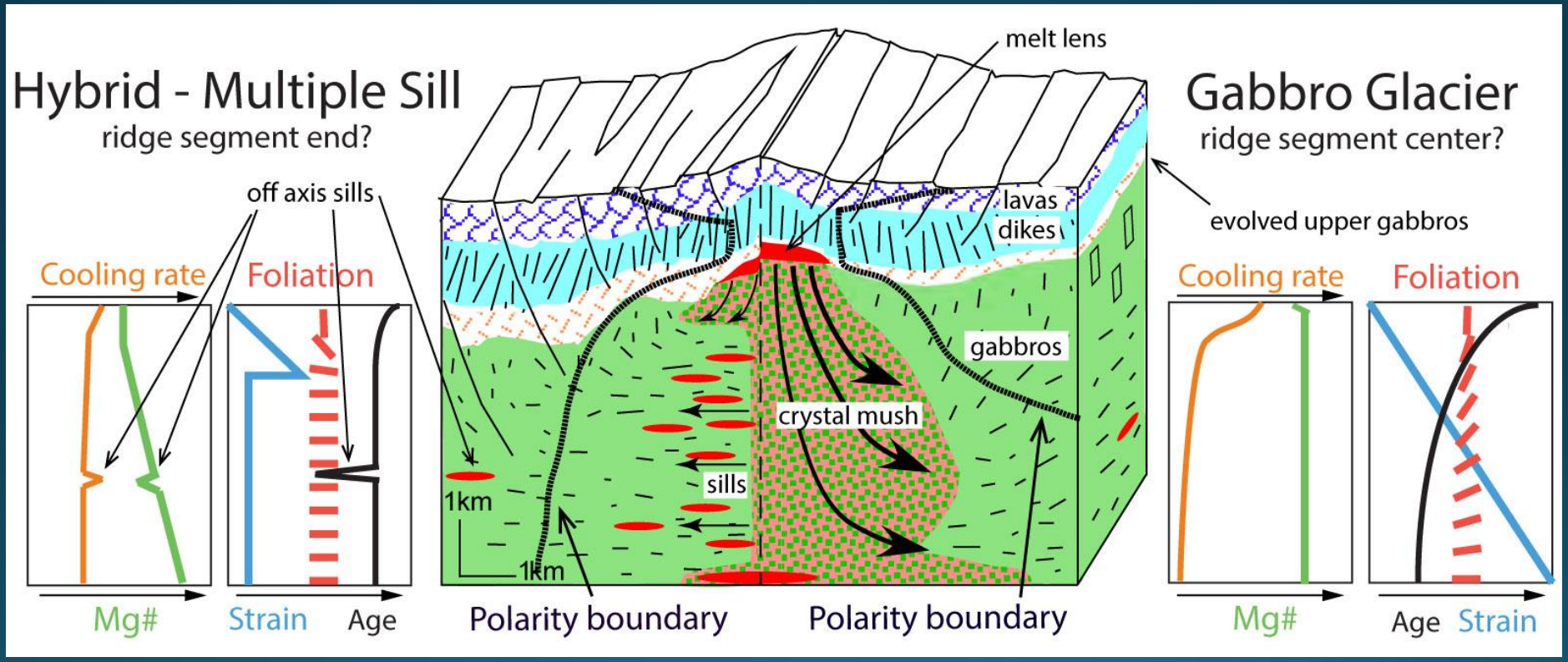
e.g. Quick and Denlinger (1993)



Hybrid-multiple Sill

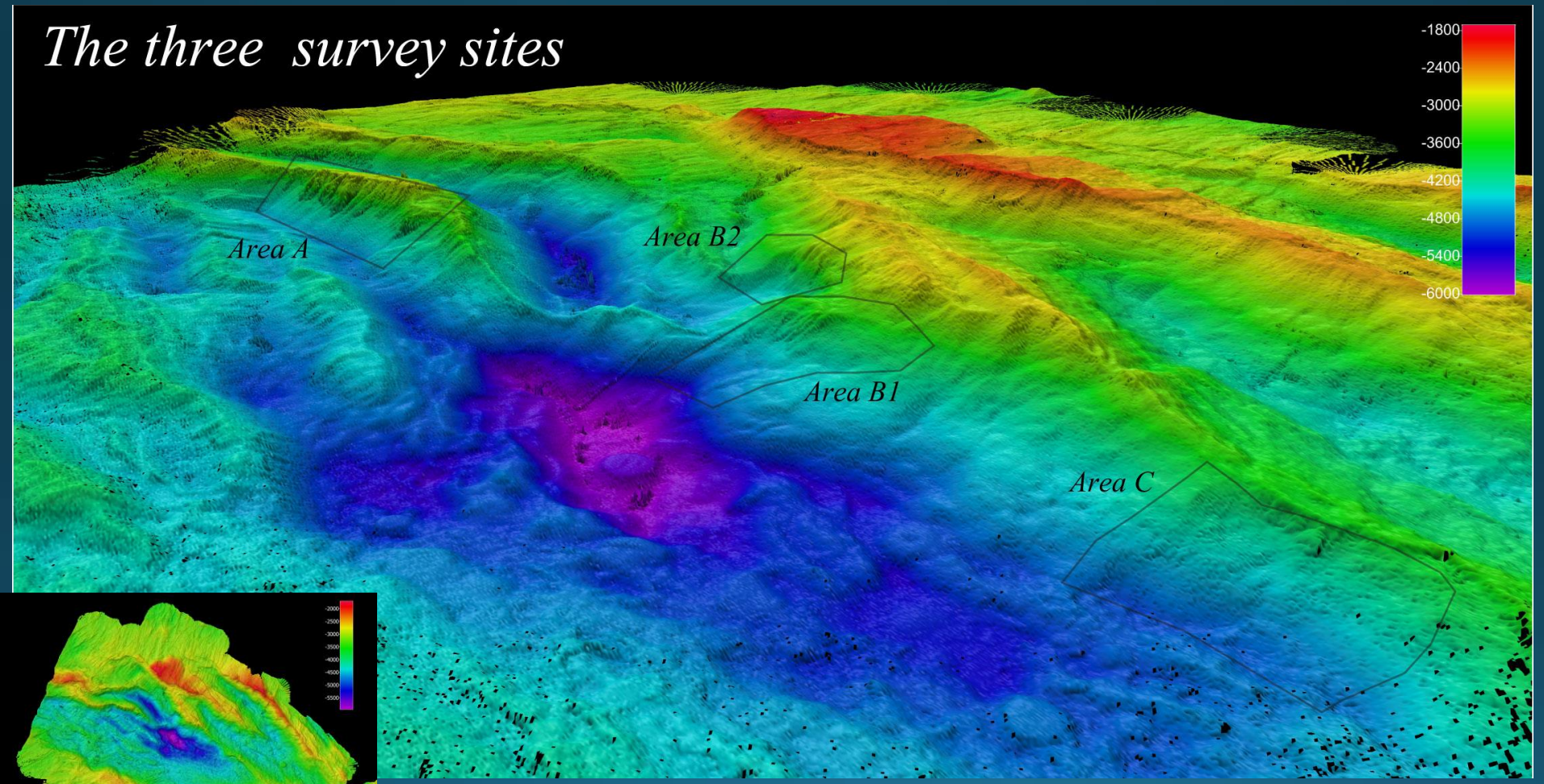
e.g. Kelemen et al (1997)

Each model makes testable predictions



Modified from Coogan, 2014

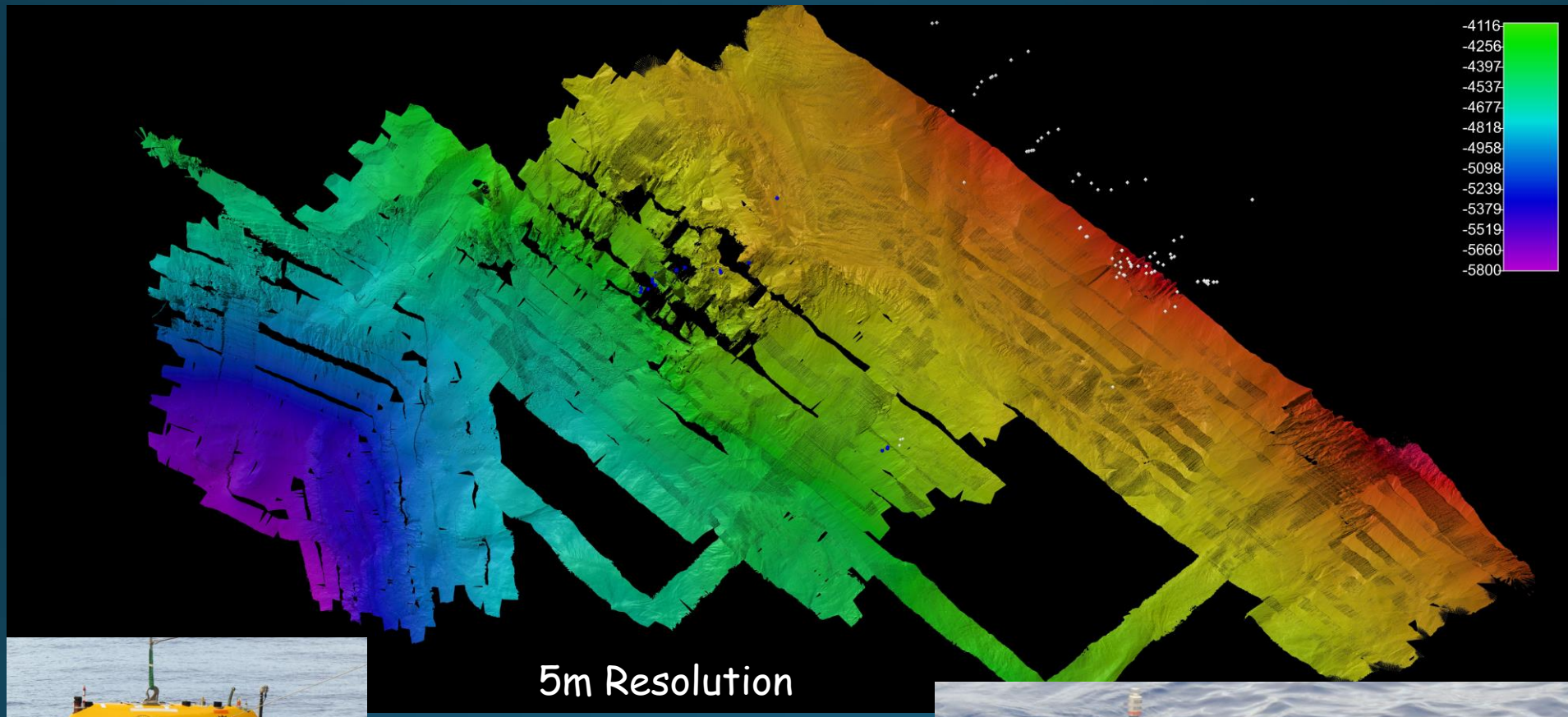
The Survey Sites & the problem- mass wasting



~ 35km from Area A to Area C

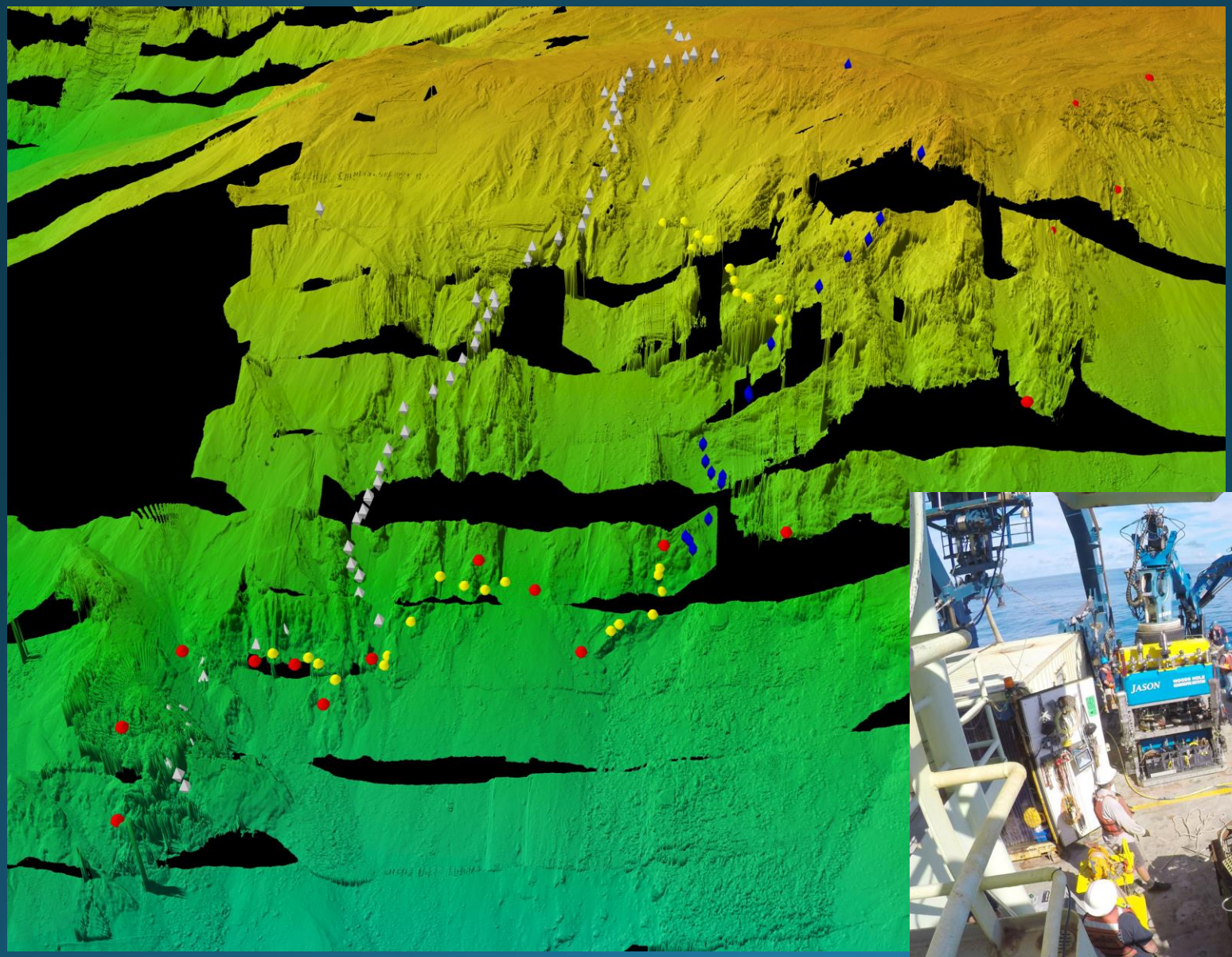
The Mass wasting problem

Sentry: to pick sample targets



5m Resolution

Jason to collect samples



L. Kavanagh

Collected 413 samples (5000 lbs)- mostly all from outcrop & oriented

3-D Photography

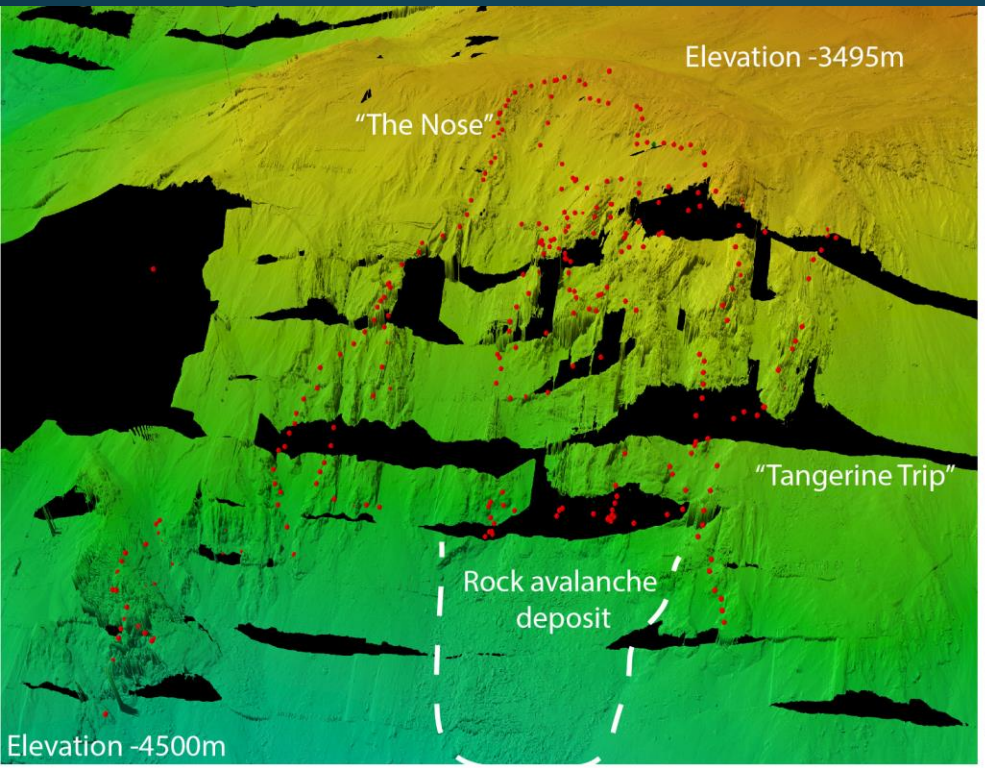
L. Kavanagh

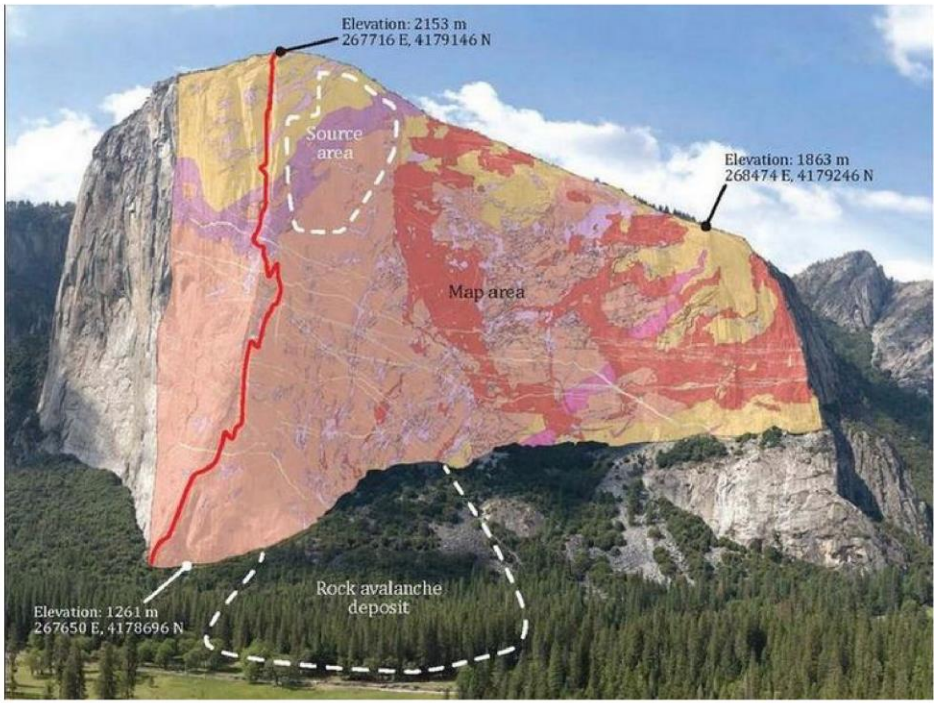
Troctolites

Orientation device

For perspective:

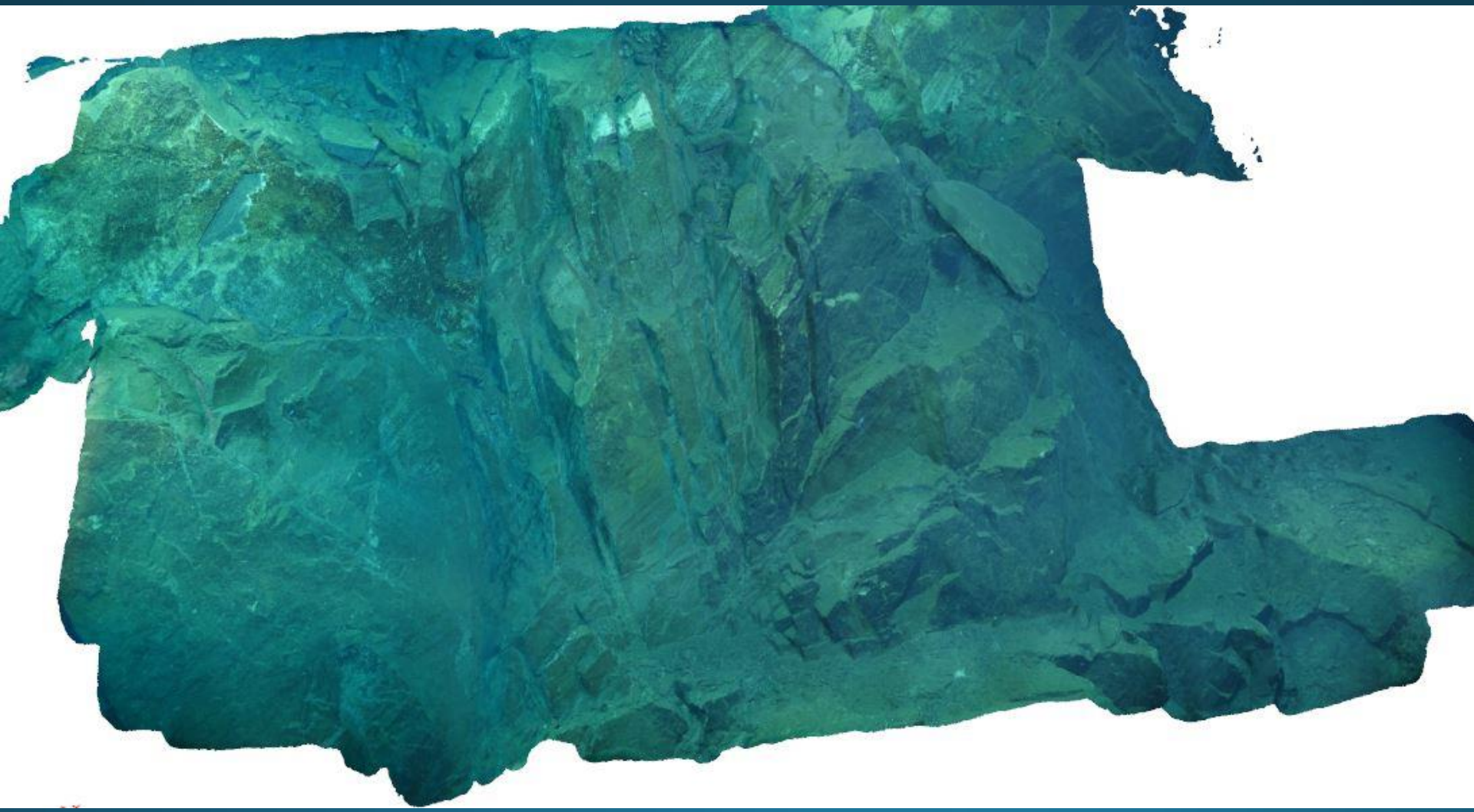
El Capitan



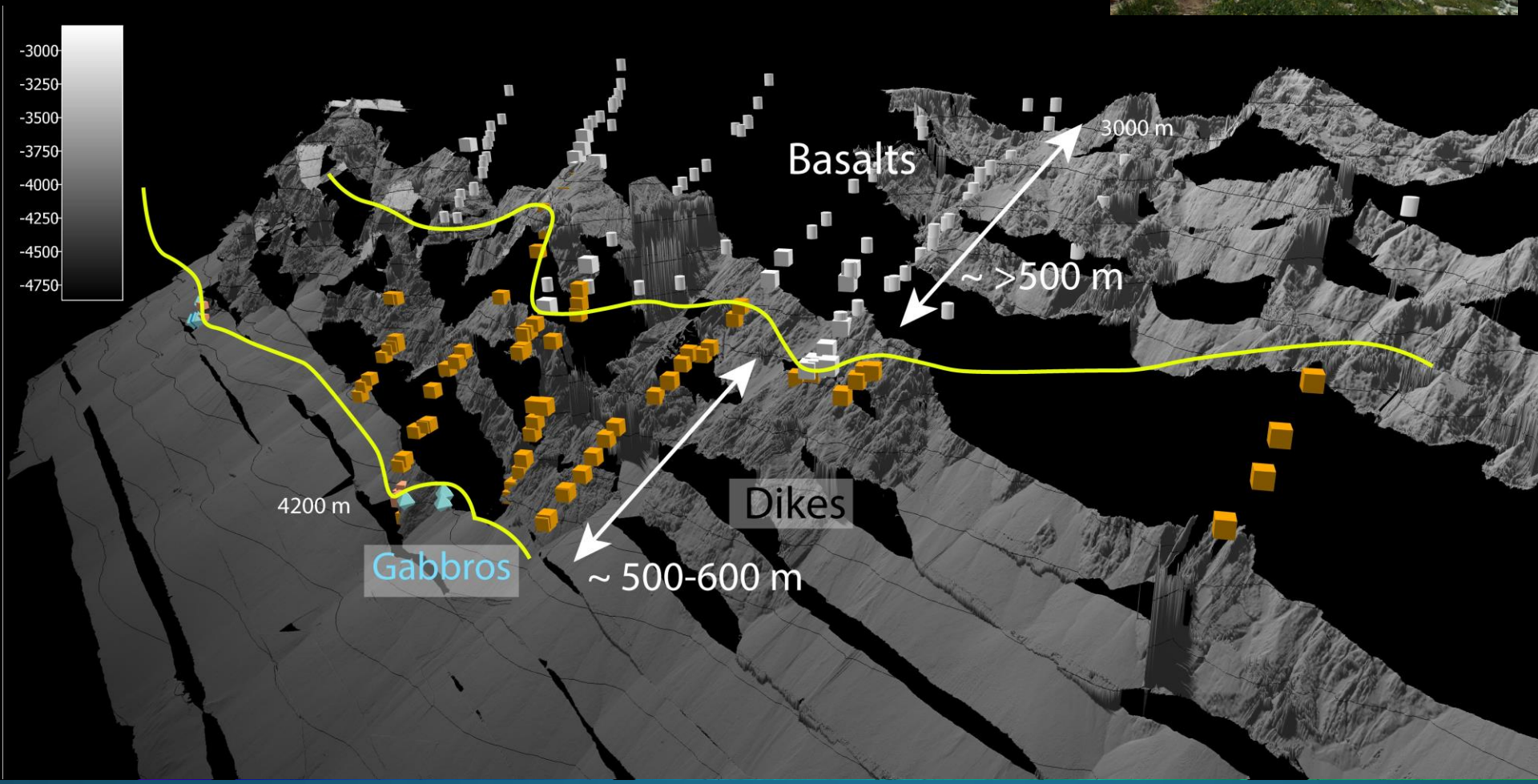


Courtesy of the USGS

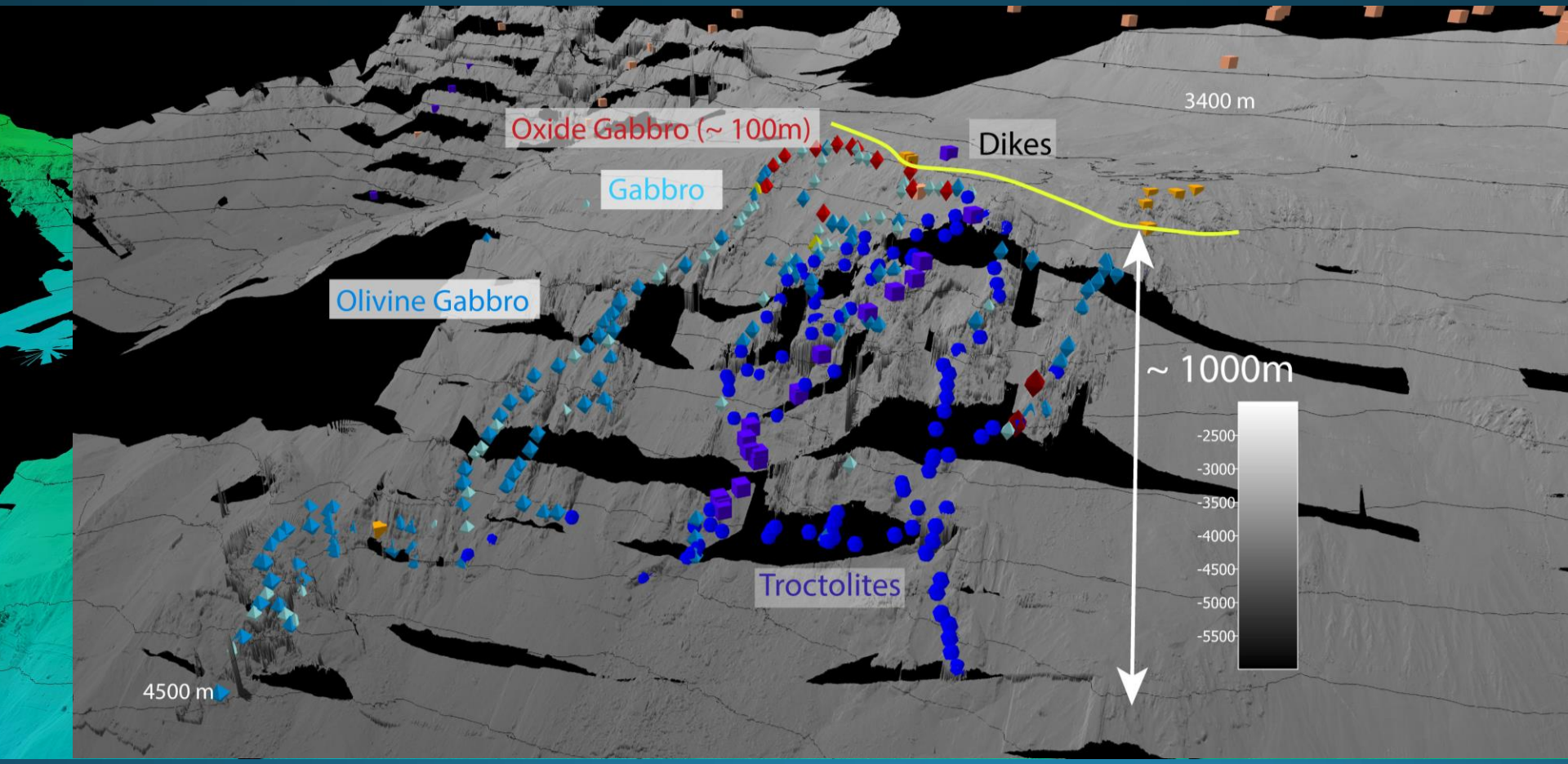
3- D visualizations of rock outcrop



Area A


-3000
-3250
-3500
-3750
-4000
-4250
-4500
-4750
Basalts
3000 m
~ >500 m
4200 m
Dikes
Gabbros
~ 500-600 m

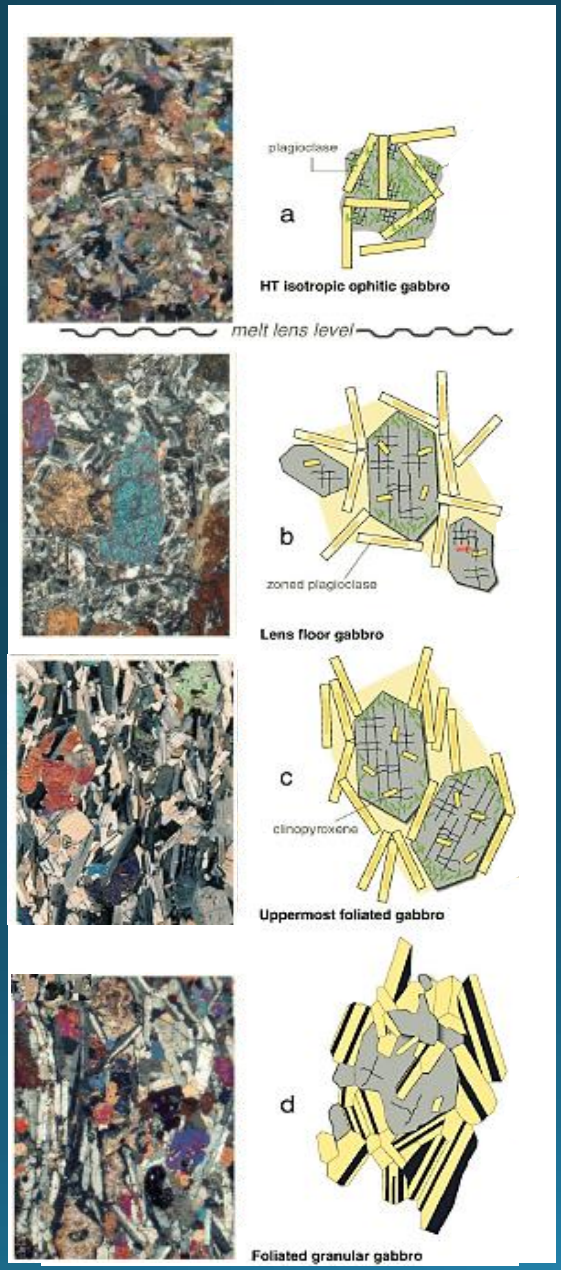
Area B


Oxide Gabbro (~ 100m)
Gabbro
Olivine Gabbro
Troctolites
Dikes
3400 m
~ 1000m
-2500
-3000
-3500
-4000
-4500
-5000
-5500
4500 m

Comparison of Oman ophiolite & Pito

Oman

~50-200 mbsd



~150-300 mbsd

After Nicolas et al 2009

Pito

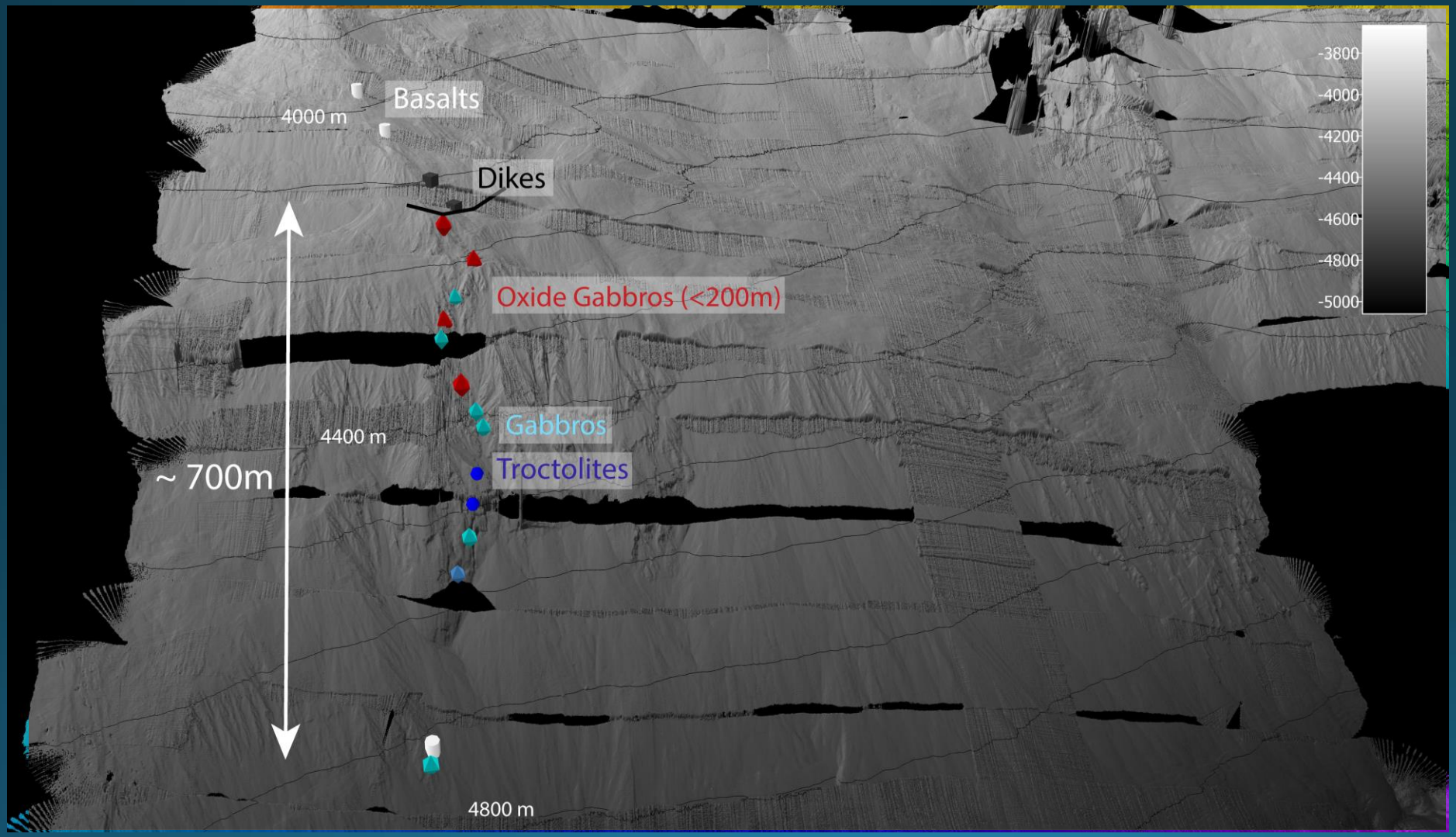
41 mbsd

45 mbsd

72 mbsd

386 mbsd

Area C- similar stratigraphy



Interim results

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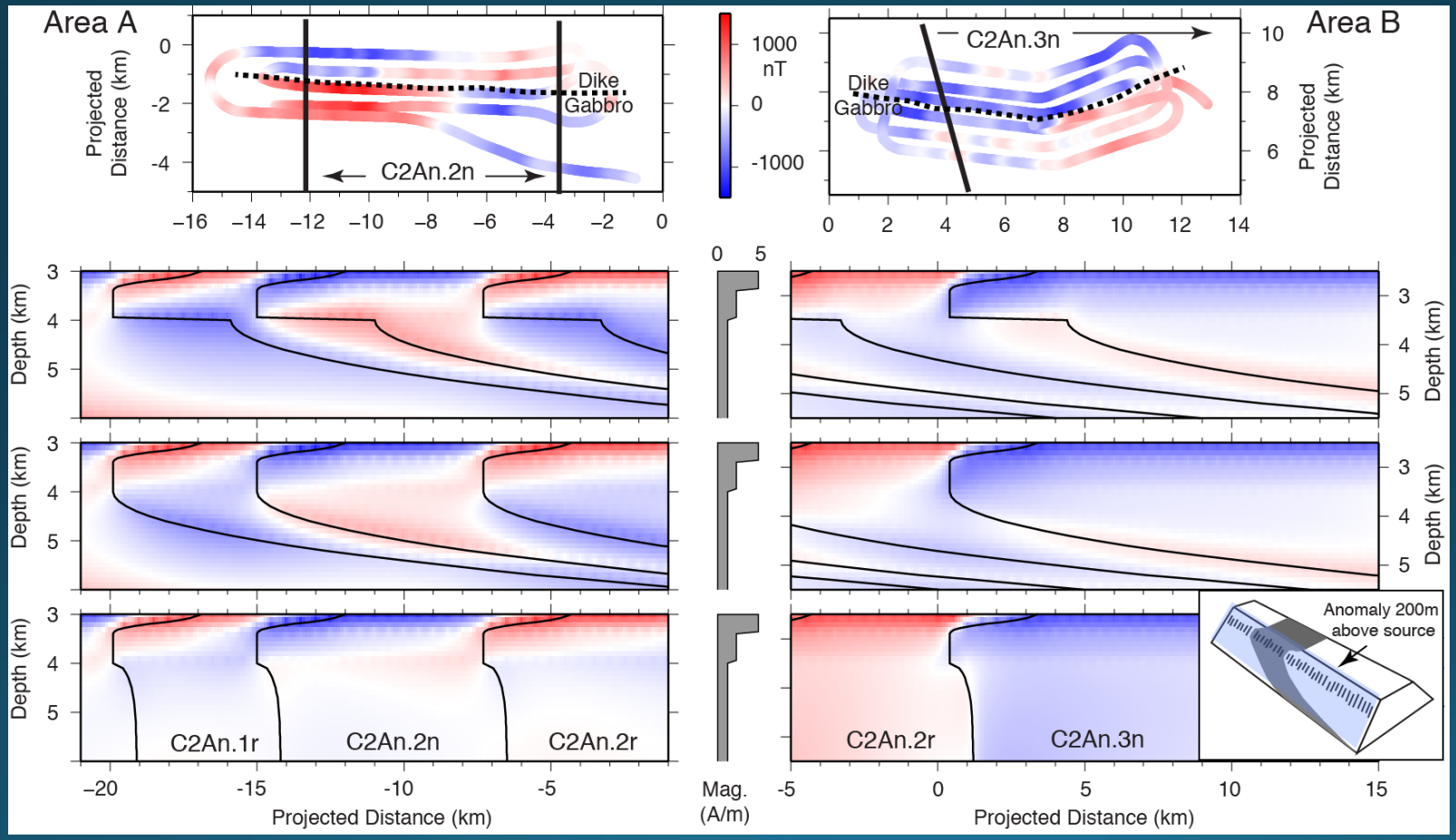
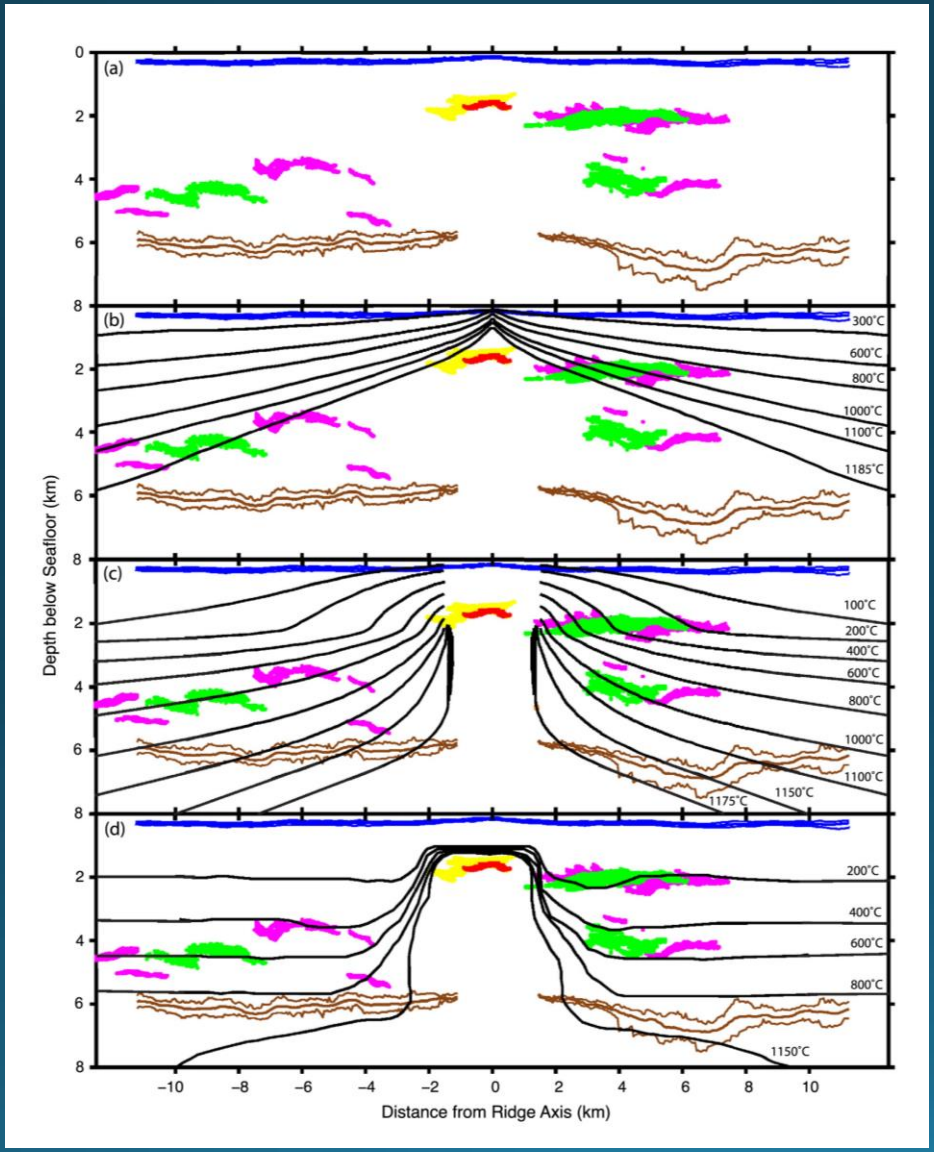
- Cumulates near the Dike gabbro transition
- Orientation of layering complicated
- Lateral heterogeneity
- Some similarities to Oman

Magnetics- Jeff Gee Scripps



Implications- wide accretion zones



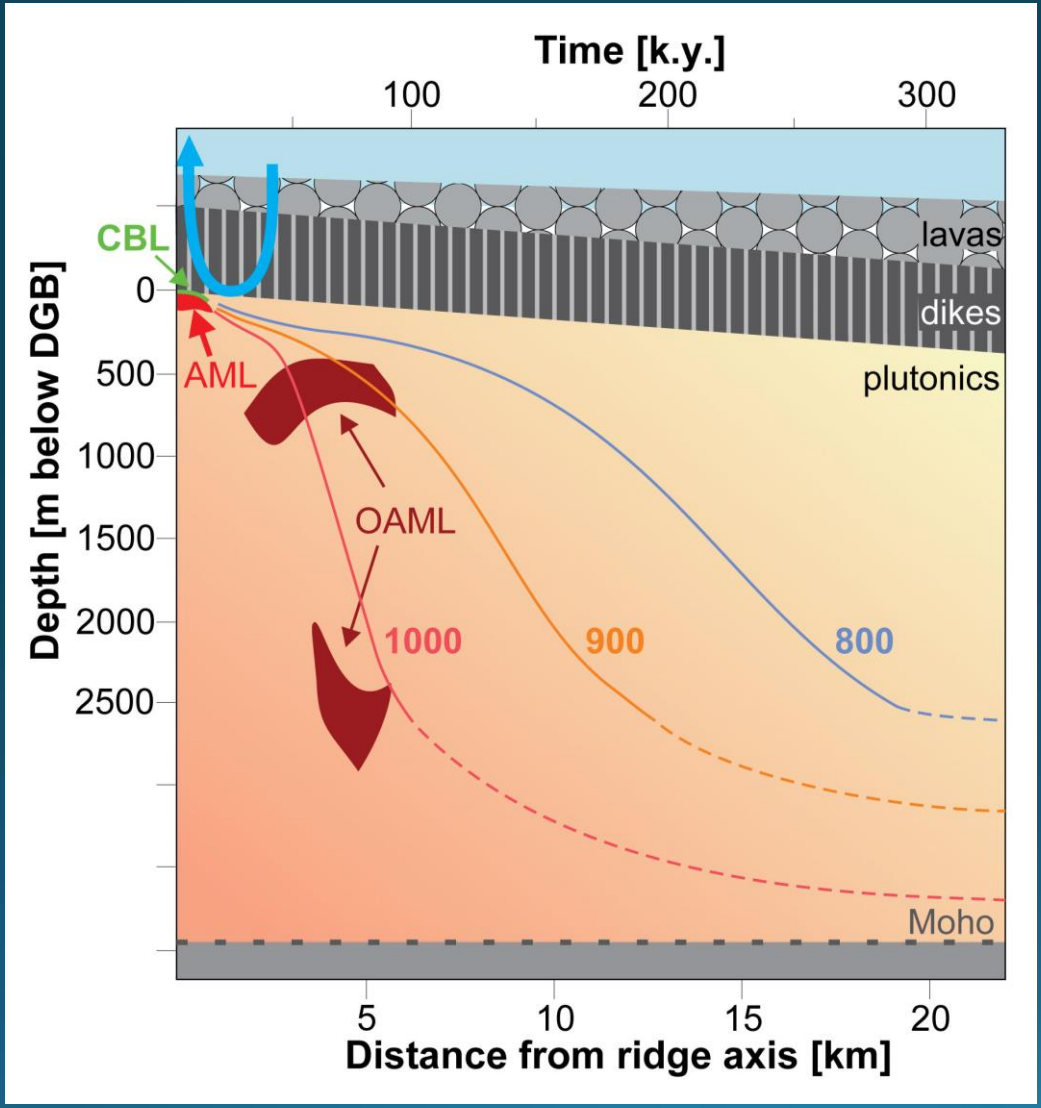
Sleep 1975

Henstock et al. 1993

Dunn et al. 2000

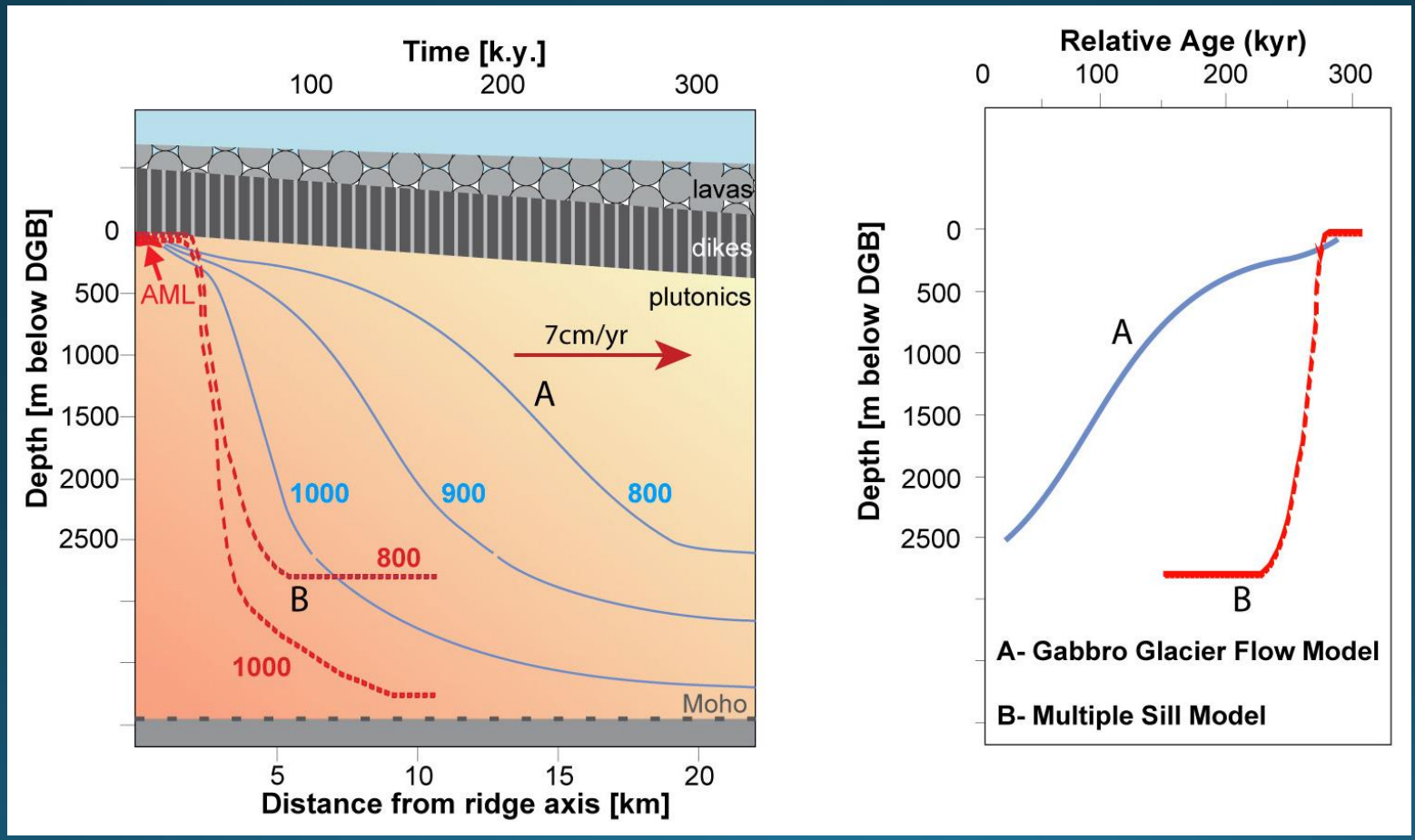
Han et al. 2003

Other constraints- Speedometry

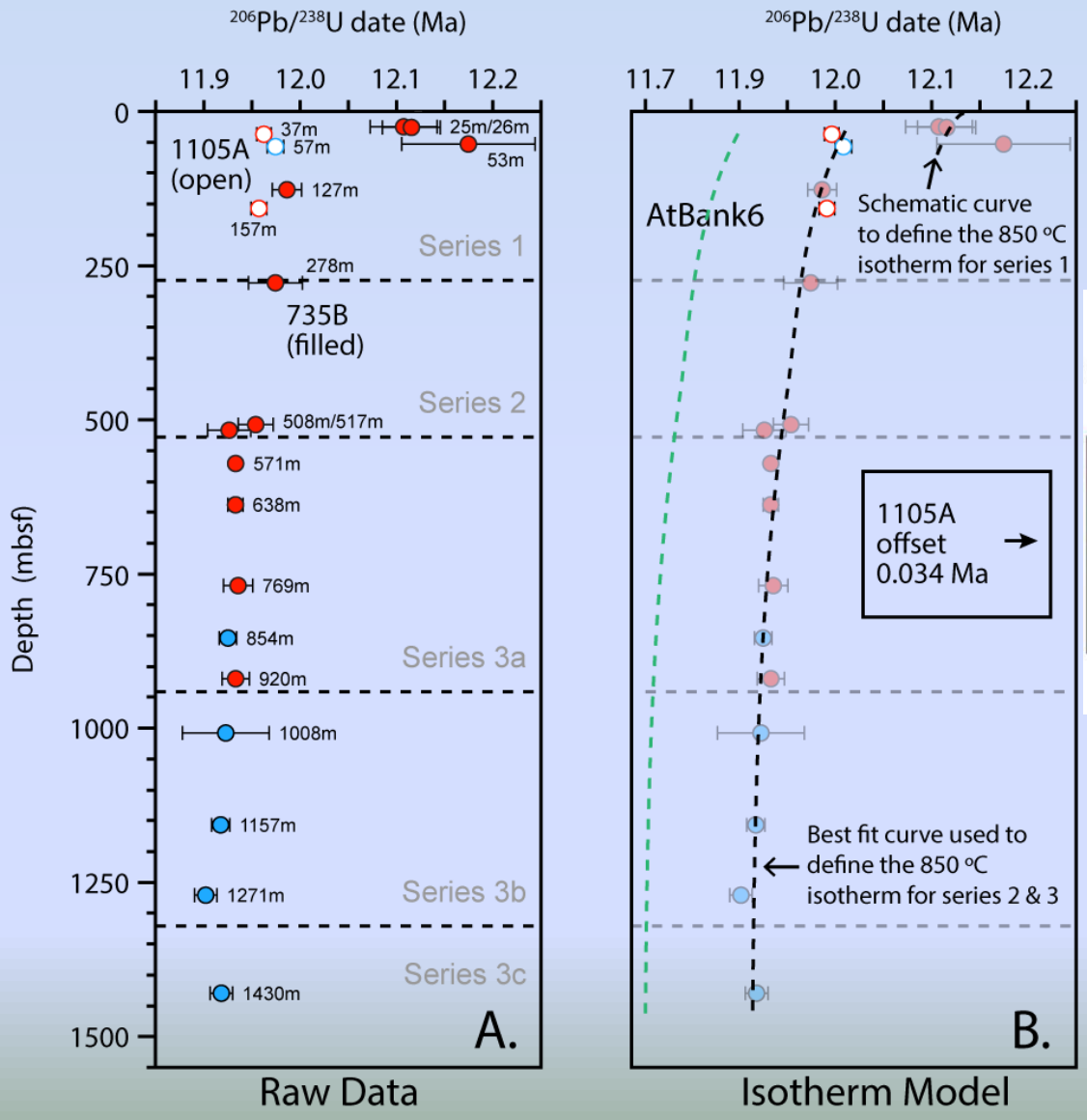


Faak & Gillis 2016

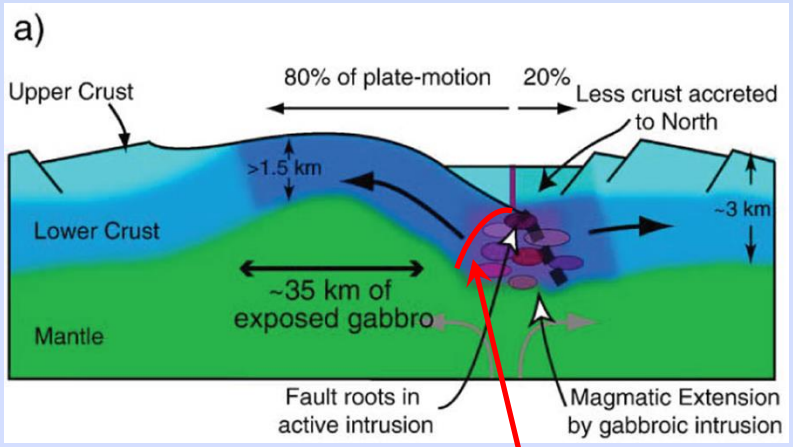
Testable with zircon geochron



Geochron- Atlantis Bank



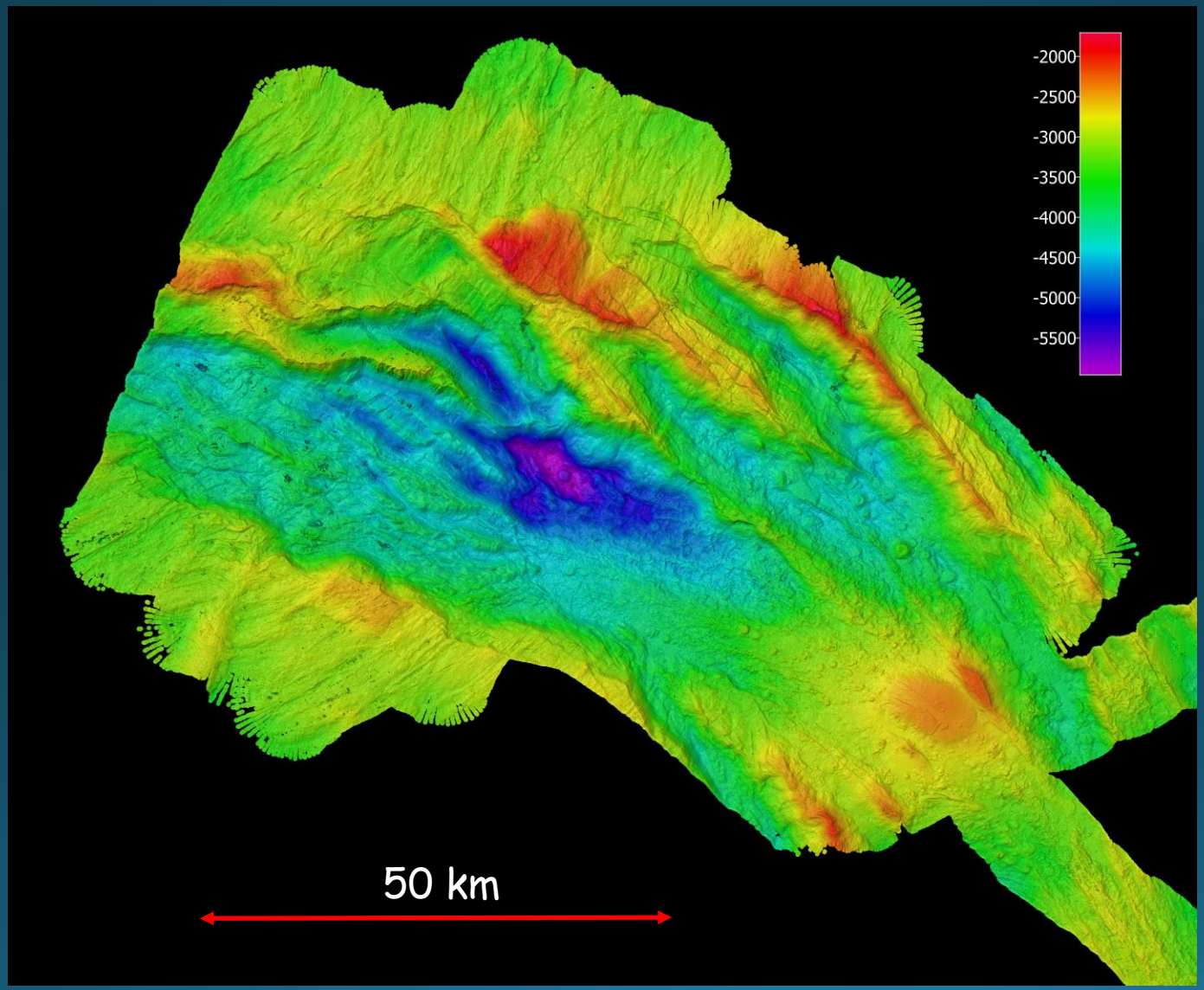
Solidus temperatures



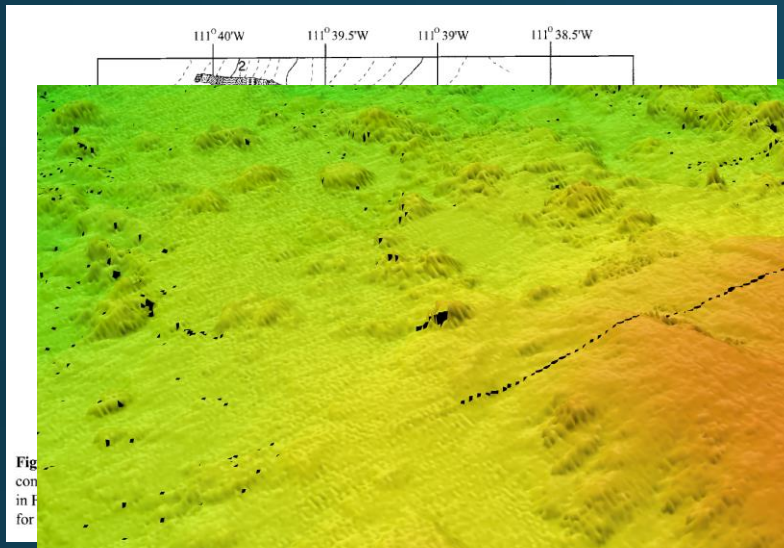
Solidus = ~ 850°C= margin of the mush zone/magma chamber

Rioux et al. 2016

Hydrothermal vents



Pito Seamount



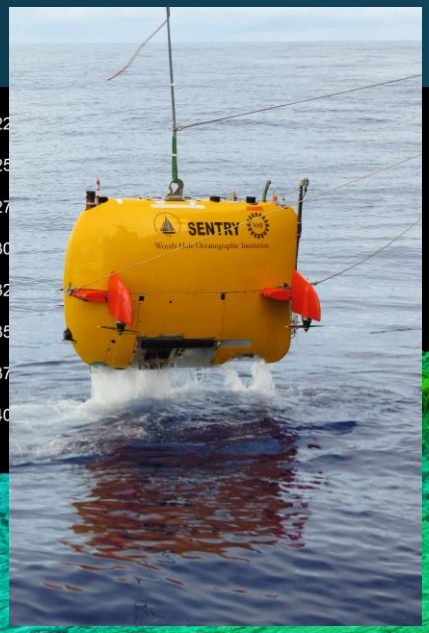
60m resolution

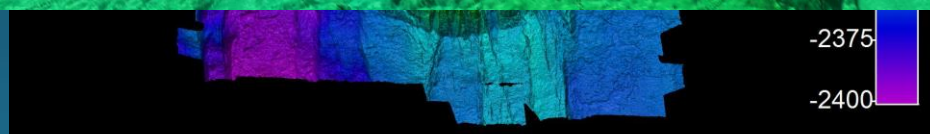
(Nautille - 1993 ; Naar et al, 2004)

Pito Seamount

2.5 km

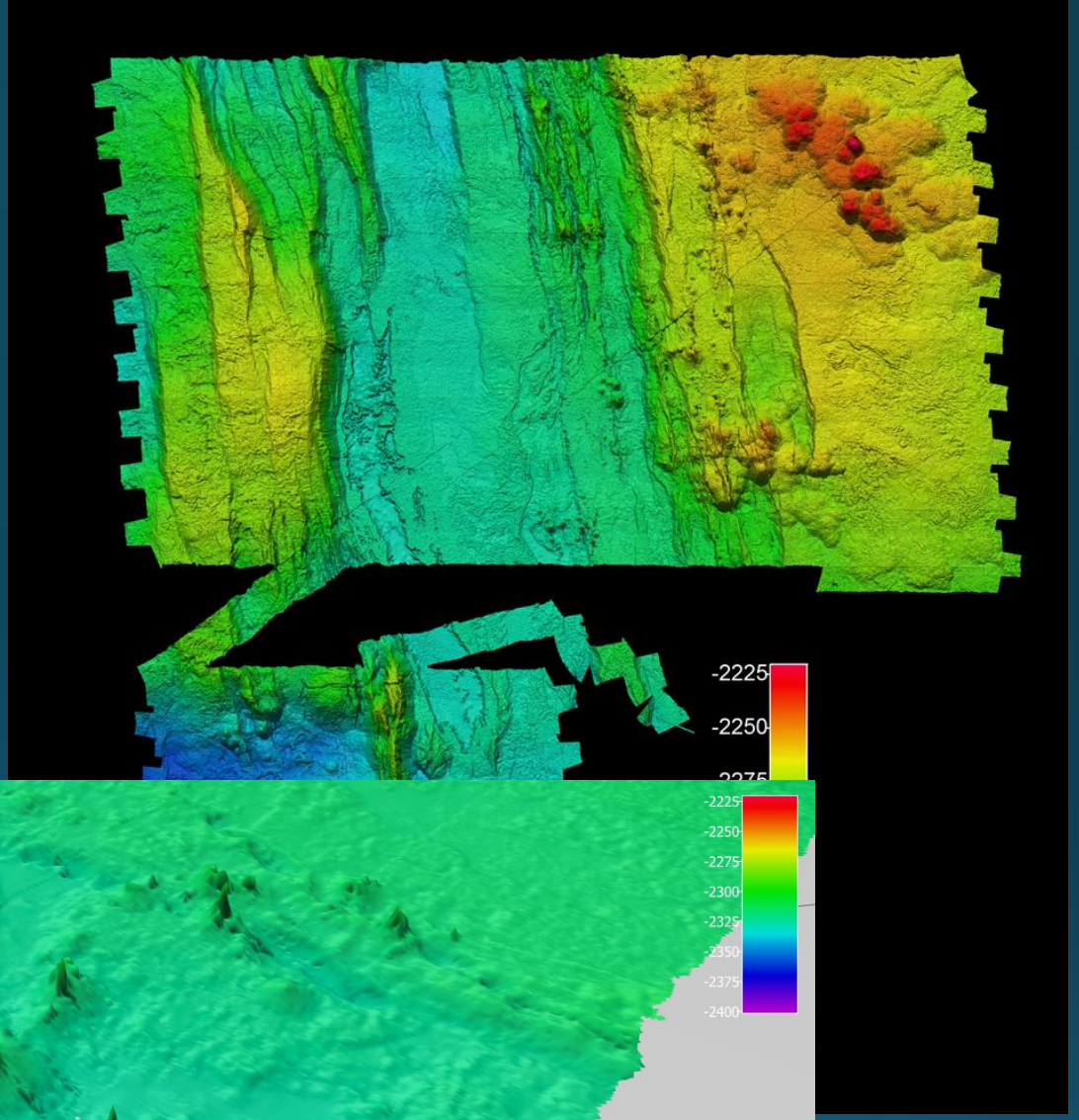
Sentry



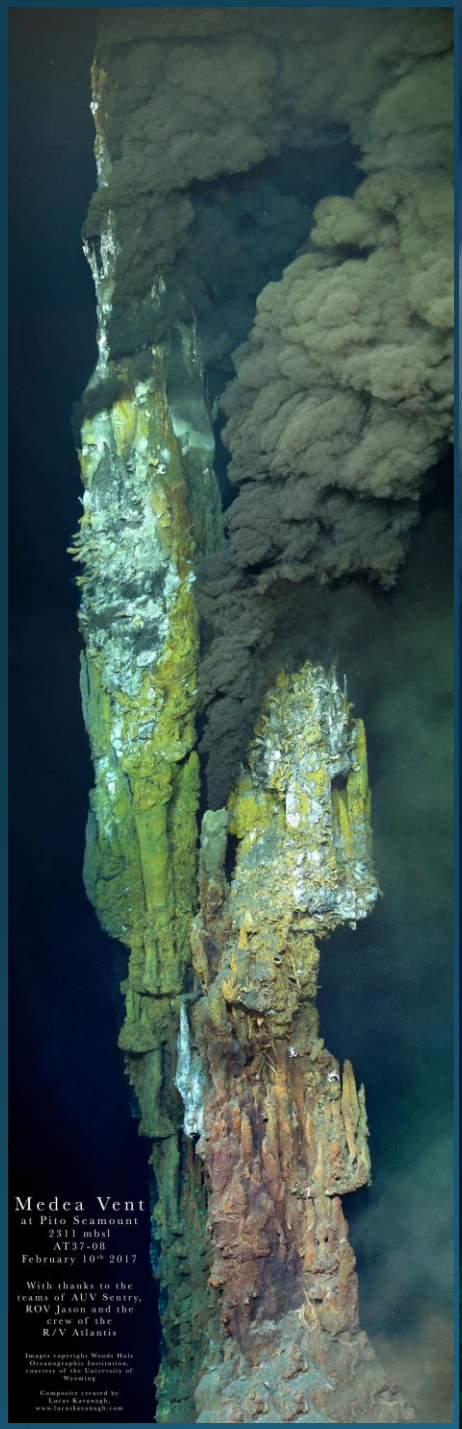


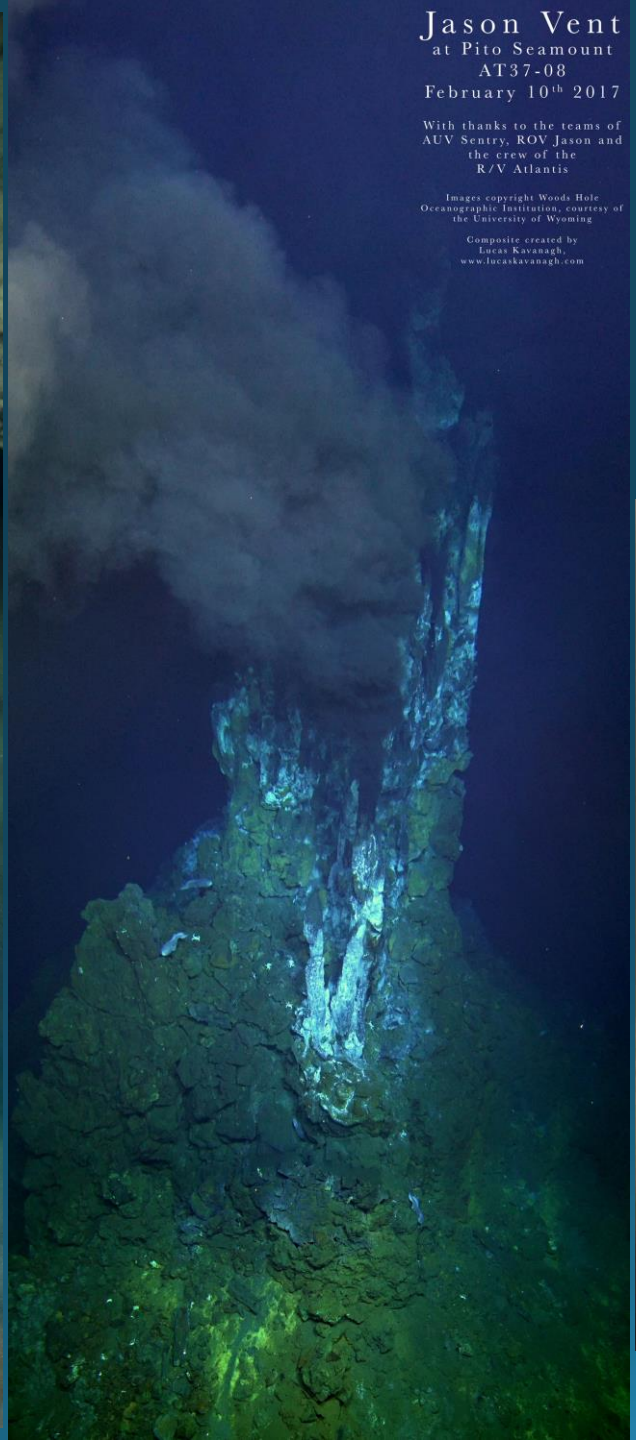
1 m resolution

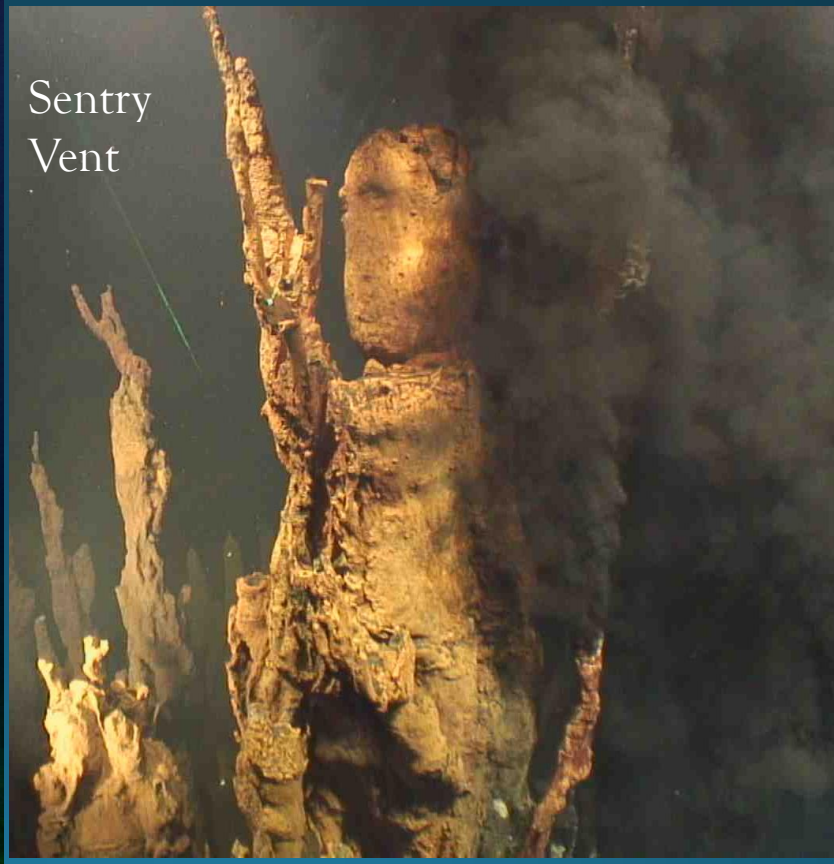
New Site?



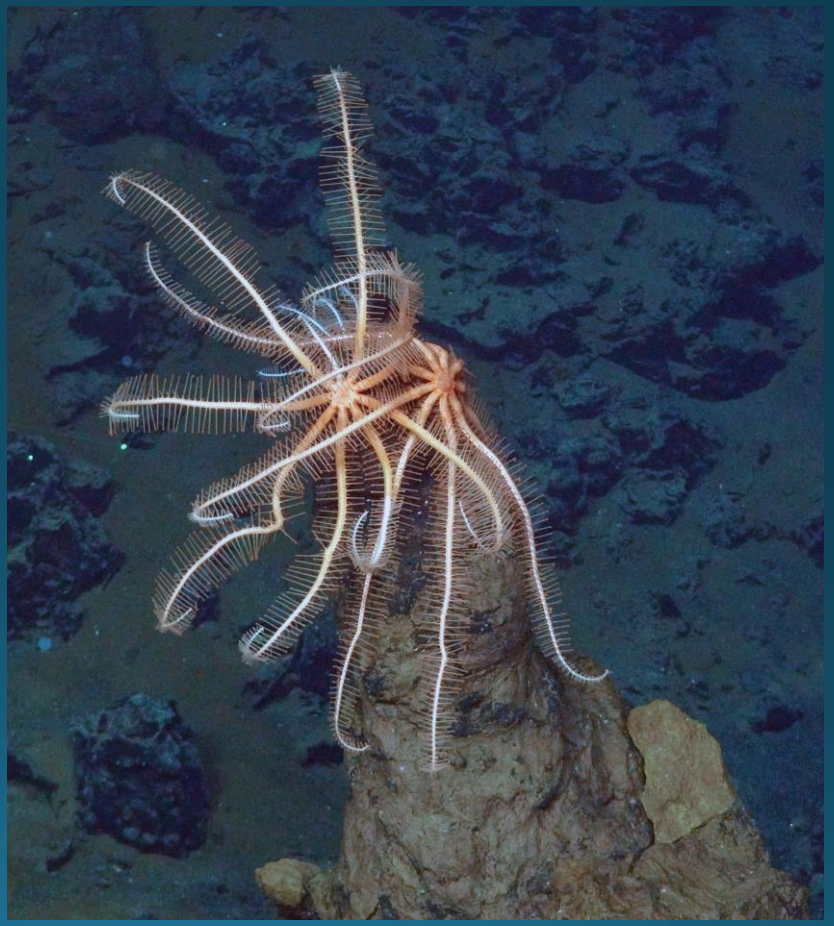
Hydrothermal Vents (reconnaissance)





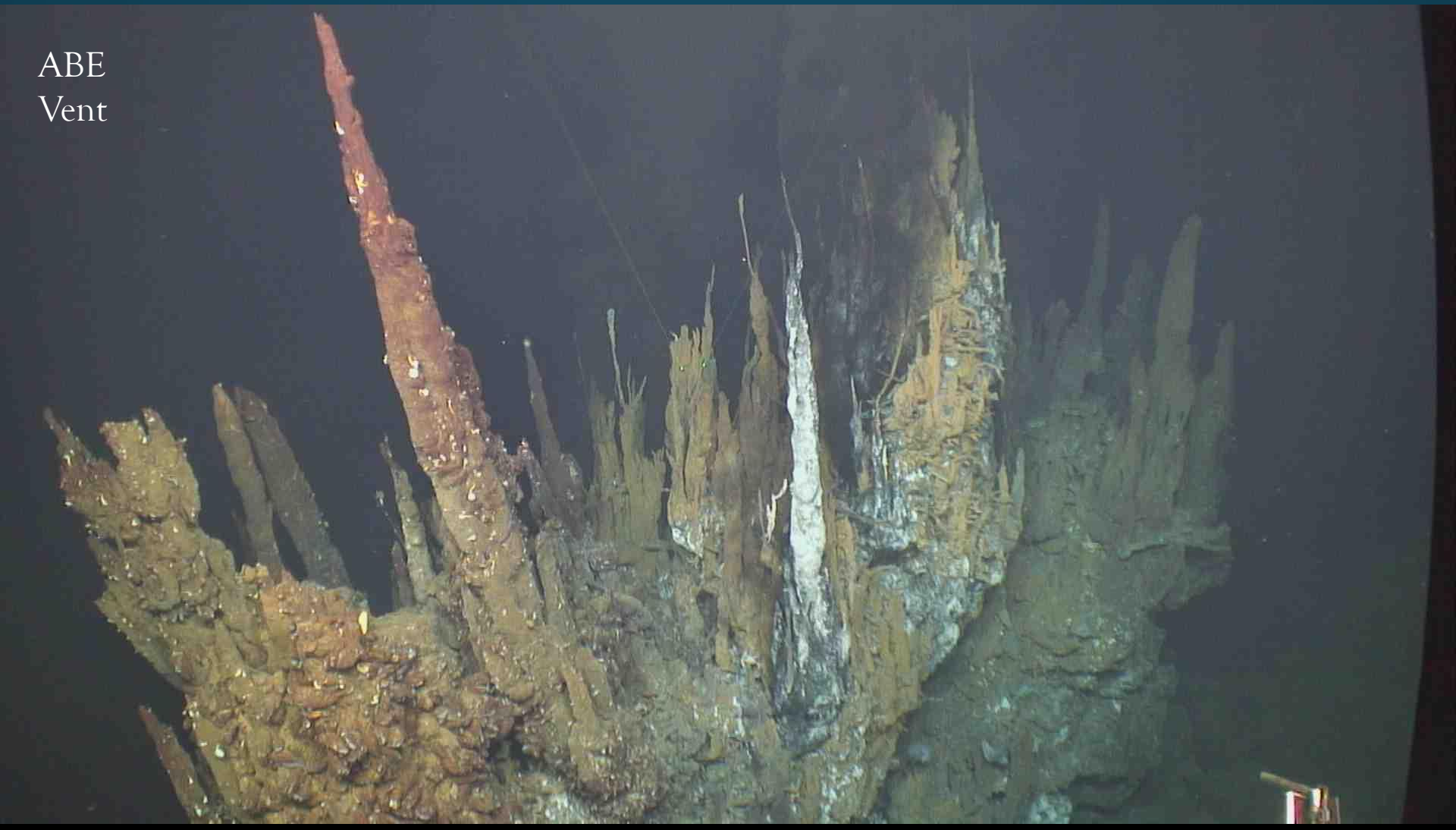


Hydrothermal Vents (reconnaissance)



- 7 active vents; > 50 chimneys (up to 22 m tall) discovered (many dead)
- active black smokers discharging >370°C water
- fauna

2017- 4K video

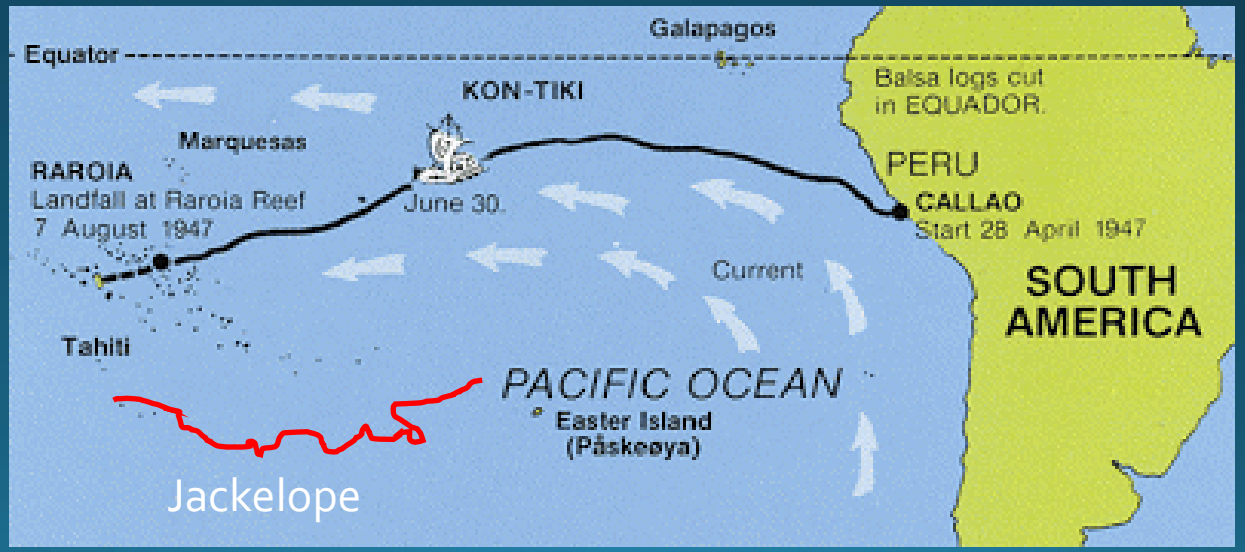


Outreach

- 33 ship-to-shore webcasts to K-12 schools, aquariums, universities & institutions across the United States, Canada, and UK. Reached 1053 students + members of the public.

- Website- 12,000 page views, Twitter, Facebook

- Miniboat- with Middle UW School



The last sunset

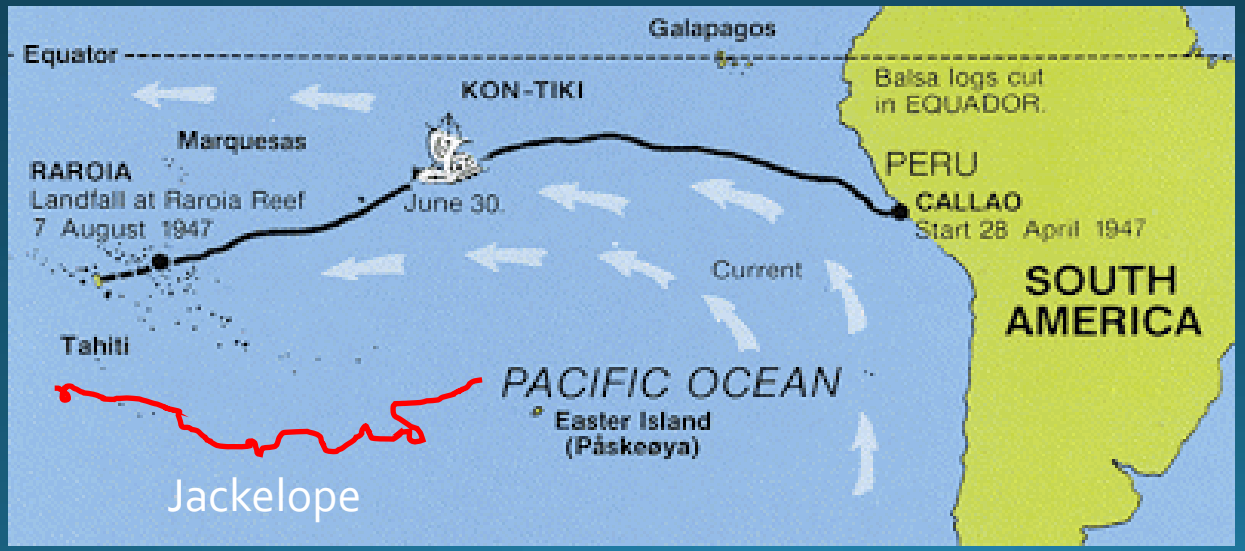
Summary….

- Lot’s to do

Outreach: the Jackelope & Kon-Tiki

- Jackelope 79 days, 2200+ miles (~ 1.2 miles/day)

- Kon-Tiki (1.7 miles/day)



Theresa Williams
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