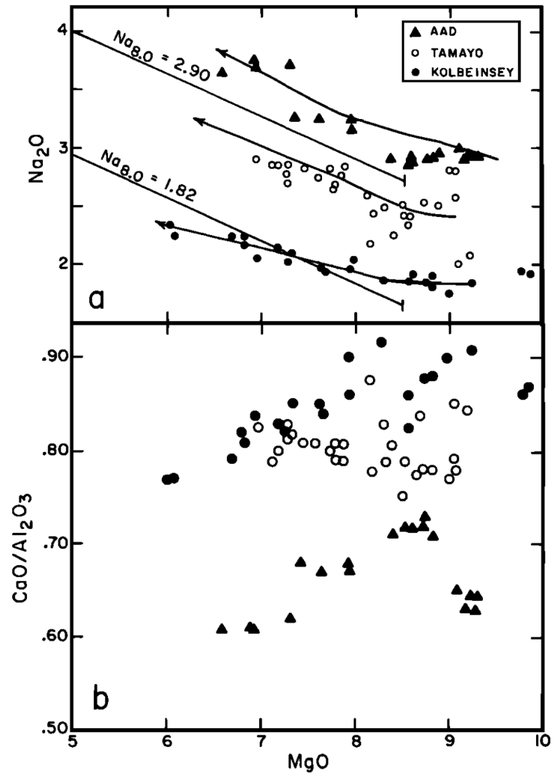
Lecture 8: Hot spots, seamounts, and ridges

The topography and geology of the seafloor offers some of the only clues we have to understanding the hidden workings of the mantle below. We have discussed some of the largest features of ocean basins, and today we consider the small seamounts and their critical role in this story.

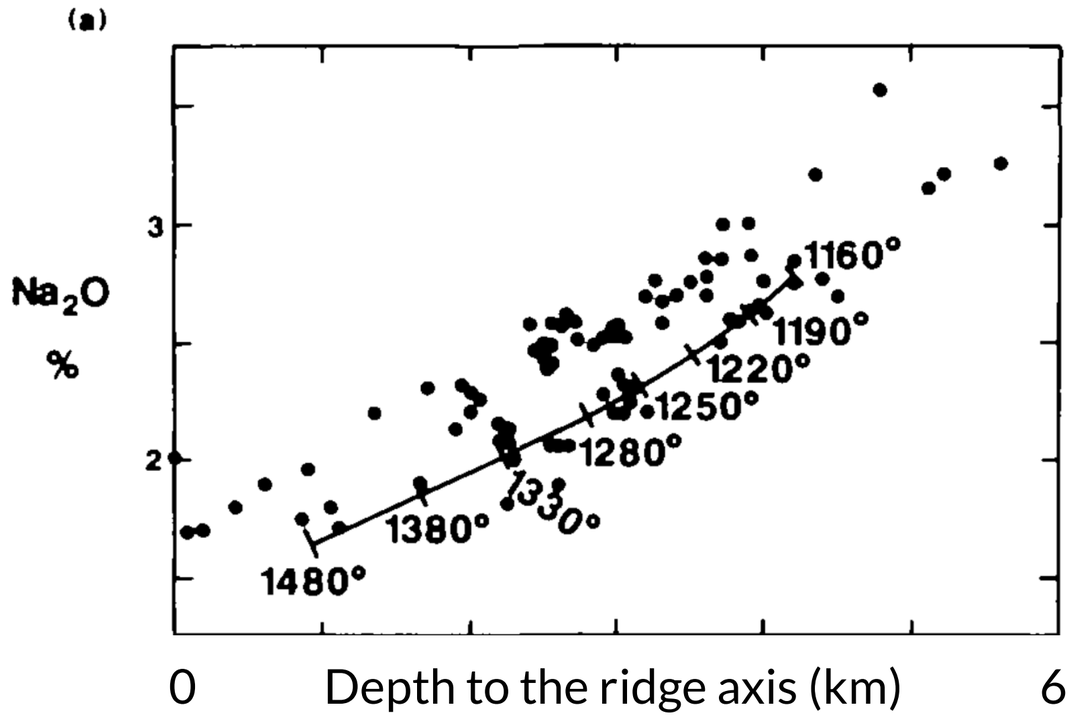
- Trace elements and isotopes in MORB/OIB
- Large low shear velocity provinces (LLSVPs)
- Current models of the mantle

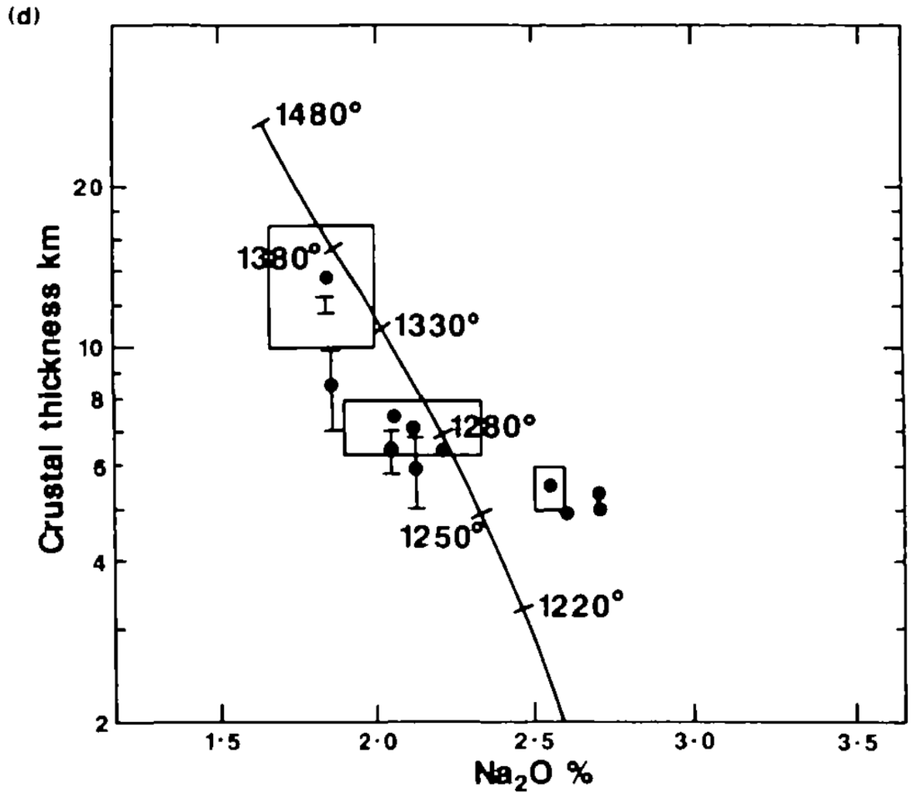
We acknowledge and respect the lək^{w}əŋən peoples on whose traditional territory the university stands and the Songhees, Esquimalt and W̱SÁNEĆ peoples whose historical relationships with the land continue to this day.

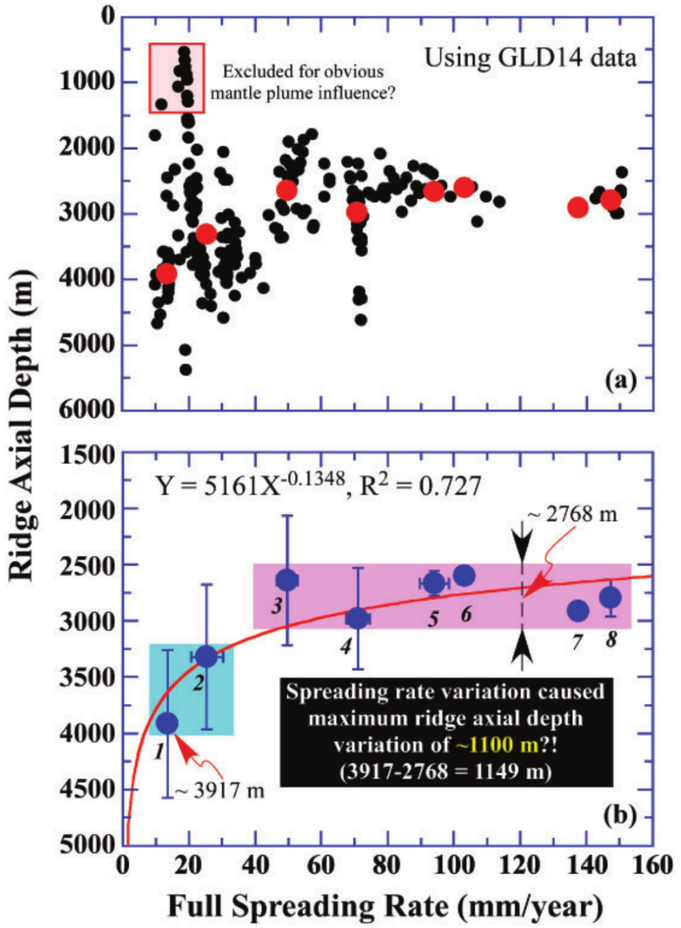
Na2O data from MORB



Normalized (MgO = 8%) Na_2O

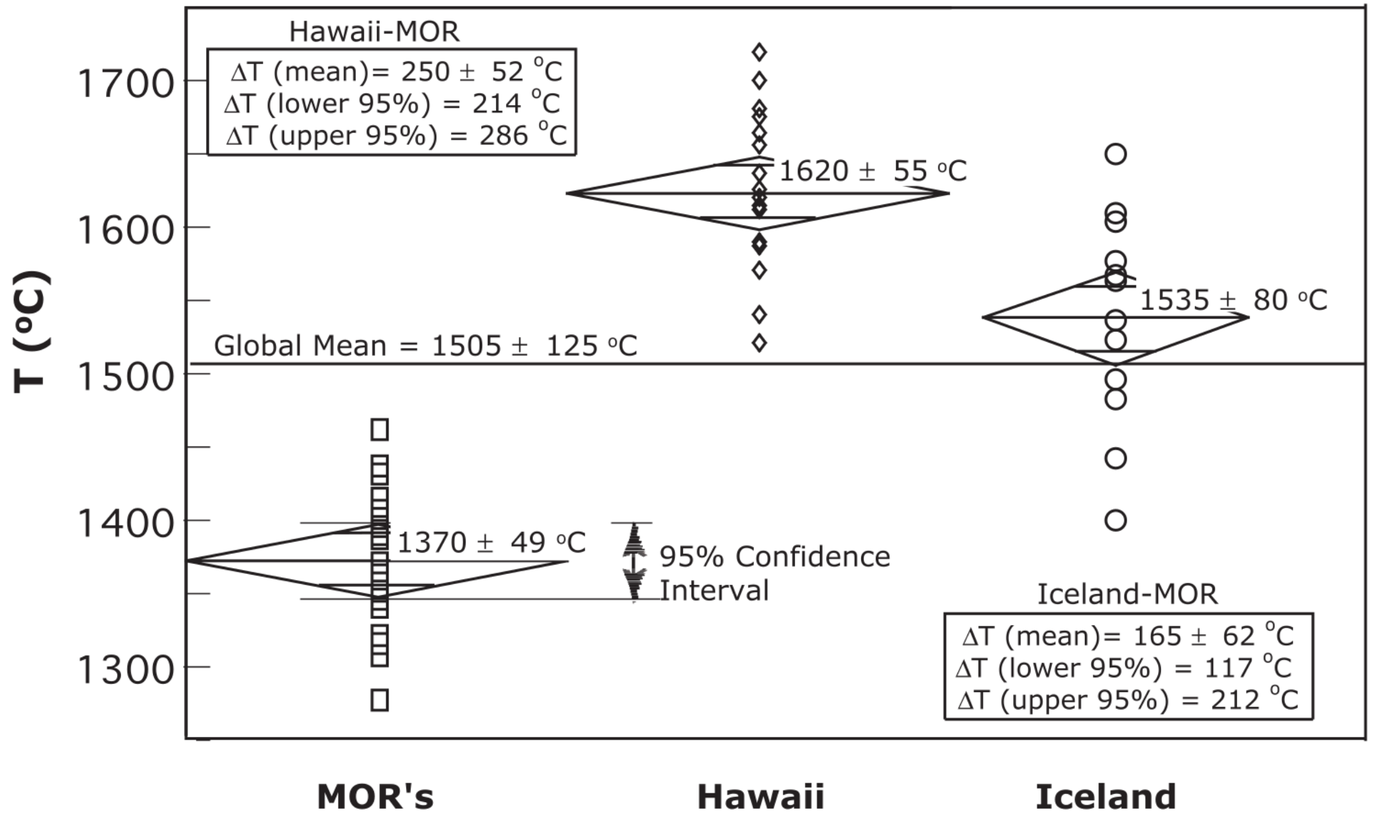





Using GLD14 data
Excluded for obvious mantle plume influence?
(a)
Ridge Axial Depth (m)
Y = 5161X^-0.1348, R^2 = 0.727
~ 2768 m
~ 3917 m
Spreading rate variation caused maximum ridge axial depth variation of ~1100 m?! (3917-2768 = 1149 m)
(b)
Full Spreading Rate (mm/year)

Potential temperatures beneath ridges and oceanic islands

The partitioning of Mg in Olivine is sensitive to temperature while the Fe/Mg partitioning is not



Strong geochemical evidence for the existence of thermally driven mantle plumes

Trace elements in MORB and OIB (review compatibility trends)

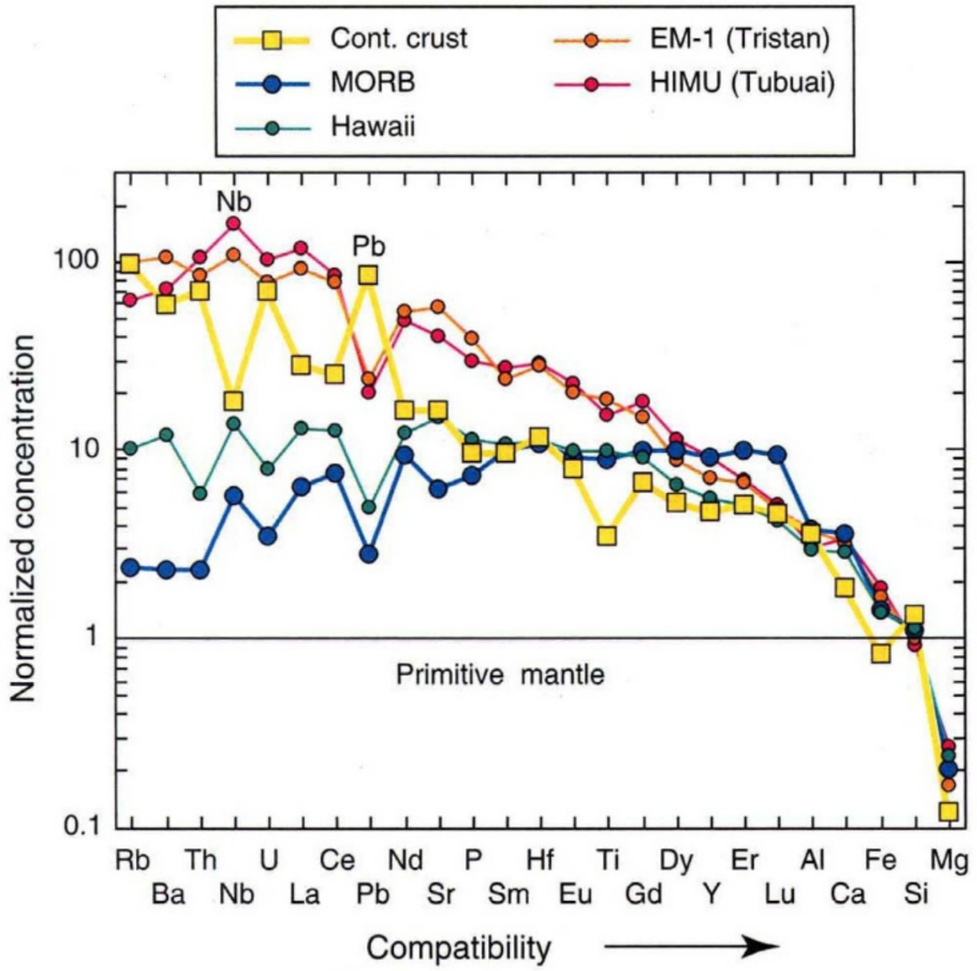
Trace elements in MORB and OIB (review compatibility trends)

Tristan, South Atlantic

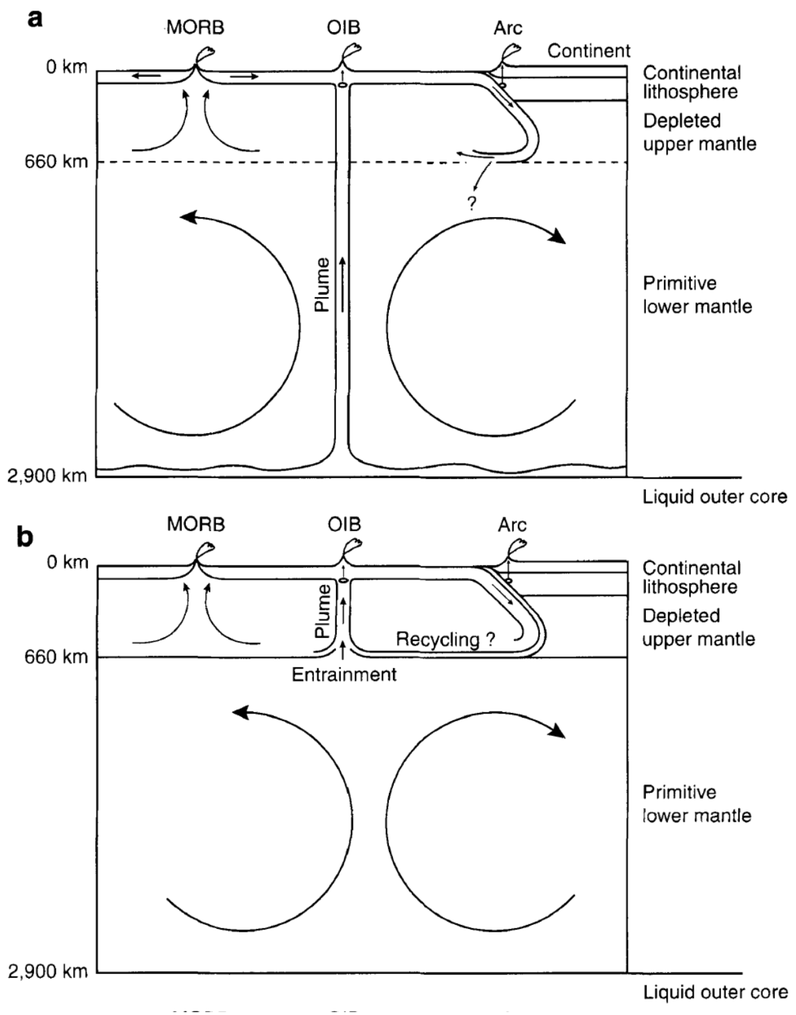
Tubuai, French Polynesia

Trace elements in MORB and OIB (review compatibility trends)

Trace elements in MORB and OIB (review compatibility trends)



Models of the mantle



Sm and Rb

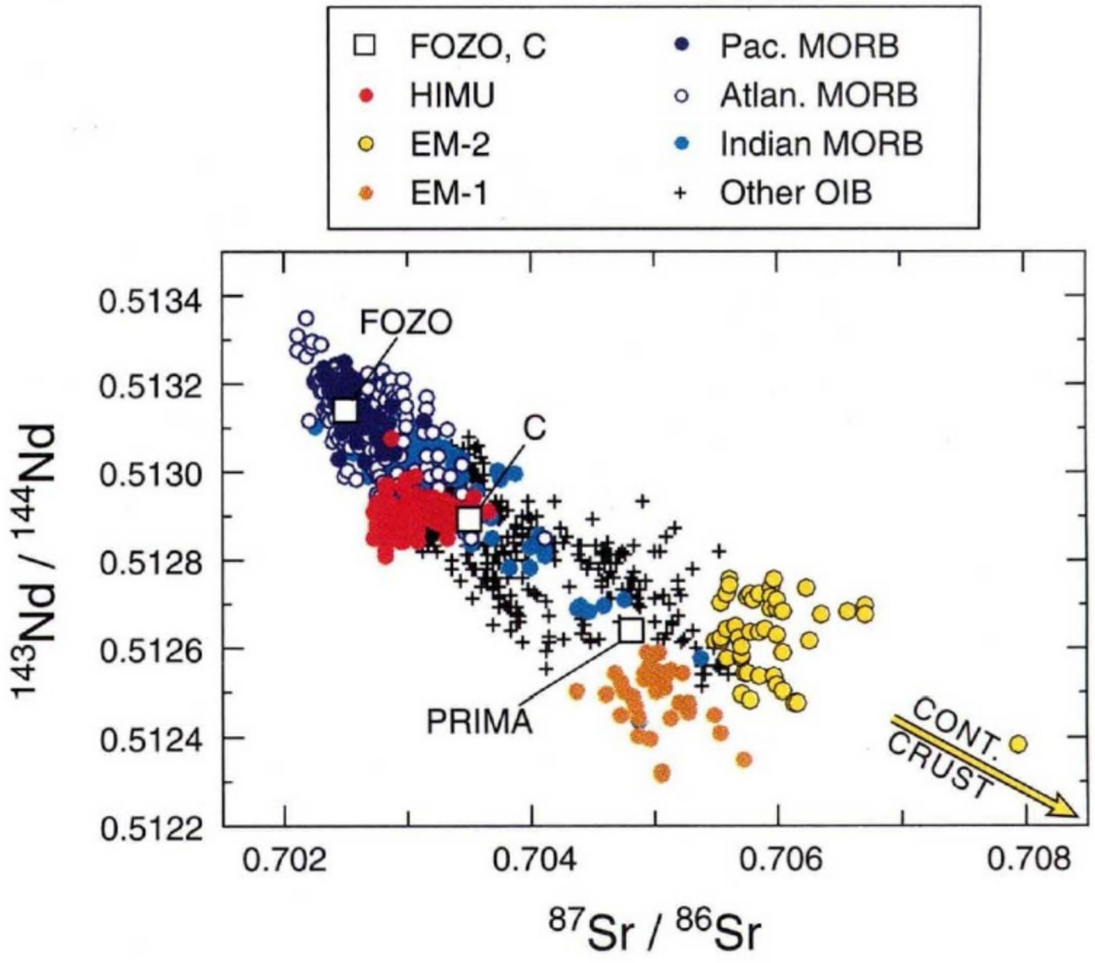
- $^{147}\text{Sm} \rightarrow {}^{143}\text{Nd}$
    - Sm more **compatible** than Nd
- $^{87}\text{Rb} \rightarrow {}^{87}\text{Sr}$
    - Rb highly **incompatible** (and more incompatible than Sr)

- What trends do you expect between primitive mantle, MORB, and continental crust?
    - If plumes sample primitive mantle, what should their radiogenic Nd and Sr look like?
    - *sketch:* $\frac{^{87}Sr}{^{86}Sr}$ *(x) vs* $\frac{^{143}Nd}{^{144}Nd}$ *(y)*

Sm and Rb

- $^{147}Sm \rightarrow {}^{143}Nd$
  - Sm more **compatible** than Nd
- $^{87}Rb \rightarrow {}^{87}Sr$
  - Rb highly **incompatible** (and more incompatible than Sr)

- What trends do you expect between primitive mantle, MORB, and continental crust?
  - If plumes sample primitive mantle, what should their radiogenic Nd and Sr look like?
  - *sketch:* $\frac{^{87}Sr}{^{86}Sr}$ *(x) vs* $\frac{^{143}Nd}{^{144}Nd}$ *(y)*

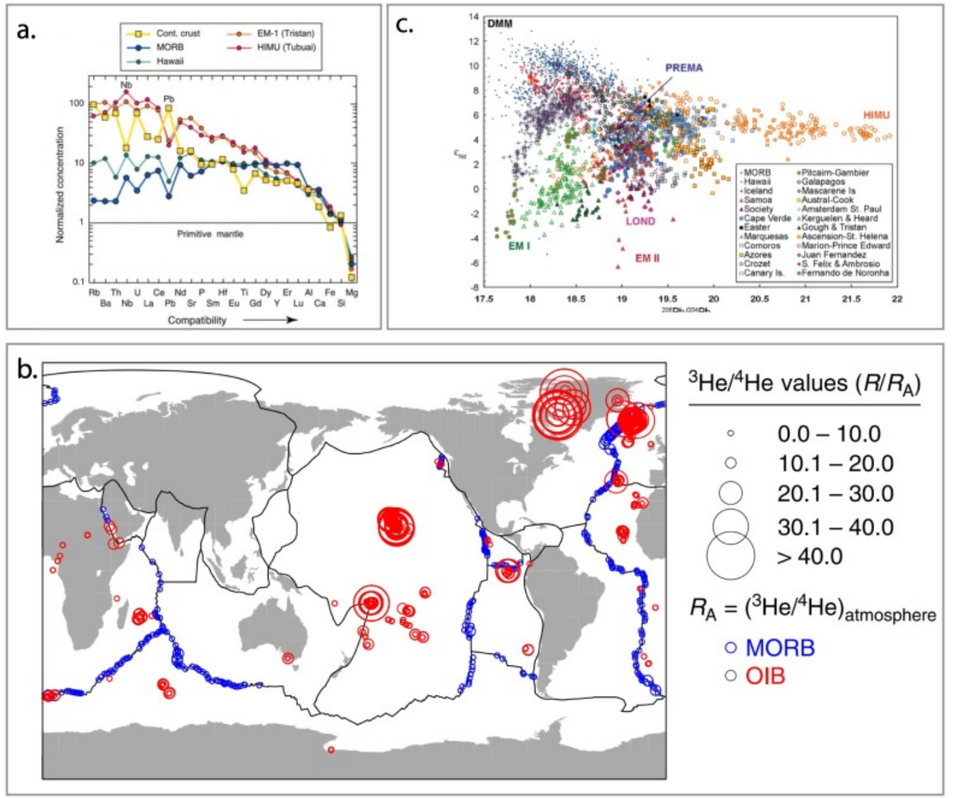


$^{3}He/^{4}He$

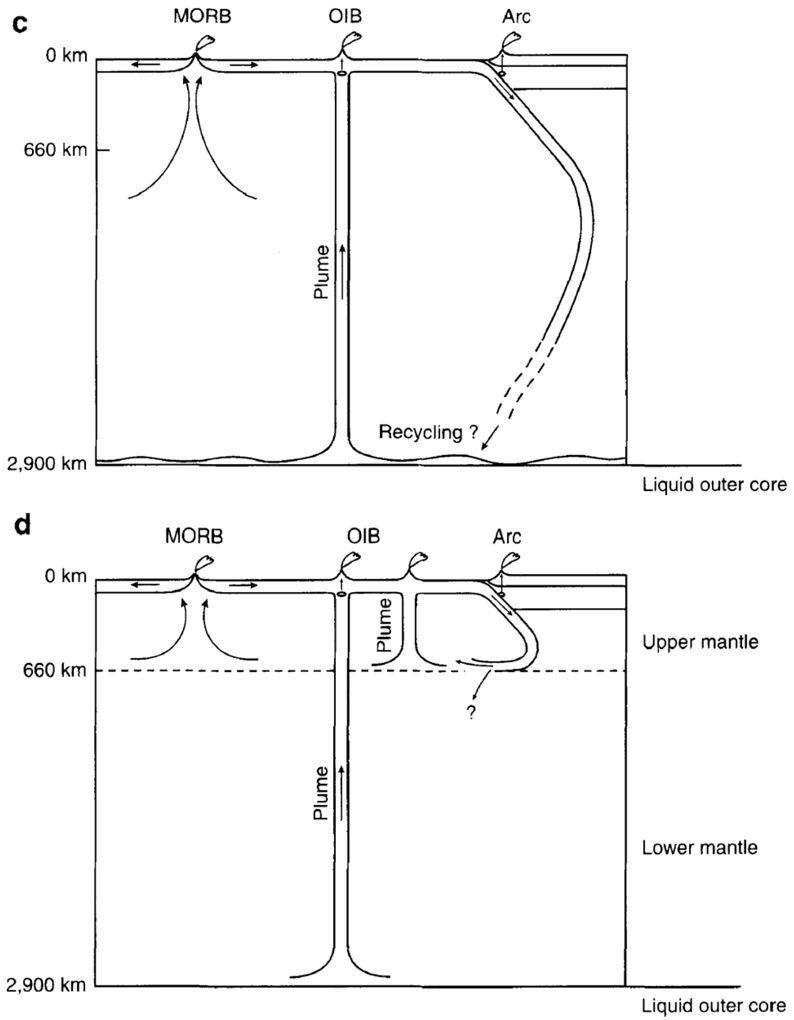
- ^{3}He is primordial, and ^{4}He is generated by alpha decays
- atmospheric $^{3}He/^{4}He$ ratio = $1.4x10^{-6}$
- continental crust has low ratios $^{3}He/^{4}He$ = 0.01 R/R_A
- MORB have rather uniform values of 8 ± 1 R/R_A
- OIB range from 5 to 30 R/R_A

$^{3}He/^{4}He$

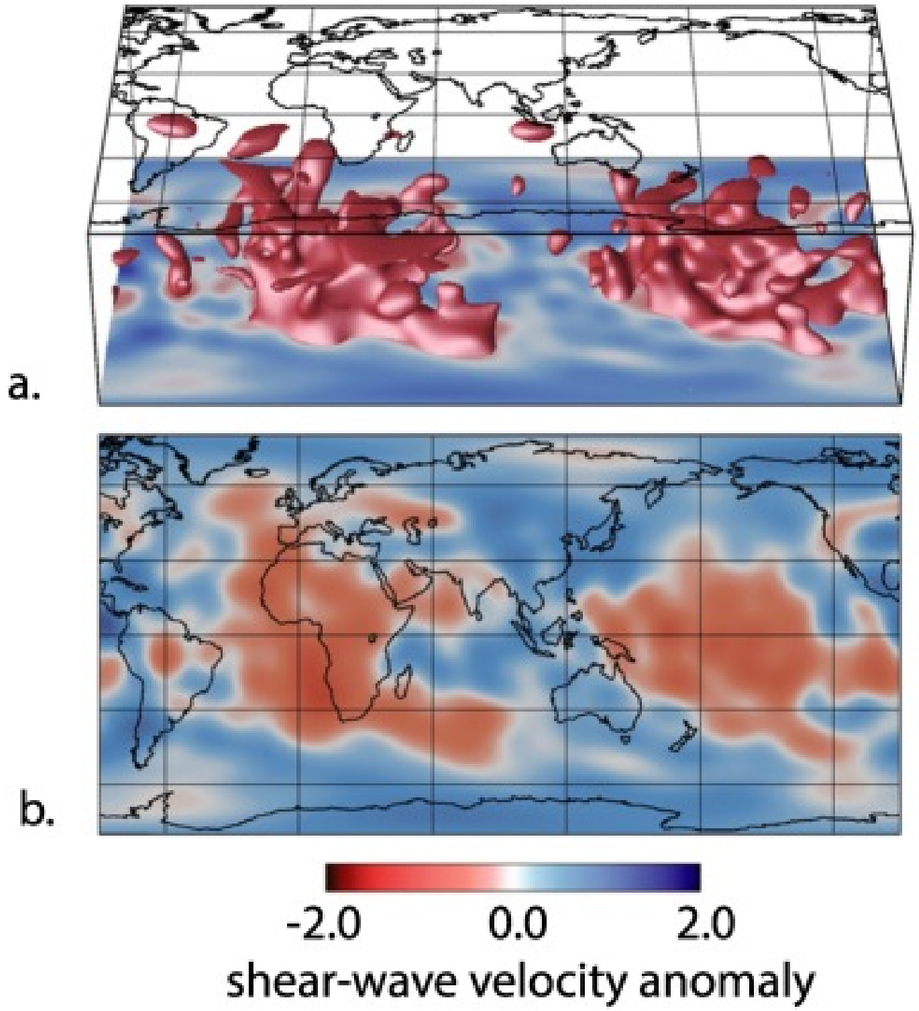
- ^{3}He is primordial, and ^{4}He is generated by alpha decays
- atmospheric $^{3}He/^{4}He$ ratio = $1.4x10^{-6}$
- continental crust has low ratios $^{3}He/^{4}He$ = 0.01 RA
- MORB have rather uniform values of 8 $\pm$ 1 RA
- OIB range from 5 to 30



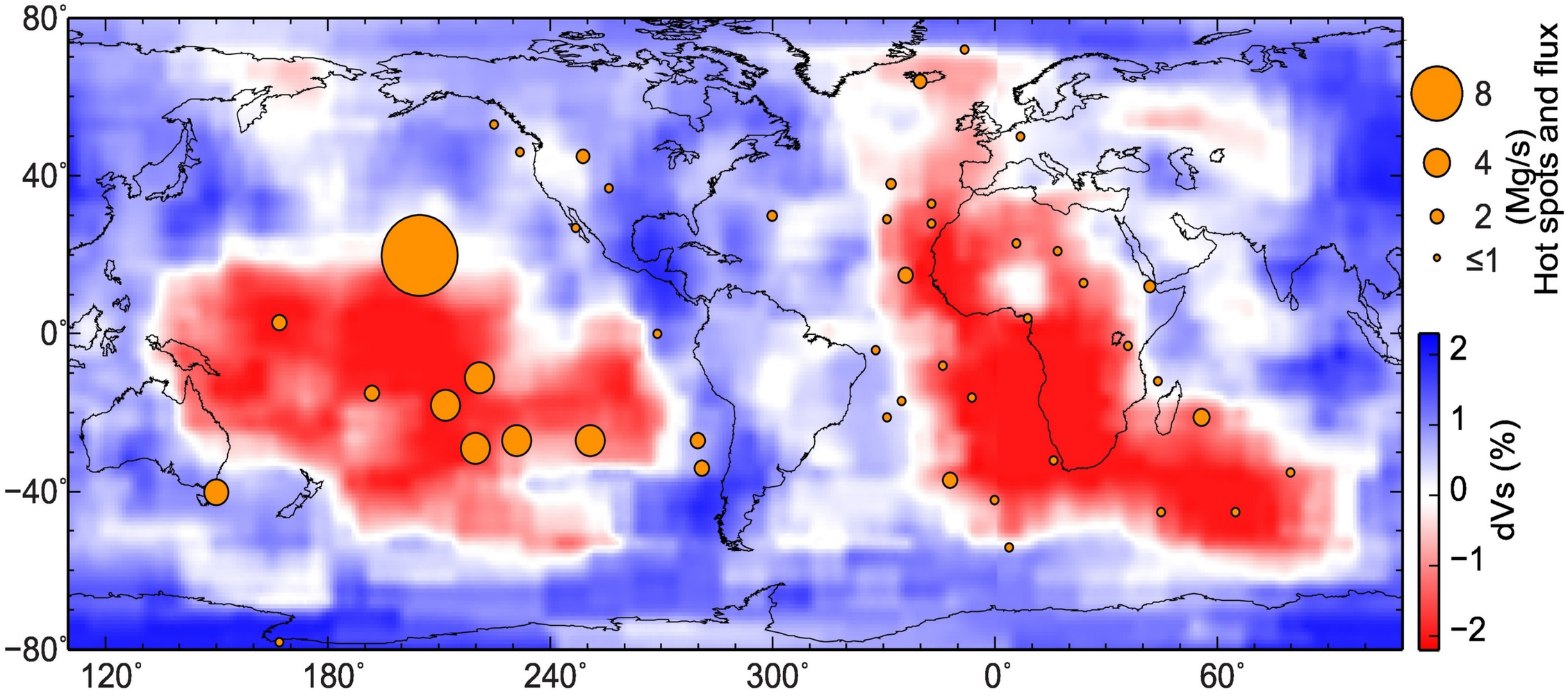
Models of the mantle



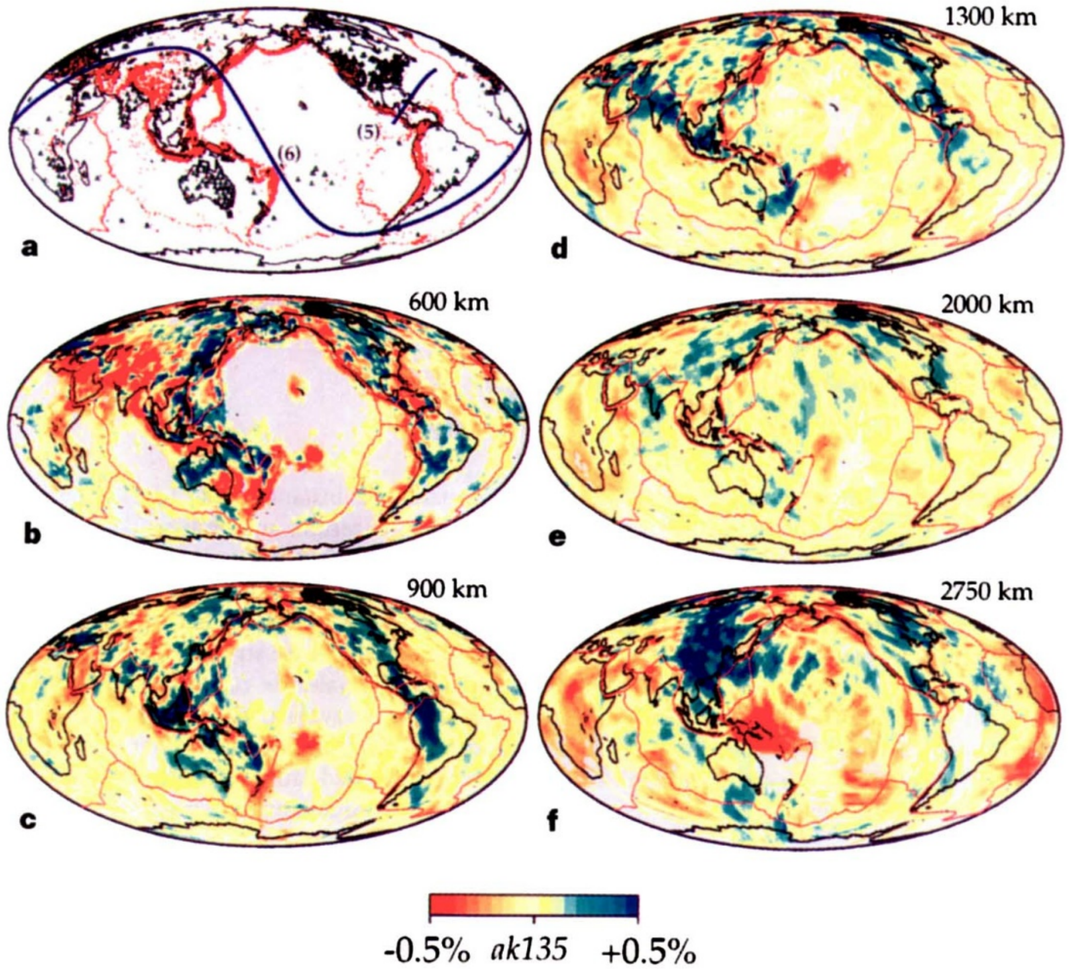
Large low shear velocity provinces (Tuzo and Jason)



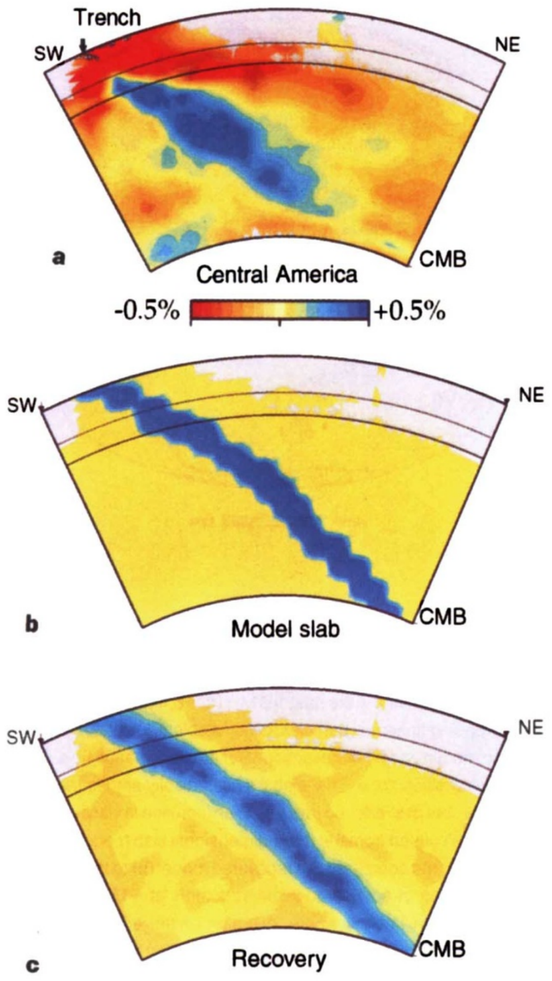
Large low shear velocity provinces (Tuzo and Jason)



The fate of slabs



The fate of slabs



Models of the mantle

What do you think the source of plumes is? Where do plumes come from?

Models of the mantle

What do you think the source of plumes is? Where do plumes come from?