Geology Summary

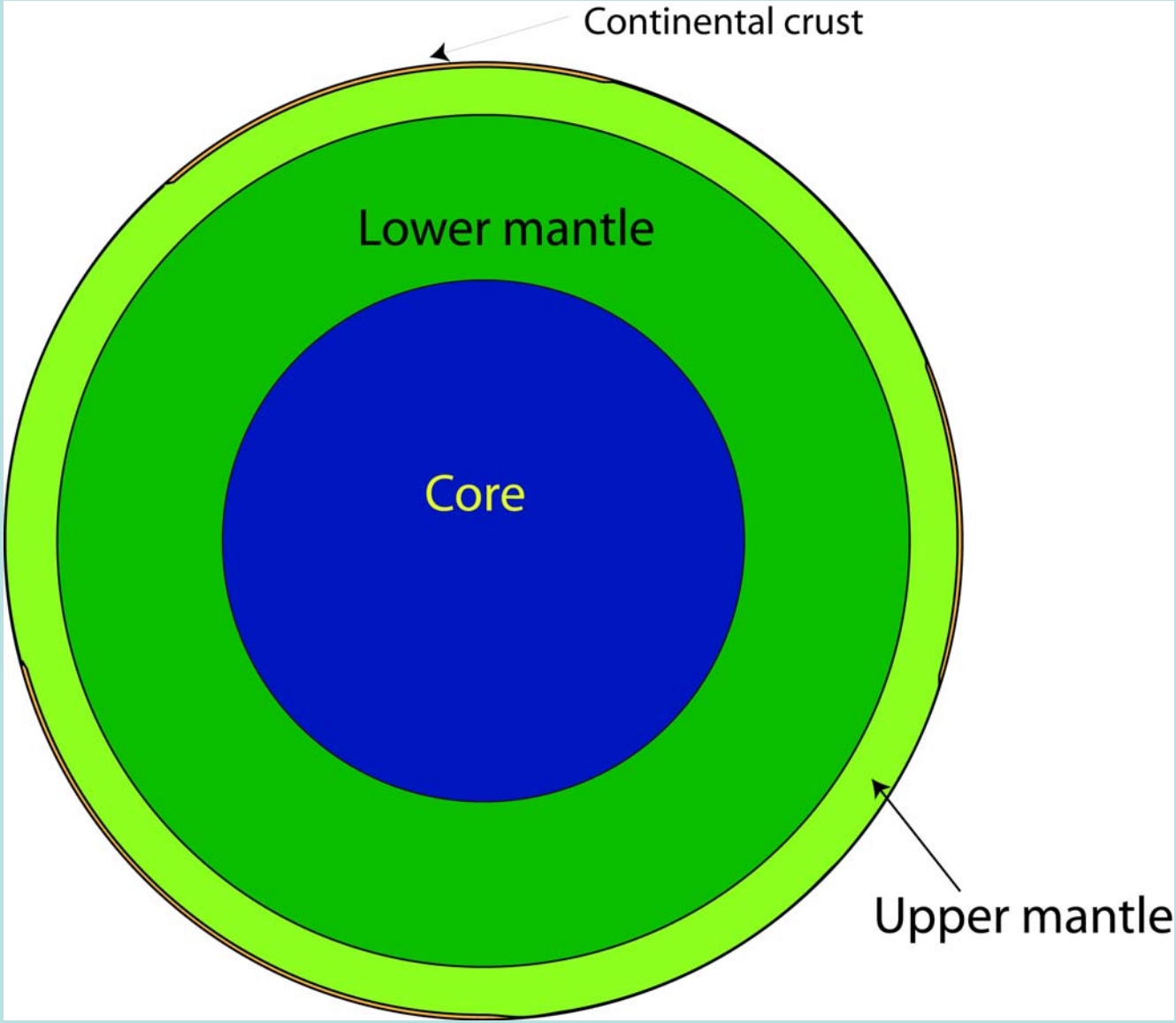
Norm Sleep

Geologists get U, Th, K

- Accretion of Earth and meteorites
- Rocks from mantle including magmas
- Their arguments can be run backwards once antineutrino data are in hand

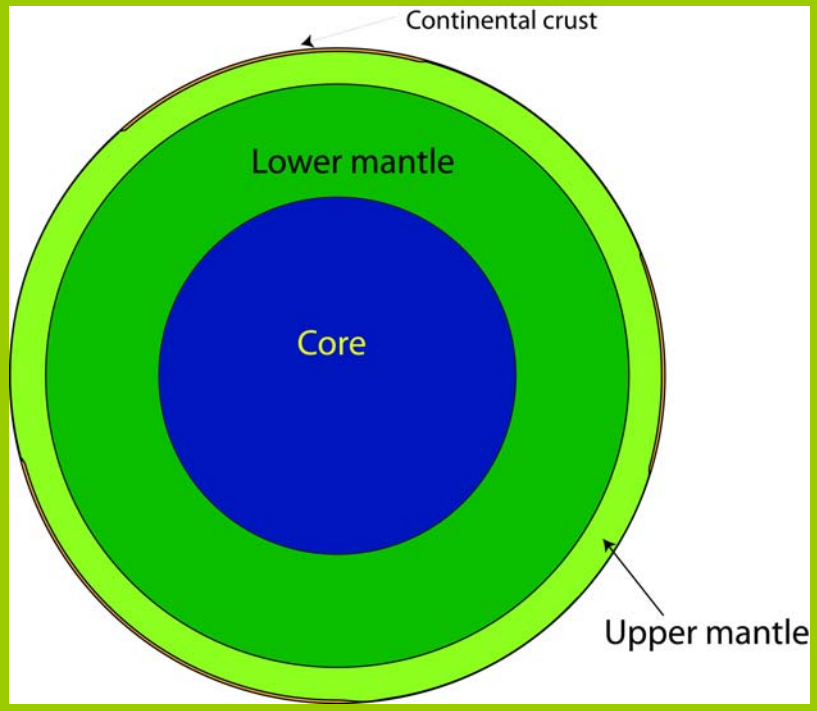
Using neutrino data

- Take advantage that a lot is already known
- Ask simple questions
- Apply results to gross habitability of planets


Continental crust
Lower mantle
Core
Upper mantle

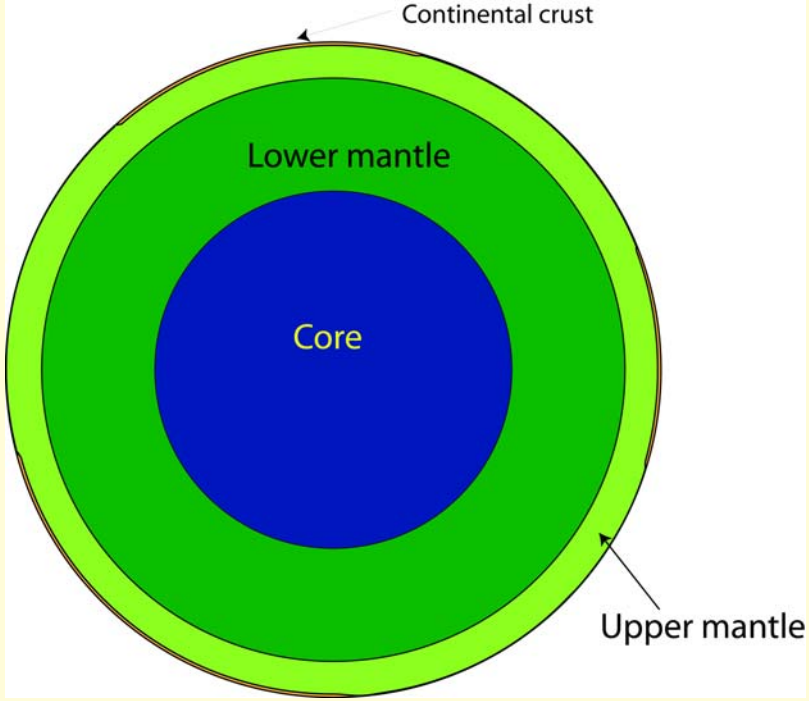
Kamland only

- Assume continental crust with local correction
- Get mantle as homogeneous shell



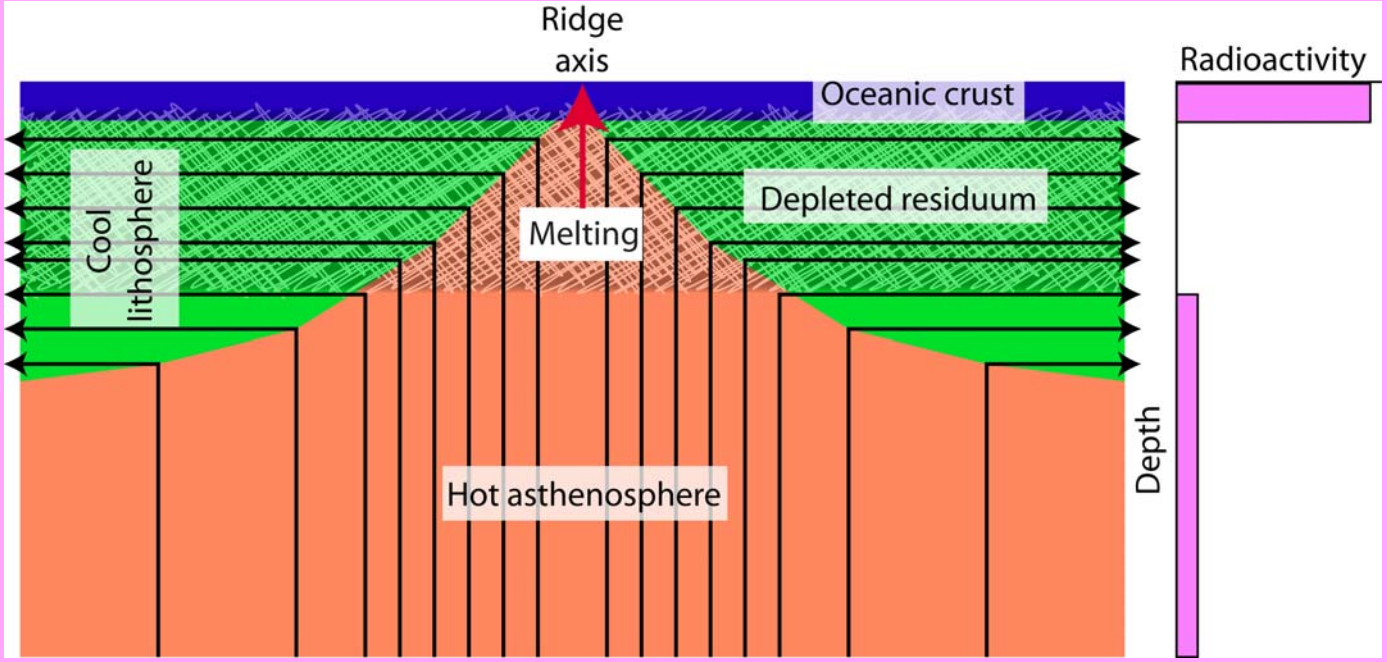
Kamland & Hawaii

- Assume local corrections
- Get mantle as homogeneous shell and average crust

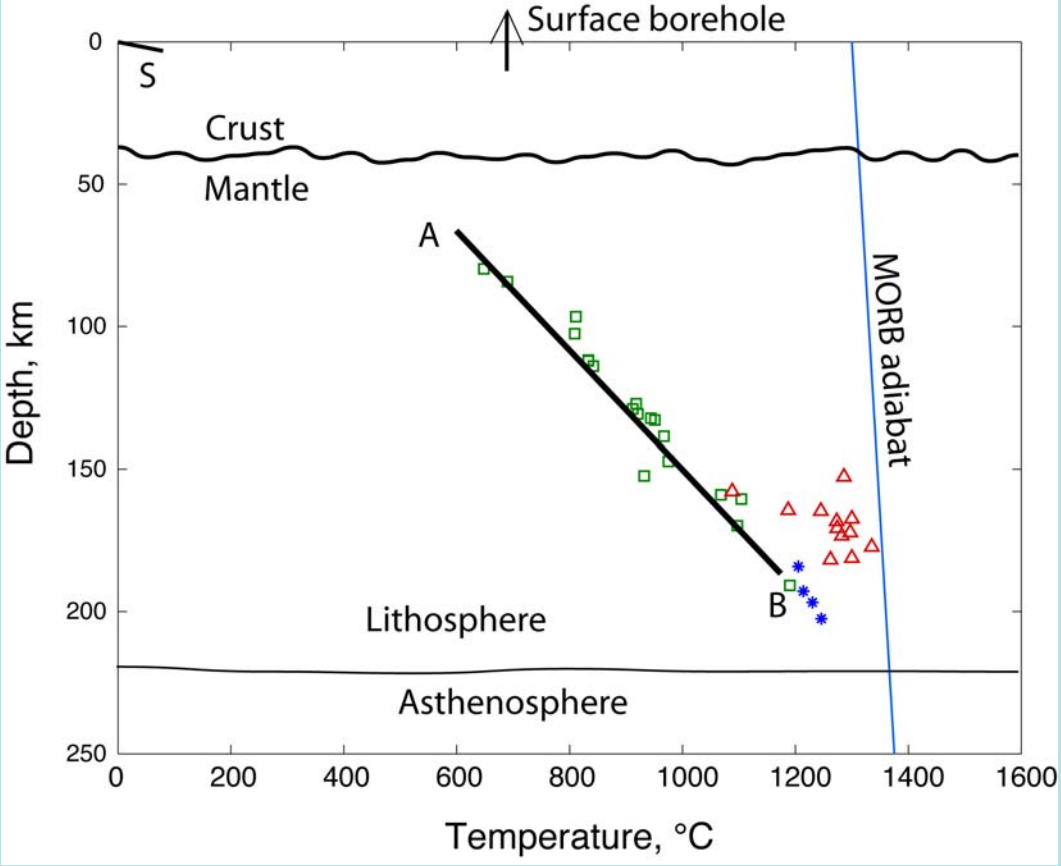


Oceanic crust

- No net change over upper ~56 km
- Can correct if needed

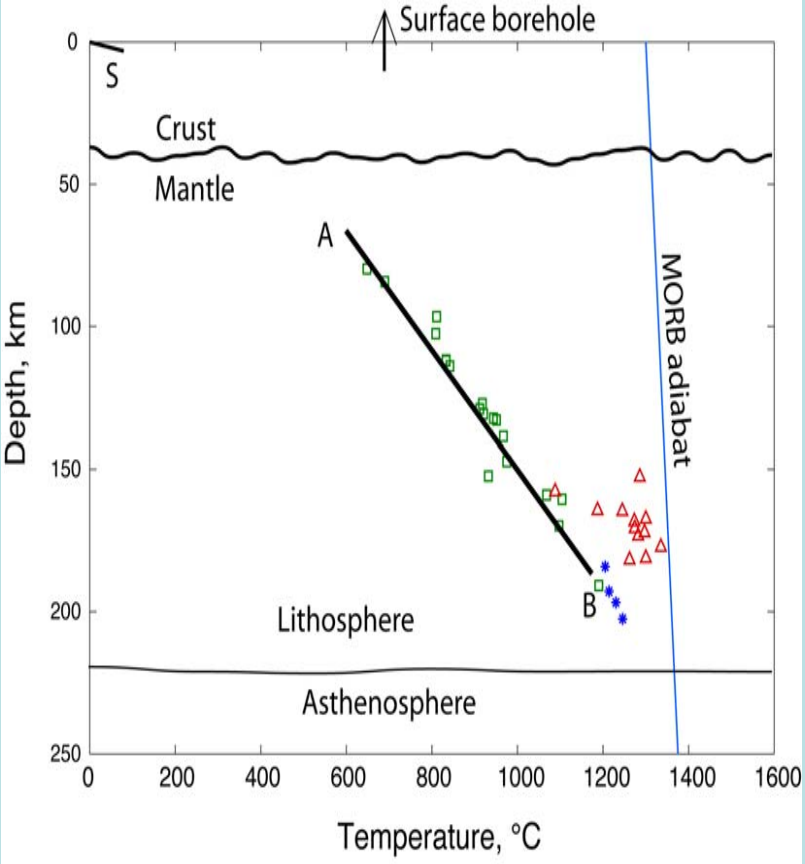


South Africa



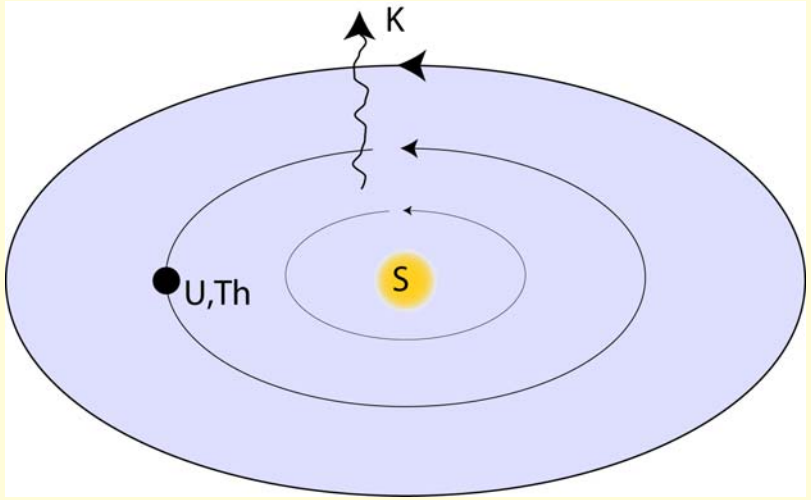
South Africa

- Heat flow is thermal gradient times conductivity
- Know at surface and in mantle
- Difference gives radioactive heat production in crust



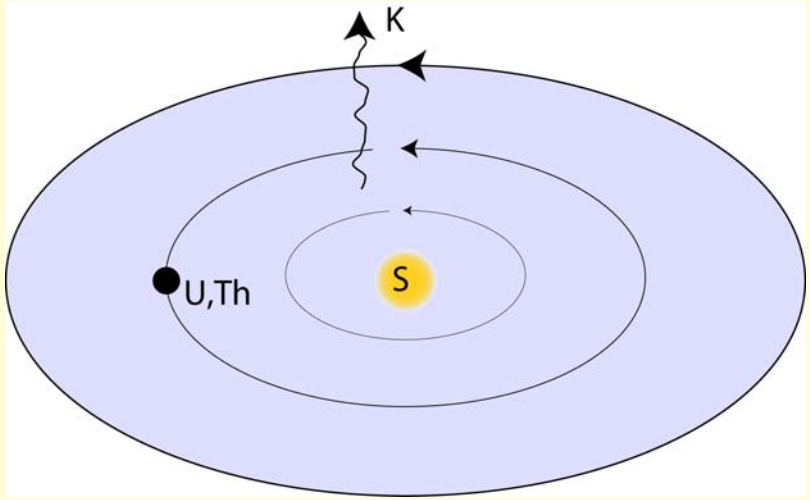
Accretion

- U and Th condense early before SiO_2
- K is moderately volatile
- Meteorites constrain nebula composition
- Earth is mixture



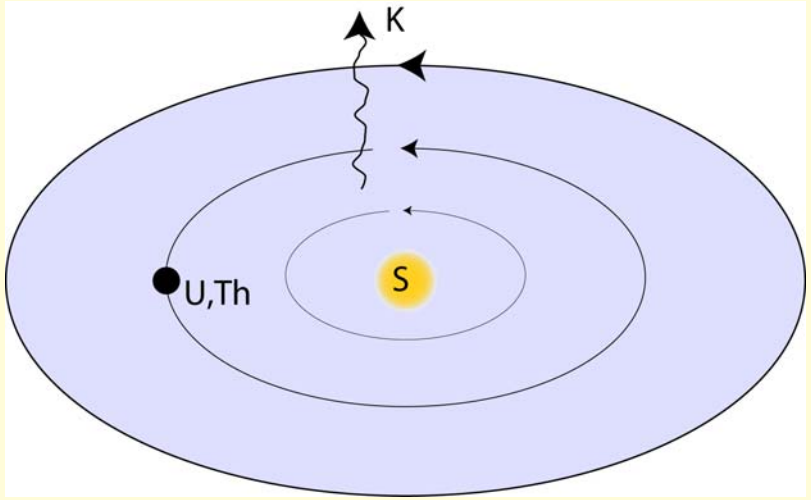
Accretion

- U and Th condense early before SiO_2
- SiO_2 is inert dilutant
- Mg:Si ratio ~20% different in Earth and meteorites
- Need this precision



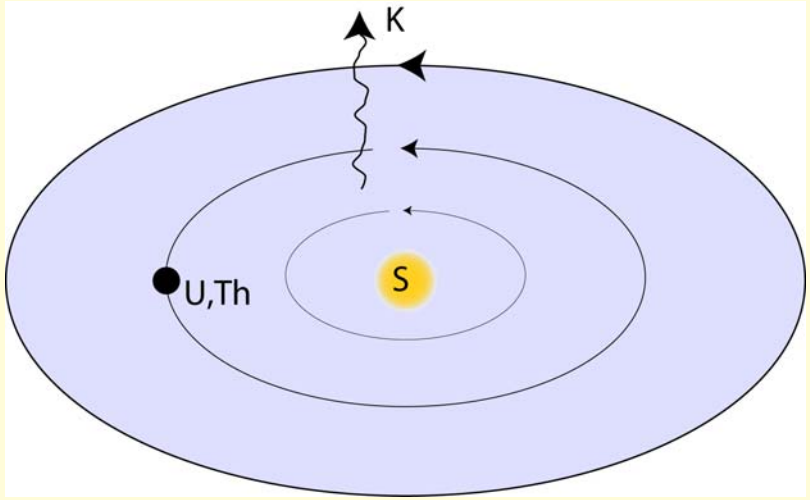
Accretion

- K condenses late
- Earth depleted by factor of 8
- Hidden reservoir deep mantle or core?
- Major core heat source?
- Magnetic field



Accretion

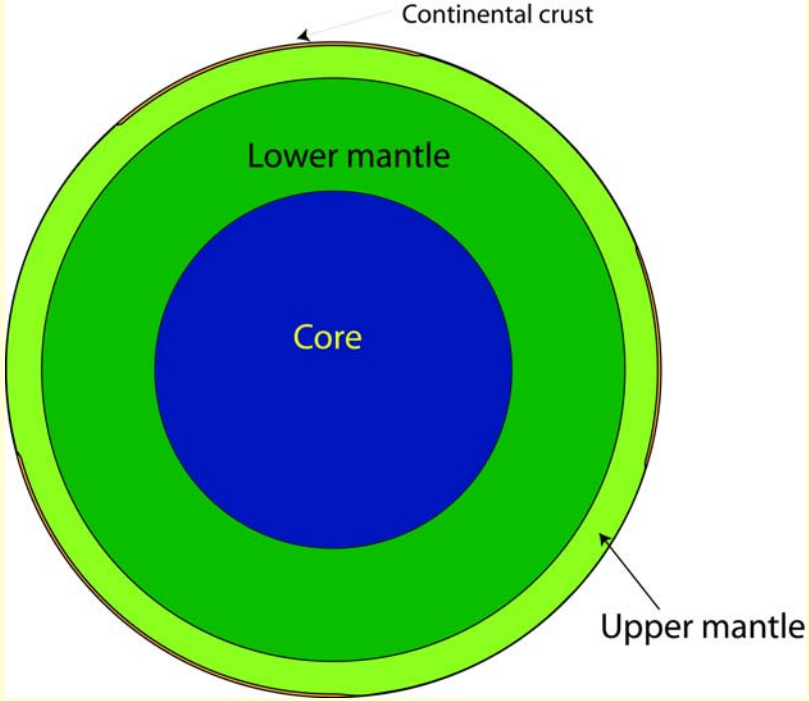
- Collisions eject crust
- U, Th, and K lost?



Hidden reservoirs

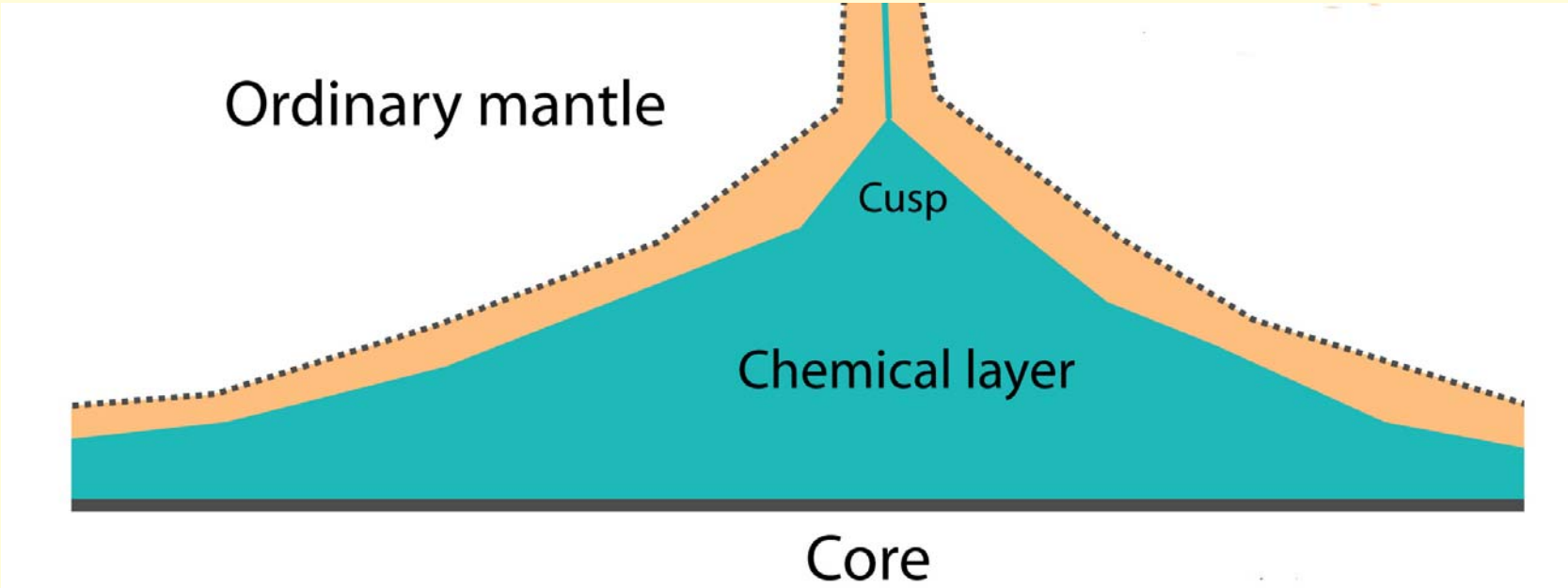
- Core K? U????

- Dregs layer in deep mantle K,U,Th?
- Thickest near hotspots
- Thin beneath slabs



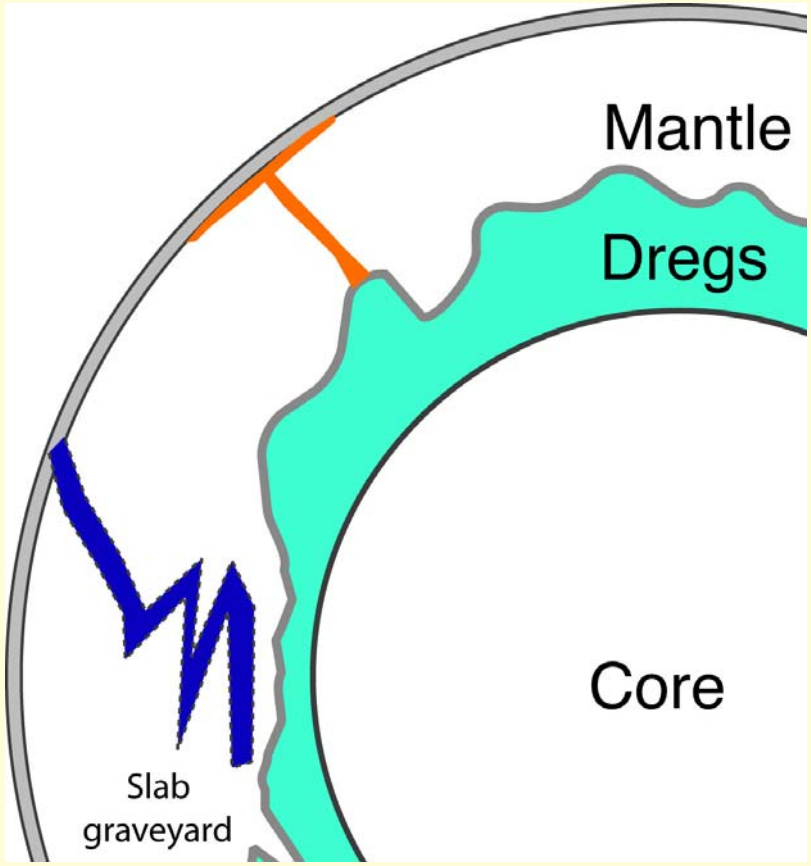
Hidden reservoirs

- **Thin dregs layer**
- Cusp above each plume
- Thin beneath slabs



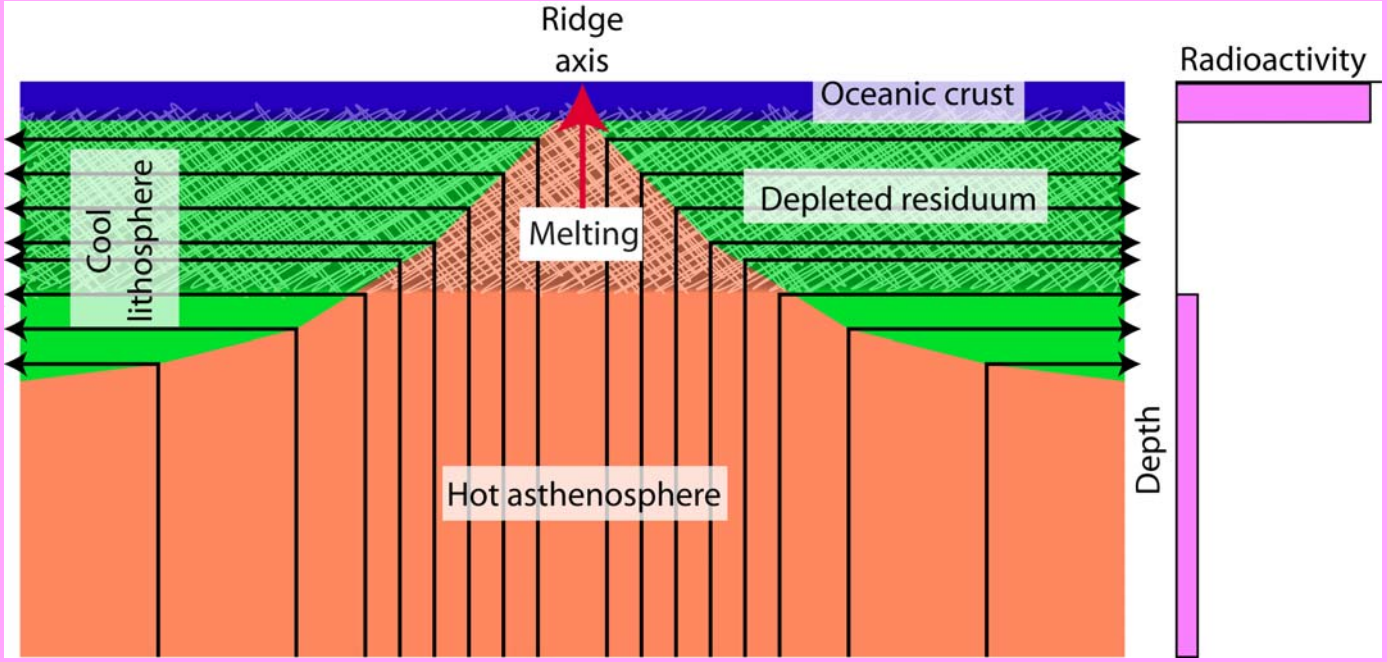
Hidden reservoirs

- **Thick dregs layer**
- Upwellings beneath hotspots
- Thin beneath slabs



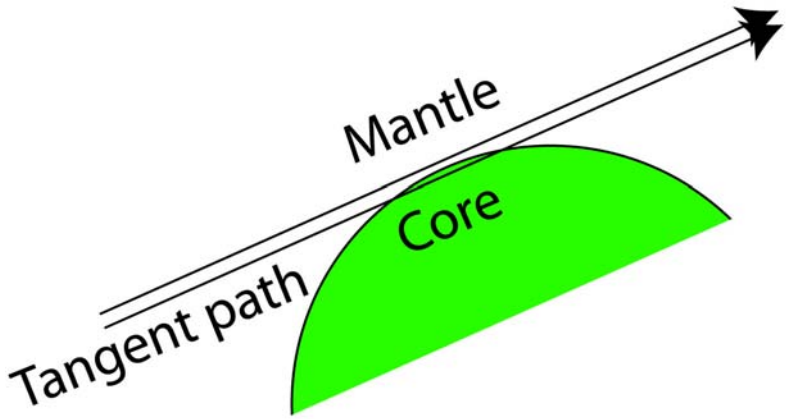
Oceanic crust

- Can calibrate melting depth if U and Th in source are known
- Constrains other elements that enter melt



Planetary habitability

- Accretion history - expected and likely?
- Heat flow budget - duration of tectonics (Lord Kelvin)
- Formation of dregs layers and fate of volatile elements

X-ray mode/directional detector

- Geophysicists familiar with tomography
- Simpler in that path is known
  - Aberration of light
  - Relativity from mass of Earth
- Get diameter and dynamic topography of core