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
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 SiO₂
• 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 $\sim$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