

Length scale of heterogeneity

- Length scale of heterogeneity after 4 Ga of convection
- Sampling the pudding
- Lateral variations in composition; fastest way is the calculation of bulk moduli benchmarked to low-pressure experiments, and then relate them to seismic velocity
- Partial melting systematics
- SLIMER – sublithospheric isotope and major element research: mantle xenolith analyses along MOR
- Need paired trace elements/major elements
- Seismology is not going to solve this problem but will be limited to the wave physics, e.g. 2% at 100 km resolution
- Use P and S to try and get to T and X

Upper mantle

- Test hypothesis for the dramatic increase in viscosity in the upper mantle (H₂O)
- Need seismic and rheological observations of where water is or isn't in the mantle
- Partial melting systematics
- Use huge array to combine receiver function studies, surface waves, body waves, and array seismology might have to wait until we see USArray in place
- Is the presence of water limited to this realm?
- Seafloor flattening with respect to half space cooling; not a solved problem

Slabs

- Avalanches and phase changes at 660 km
- P-T-V-X equations of state, in the presence of water
- How much of the lithospheric mantle is being serpentized in subduction zones; this is key to the water budget in the Earth
- Geodynamicists need to give us temperature anomalies for subduction zones; this is a simple example of how a forward model can be used as a prediction for seismology; but we need real input, not tell them what they should find in the first place
- Anisotropy is one parameter whose resolution will improve
- Deep earthquakes: make faults in plastic regime, by water or phase transitions? Who knows?

Hot spots/upwellings/plumes

- Shape and distribution of swells
- Mechanisms and geodynamic predictions and tests
- Pressure and temperature derivatives of the effects of melt, water and mineral interaction
- Effects of volatiles and map their 3D deformation
- Look at geochemical signals of core-mantle interaction
- Match geochemistry with tomography source depth
- Mapping of all relevant elastic parameters
- Seismic tests for hypothetical structures

Lower Mantle

- Heat distribution and heat flow
- Determine heat capacity and thermal conductivity
- Effects of volatiles and map their 3D deformation
- Consistency between geochemistry systems
- Trace evolution of convection, something we can only get from geochemistry
- What is the triple point of perovskite?
- Statistical tests and properties of the heterogeneity
- Is the presence of water possible here?

Water

- What is the water budget of the Earth? How much can continents hold before they dehydrate; how much goes down in subduction zones and how much comes up in ridges and plumes?
- Mineral physics can tell you how much it might hold by solving the solubility problem, but we need to know the bulk values to do proper accounting