

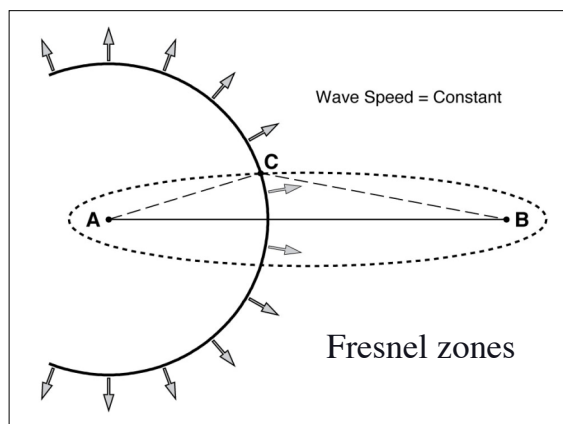
Lecture 8

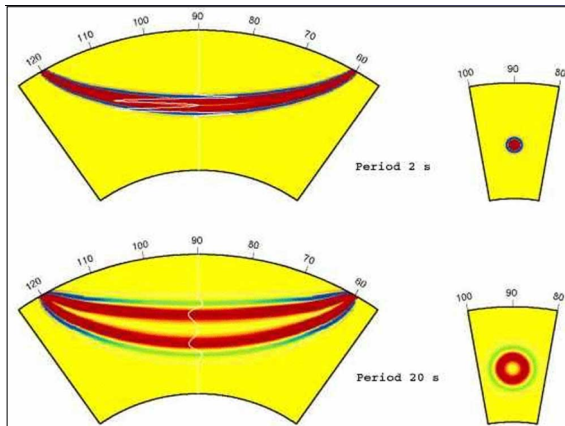
Earth structure

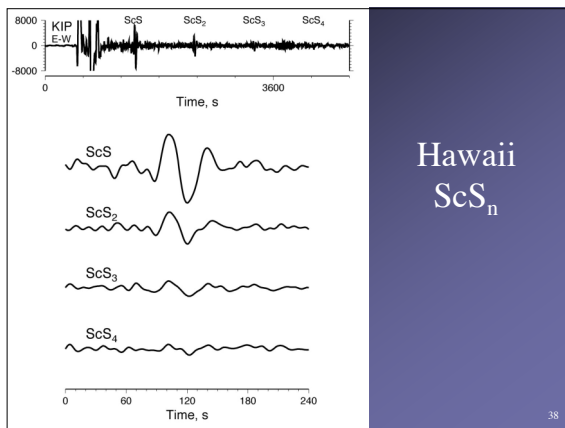
Whole mantle tomography

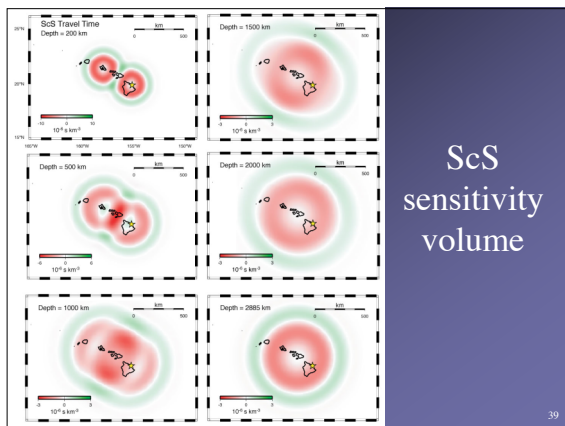
- Earth is a sphere
- Outer core is fairly homogenous because liquid
- Extremely long wavelengths—structures of the order of 1000 km in size best that can be achieved

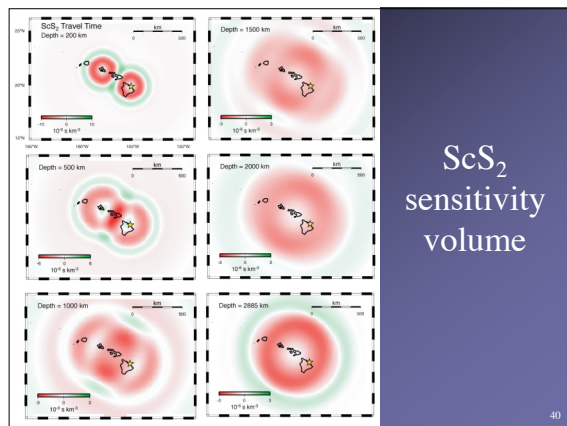
35

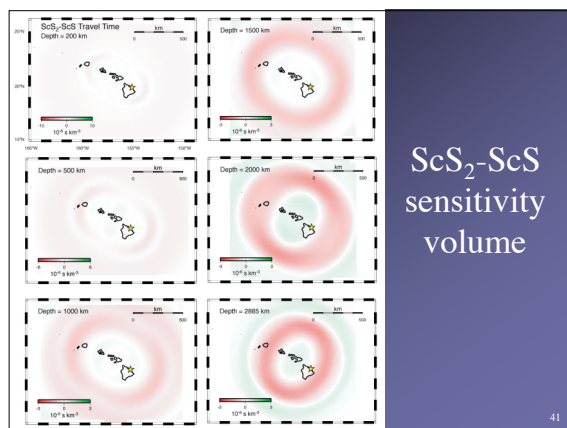










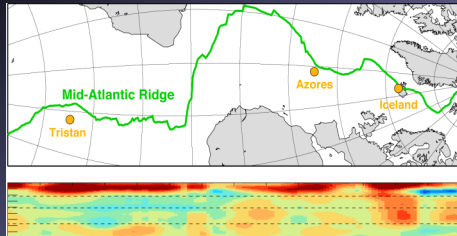


Whole-mantle tomography

- Over 2,000,000 data
 - S-wave arrival times (S, SS, SSS, ScS & SKS)
 - fundamental- & higher-mode Rayleigh-wave phase velocities
 - normal-mode frequencies

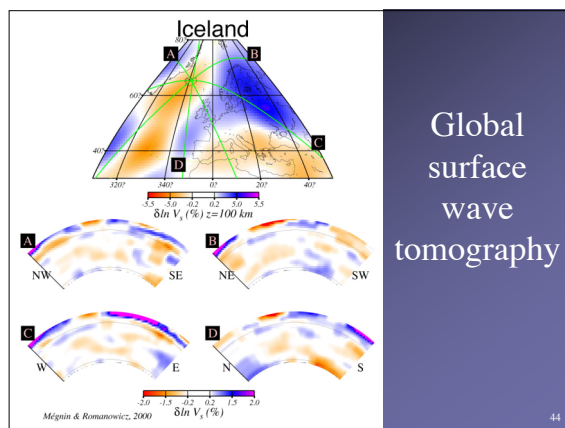
Ritsema et al. 1999 42

Mantle tomography



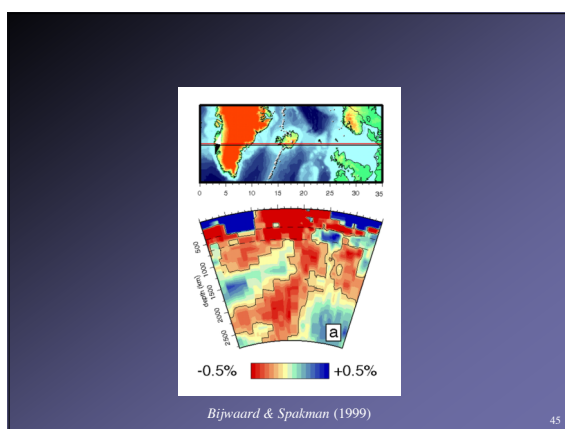
Vertical exaggeration x 2

from Ritsema (1999)₃



Global
surface
wave
tomography

44

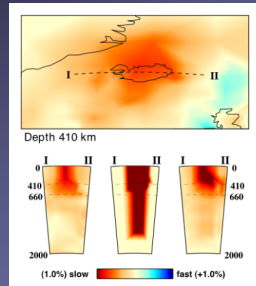


Bijwaard & Spakman (1999)

45

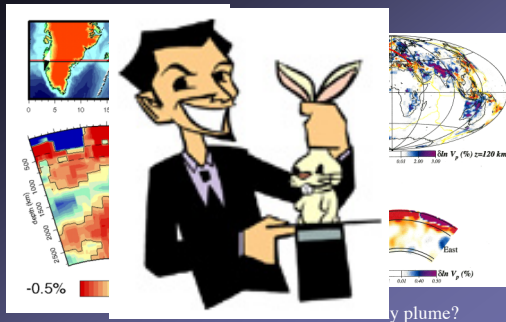
Whole-mantle tomography

The data used by
Bijwaard &
Spakman have no
resolution in the
lower mantle



From Foulger et al. (2001) 46

Whole-mantle tomography

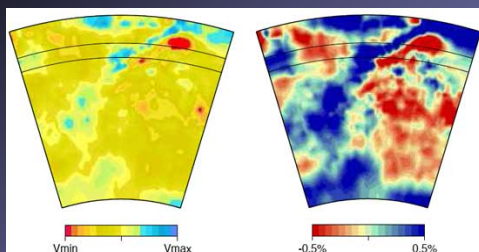


Bijwaard & Spakman (1999)

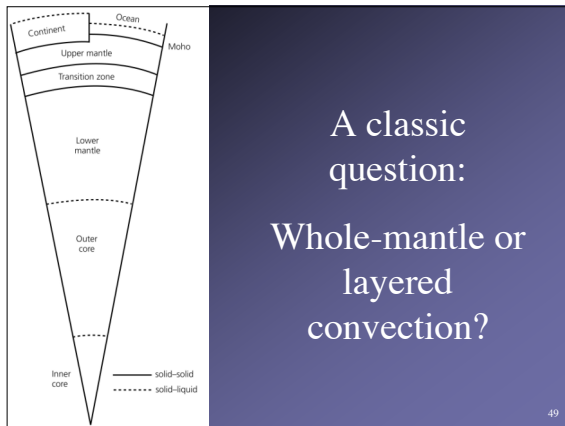
y plume?

47

Different color schemes

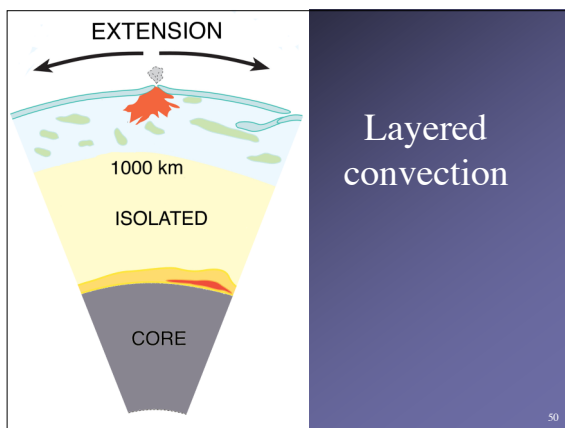


48



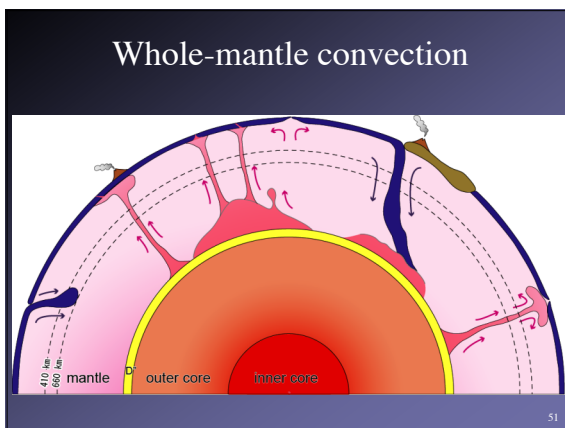
A classic question:
Whole-mantle or layered convection?

49



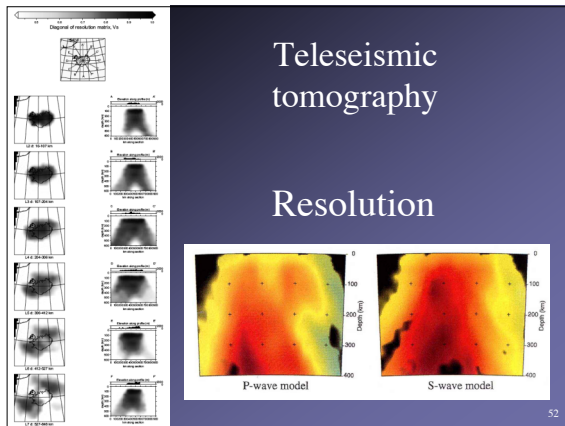
Layered convection

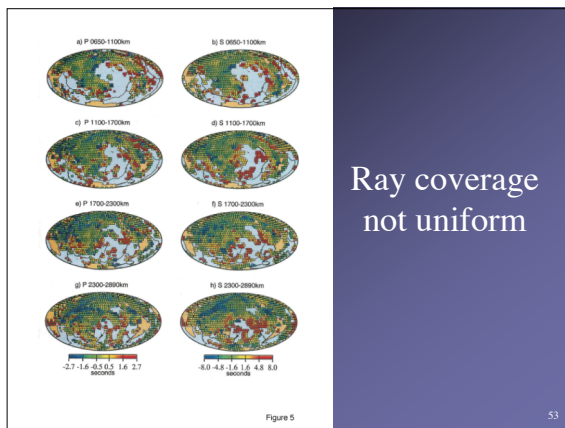
50

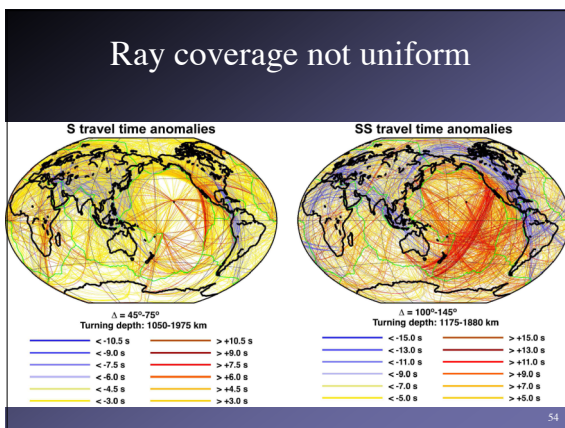


Whole-mantle convection

51

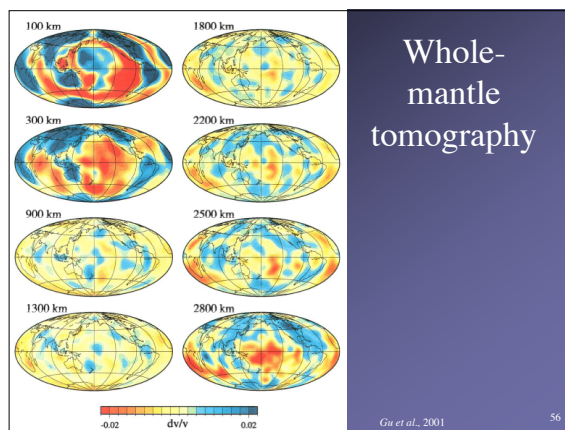


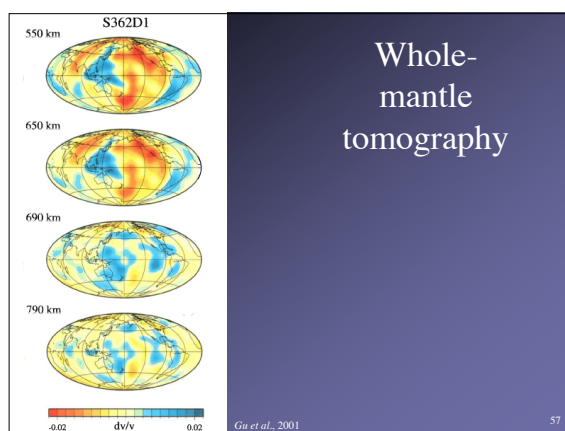


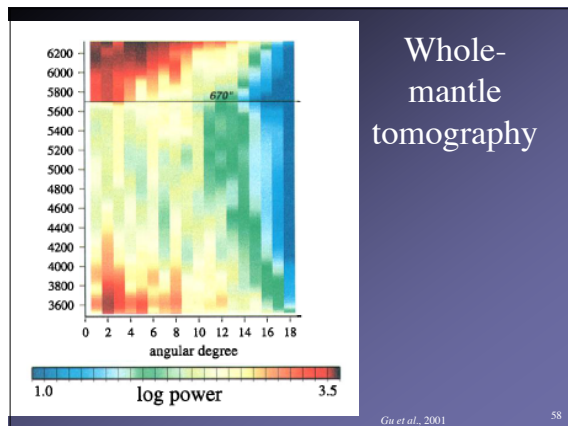


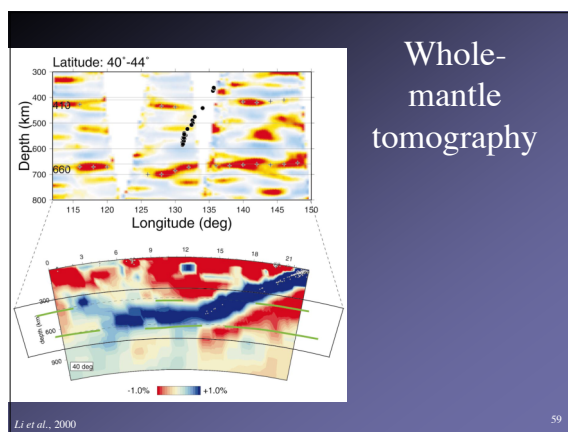
1-layered or 2-layered convection?

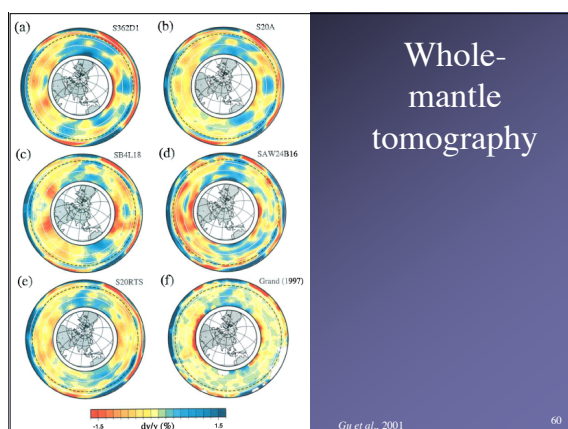
a) Downwellings





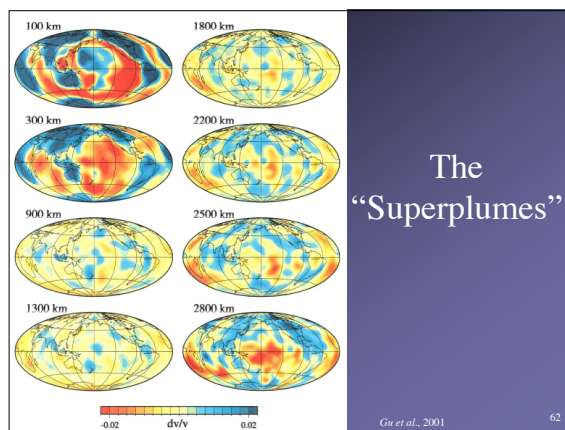




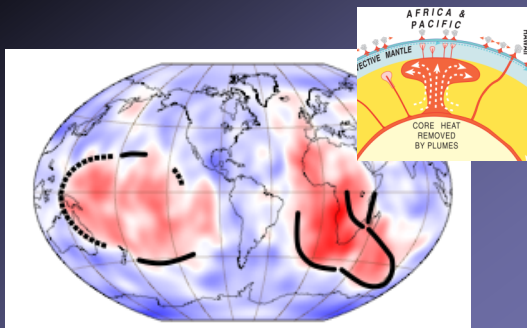


1-layered or 2-layered convection?

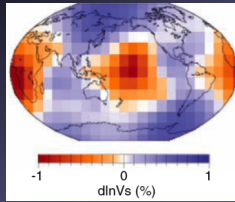
b) Upwellings



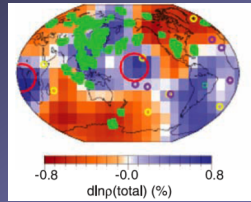
The “Superplumes”



Problem: They are not hot.
They are dense, chemical anomalies.

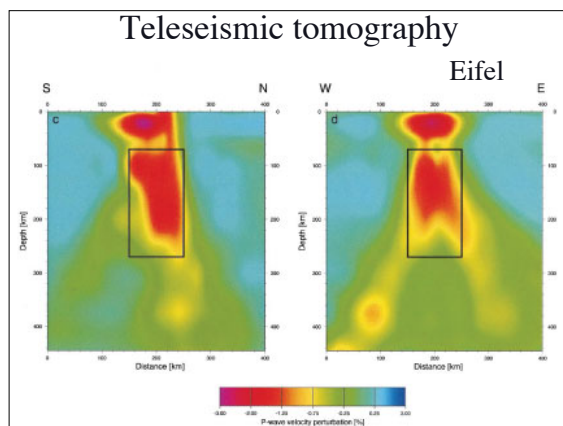
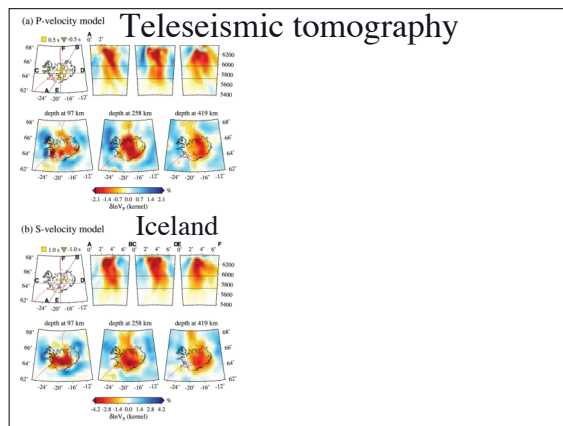


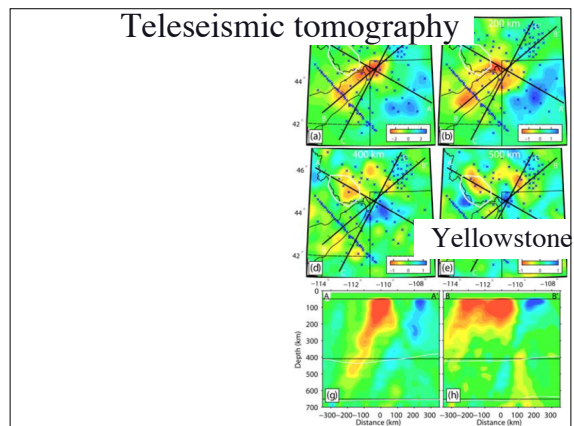
V_s

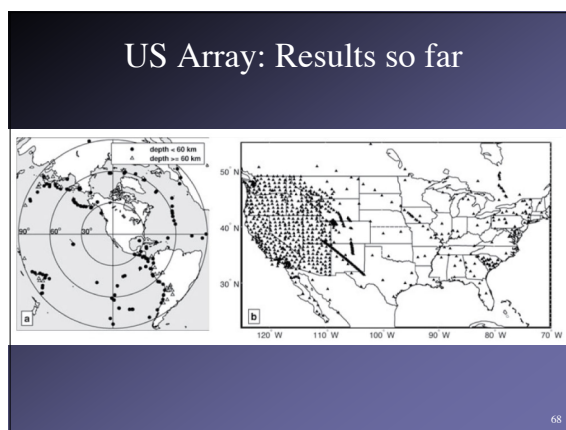


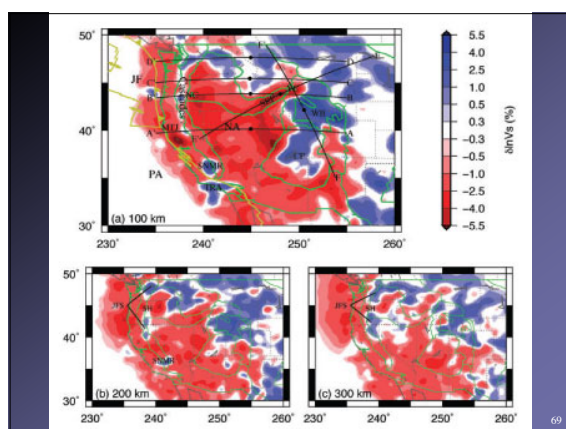
Density

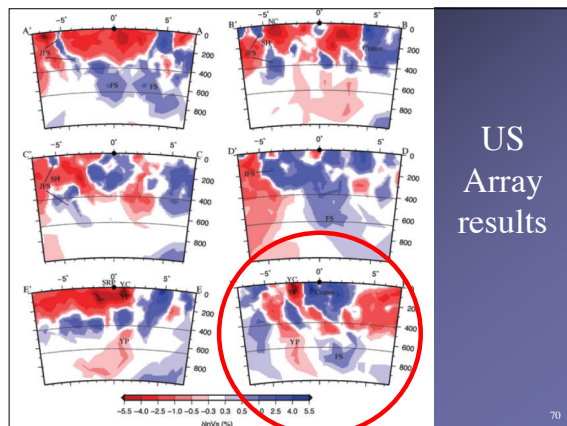
Trampert et al. (2004) 64











Critical question

How to interpret seismic wave speeds?

Interpretation is ambiguous

- Phase
 - Mineral
 - State
- Composition
- Temperature

Seismology is not a thermometer



Seismology cannot detect melt

Seismology cannot simply be
assumed to “see” slabs and
plumes

The big question is still out there:
Is there material transfer across
the transition zone?

