Seismic Velocity and Density Jumps across the 410- and 660-kilometer Discontinuities

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What did they do?

- Used modeling to determine velocity and density changes across 410 and 660
- Based models on reflected long-period seismic waves
- 410 results agree with PREM
- 660 results do not closely agree with PREM

We will see what implications this has.

Introduction

- Reflected waves give good agreement (within 1%) for discontinuity depth
- P and S wave velocities are not as precisely determined
- Velocity jumps disagree by up to a factor of 2
- Density is difficult and often based on simple scaling

Separate velocity and ρ

- Studied the behavior of reflection coefficients as a function of ray angle
- Used observed amplitudes of waves reflected off of the *bottoms* of each discontinuity
- These waves arrive as precursors to *SS & PP*
- Stacked 19 years worth of data

What was measured?

- Measured relative amplitude between reflected waves and *PP* and *SS*
- Made some corrections for time shift of each phase

A note on discontinuities

- This study used long period waves
- This precluded resolving gradients of v and ρ finite distances
- In other words, this may have made the discontinuities appear sharper than they actually are.

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For 410, the observed amplitudes

Created a model by . . .

- Combining $\Delta\alpha$, $\Delta\beta$, $\Delta\rho$
- Compared synthetic amplitudes with observations to define confidence ellipsoids
- Best fit model 410: higher v, lower ρ than PREM
- Best fit model 660 in close agreement with EK1 model: $\Delta\alpha$=2.0%,$\Delta\beta$=4.8%, $\Delta\rho$=5.2%

PREM lies within their best fit for 410, but outside there best fit for 660.

Discussion

- Modeling results assume a simple first-order change in velocity and density
- Cannot distinguish between a gradual and a sharp change

Discussion of the 410

- Density and S-velocity jumps at 410 agree with Pyrolite model of 55 % olivine and only marginally agree with piclogite model of 35% olivine
- This study proposes ~55% mantle olivine

Discussion of the 660

- Observed absence of large change in Bulk Modulus consistent with piclogite models
- Still unsure "more complete forward modeling will be required"
- Shortfall in density increase must be accompanied by increase elsewhere in the transition zone

Discussion of the 660

- Suggest 520-km (absent in PREM)
- 2 to 3% increase possible here
- Density jump is important in mantle convection
- If Clapeyron slope is negative, the 660 will resist thermally driven flow.
- Given the disagreement with PREM regarding density . . .

Discussion of the 660

- Know that buoyancy scales with density
- A 5% density contrast across the 660 boundary could be enough to preclude layered convection