



Fe Partitioning in a Pyrolite Mantle and the Nature of the 410-km Seismic Discontinuity

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Introduction

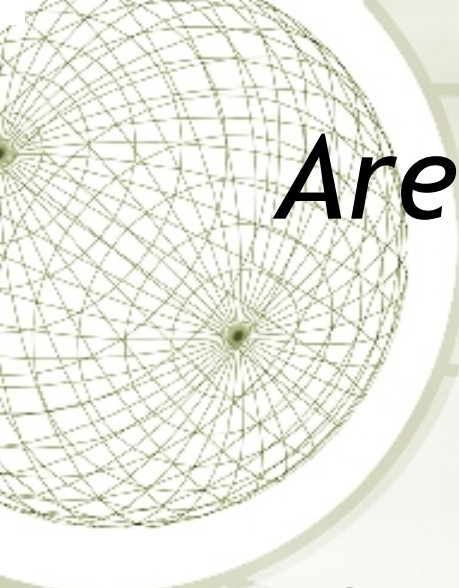
- ★ Pyrolite mixture is the model applied to the mantle
- ★ 410 km = α to β transition (13.5 GPa)
- ★ 660 γ to MgSiO_3 -rich perovskite +mv
- ★ Problem: Seismic transition is sharper than α to β
- ★ Mineral Physics Disagreement



What they did . . .

- ★ Phase equilibria study of pyrolite composition
- ★ 6-16 GPa or ~180 to 480 km
- ★ Examined the way Fe substitution for Mg changes as a function of Pressure
- ★ Found that Pyrolite model can work when Fe is taken into account

Started with both artificial pyrolite glass and natural Mg_{0.89}/Fe_{0.11} olivine
Squeezed, Heated, then quenched and x-rayed
Note: these are quenched samples



Are seismic and mineral data at odds?

- ★ Seismology suggests a transformation interval less than 3-6 km
- ★ α to β transition from experiments suggest up to ~18 km



Some explanations for the differences . . .

- ★ Metastable transformation of olivine?
- ★ Melt at the transition zone?
- ★ Trace amounts of water?
- ★ But (to this point) these studies only examined one component



Mineral Physics

- ★ Historically, fixed olivine composition used for ρ and velocity
- ★ Generally in good agreement with seismology, discrepancies arise
- ★ Mantle olivine estimated as ~30-50 vol.%
- ★ Or upwards of ~60 vol.%



Irifune and Isshiki conclude . . .

- ★ Olivine is more Mg-rich as P increases
- ★ $(\text{Mg}_{0.92}\text{Fe}_{0.8})_2\text{SiO}_4$ at 410 km depth
- ★ Modified-spinel ($\text{Mg}_{0.88-0.89}$)
after phase change



Zha et al. 1999

- ★ Bulk and Shear Moduli similar pure Mg-end member olivine and Mg#=90 olivine
- ★ True below 300 km
- ★ But they were assuming a fixed composition



For a non-isochemical olivine.

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- ★ Density (ρ) is substantially higher
- ★ This will allow for increased velocity
- ★ In turn, this requires more olivine
- ★ They propose an increase of ~4-5 vol.%

We now know that if we add more iron to olivine at high-P

V_p and V_s data show that for the alpha/beta transition of olivine, velocity jumps are smaller with increasing pressure--this also requires a larger proportion of olivine.