The post-spinel transformation in Mg_2SiO_4 and its relation to the 660-km seismic discontinuity

Shim, Duffy & Shen (2001)

Issue

- First in-situ experiment indicated transformation 2GPa lower than previously thought (~600km)
  - Implication=660 discontinuity may not be post spinel transition

Experimental Design

- Laser heated diamond anvil cell and synchrotron x-ray diffraction
- Sample Chamber (100µm x ~30µm) Contained:
  - Pure synthetic forsterite ($MgSiO4$)
  - **Platinum** (for laser absorption – heating)
  - Argon (hydrostatic pressure medium)
  - Ruby (pressure calibration)
- Temperature uncertainty ± 50 - 150°K
- Pressure uncertainty 0.3 - 0.9 GPa

Observations

- Low and Hi pressure phases coexist within a 2GPa region
- Phase boundary is defined by region in P-T space with coexisting phases
- Clapeyron Slope (-2.75 MPa/K) was taken from multi-anvil studies
- Weight assigned to points based on precision of associated P & T determination
- Phase Transition is 2.6 GPa deeper than previous results (Irifune, 1998)

Phase Diagram of Mg_2SiO_4

Image removed due to copyright considerations.

Possible Error Sources

- Temperature Uncertainty
  - Propogates to pressure through thermal-pressure term
  - 2.6 GPa = 380°K discrepancy (higher than experimental error)
- Differential Stresses are negligible
- Ruby pressure ~1.2 GPa lower but this may be attributed to position in sample chamber

Equation of State Argument

- Irifune et al. = gold
- Shim et al. = platinum
- Periclase transition is cited as evidence for both EOS and can be used to compare the two calibration methods

Periclase EOS Comparison

Image removed due to copyright considerations.

- Discrepancy is a function of Gruneisen Parameter
  - Speziale: used thermodynamic relationship
  - Jamieson: low-accuracy shock wave data

Questions

- How does thermal relaxation and thermal expansion occur? P-572 bottom left column