

Structure and Composition of the Earth's Interior (GEO4-1401)

Tentamen - 5 November 2012

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The numbers in () indicate the percentage for evaluation. No documents are allowed during the examination, but calculators are useful. Please write clearly and don't forget to indicate your name.

1. (30) There are at least 3 different arguments which indicate that compositional variations are present in the lower mantle, mostly from seismic tomography. Think of ratios of speed variations, differences in bulk sound and shear wave speed, but also density. Can you explain?
2. (20) What is your preferred model which explains data from geochemistry and geophysics? Explain why and give references to papers we read.
3. (20) From seismology we know that there are several discontinuities in the mantle. At what depth are they found and what is the reason for their existence.
4. (30)

We would like to investigate the possibility to estimate the temperature in the lower mantle using mineral physics data. At a depth of 2200 km, the pressure is 100 GPa. Laboratory measurements for some mantle assemblage, at 0 GPa and 300 K, are: $K_0 = 264$ GPa, $K' = \partial K / \partial P = 4$ and $\dot{K} = \partial K / \partial T = -0.03$ GPa/K. The equation of state is split into two parts. First the heating at zero pressure to the desired temperature T is:

$$K(T) = K_0 + \dot{K}(T - 300) \quad (1)$$

The compression at T from $P = 0$ to P is given by a simple Murnaghan equation of state.

$$K = K(T) + K'P \quad (2)$$

- (a) At a depth of 2200 km the earth model PREM which gives a value of 545 GPa for K . What is then the temperature? Is that a reasonable value?
- (b) We now put some iron in the system. The laboratory measurements show that K_0 is increased by 5% if we include 10% iron. All other parameters remain unchanged. What is the temperature now after adding 10% of iron? Is this still a reasonable value?
- (c) Based on the above, what strategy would you propose to estimate the Earth's temperature.

Good luck.