12th International Workshop on Modeling of Mantle Convection
and Lithospheric Dynamics

August 20th to 25th 2011, Döllnsee Germany

Influence of Post-perovskite Rheology on Mantle Thermal Evolution & Convective Stirring Efficiency

Henri Samuel[1] & Nicola Tosi[2,3]
[1]*Bayerisches Geoinstitut, Universität Bayreuth, Bayreuth, Germany*
[2]*Deutsches Zentrum für Luft und Raumfahrt, Berlin, Germany*
[3]*Technische Universität Berlin, Berlin, Germany*
henri.samuel@uni-bayreuth.de

Constraining the efficiency of stirring processes in the Earth's mantle is essential to the interpretation of the surface geochemical record. In such a context even the deepest parts of the Earth's mantle play a important role in erasing geochemical heterogeneities via the repeated action of stretching and folding of mantle material.
A range of geophysical and mineral physics considerations strongly support the presence of the post-perovskite (ppv) phase in the lowermost mantle. In the past years, density variations associated with this endothermic phase change have been firmly established by experiments and first principle calculations. More recent studies also point to the possibility of strong viscosity differences between the perovskite (pv) and the post-perovskite phases. The magnitude and sign however of such a pv-ppv viscosity contrast remains debated, with studies supporting the idea of a weaker ppv [1], while other suggest a stronger ppv [2].
Previous investigations have found that the ppv rheology has a first order influence on mantle dynamics and thermal evolution. Here we focus on the impact of ppv strength on the thermal-evolution and on the convective stirring efficiency, using both numerical modeling and analytical theory. Both approaches show that the ppv viscosity has a major influence of mantle stirring efficiency (see figure below).

References

[1] Amman, M., Brodholt, J., Wookey, J. and Dobson, D. (2010), First-principles constraints on diffusion in lower-mantle minerals and a weak D" layer, Nature, 465, 462-465.
[2] Karato, S. (2011), Rheological structure of the mantle of a super-Earth: Some insights from mineral physics, Icarus, 212, 14-23.

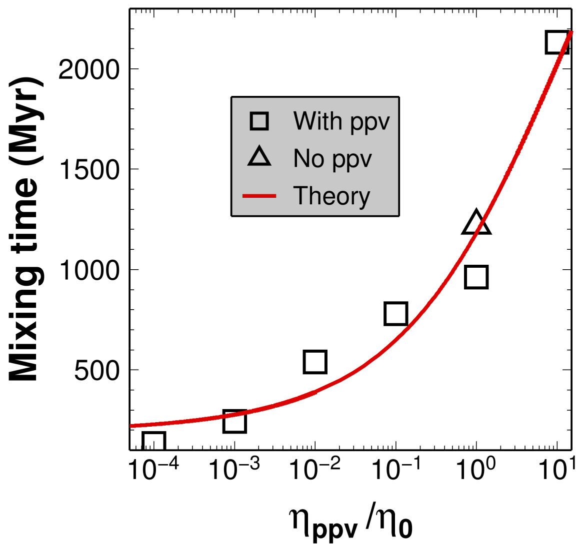

Figure 1: Mixing time as a function of the post-perovskite viscosity. Symbols: numerical experiments. Red curve: chaotic mixing model.