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Density structure of the lithospheric mantle: upscaling from minerals to peridotites

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The knowledge of the density structure of the lithospheric mantle is critical to our comprehension of tectonic and magmatic events occurring within the lithosphere and crucial to model the evolution of complex geodynamic processes (e.g., subduction dynamics, mantle plume upwelling etc). Furthermore, a thorough understanding of the density evolution at mantle conditions is essential to interpret geophysical data such as seismic tomography (e.g., Afonso et al., 2008; Stixrude and Lithgow-Bertelloni, 2012).

The density of mantle peridotites is related to chemical composition, modal abundance and elastic properties of their constituent minerals, which in turn are controlled by pressure, temperature and bulk composition of the system. Accordingly, the elastic properties of mantle minerals combined with the thermal state of the lithosphere can predict how the physical properties (e.g., density, elastic *moduli*) of mantle peridotites vary with depth. To this aim, (i) we examined the existing literature data (compressibility, thermal expansion and elasticity) suitable to constrain the elastic properties of peridotite minerals and (ii) we addressed the density structure of two potential lithospheric mantle sections (fertile and depleted) across different thermal regimes from the perspective of the Equations of State (EoS) of their constituent minerals.

In a mantle characterized by a relatively cold geotherm (45 mWm^{-2}), the density of a depleted peridotitic system remains nearly constant up to about 4 GPa, while it moderately increases in a fertile system. In a mantle characterized by a relatively hot geotherm (60 mWm^{-2}), the density of both depleted and fertile systems decreases up to about 3 GPa, due to the more rapid raise of temperature compared to pressure, and then it increases downwards.

These preliminary results show that the thermal state of the lithosphere produces a first-order signature in its density structure, with few differences owing to different modes and crystal chemical compositions.

References

Afonso, J.C., Fernàndez, M., Ranalli, G., Griffin, W.L., Connolly, J.A.D., 2008. Integrated geophysical-

petrological modeling of the lithosphere and sublithospheric upper mantle: Methodology and applications. Geochemistry, Geophys. Geosystems 9, Q05008.

Stixrude, L., Lithgow-Bertelloni, C., 2012. Geophysics of Chemical Heterogeneity in the Mantle. Annu. Rev. Earth Planet. Sci. 40, 569–595.