Seismic constraints on thermo-chemical nature of the lower mantle and on $S - to - P$ heterogeneity ratio

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We analyse our joint $V_P$-$V_S$ model $SPani$ and the data that went into it to assess the thermochemical nature of the lower mantle. Robust structural variations between $V_P$ and $V_S$ and an increase of decorrelation with depth between $\delta \ln V_S$ and $\delta \ln V_P$ in the two Large Low Shear Velocity Provinces (LLSVPs) indicate the presence of compositional heterogeneity inside the LLSVPs and compositional layering. The morphology of subducting slabs confirms the complexities recently imaged by $V_P$ models (e.g. Fukao and Obayashi 2013) and the comparison between $V_P$ and $V_S$ suggests the presence of chemical variations also in the transition zone and mid-mantle. A quantitative interpretation of chemical heterogeneity is hampered by the difficulty to provide precise estimates of the heterogeneity ratio $\delta \ln V_S / \delta \ln V_P (R_{S/P})$. For instance, the global median value of $R_{S/P} (< R_{S/P} >)$ drops from $\sim 2.8$ to $\sim 1.9$, at 2500km depth when the $V_P$ component of $SPani$ is replaced by a $V_P$ model resulting from a differently regularized inversion. Boosting the $V_P$ anomalies of 20% also drastically reduces $< R_{S/P} >$ without significantly degrading the data fit. In spite of robust decorrelations between $V_P$ and $V_S$ structure, we found that high values of $R_{S/P}$ associated with both positive and negative velocity anomalies in the lower mantle, including the two LLSVPs, are affected by noise in the model parameters and can be overestimated. Additional uncertainties in compositional effects on $R_{S/P}$ from mineral physics and in the conversion of $\delta \ln V_S$ or $\delta \ln V_P$ into density contributes to further complicate a quantitative thermo-chemical interpretation.