Geophysical Research Abstracts
Vol. 18, EGU2016-14376, 2016
EGU General Assembly 2016

Using thermodynamic data to reproduce main seismic features of transition zone

Ilya Fomin (1), Anna Saukko (2), Paul Edwards (3), and Christian Schiffer (4)

(1) ETH Zurich, Switzerland (ilya.fomin@erdw.ethz.ch), (2) Åbo Akademi University, Turku, Finland, (3) University of California, Davis, USA, (4) Aarhus University, Denmark

Most of the seismic tomography studies nowadays are based on comprehensive models with optimization of lots of parameters. These models are able to resolve very subtle features of the Earth's mantle, but the influence of each specific parameter is not seen directly. In our research we try to minimize the number of processed parameters to produce simple synthetic cases. The main goals of our model are to see how water content influences the depth of the transition zone, and if melting at the transition zone is plausible. We also attempt to see how water content and the presence of melts influence the signal strength of the transition zone in receiver functions.

Our MATLAB-code calculates phase assemblage according to specific temperature and pressure within 2D numerical domain (e.g. 300x700 km). Phase properties are calculated with database of Stixrude and Lithgow-Bertelloni [2011], with corrections for water impact on elastic constants according to Liu et al., [2012]. We use the mantle phase composition 55% garnet and 45% olivine-polymorph, soliduses by Ohtani et al. [2004] and melt properties by Sakamaki et al. [2006]. These data are used to calculate seismic velocities and, furthermore, receiver functions with standard routines (e.g.[Schiffer et al., 2012]).

Model predicts Vs within 5 to 5.5 km/s and Vp around 9.5-10 km/s within transition zone (Vp/Vs = 1.84-1.87), which is close to standard values. The presence of water enlarges the wadsleyite region, but also dampens the peak of receiver functions down to background level. Increase in water content causes melting at much shallower depths.

Using a normal thermal gradient, we can get up to 10% of melt at depths around 390 km with 80% of water saturation, shown by a negative anomaly on receiver functions. This result is similar to data obtained for Afar Plateau [Thompson et al., 2015]. With cratonic thermal gradient, the olivine-wadsleyite transition and corresponding melt layer appear at depths around 350 km. This is comparable to data by Vinnik and Farra [2007], who proposed the presence of melt-rich piles at 350 km under continental crust at several locations worldwide.

Our model also shows that in case of Moho depths close to 35 km, the Moho itself produces a multiple of receiver functions close to the 410 discontinuity. This multiple peak can affect the interpretation of the position of the real olivine-wadsleyite transition depth. It may also explain why the 410 km peak is still observed in cases with low-depth melting [Thompson et al., 2015; Vinnik & Farra, 2007], which probably should be related to the beginning of transition zone.