Single Crystal Elasticity of majoritic garnets: stagnant slabs and thermal anomalies at the base of the transition zone

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Introduction

These supplemental materials include the experimental run that produced single crystals of majoritic garnets figure (S1), a text (text S1) describing the external resistive heater designed for this study showed in figure (S2) and a text (text S2) and figure (S3) explaining how the error calibration curve has been obtained. Figure (S4) shows the sound velocities for different lithologies along a mantle adiabat of 1673K at pressures corresponding to the transition zone. The Reuss and Voigt bounds are shown for each lithology.

Text S1. External resistive heater designed in this study

An external resistive heater suitable for the piston cylinder type cells employed in this study was designed and placed around the diamonds for achieving high temperatures. The heater is fabricated from a ceramic cylinder ring with an internal diameter of 18 mm and external diameter of 20 mm and height of 5 mm (Figure S2). Grooves are made from both sides of the ceramic ring in order to accommodate the platinum (Pt) wire of 0.4 or 0.5 mm in diameter. The Pt wire is then coiled around the cylinder to form loops as shown in Figure S2. The wire is deepened into the grooves of the ring in order to provide electrical insulation since the ceramic heater is mounted in contact with the metal base of the cell. An additional protection from electrical contact is achieved by high temperature resistant cement. We use S type thermocouple wires, inserted through the drilled hole of 0.5 mm. The thermocouple and end wires of the heater are insulated with pyrophyllite tubing not visible in Figure S2 because these are inserted once the cell is mounted on the diffractomter.

Text S2. Calibration curve

Brillouin spectra collected using diamond anvil cell at different pressures and orientations have typically different signal to noise ratio, depending on the crystal optical quality and its orientation, as well as on laser focusing, sample alignment and time of collection. This results in different uncertainties on the V_s and V_p values which are then fit together to obtain the elastic constant of the material. Ideally, one should weight any data point according to its uncertainty, however since estimating the error of a single measurement is a time consuming task, normally the fitting of the V_s and V_p data are done with unit weights, a procedure which is usually followed to analyse spectra collected in air and therefore having much better quality than those collected from a DAC. In order to weight properly our data points we have estimated the uncertainty of a single measurement by measuring the same Brillouin spectrum with a given signal to noise ratio many times and we have repeated such procedure for different signal to noise ratio. We have been therefore able to calculate the standard deviations of these repeated measurements obtaining their precision. By plotting the calculated standard deviations versus the signal to noise ratio of the set of measurements we obtained a "calibration curve" (Figure S3) which gives the uncertainty in m/s of single measurements with a given signal to noise ratio.

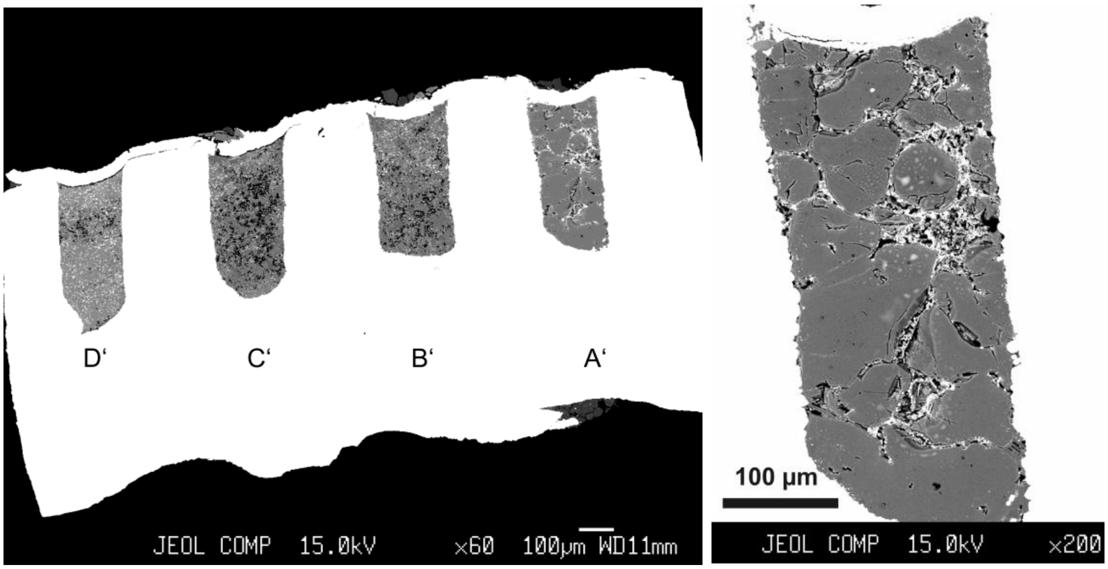

Figure S1. Backscattered electron image of the $Py_{76}Mj_{24}$ synthesis experiment performed at 17 GPa and 1900 °C. **(**left) Capsule chambers filled with starting materials containing increasing amounts of H_2O from left to right; (right) electron image of the run product obtained from mixture A' (10.56 wt. % H_2O) consisting of large single crystals of majoritic garnet.

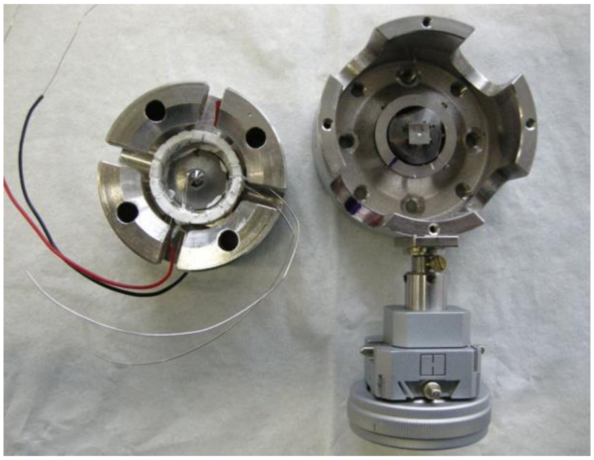

Figure S2. Electrical heater designed and developed for the piston cylinder DAC used in this study. The heater is placed in the piston part of the cell, together with the thermocouple whereas a rhenium gasket is glued in the cylinder part. The DAC is then mounted on a Huber goniometric head for the X-ray diffraction and Brillouin scattering measurements.

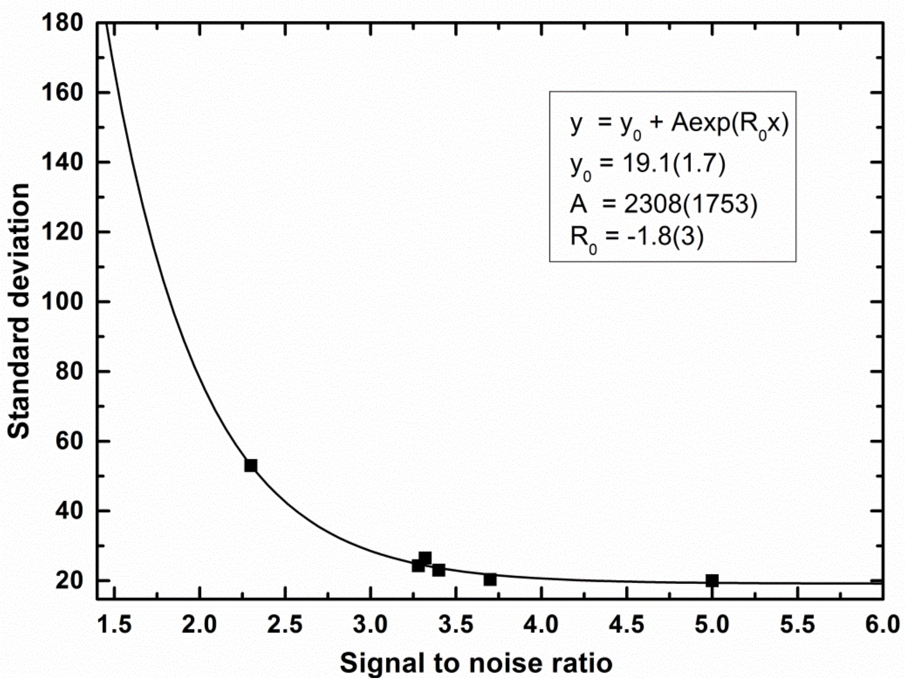

Figure S3. **“**Calibration curve” showing the exponential increase of the uncertainty of a Brillouin velocity peak as its signal to noise ratio decreases.

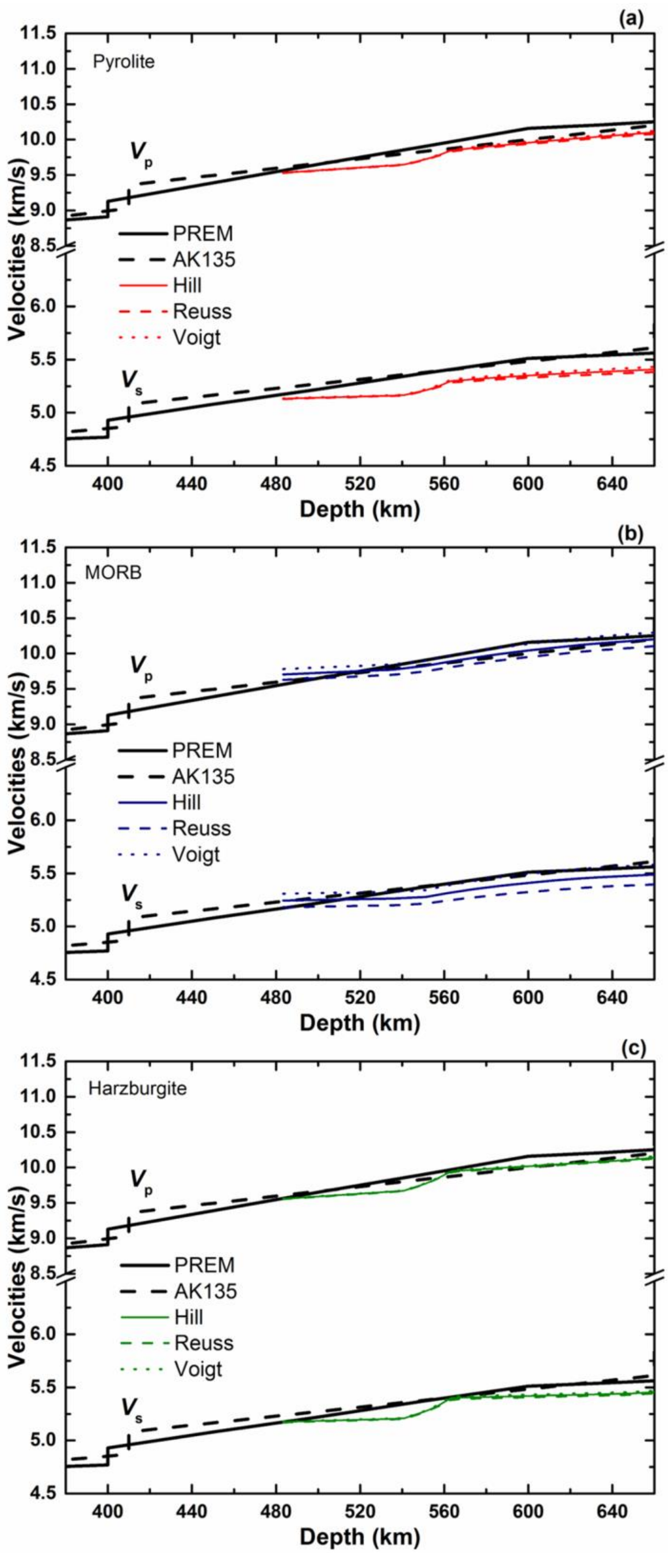

Figure S4. Sound velocities for (a) pyrolite, (b) MORB and (c) harzburgite compositions obtained from the parameters reported in Table 4 along a mantle adiabat of 1673 K at pressures corresponding to the transition zone. The solid and dashed black curves show PREM and AK135 seismic reference models, respectively. For each lithology, the coloured solid lines correspond to the Voigt-Reuss-Hill average whereas the dashed and dotted lines represent the Reuss and Voigt bounds respectively.