$MgSiO_3$ post-perovskite phase P-V-T equation of state

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The aim of this experiment was to measure the P-V-T (pressure, volume and temperature) equation of state (EoS) of $MgSiO_3$ post-perovskite phase. The results are of first importance in order to get precise information on the structure of the Earth's D'' layer, the lowermost part of the lower mantle, since this phase is now considered to be the major phase of this layer.

We used Mg_2SiO_4 forsterite as starting material. It further decomposes in $MgSiO_3$ + MgO, i.e. the phase of interest and the pressure gauge, respectively. Pt was mixed with forsterite to absorb laser radiation. The sample was then loaded in a 30 microns hole drilled in a Re gasket. NaCl was used as a pressure transmitting medium and thermal insulator. We used ID27 double sided YAG laser heating facilities to heat the sample above 1.1 megabar. Figure 1 shows the diffraction pattern quality achieved in this experiment. Notice also that the alignment of the X-ray beam on the laser hotspot was easy since it is possible on ID 27 to see the gasket fluorescence induced by the monochromatic beam, which was used to set the X-ray position.

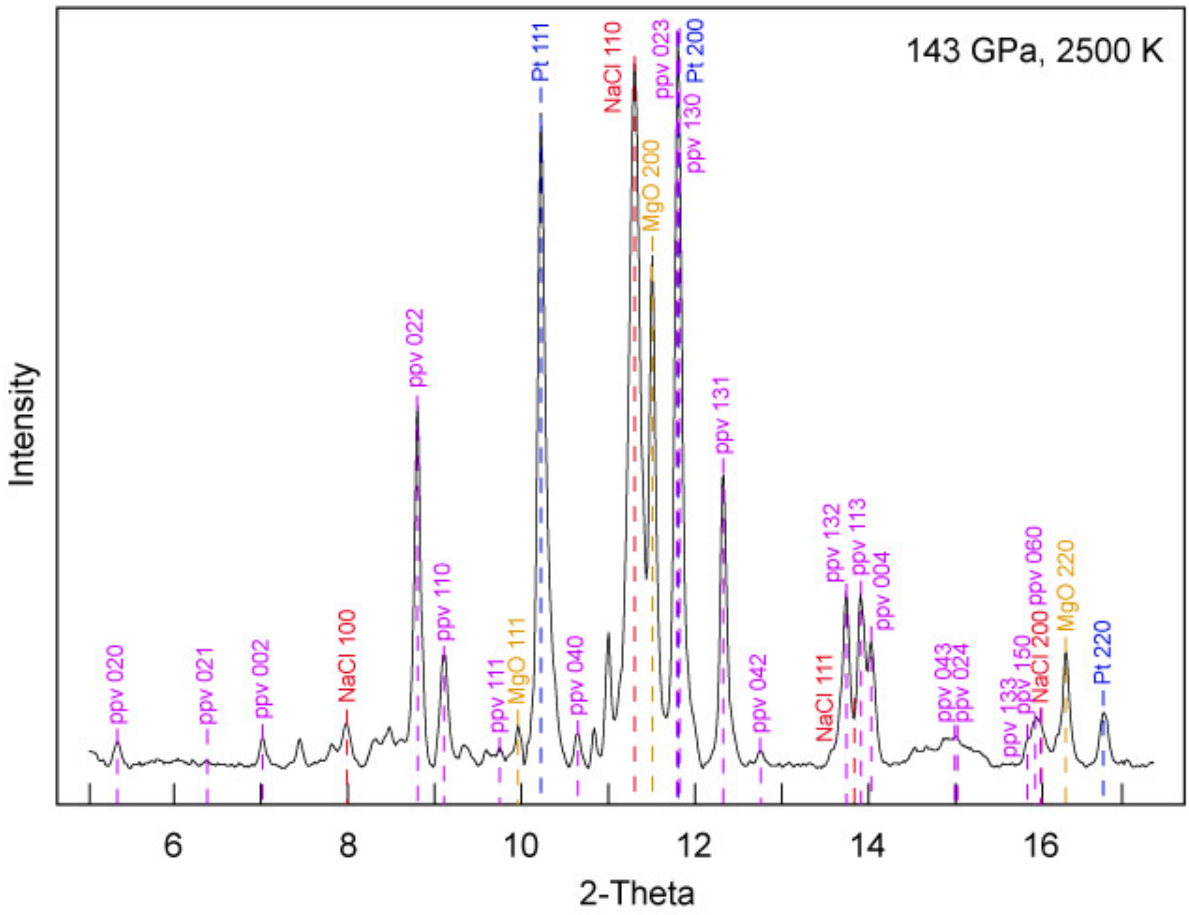

Figure 1: Diffraction pattern obtained at 143 GPa and 2500 K. Sharp peaks of every phases are easily refined. The few minor unindexed peaks probably correspond to $MgSiO_3$ perovskite phase.

The Figure 2 displays all data collected, ranging from 111.1 GPa to 148.7 GPa and 300 K to 2535 K. The data set compares well with the model published by Ono and Oganov (2005). At 300 K, the agreement is perfect. At higher temperature, the discrepancy between experimental data and model increase with temperature, which shows a significant difference in the determination of $MgSiO_3$ post-perovskite phase thermal expansion.

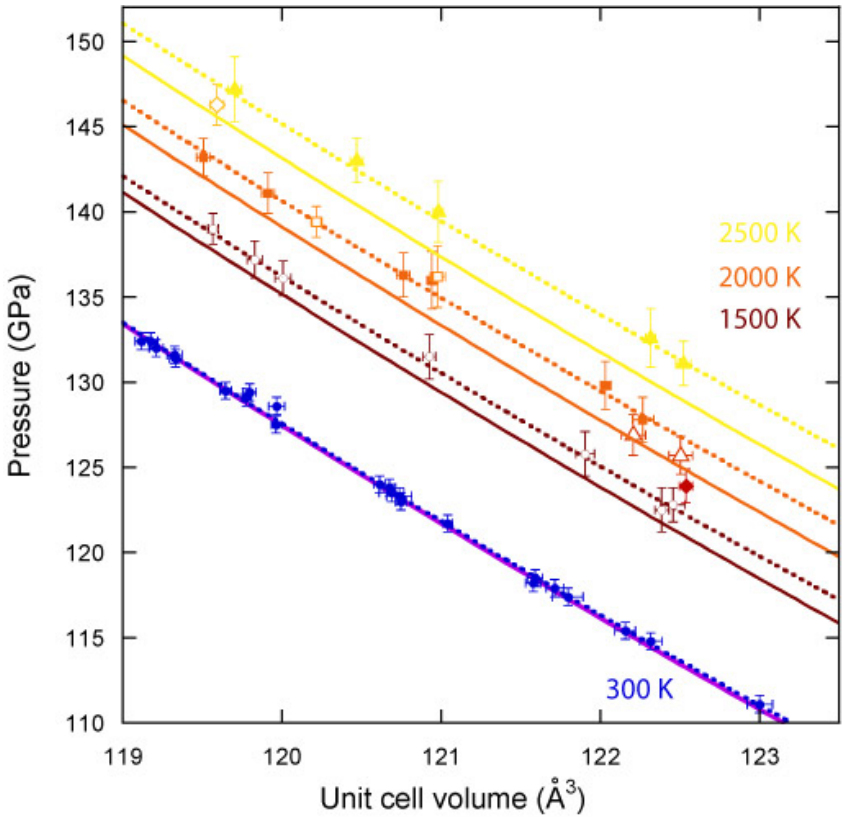

Figure 2: Experimental data (solid circles: 300 K, empty circles:1500 K, solid diamond: 1700 K, empty triangle: 1900 K, solid square: 2000 K, empty square: 2100 K, empty diamond: 2400 K, solid triangle: 2500 K). Dotted lines show the data fits at 300 K, 1500 K, 2000 K and 2500 K. Solid lines are the corresponding models from Ono and Oganov (2005).

Thanks to this study, we will soon propose new values for the bulk modulus, volume at room pressure and grüneisen parameter $\gamma(V)$. This will allow the calculation of $MgSiO_3$ post-perovskite phase density beyond the temperatures measured experimentally. We didn't have enough time to perform experiments on more complex chemistries (including Al and Fe), but we hope to do it in a next experiment.