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Pressure determination in HDAC experiments, the behavior of isochoric water-silicate systems at high pressure, and implications for melt (glass) inclusion studies

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The Hydrothermal Diamond Anvil Cell (HDAC) could be seen as a synthetic fluid inclusion, where the composition of the trapped phase(s) and the type of fluid medium are controlled by the experimentalist.
Accurate pressure determination in Hydrothermal Diamond Anvil Cell (HDAC) experiments has proven to be a complex achievement. In this study we employed in-situ visualization of the alpha-beta quartz transformation via laser interferometry for the purpose. This inexpensive and convenient method allowed for an accuracy of less than 30-40 MPa in the pressure range 130-900 MPa, which is relevant for crust and shallower upper mantle investigations.
Our experiments with water + haplogranite glass crossed into the undercooled liquid and melt state of the silicate phase, where the pressure medium contains a significant amount of solute. The principal goal of this experimental series was to compare the actual run pressure with that calculated for pure water pressure medium. We found that for runs where the alpha-to-beta transition temperature is $\leq$ 665 °C run pressure is lower than that computed for pure water. On the contrary, at 780 °C the pressure in the HDAC is 100 MPa greater than that estimated using pure water isochore.
We employed a simplified model of haplogranite dissolution in water for an isochoric sample chamber to explain the negative sign and the variation of the observed discrepancy between measured and calculated pressure. We suggest that, beyond the change in the intrinsic properties of the fluid phase (e.g., compressibility) with increasing solute concentration, two factors control the P–T path in the HDAC: (1) hydration of the glass prior to the glass transition; and (2) changing volume of the aqueous pressure medium.
The latter effects must be considered when investigating hydrothermal isochoric systems where the solid/melt phase is highly soluble in the fluid, such as in the determination of the P–T path during rehomogenization of water-rich melt (glass) inclusions. Glass hydration and solid/melt dissolution-related change of volume of the aqueous pressure medium could be as relevant as the increase of the total volume of the inclusion consequent to the expansion of the host phase on the calculation/estimate of the inclusion's homogenization pressure.