Effects of water and iron on the compressibility of silicate glasses under high pressures

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Knowledge of the density and compressibility of silicate glasses/melts is crucial to understanding the evolution of magma oceans in the early Earth and other planetary interiors. The compressibility, density, and viscosity of silicate melts are key factors that control the migration of magma in the deep mantle. In particular, the density contrast between melts and the coexisting solid phases controls the fate of subducting slabs and remnants of a deep magma ocean. Recently, synchrotron transmission X-ray microscopy (TXM) with high spatial resolution of tens of nanometers coupled with a diamond anvil cell (DAC) has emerged as a powerful technique for direct determination of the volume of an amorphous sample under high pressures. The accuracy of using nanoscale-TXM for direct pressure-volume measurements rivals X-ray diffraction of crystalline phases, which makes it an ideal approach to measure the volume (and therefore density) evolution of an amorphous sample as a function of pressure. We investigated effects of water and iron on the compressibility of silicate glasses (as analogues to silicate melts) up to 65 GPa using nanoscale-TXM. These experimental results provide insight into the evolution of deep magma oceans in the early solar system.