A multifaceted experimental approach to studying silicate liquids under high pressure

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We have developed a range of experimental techniques at GSECARS beamlines of the Advanced Photon Source (APS) to study structures and physical properties of liquids and glasses under high pressure. A Paris-Edinburgh press (PEP) is used to study structures of silicate liquids using monochromatic x-ray diffraction. A multichannel collimator (MCC) is inplemented with the PEP to minimize background scattering of the pressure media used in the high-pressure cell. Structural data have been collected at pressure and temperature conditions up to 7 GPa and 2300 K, respectively, on $MgSiO_3$, $CaSiO_3$, and $MgCaSi_2O_6$ liquids. Acoustic velocity measurements are conducted in a Kawai apparatus. Relaxed acoustic velocities of $MgCaSi_2O_6$ liquid have been measured to 4 GPa and 2400 K, to constrain equation of state for this liquid. To complement these data on liquids from the large-volume press, diamond-anvil cell experiments are conducted on glasses (supercooled liquids) to 70 GPa, using both synchrotron x-ray diffraction and micro-Raman spectroscopy. While the x-ray diffraction technique provides information on time- and volume-average atomic arrangements of liquids and glasses, Raman spectroscopy senses local atomic interactions. With the two techniques combined, more information can be extracted to understand structural response to pressure. Brillouin scattering is then used to examine unrelaxed elastic response of glasses to pressure. Such responses are then correlated with Raman spectroscopy and x-ray diffraction observations to understand the impact of pressure on structural evolution and physical properties. We will present new data on $MgSiO_3$ liquid and glass to demonstrate the power of this multifaceted approach.

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