The anomalous behavior of silicate glasses and liquids on densification: A combined X-ray tomography and diffraction study at high pressure

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At modest pressures (<10 GPa), the main structural feature of silicate glasses and liquids is the interconnected network of SiO_4 tetrahedra. Depolymerized compositions ($MgSiO_3$ – Mg_2SiO_4 pseudo binary) have anomalously high proportions of interconnected SiO_4 tetrahedra compared to the predictions based on stoichiometry (NBO/T calculations). Polymerized silicate glasses (SiO_2-$MgSiO_3$ pseudo binary) exhibit anomalous volumetric and elastic properties at high pressure and room temperature. The unusual behavior of polymerized silicate glasses on compression, where the compressibility increases or is weakly pressure dependent, is consistent with densification being controlled by network flexibility, rather than the compression of interatomic bonds as exhibited in their crystalline counterparts. What remains unknown is the pressure-temperature-composition range over which network flexibility controls densification. To this end, we will present experimental results from the newly developed RoToPEC (Rotational Tomography Paris-Edinburgh Cell) large volume press combining *in situ* X-ray diffraction and microtomography datasets at elevated pressure and temperature at ESRF and Soleil synchrotron for a suite of silicate glasses spanning the SiO_2-$MgSiO_4$ binary. Simultaneous acquisition of X-ray diffraction on a large Q-range and 3D tomography (to obtain the density of the amorphous sample) were performed under extreme conditions. We use these results to investigate the role of network flexibility and polyamorphism in the anomalous high pressure behavior and whether the densification mechanism that underlies the anomalous behavior in the glasses extends into the liquid state.