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

A.N. Clark¹, G. Morard¹, Y. Le Godec¹, N. Guignot², A. King²

¹ Institut de minéralogie, de physique des matériaux et de cosmochimie, Univ. Pierre et Marie
Curie, CNRS UMR 7590, Paris, France
² Synchrotron Soleil, CNRS UMRUR1, Gif-sur-Yvette, France

At modest pressures (<10 GPa), the main structural feature of silicate glasses and liquids is the interconnected network of SiO₄ tetrahedra. Depolymerized compositions (MgSiO₃ – Mg₂SiO₄ pseudo binary) have anomalously high proportions of interconnected SiO₄ tetrahedra compared to the predictions based on stoichiometry (NBO/T calculations). Polymerized silicate glasses (SiO₂-MgSiO₃ 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 \textit{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 SiO₂-MgSiO₄ 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.