Structure of Mg_2SiO_4 glass up to pressures of the core-mantle boundary

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The physical properties of melts at temperature and pressure conditions of the Earth's mantle have a fundamental influence on the chemical and thermal evolution of the Earth. However, direct investigations of melt structures at these conditions are experimentally very difficult or even impossible with current capabilities. In order to still be able to obtain an estimate of the structural behavior of melts at high pressures and temperatures, amorphous materials have been widely used as analogue materials.

Here we report an experimental investigation of the structural behavior of Mg_2SiO_4 glass as an analogue to peridotitic melts up to 140 GPa using X- ray total scattering and pair distribution function analysis. The very high pressure range for these measurements were enabled by the newly developed multichannel collimator (MCC) setup at GSECARS, APS.

The data clearly shows changes from 4- to 6-fold coordination of Si, which is completed around 60 GPa. Additionally we observe a change in structural behavior at around 130 GPa, close to the core-mantle boundary, visible in both, S(q) and g(r).

We will present experimental data and our accompanied molecular dynamics modelling effort to understand the structural changes at high pressures. Furthermore, we will discuss densification mechanisms of Mg_2SiO_4 glass at high pressures, and elaborate on the potential of negatively buoyant melts close to the core-mantle boundary.