Density and structure of amorphous silicates at high pressure conditions

Sylvain Petitgirard*[1], Wim Malfait[2], Ilya Kupenko[3], Christoph Sahle[4], Ines Collings[4], Christopher Weis[5], Georg Spikermann[6], Ryosuke Sinmyo[7], Eleanor Jennings[8], Ingrid Blanchard[8], Christian Sternemann[5], Max Wilke[6], and David Rubie[8]

[1]Bayerisches Geoinstitut (BGI) – Universitaetsstr. 30, 95447 Bayreuth, Germany
[2]Swiss Federal Laboratories for Materials Science and Technology (Empa) – Switzerland
[3]University of Muenster – Germany
[4]European Synchrotron Radiation Facility (ESRF) – European Synchrotron Radiation Facility – France
[5]Technische Universität Dortmund (TU-Dortmund) – Germany
[6]Univeristy of Potsdam – Germany
[7]Tokyo Institute of Technology (ELSI) – Japan
[8]Bayerisches Geoinstitut (BGI) – Germany

Abstract

Modelling the formation and evolution of the deepest parts of the Earth through time requires the densities of solids and melts to be constrained. Other properties such as the structure and viscosity of high pressure melts are also needed to undersatnd the fate of deep mantle melts.
The main parameter controlling the entrainment or settlement of matter in the lowermost mantle and the possible deep magma ocean formation is the density contrast between solid and magma. To measure the density of amorphous silicates, we have adapted the X-ray absorption method to the diamond anvil cell confinment to enable density measurements of silicate glasses to be made to unprecedented conditions of high pressure [1]. We have consequently measured the densities of SiO2 and MgSiO3 glasses up to 110 and 127 GPa, respectively. We found that the glass and melts at CMB pressure can be as dense as their counterpart solids. Recently we extended the data to iron-bearing compsoition (Mg0.7Fe0.3SiO3) to 150 GPa and we aim at forming a density model for amorphous silicate in the MgO-FeO-SiO2 system.

To understand the changes in the structure associated with such high densifictaion we measured the changes of the Si L2,3-edge and O Kedge in SiO2 glass under pressure by means of X-ray Raman scattering specrtoscopy up to 110 GPa. Together with the density measurments, we are able to give a framework for the densification of SiO2, with the appearance of a "5-fold-like" strutcure bewteen 20 and 60 GPa that accomodate the transition from 4-fold to 6-fold coordination.

These new data bring a deeper knowledge of the density, structural, polymerization and viscosity changes of silciate magmas at lower mantle pressures.

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*Speaker