ESRF	**Experiment title:** Fate of silicate melts in the deep Earth's mantle	**Experiment number**: ES-527
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Shifts: 18	**Local contact(s)**: Manfred Burghammer and Andreas Johannes	*Received at ESRF:*

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Report:

Density contrast is the main parameter that controls the entrainment or settlement of matter in the deep Earth's mantle, and is a key to understand the formation and dynamic of the deep Earth (1). However density measurements of melts at the conditions of the Earth's deep mantle are scarce due to technical challenges. To understand the buoyancy of melts at deep Erath conditions it is necessary to measure their densities relative to the one of the remaining solids. Upon melting iron partition preferably into the melt phase and the solid residue is depleted in iron. Because iron is a heavy element, it will further affect the density contrast between the liquid and solid. However there is no data on the density of iron bearing silicate magmas to the pressure of the core-mantle boundary. Using our recent method to measure the density of amorphous (glass, liquid and melts) material to unprecedented conditions of pressure (2), we have measured the density of iron bearing silicate glass $Mg_{0.7}Fe_{0.3}SiO_3$ up to 160 GPa covering the entire pressure range of the mantle.

Experimental procedure:

The iron-bearing silicate glass was prepared using an aerodynamic levitation system in Orleans. It was either grinded in powder for high pressure runs or cut in piece from a double polished plate of 20 µm thickness for low pressure runs. To allow radial access to the sample, we used 3mm diameter beryllium gaskets to seal and compress the sample to high pressure in between the diamond anvils. For low pressure runs, a piece of glass with sharp edges was cut from the double polished plate and immersed in a methanol-ethanol mixture in the Be gasket sample chambers together with a 3000ppm Cr doped ruby sphere to record the pressure using the Cr3+ luminescence R1 line shift with pressure. For high-pressure runs, the sample chamber was filled with powder only, and pressure was recorded using the Raman shift.

The measurements were performed as follow:

1- A map was made through the Be gasket to obtain the absorption of the sample
2- The DAC was rotated by 90 degrees and a second map was made to extract the path length of sample exposed in the previous map
3- The combination of both maps, i.e. absorption and path length, gives the linear absorbance of the sample which is directly linked to the density of the sample.

Preliminary results:

We measured the densities of $Mg_{0.7}Fe_{0.3}SiO_3$ glass from 0 and up to 160 GPa and the results are presented in Figure-1. At low pressure, below 10 GPa, the density increases very fast, as we observed for $MgSiO_3$ (2) and SiO_2 (3) up to 20 GPa. Above 20 GPa, the density trend decreases regularly along a smooth curve. At about 110 GPa, a further step in the data trend is observable, with a further densification of the iron-bearing glass in the lower-most mantle. The optical images of the sample show an increase in the opacity of the material becoming nearly completely opaque at 110 GPa. These two signs indicate a major change in the electronic structure of the glass probably related to a spin transition in iron.

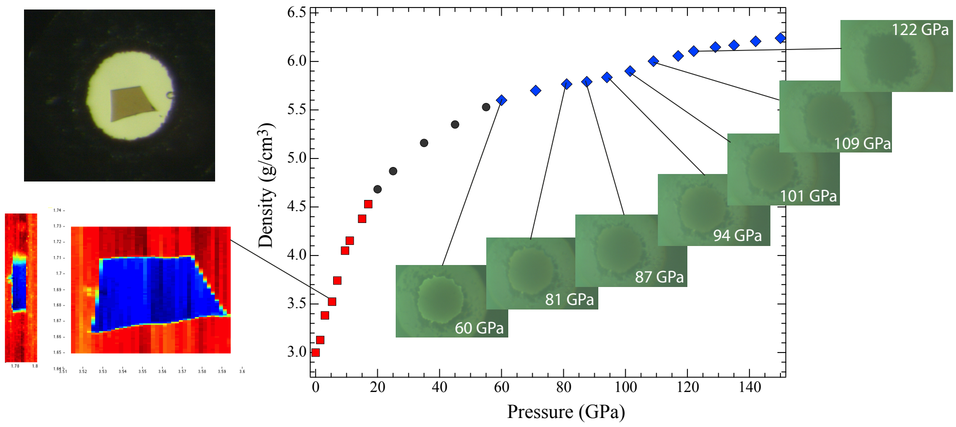

Figure 1. $Mg_{0.7}Fe_{0.3}SiO_3$ glass density as a function of pressure. Colors indicate the different individual loadings. Red points were preformed in methanol-ethanol. For Dark and blue points, the sample was loaded as a powder filling the sample chamber.

References:

1. Labrosse S, Hernlund J, Coltice N (2007) A crystallizing dense magma ocean at the base of the Earth's mantle. Nature 450(7171):866–869.

2. Petitgirard S, et al. (2015) Fate of MgSiO3 melts at core-mantle boundary conditions. Proc Natl Acad Sci U S A 112(46):14186–14190.

3- Petitgirard S, et al. (2017) SiO_2 glass density to lower-mantle pressures. PRL, 119, 215701