ESRF	**Experiment title:** Density of iron-bearing melts in the early Earth's mantle	**Experiment number**: ES-595
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Shifts: 15	**Local contact(s)**: Marine Cotte	

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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. Recently we have implemented a new method to measure the density of amorphous (glass, liquid and melts) material to unprecedented conditions of pressure (2). During this beamtime we implemented the technique on ID21 beamline and made considerable steps forward to improve data quality and acquisition time. Indeed the sub-micrometer beam (0.3x0.6 µm) at a low energy of 8.5 keV combined with fast piezo-stage enable considerable gain: i) in spatial resolution, ii) in absorption contrast and iii) in time per pressure point (up to 4 times faster). These tremendous developments allow us measuring more data than the previous beamtimes, instead of one composition; we could measure four compositions in one session.

During beamtime ES-595, we measured a baslat composition, a iron silicon bearing glass $Mg_{0.7}Fe_{0.3}SiO_3$, a quartz sample throught the amorphization transition, a carbonatitic glass and we complemented previous data on SiO_2 (3).

Experimental procedure:

The basaltic and iron-bearing silicate glass were prepare using an aerodynamic levitation system in Orleans. They were 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 basaltic 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 slowly to 5 GPa and then increases very sharply to 10 GPa. Above 10-15 GPa, the density trend decreases regularly along a smooth curve. At about 110 GPa, a further step in the data trend may be observable, which would indicate a further densification of the basalt composition in the lower-most mantle. The other compositions are also under evaluation and we expect several publication form this very fruitful beamtime.

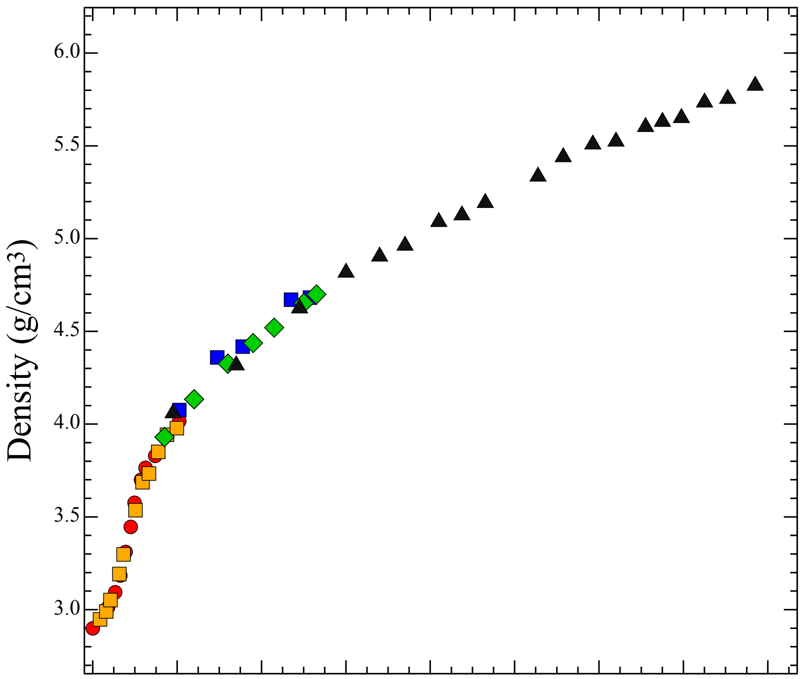

Figure 1. Basaltic glass density as a function of pressure. Colors indicate the different individual loadings. Orange and red were preformed in methanol-ethanol. Green, blue and black the sample was loaded as a powder filling the sample chamber.

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. In review.