



	Experiment title: Structural changes in a natural basalt glass at high-pressure by means of X-ray Raman Scattering (XRS)	Experiment number: ES-777
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Names and affiliations of applicants (* indicates experimentalists): Petitgirard Sylvain*, Bayerisches Geoinstitut, Bayreuth, Germany Spiekermann Georg*, Universitaet Potsdam, Potsdam, Germany Albers Christian*, Technische Universitaet Dortmund, Dortmund, Germany Sakrowski Robin*, Technische Universitaet Dortmund, Dortmund, Germany Sternemann Christian*, Technische Universitaet Dortmund, Dortmund, Germany Wilke Max*, Universitaet Potsdam, Potsdam, Germany		

Report:

Scientific Background

Basalt is one of the most common products of mantle melting on the Earth's surface and compose most of the oceanic lithosphere. It is then recycled in subduction zones from the surface down to the mantle. Seismic tomography highlights the subducted slab to stagnate at the transition zone (interface between upper and lower mantle at 660 km depth) or the possibility to even penetrate in the lower mantle down to the deep mantle. Because these rocks can contain some amount of water and volatiles (up to 1%), their melting temperature is relatively lower compared to the surrounding dry mantle, and could be the main source of partial melting at the core-mantle boundary (CMB) [4], at the transition zone [5], at subduction zones [6] or at the lithosphere-asthenosphere-boundary (LAB) [7]. To better understand the fate of basaltic melt at depth, knowledge on the degree of depolymerisation and coordination environment of melts can help to constrain their viscosity and mobility at high pressure.

To elucidate the role of cation network modifiers and their influence on the local environment of light elements in high-pressure melts, we measured the near edge absorption structure using X-ray Raman scattering signal of the Si L-edge, Ca L-edge and O K-edge in a natural basalt glass up to 35 GPa.

Experimental procedure

A natural mid-ocean ridge basalt (MORB, from Norwegian see) glass (composition: SiO₂ 52.8%, MgO 7.2%, Al₂O₃ 14.6%, CaO 11.1%, FeO 10.7%, Na₂O 2.6%, TiO₂ 1.4%) was re-sintered in a levitation set up in Orleans. It was then ground in a powder and loaded without pressure transmitting medium in a BX90 Diamond Anvil Cell equipped with miniature diamonds. Using the large opening angle of the DACs, it was then possible to use at three

Si(660) analyser arrays of the XRS spectrometer installed at ID20 in both the forward and backward geometry respectively, for a total of 36 crystals out of 72. We collected the absorption spectra for three different edges of the sample: Si L-edge, Ca L-edge and O K-edge up to 35 GPa.

Preliminary results

Here, we present the preliminary results for the Ca L-edge up to 35 GPa (Figure-1). For the first time we collected data on three different edges at the same time and beyond 20 GPa for Ca L-edge with an energy resolution of 0.7 eV. From the analysis of the Ca L-edge we observe a smooth decrease with pressure up to 30 GPa and a sudden change at 35 GPa. To understand the evolution of the structure and compaction mechanism we need to complement measurements at higher pressure to characterise and confirm these changes most probably related to a coordination evolution in the glass.

To understand the compaction mechanism of the amorphous phase relative to the crystalline phase, we will also measure the reference crystal that show the main form of coordination at ambient conditions but also under pressure to follow their absorption edge features and compare with the amorphous phase.

Our XRS data collected so far will be compared with calculations utilizing the OCEAN code on basis of MD simulations and will shade a new light on the structural changes that occur in amorphous silicate networks at high pressure.

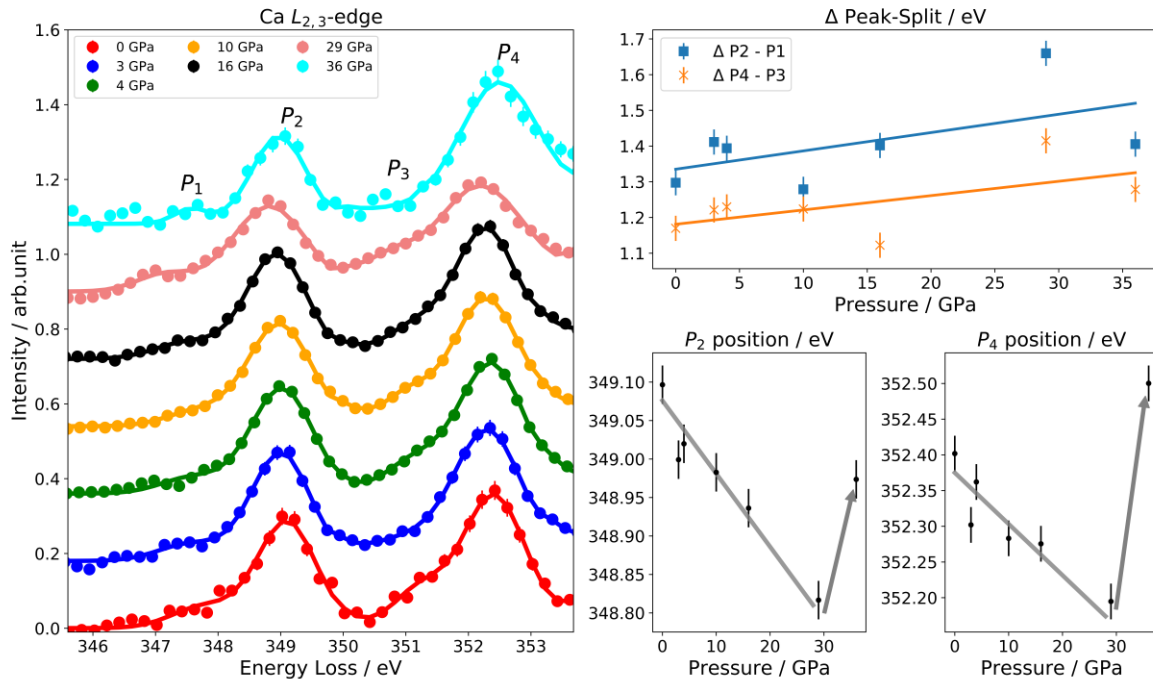


Figure 1. Results for the Ca $L_{2,3}$ edge. On the left side, collected spectra of the amorphous phase under pressure. Right side, data evaluation with on top the splitting between the two main peak and bottom the evolution of the peak position as a function of pressure.

