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In situ insights to Se (S) partitioning between silicate and metallic melts at extreme conditions

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The Earth's core mainly consists of a metallic Fe-Ni mixture. However, seismic observations show that the density is about 5-10% lower than expected for an Fe-Ni alloy under similar pressure and temperature conditions (e.g., [1,2]). This discovery initiated numerous studies to identify and quantify light elements in the Earth′s core. Among others, sulphur has been suggested to be a promisingly candidate to alloy with the metallic core because of its depletion in the crust and the mantle relative to other volatile elements by several orders of magnitude (e.g., [3-5]). In the last decades, several experimental studies have aimed to quantify the sulphur content in the Earth's core and to determine its influence on the physical properties (e.g., [6]). However, experimental data on sulphur partitioning between silicate and metallic liquids at pressures and temperatures relevant for core-mantle boundary conditions are missing. This lack is due to pressure and temperature limitations of conventional experimental approaches (up to 25 GPa and 2200 K). New developments, like laser-heated diamond-anvil cells (LDAC), allow studies at core-mantle boundary conditions, but in-situ chemical analysis of sulphur in LDACs is impossible due to the high absorption of S fluorescence in the diamonds. Instead of sulphur, selenium can be used to model sulphur partitioning between silicate and metallic melts at elevated PT conditions. This is based on the fact that sulphur and selenium can be considered as geochemical twins ([7,8]). The main advantage of this approach is the much higher excitation energy of selenium compared to sulphur, which enables in-situ XRF analysis in LDACs.
Here, we present preliminary data on Se partitioning between silicate and metallic melt at extreme conditions. The experiments have been performed in double-sided laser-heated LDACs at the high pressure beamlines P02.2 (DESY, Germany) and ID27 (ESRF, France) as described in [9]. Micro-XRF mappings are used to visualise changes of the Se distribution before and after laser heating. Micro-XRD is used to determine the experimental pressure, the onset of melting and also provides information on distribution of high-pressure / high temperature phases (XRD map). In order to fully apply the observed in-situ Se results to the S partitioning, the recovered samples will be additionally analysed ex-situ for Se and S by XRF, EMP, and HRTEM. This will also set constraints on the effect of quenching.

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