Synthesis of iron-rich silicates under the P-T conditions of the lower mantle

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Iron-bearing bridgmanite (Mg,Fe)SiO_3 is the most abundant mineral in the Earth's lower mantle. High pressure and high temperature experiments have been conducted to explore the thermal stability and phase relations in the $MgSiO_3$-$FeSiO_3$ system[1, 2, 3, 4]. However, there has long been a controversy about the existence of pure iron-silicate phase in the lower mantle. Here we employed a laser-heated diamond anvil cell (LH-DAC) to study the phase relations in the FeO-SiO_2- and MgO-FeO-SiO_2- H_2O systems under the conditions of the lower mantle, and to understand the role of water in this system.

We have carried out some high pressure-temperature (*P*-*T*) experiments between 40~95GPa, 2000~2500K. Under the conditions of 45GPa and 1900K in the system Fe_2O_3-SiO_2-H_2O, we found almost all the hematite transferred into the high-pressure phase of magnetite (HP-Fe_3O_4, space group: *Bbmm*). With increasing P-T conditions to 95GPa and 2500K, only FeO was identified. In all runs, SiO_2 existed as an individual phase, stishovite or $CaCl_2$-type structure phase and we did not synthesize an iron-rich silicate yet. Future experiments will be carried out in the systems FeO-SiO_2-H_2O and MgO-FeO-SiO_2-H_2O using laser-heated diamond anvil cells at 40~100 GPa and 2000~3500 K. The amount of H_2O in the system can be controlled by using SiO_2 gel containing 2wt.% H_2O. Water can produce an oxidized lower mantle region through redox reactions between water and iron/iron oxides, i.e., $4FeO + 2H_2O = FeH + 3FeOOH_x$ (py-phase) [5]. Through this study, we aim to synthesize pure iron-rich silicates under hydrous lower mantle conditions. The results will be of primary relevance for composition and dynamics of the lower mantle.

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