Preliminary results on in situ X-ray observations of the spinel-postspinel transformation in a pyrolite composition

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We have tested performance of a new high-pressure cell for multi-component systems in order to define the spinel-postspinel phase boundary in realistic mantle compositions, using a combination of white X-ray at BL04B1 and a multi anvil system, SPEED-1500. Anvil truncation of 2.5 mm (TEL=2.5 mm) was adopted to cover higher pressures than previously obtained in our experiments with carbide anvils of TEL=3.0 mm. As the anvil gap became smaller according to the smaller gasket size, we introduced a new configuration for the furnace assembly.

Pyrolite starting material, which was previously used in a systematic study based on quench experiments, was used in the present study. In these quench experiments, metal capsules were used to seal the sample to avoid contamination from the surrounding pressure medium and also to prevent reduction of Fe^{2+} in the sample by the highly reducing heating element, whereas in the present cell for in situ X-ray diffraction measurements, only a molybdenum foil was placed between the sample and the heater.

Some preliminary quench runs were made to estimate the P/T conditions of the postspinel phase boundary using the new cell and SPEED-1500 during off-beamline time. The results of these experiments demonstrated that the nature of the phase transformations in pyrolite is consistent with the author's earlier results. Moreover, the oxygen fugacity seemed to be maintained in an expected range, as we didn't see any evidence of the presence of metallic iron in the sample.

During the assigned beam time, we were able to see the formation of the postspinel phase at a temperature of 1600℃ and pressures about 24 GPa by in situ X-ray diffraction measurements. Temperature and pressure were stably kept for one hour without any failure in the heating system and the thermocouple, and we confirmed that the present cell is indeed suitable for the experiments with multi-component systems. Although we were unable to constrain the postspinel phase boundary due to the very limited beam time, further additional runs are currently pursued in this direction.

In addition to these experiments on the postspinel transformation, we made one in situ X-ray diffraction run with a $(Mg_{0.5},Ca_{0.5})SiO_6$ diopside composition to see the nature of the formation of perovskites in diopside at pressures greater than 20 GPa.