In-situ x-ray diffraction study of an unquenchable high pressure phase in strontium silicates

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It is known that some of the high pressure minerals exhibit an extraordinary instability at atmospheric pressure, where the minerals convert to an amorphous state even at room temperature. It was so called unquenchable phase in the category of the high pressure polymorphs. The one of the typical unquenchable phases appears in a CaSiO3 composition to be a dense cubic perovskite structure. The existence only can be confirmed by in-situ observations under high pressure. Since the perovskite is the one of the most important constituent minerals in the Earth, the study on such an unquenchable perovskite is significant for understanding the Earth's interior as well as the systematic in the perovskite structure. The element of strontium belongs to same group as the calcium. In addition, the ambient phase is a pseudo wollstonite similar to the wollastonite in the CaSiO3 composition. Recent study, Akaogi et al. (2003) reports the possibility of an unquenchable phase in the SrSiO3 composition, basing on evidence of the amorphous SrSiO3 phase recovered from high P-T experiments above 20 GPa using a multi anvil apparatus. Hence, in this study, we have tried to make an in-situ x-ray diffraction study under high pressure to illuminate the high pressure unquenchable phase in SrSiO3.

The experiments have been done using a high brilliance x-ray source from a synchrotron radiation facility at SPring-8. The beam line (BL-10XU) equips with a laser heating system to conduct high P-T experiments using a diamond anvil cell. The angle dispersive x-ray diffraction rings detected by the area detector of an imaging plate or an x-ray CCD detector provide a high precision of d-values as well as intensity data. The energy of the incident beam is 30 keV which is suitable for strontium bearing compounds. The starting sample was prepared as a powdered mixture of the pseudo wollastonite and platinum powder (0.3 wt %), which works as an absorption material for the laser wavelength. The sample was compacted in a hole of a stainless or a rhenium gasket together with a few grains of ruby chips for a pressure measurement. After the compression up to 35 or 40 GPa, the sample was heated at about 1500 degree C. The temperature was determined by the fitting the emitted lights to a gray body radiation function. The refractive index of the heated area exhibits a higher than the unheated one. Moreover, the pressure relaxation, which is 25 % decrease of pressure, takes place after the heating. These evidences suggest that a dense phase formed at the heated spot. The x-ray diffraction was collected from the heated spot using a thin collimator of 20 micron in diameter. We have also taken an x-ray pattern from an unheated sample as comparison. Interestingly, it shows an amorphous halo-like pattern except for diffraction lines of platinum and thus can be explained by a pressure induced amorphisation. The new peaks obtained from the heated area can be indexed by an orthorhombic phase, which has lattice parameters of a=6.2103(5), b=4.3889(3), c=4.1386(4). The structure could be a perovskite structure on the account of the similarity to the CaSiO3 phase. The phase also changed to an amorphous halo after releasing the pressure to ambient condition. It corresponds to the amorphous phase obtained by Akaogi et al. (2003). We are making a further analysis and a refinement of the crystalline structure. The volume change between low and high pressure phase and a systematic interpretation in the perovskite structure will be given at the session.