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Phase transition of Mg1.8Fe0.2Si2O6 orthopyroxene by in-situ high-temperature X-ray experiments

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Pyroxene is one of the most important rock-forming minerals not only for its abundant occurrence but also for various paragenesis which provide information on the thermal history of pyroxene-bearing rocks. In the system Mg2Si2O6-CaMgSi2O6, there had been the controversy about the appearance and stability of the orthopyroxene (Opx) phase near 1400 C other than protopyroxene (Ppx) since the discovery by Foster and Lin (1975). In recent years, Ohi et al. (2008) observed the phase transition between low-temperature Opx (LT-Opx) and high-temoperature Opx (HT-Opx) at 1170 C during both heating and cooling processes by high-temperature X-ray diffraction (HT-XRD) experiments for the composition of (Ca0.06Mg1.94)Si2O6. They concluded that Opx the phase near 1400 C was HT-Opx. Ohi et al. (submitting) observed the phase transition between LT-Opx and Ppx at 1000 C and the metastable phase transition between LT-Opx and HT-Opx at 1130 C by high-temperature experiments for the composition of Mg2Si2O6. They showed that the transition temperature were raised with increasing Ca contents. In pyroxene quadrilateral, Opx contain a little amount of Ca and have the composition between Mg2Si2O6- Fe2Si2O6 solid solution. The purpose in present study is to research the transition temperature between LT-Opx and HT-Opx toward Fe contents.
The natural Opx (Mg1.8Fe0.2Si2O6) from morogoro, Tanzania was used as the starting material for HT-XRD experiments. HT-XRD experiments were performed by using a multiple-detector system of Toraya et al. (1996) with a compact furnace of Yashima t al. (2005, 2006) at the BL-4B2 beam line of the Photon Factory (PF), High Energy Accelerator Research Organization (KEK) in Tsukuba, Japan. Two series of HT-XRD experiments with two heating programs (Run-1?2) were carried out at atmospheric pressure. In Run-1, the diffraction experiments were performed a 25, 500, 900, 1000, 1050, 1100, 1200 and 1300 C during heating. In Run-2, the diffraction experiments were performed at 960, 1000, 1040, 1060, 1080, 1100, 1120, 1140 1160 and 1180 C during heating and 1140, 1120, 1100, and 1080 C during cooling.
X-ray diffraction patterns showed that LT-Opx with the composition of Mg1.8Fe0.2Si2O6 changed to HT-Opx at 1130 C and a part of HT-Opx changed to Ppx at 1170 C. While the transitions from LT-Opx to HT-Opx and HT-Opx to Ppx, a and c dimensions and volume jump to the higher value while b dimension jump to the lower value.
The transition between LT-Opx to Ppx with the composition of Mg1.8Fe0.2Si2O6 was not observed below 1130 C, which is the transition temperature between LT-Opx to HT-Opx. Therefore, the transition temperature of LT-Opx to Ppx is higher than 1130 C. The transition temperature of LT-Opx to Ppx with the composition of Mg2Si2O6 was about 1000 C. The transition temperature of LT-Opx to Ppx may be raised with increasing Fe contents. This corresponds to the phase diagram in Mg2Si2O6- Fe2Si2O6 system given by Huebner (1980). Both transition temperatures between LT-Opx to HT-Opx with the composition of Mg2Si2O6 and of Mg1.8Fe0.2Si2O6 was about 1130 C, hence the transition temperature change little with increasing Fe contents.
The metastable transition between LT-Opx to HT-Opx with the composition of Mg2Si2O6 was occured in Ppx stability field. On the other hand, that with the composition of Mg1.8Fe0.2Si2O6

was occured below the transition temperature to Ppx, hence the transition between LT-Opx to HT -Opx in present study was occured in LT-Opx + HT-Opx fields.

Keywords: orthopyroxene, high temperature in-situ x-ray experiments, enstatite-ferrosilite system, phase transition