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High temperture phase transition in the system $KAlSiO_4-MgAl_2O_4$

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Oceanic basalt which consist of upper part of the oceanic plate is rich in aluminum component, compared with average mantle rock, and transforms into an assemblage including aluminum-rich phase under high temperature and high pressure. Moreover, some aluminum phases are considered to contain alkaline elements, and are related to behavior of alkaline elements in the lower mantle. It was found that Hexagonal phase (Hp) is formed in the system $CaAl_2O_4-MgAl_2O_4$ at the mole ratio of 1:2 and in the system $NaAlSiO_4-MgAl_2O_4$ at the mole ratio of 1:1 (Akaogi et al., 1999). Moreover, it is thought that Hp is a candidate of aluminum-rich host phase containing the alkaline elements in the lower mantle (Miyajima et al., 2001). We have done high temperature and high-pressure experiment in the system $KAlSiO_4-MgAl_2O_4$ for better understanding of behavior of the alkaline metal in the mantle.

A 6-8 type multi-anvil apparutus at Gakushuin University was used for high temperature and high-pressure experiments. Tungsten carbide anvils with truncated edge length of 2.5mm were used. Rhenium foil was used for the heater and tungsten-rhenium thermocouple was used. Experiments were performed in the temperature range of 1200 to 1500 degrees C, and in the pressure range of 15 to 23GPa. In all of the runs, a sample was held at desired pressure-temperature conditions for 1 to 4 hours then was quenched. Recovered run products were characterized by using a X-ray diffractometer.

Starting materials for high pressure experiments were prepared as follows. $KAlSiO_4$ was synthesized from a mixture of high purity reagents of K_2CO_3, Al_2O_3, SiO_2 in the mole ratio 1:1:2 by heating at 1050 C for 24 hours, and $MgAl_2O_4$ was synthesized from a mixture of high purity reagents of MgO, Al_2O_3 in the mole ratio 1:1 by heating 1500 C for 24hours. Starting materials for high pressure experiments were mixtures of $KAlSiO_4$ and $MgAl_2O_4$ in the mole ratios 1:0, 1:2, 1:3 and 1:1. Moreover, in order to enhance reactivity, $KAlSiO_4$ was synthesized from a mixture of K_2CO_3,$Al(NO_3)_2$-$9H_2O$,$(C_2H_5O)_4Si$ in the mole ratio 1:1:2, and $KMg_2Al_5SiO_{12}$ was synthesized from a mixture of K_2CO_3,MgO,$Al(NO_3)_2$-$9H_2O$,$(C_2H_5O)_4Si$ in the mole ratio 1:4:10:2, by using sol-gel method. After drying, they were heated at 700 C.

It was found that $KAlSiO_4$ disproportionate into $KAlSi_3O_8$ hollandite and an unknown phase X. For the mixture of $KAlSiO_4$ and $MgAl_2O_4$ in the mole ratio 1:2, It was found that Hp is stable at pressure range of 17.5GPa to 23GPa at 1500 C and that Hp disproportionates into corundum, spinel, and an unknown phase Y below 17.5GPa. Moreover, in the mixture of $KAlSiO_4$ and $MgAl_2O_4$ in the mole ratio 1:3 and 1:1, Hp was found to form with additional phase. Therefore, we concluded that composition range of Hp is narrow.