# High-pressure phase relations of K-bearing NAL phase with implications to aluminosilicate inclusions in superdeep diamonds in kimberlites

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It is widely accepted that mineral inclusions in diamonds in kimberlites provide important information on mantle-constituent minerals and dynamic processes of subducted materials in the mantle, as shown by recent discovery of hydrous ringwoodite and $CaSiO_3$ perovskite as inclusions in diamonds. Walter et al. (2011) and Thomson et al. (2014) reported that some composite inclusions found in diamonds in the Juina kimberlite of Brazil had compositions close to those of hexagonal aluminous (NAL) phases which are accepted as major aluminous phases in subducted basalt in the lower mantle conditions. Experimental studies indicated that NAL phase is a candidate of K-host mineral in the deep mantle. In this study, we have examined phase relations in the system $KAlSiO_4$-$MgAl_2O_4$ at high pressure and high temperature. Based on the experimental data, we discuss stability of K-bearing NAL phase at high pressure and transport processes of the diamonds containing the mineral assemblages of the NAL phase compositions. The high-pressure and high temperature experiments were performed using multianvil apparatus. As the starting materials, mixtures of synthetic $MgAl_2O_4$ spinel and $KAlSiO_4$ gel were used. phase relation experiments were made at 5-28 GPa and 1200-1500 ˚C. The results indicate that the NAL phase is stable above 16 GPa at 1500 ˚C in a range of about 60-65 mol% $KAlSiO_4$ in the system $KAlSiO_4$-$MgAl_2O_4$. At lower pressures, $MgAl_2O_4$ spinel, corundum, pyrope and $K_2Mg_2Si_2O_7$-rich phase X are stable at ~8-16 GPa, and $KAlSiO_4$ kalsilite and $MgAl_2O_4$ spinel are stable below ~8 GPa. Based on these results, we suggest possible origin and transportation processes of the kimberlitic diamonds containing the composite inclusions of kalsilite and spinel, as follows. NAL phases with approximate compositions in the system $(K,Na)AlSiO_4$-$MgAl_2O_4$ were trapped in the diamonds during the growth in the lower mantle, then were transported to depth range of about 150-210 km where kalsilite and spinel crystalized in the diamonds, and the diamonds were finally transported rapidly to the earth’s surface by the kimberlite volcanism.

Keywords: high pressure, NAL phase, phase transition, diamond inclusion, kimberlite

 