The effect of potassium on the stability of NAL phase in the lower mantle

Chie Kato\textsuperscript{1,}\textsuperscript{*}, Kei Hirose\textsuperscript{1}, Tetsuya Komabayashi\textsuperscript{1}, Haruka Ozawa\textsuperscript{2}, OHISHI, Yasuo\textsuperscript{3}

\textsuperscript{1}Tokyo Institute of Technology, \textsuperscript{2}JAMSTEC, \textsuperscript{3}JASRI

High-Pressure (P) and high-temperature (T) experiments were conducted at $P = 33$ to 144 GPa and $T = 1,800$ to 2,700 K in order to examine phase relations on the join Na\textsubscript{1.00}Mg\textsubscript{2.00}Al\textsubscript{4.80}Si\textsubscript{1.15}O\textsubscript{12} - K\textsubscript{1.00}Mg\textsubscript{2.00}Al\textsubscript{4.80}Si\textsubscript{1.15}O\textsubscript{12}. Stable phases were identified in-situ at high $P$-$T$ in a laser-heated diamond-anvil cell (DAC), based on synchrotron X-ray diffraction measurements. The results show that K-rich new aluminous (NAL) phase forms continuous solid solution on the join Na\textsubscript{1.00}Mg\textsubscript{2.00}Al\textsubscript{4.80}Si\textsubscript{1.15}O\textsubscript{12} - K\textsubscript{1.00}Mg\textsubscript{2.00}Al\textsubscript{4.80}Si\textsubscript{1.15}O\textsubscript{12} at 30 GPa. And, NAL is formed as a single phase up to the lowermost mantle conditions in both Na\textsubscript{0.75}K\textsubscript{0.25}Mg\textsubscript{2.00}Al\textsubscript{4.80}Si\textsubscript{1.15}O\textsubscript{12} and K\textsubscript{1.00}Mg\textsubscript{2.00}Al\textsubscript{4.80}Si\textsubscript{1.15}O\textsubscript{12} compositions. On the other hand, single-phase NAL is found only to 100 GPa at 2,500 K, and NAL coexists with calcium-ferrite type (CF) phase at 120 GPa and 2,300 K in Na\textsubscript{0.75}K\textsubscript{0.25}Mg\textsubscript{2.00}Al\textsubscript{4.80}Si\textsubscript{1.15}O\textsubscript{12}. Considering the NAL phase with Na\textsubscript{1.00}Mg\textsubscript{2.00}Al\textsubscript{4.80}Si\textsubscript{1.15}O\textsubscript{12} composition is stable only up to 45 GPa at 1,850 K, these results clearly indicate that the presence of potassium drastically expands the stability $P$-$T$ field of NAL. In addition to hollandite, the NAL phase should be an important host of potassium in the deep lower mantle, formed in K-rich materials such as subducted continental crust.