

Complete solid-solution between $\text{Na}_3\text{Al}_2(\text{PO}_4)_3$ and $\text{Mg}_3\text{Al}_2(\text{SiO}_4)_3$ garnets at high pressure

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ABSTRACT

Syntheses along the $\text{Mg}_3\text{Al}_2(\text{SiO}_4)_3$ - $\text{Na}_3\text{Al}_2(\text{PO}_4)_3$ join were carried out in the 15–17 GPa range at temperatures between 1200 and 1600 °C. An $\text{Na}_3\text{Al}_2(\text{PO}_4)_3$ compound of garnet-like structure, with a cubic-cell parameter of 11.579(2) Å, was synthesized and characterized. Intermediate compositions are also found to crystallize in the garnet structure. Between pyrope and $\text{Na}_3\text{Al}_2(\text{PO}_4)_3$, the cubic unit-cell volume increases by 3.1%. In addition, nominal compositions, $\text{Mg}_{2.5}\text{Na}_{0.5}\text{Al}_2\text{Si}_{2.5}\text{P}_{0.5}\text{O}_{12}$ and $\text{Mg}_2\text{Na}_1\text{Al}_2\text{Si}_2\text{P}_1\text{O}_{12}$, were run at 3 GPa and 875 °C. They yielded garnet, among other phases, but with no significant phosphorus incorporation as indicated by a pyrope-like unit-cell volume. Phosphorus content in pyrope from the UHP Dora-Maira quartzites appears as a potential pressure indicator where UHP garnet coexists with phosphate minerals. The P-content in upper mantle garnets can be used as a probe of phosphorus activity in the host rock.

Keywords: Crystal synthesis, phosphate garnet, high-pressure studies, garnet, petrography, phosphorus in garnet, XRD data, P-Si garnet solid-solution series