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In situ observation of the pyroxene-majorite transition in Na2MgSi5O12 using synchrotron radiation

Anna Dymshits (1,2), Igor Sharygin (1,2), Konstantin Litasov (1,2), Anton Shatskiy (1,2)

(1) V.S.Sobolev Institute of Geology and Mineralogy, Novosibirsk, Russian Federation (a.dymshits@gmail.com), (2) Novosibirsk State University, Novosibirsk, 630090, Russia

In situ X-ray diffraction study of the pyroxene-to-majorite transition in Na2MgSi5O12 was carried out in a Kawai-type high-pressure apparatus coupled with synchrotron radiation. The phase boundary between Na-pyroxene and Na-majorite has been determined over the temperature interval of 1,073–1,973 K. Newly determined boundary can be described by a linear equation P(GPa) = 12.39 + 0.0018 $\times$ T (K). The Clapeyron slope (dP/dT) determined in this study is similar to that predicted by computer simulations (Vinograd et al., 2011) but gentler than that obtained by quenched experiments (Dymshits et al., 2010). The presence of sodium in the system lowers pressures of pyroxene-majorite transformation. Estimating the pressure of natural samples should be with respect to Na-majorite concentration especially for the garnets containing high amounts of the sodic components. The combination of computer simulations with experiments can be applied for prediction of mixing thermodynamic properties for minerals of a broader composition. For the first time Na-majorite was characterized using Raman spectroscopy. Raman peaks of Na-majorite are broader than those of pyrope, due to the substitution of Mg2+ for Na+ at the X site. Both Si-O symmetric stretching (A1g-ν1) and O-Si-O symmetric bending (A1g-ν2) modes of Na-majorite significantly shift to higher frequencies relative to the corresponding bands of pyrope. In contrast, the A1g-R(SiO4) mode (342 cm–1) of Na-maj displays a lower frequency than that (366 cm–1) of pyrope. The results are important for describing the phase transformations and equilibria in the Earth's mantle concerning to majorite garnets.

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