

Natural occurrence of keatite precipitates in UHP clinopyroxene from the Kokchetav Massif: A TEM investigation

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ABSTRACT

We report the first natural occurrence of keatite, also known as silica K, discovered as a precipitate in the core of ultrahigh-pressure (UHP) clinopyroxene (Cpx) within garnet pyroxenite from the Kokchetav Massif, Kazakhstan. High-resolution transmission electron microscopy and electron diffraction demonstrate that sub-micrometer and nano-scale keatite precipitates have a definite crystallographic relationship with the host pyroxene (diopside = $\sim\text{Di}_{90}$) Cpx (100) || keatite (100) and Cpx (010) || keatite (001). Clinopyroxene provides a template for keatite nucleation due to the close structural relationship and excellent lattice match between the diopside and keatite. We propose that keatite micro-precipitates are formed in localized low-pressure micro-environments produced as a result of exsolution of extra silica and vacancies held within UHP host diopside and stabilized by the pyroxene lattice. Low-density metastable keatite and its relationship to the host pyroxene likely reflects the important influence of pyroxene/precipitate interfacial energy on the micro- and nano-scales in controlling the nature of exsolved phases in exhumed UHP minerals.

Keywords: HRTEM, ultrahigh pressure (UHP), diopside, keatite, silica exsolution, epitaxial growth