American Mineralogist, Volume 111, pages 509–517, 2026

(Li,Na)-P substitution in garnet: An indicator of ultrahigh-pressure conditions in subducted continental crust

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Abstract

Findings of coesite and diamond in quartzo-feldspathic rocks confirmed that continental crust, despite its buoyancy, can be subducted to ultrahigh-pressure (UHP) conditions. In addition to these index minerals, UHP conditions can be revealed by specific minor elements incorporated in common minerals, as it is well known from the Earth's mantle but poorly explored in continental crust. Here, we investigate garnet with coesite inclusions from subducted metagranites of the Eger Crystalline Complex, Bohemian Massif (Czech Republic). The garnet shows chemically distinct concentric domains with minor amounts of P, Na, and Li. From the correlation of these elements, we infer $(Na,Li)_1P_1M^{2+}_{-1}Si_{-1}$ substitution, where Li compensates for the Na deficiency in a 2:3 ratio. This is the first time that such a coupled substitution in garnet has been defined and clearly connected to UHP conditions in natural samples, proving itself as a new tool indicative of UHP conditions. Moreover, garnet in subducting slabs needs to be considered as an important Li carrier, capable of transporting significant amounts of Li into the Earth's mantle.

Keywords: Garnet, (Li,Na)-P substitution, ultrahigh-pressure conditions, coesite, Erzgebirge, Bohemian Massif