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SPECIAL COLLECTION: ADVANCES IN ULTRAHIGH-PRESSURE METAMORPHISM

Immiscible melt droplets in garnet, as represented by ilmenite–magnetite–spinel spheroids in an eclogite-garnet peridotite association, Blanský les Granulite Massif, Czech Republic

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Abstract

Interlayered eclogite and symplectitic garnet rock that is interpreted as former garnetite are found in the Gföhl Unit of the Bohemian Massif. They show unusual Fe–Ti-rich compositions, characterized by TiO_2 contents up to 2.34 wt%, and Mg# of 59.8 and 51.6, respectively. Equilibration conditions of 1250 °C and 4.0 GPa are calculated for eclogite. The petrogenesis of this rock association can be best explained as high-temperature and ultrahigh-pressure magmatic cumulates. Highly decoupled Sr-Nd isotopic composition with nearly constant radiogenic $^{87}Sr/^{86}Sr$ values and a slightly negative ε Nd value suggests interaction of aqueous fluid most likely derived from a subducting slab and/or from parental magmas. The garnetite contains large (up to 0.5 mm) Fe–Ti-rich spheroids of ilmenite–magnetite–spinel, interpreted as frozen droplets of a melt incorporated in the growing garnet. The interstices between these garnet crystals are filled by ilmenite–magnetite–spinel aggregates, with concave outer surfaces with trapped Fe–Ti-rich melt. These ilmenite–magnetite–spinel spheroids represent possibly the first record of such an oxidized assemblage in mantle rocks, and probably the first description of Fe–Ti-rich melt in eclogite-garnetite mantle rocks. A calculation based on mineral proportions in the spheroids and mineral composition indicates that the immiscible Fe–Ti-rich melt consisted of 28.7 TiO_2, 3.7 Al_2O_3, 0.2 Cr_2O_3, 27.9 Fe_2O_3, 37.0 FeO, 0.8 MnO, and 1.7 MgO wt%. Petrology and geochemistry of the garnetite indicates an unusual composition for an upper mantle melt with a high oxygen fugacity and relatively high Fe content.

Keywords: Ilmenite–magnetite–spinel, Fe–Ti-rich melt, UHP crystallization, garnetite, eclogite, garnet peridotite, Moldanubian Zone, Invited Centennial article