**Jingsuiite, TiB₂, a new mineral from the Cr-11 podiform chromitite orebody, Luobusa ophiolite, Tibet, China: Implications for recycling of boron**

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**ABSTRACT**

The new mineral jingsuiite (TiB₂, IMA-2018-117b), together with osbornite-khamrabaevite solid solution (TiN-TiC), deltalumite, and a potential new mineral, hexagonal Ti₁₀(Si,P,Fe)₁₇, constitute four inclusions up to 50 μm across in corundum recovered from the Cr-11 podiform chromitite orebody near Kangjinla, Luobusa ophiolite, Tibet, China. EELS, EDS, and 3D electron diffraction were applied to study the phases. In one inclusion, jingsuiite forms a rounded grain 40 μm across. Associated osbornite-khamrabaevite solid solution forms an irregular mass up to 10 μm across having the composition Ti₆(N₁₀.₅C₀.₅O₅) and the Ti₁₀(Si,P,Fe)₁₇ phase forms an incomplete overgrowth up to 20 μm thick around the grain of jingsuiite. In a second inclusion, jingsuiite, osbornite-khamrabaevite solid solution, Ti₁₀(Si,P,Fe)₁₇ and deltalumite form a lamellar intergrowth 100 μm long composed of tablets of the four phases up to 50 μm long × 4 μm in thickness. Jingsuiite has a primitive hexagonal cell with \( a = 3.04(6), b = 3.04(6), c = 3.22(6) \) Å, \( \alpha = 90^\circ, \beta = 90^\circ, \gamma = 120^\circ, V = 25.8 (9) \) Å\(^3\), space group P6/mmm, \( Z = 1 \). Its structure was determined ab initio and dynamically refined on the basis of three-dimensional electron diffraction data; it is equivalent to that of synthetic TiB₂. Our preferred scenario is that corundum with entrapped Ti-Si-P-Fe intermetallic melts was precipitated from basaltic magmas during exhumation following deep subduction. Enrichment of B in the melt pockets is attributed to the highly reducing conditions that led to the segregation of siderophile elements into intermetallic melts and to the siderophile behavior of B, thereby concentrating it in the intermetallic melts in preference to silicate melt. Experimental work on the Ti-Fe-Si system indicates that minerals enclosed in corundum grains such as Ti, FeTiSi₂, and TiSi₂ could have crystallized from alloy melts at the lowest \( T \) accessible on the liquidus, i.e., \(<1300^\circ C \). The presence of TiB₂ in four inclusions in the Cr-11 orebody suggests incorporation of crustal sediments in the ophiolite followed by deep subduction to the Transition Zone where qingsongite (cubic BN) is inferred to have crystallized and subsequently exhumed to shallower levels where hexagonal BN and jingsuiite presumably crystallized.

**Keywords:** Boron, jingsuiite, intermetallic melts, crystal structure, transmission electron microscopy, three-dimensional electron diffraction; Lithium, Beryllium and Boron: Quintessentially Crustal

**INTRODUCTION**

Boron is a quintessential crustal element. Of the 300 known minerals containing essential B, qingsongite, cubic BN, is the first B mineral believed to have originated in Earth’s mantle (Dobzhinetskaya et al. 2009, 2014). It occurs in trace amounts with osbornite (TiN) in a kyanite and coesite-bearing zone adjacent to a rim of α-Ti (native titanium, Fang et al. 2013) surrounding a core of Fe-Ti alloy in a fragment <1 mm across extracted from the Cr-31 chromitite orebody, Luobusa ophiolite, Tibet (Fig. 1) (Yang et al. 2007). Dobzhinetskaya et al. (2014) interpreted the fragment to be a hybrid consisting of crustal material subducted to 400–500 km depth, where mantle components were incorporated. Other super-reduced species extracted from the Cr-31 chromitite include linzhilite, FeSi₂ (Li et al. 2012) and zango boite, TiFeSi₂ (Li et al. 2009).

Super-reduced intermetallic phases have also been reported in the Cr-11 podiform chromitite orebody (Fig. 2), which located at an elevation of 5300 m at 29°11’N, 92°18’E in the Kangjinla district, 11 km east of the Cr-31 chromitite orebody (Fig. 1). However, the mode of occurrence is very different—the phases are enclosed in vitreous corundum grains (Fig. 3) that were found in mineral separates prepared from 1100 kg of chromitite. Xu et al. (2009, 2013, 2018) reported compounds that appear to correspond to known minerals, such as native titanium (Fang et al.