

Mineral chemistry, spectroscopy and parageneses of oxyborates in metamorphosed Fe-Mn oxide deposits, Bergslagen, Sweden

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Oxyborate minerals represent an important sink for boron in some mineralised systems with low silica-activity; hence their occurrence, paragenesis and character may yield insights into the hydrothermal processes transporting and distributing boron, as well as later metamorphic overprinting of such deposits.

In this study we have sampled a representative suite of Mg-(Fe-Mn) oxyborate assemblages from the western part of the Bergslagen ore province in south central Sweden, to characterise them utilising optical microscopy, field emission electron probe microanalysis (FE-EPMA) with wavelength dispersive spectroscopy (WDS), and Raman spectroscopy.

Minerals studied comprise blatterite $[(\text{Mn}^{2+}, \text{Mg})_{35}(\text{Mn}^{3+}, \text{Fe}^{3+})_9\text{Sb}_3^{5+}(\text{BO}_3)_{16}\text{O}_{32}]$, fredrikssonite $[\text{Mg}_2(\text{Mn}^{3+}, \text{Fe}^{3+})\text{BO}_5]$, orthopinakiolite $[(\text{Mg}, \text{Mn}^{2+})_2\text{Mn}^{3+}\text{BO}_5]$, as well as pinakiolite $[(\text{Mg}, \text{Mn}^{2+})_2(\text{Mn}^{3+}, \text{Sb}^{5+})\text{BO}_5]$, and ludwigites of variable compositions [c. $(\text{Mg}, \text{Fe}^{2+})_2\text{Fe}^{3+}\text{BO}_5$]. Textural evidence suggests that the presently studied oxyborate minerals primarily formed during metamorphism of pre-existing, carbonate-hosted, variably metal-rich assemblages.

Among others, the results also suggest a correlation between the cation distribution in the examined oxyborates and their associated metal oxides, comprising spinel group minerals, hausmannite and iwakiite. The broad chemistry of the host rock phases associated with ludwigite and fredrikssonite, reveals why the two latter are more frequently found, compared to pinakiolite and orthopinakiolite. Furthermore, Raman spectroscopy verifies the structural character of boron in the examined oxyborates and shows a possible connection between the distribution of manganese and whether the BO_3^{3-} ion is allowed to be positioned in less than three-fold symmetry sites within the crystal structure.

Our observations and results add to the current knowledge of silica-undersaturated deposits such as those of the Långban-type, and also provide a dataset combining highly resolved mineral chemistry and Raman spectra, to better understand structural features of the oxyborate minerals, both e.g. applicable to future boron isotope studies.