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A multi-methodological study of the bastnäsite-synchysite polysomatic series: Tips and tricks of polysome identification and the origin of syntactic intergrowths

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Abstract

In this paper, we evaluated the potentialities of Raman spectroscopy and electron backscattered diffraction (EBSD) in the microscopic characterization of Ca-REE fluorcarbonates (CRFC) belonging to the bastnäsite-synchysite series to provide a "road map" for further investigations with transmission electron microscopy (TEM). EBSD was effective in establishing the sample orientation, setting up the oriented cuts, and ascertaining the effective syntactic relationship among all the detected CRFC phases; however, it failed to distinguish between different polysomes. On samples with different orientations that were preventively ascertained by EBSD and characterized by scanning electron microscopy (SEM) coupled with energy-dispersive X-ray spectroscopy (EDS), micro-Raman spectroscopy allows for distinguishing between polysomes based on the differences in intensity and position of the symmetric stretching vibration (ν_1) of the carbonate group (CO_3^{2-}) in the region around 1080–1099 cm^{-1}. However, as evidenced by TEM-EDS, what appears as a homogeneous polysome in backscattered electrons (BSE) images may be a disordered intergrowth of compositional faults with a bulk composition being matched with that of a real polysome only by accident. Therefore, we conclude that the Raman signal is sensitive to different Ca/(Ca+REE) ratios but not to any ordered distribution of Ca-poor and Ca-rich lamellae within the analyzed volume, making the unambiguous identification of a polysome tricky. Finally, several ordered polysomes were detected at the TEM scale, including a B_2S and a long-range polytype with a 32 nm repeat distance along *c*. The possible implications of the detected microstructure for ore mineral formation are discussed.

Keywords: Raman spectroscopy, electron backscattered diffraction, transmission electron microscopy, bastnäsite, synchysite, parisite, polysomatism