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Fluorapatite deposit in a carbonatitic environment: processes and prospects

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Phosphate is one of the most important resources associated with carbonatites and alkaline complexes [1]. It is mined mainly to produce fertilizers [2]. Phosphate deposits consist of either primary apatite in carbonatites, or apatite and other secondary phosphates in associated residual deposits. The importance of the magmatic, hydrothermal and supergene processes leading to economic phosphate concentration has been assessed for the Matongo phosphate deposit [3], which in Burundi is associated with a Neoproterozoic alkaline-carbonatite complex [4,5].

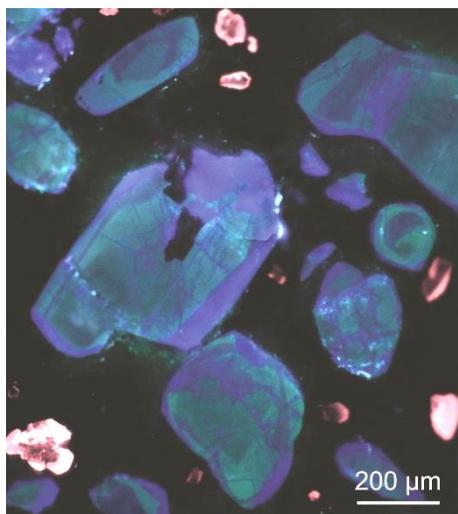


Figure 1: Fluorapatite crystals, with a green CL in the core and blue-violet CL (indicating a LREE enrichment) in the outer rim. The dark CL matrix is an assemblage of siderite and carbonate-fluorapatite.

Most of the facies representative of the Matongo phosphate deposit are brecciated and comprise magmatic fluorapatites set in either a siderite-carbonate-fluorapatite matrix or a hardened phosphorite (made of fibrous fluorapatite) or a calcite-rich matrix.

The primary magmatic fluorapatite locally occurs as aggregates of up to 3 mm in size. It shows several growth zones as highlighted by different cathodoluminescence colors (CL) in Figure 1. A Light Rare Earth Elements (LREE) enrichment - up to 1.32 wt% LREE₂O₃ - characterizes the latest generation of magmatic fluorapatite (Figure 1).

A K-fenitization event in connection with the carbonatitic activity resulted in the brecciation and partial dissolution of the earlier formed magmatic fluorapatite. Simultaneously, the calcite - that locally forms the phosphate breccia matrix - was precipitated under hydrothermal conditions, as inferred from its stable isotope compositions ($\delta^{18}\text{O} = 22.1\text{‰}$ and $\delta^{13}\text{C} = -1.5\text{‰}$).

The $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ values of the siderite matrix (25.4 - 27.7 ‰ and -9.2 - -12.4 ‰, respectively) argue for the involvement of supergene fluids, which are unrelated to the magmatic history.

Accordingly, the fibrous fluorapatite forming the hardened phosphorite is commonly considered as a supergene phosphate in comparable deposits [1,6].

High concentrations of REE (from 707 to 5486 ppm) are observed in the Matongo phosphate deposit. The REE mostly occur within the fluorapatite, being therefore quite easy to extract [7]. As for other magmatic or sedimentary phosphate deposits [7,8,9], this would allow potential REE recovery as by-product in case of exploitation of the Matongo phosphates.

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