Copiapite group: occurrence and properties in mining contamination scenarios

Grupo da copiapite: modos de ocorrência e propriedades em ambientes de contaminação mineira

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Sumário: *O grupo copiapite apresentou uma ampla gama de composições químicas, permitindo a identificação de várias fases minerais (por exemplo, aluminocopiapite e magnesiocopiapite). Esses minerais, normalmente observados em ambientes mineiros, são formados a partir da precipitação e evaporação da drenagem ácida da mina. Nessas áreas, a copiapite tem sido estudada para compreender a sua capacidade de adsorção de alguns elementos potencialmente tóxicos. O presente trabalho visa caracterizar amostras minerais de copiapite, utilizando diferentes técnicas, para entender a sua morfologia, composição mineralógica e química, bem como o seu papel ambiental.*

Palavras-chave: *Grupo da copiapite, Drenagem Ácida Mineira, morfologia, composição química.*

Key words: Copiapite group, Acid Mine Drainage, morphology, chemical composition.

The copiapite group has been described with a general formula of $MFe_4^{3+}[SO_4]_6(OH)_2\ 20H_2O$, where M= Fe^{2+}, $2/3Fe^{3+}$, $2/3Al^{3+}$, Mg, Ca, Zn, Cu (Ogorodova et al. 2021). This variety of chemical composition results in the formation of several types of copiapite: ferro-, magnesio-, cupro-, alumino-, and zincocopiapite (IMA, 2023). Copiapite minerals are frequently found in nature, especially in mining contaminated environments, where the copiapite is observed as a product of the precipitation and evaporation of acid mine drainage (AMD) (Paramanick et al. 2021). A particular characteristic of these newly formed minerals is that they can adsorb potential toxic elements (PTE), playing a role in the environmental behavior of the mine wastes. For example, Nieva et al. (2021) observed that copiapite can be considered one of the most important temporary reservoirs of As due to its high solubility, which is released in the wet seasons. Therefore, the present work aims to characterize the variety of copiapite group, with different techniques, to understand their occurrence, properties, and occurrence variations in mining degraded systems.

Copiapite mineral samples were collected in different mining areas in Portuguese and Spanish sectors of Iberian Pyrite Belt and analyzed to obtain their morphology, mineralogical and chemical composition. In the field, this group occurs with distinct shapes: yellowish to greenish efflorescent coatings, scales, granular encrustations, or as gel (Fig. 1).

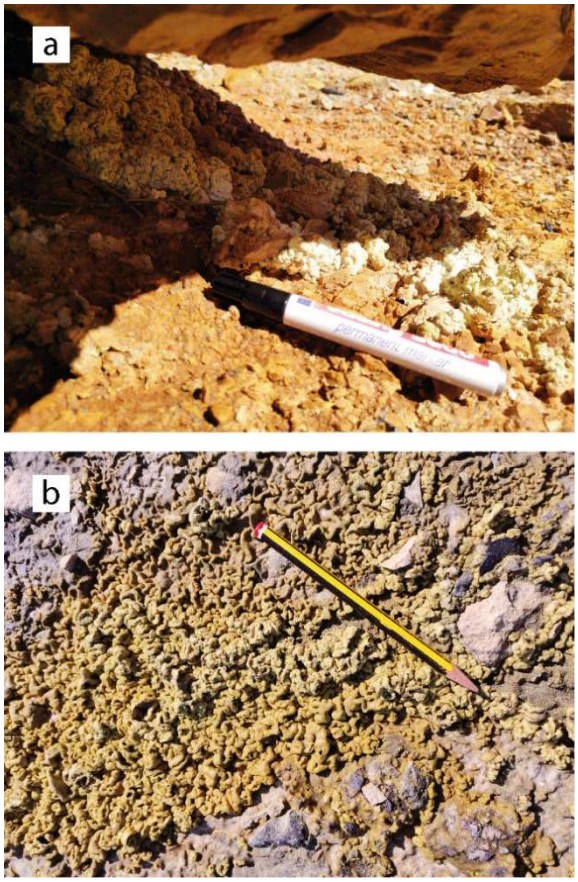

Fig. 1. - Different occurrences of copiapite: (a) yellowish granular encrustations, and (b) gel coatings

The mineral phases were confirmed by powder X-Ray diffraction (XRD) analysis; SEM-EDS and FTIR were

used for morphological and chemical characterization.

The XRD patterns show that the samples collected were aluminocopiapite and copiapite (Fig. 2a and b, respectively). Aluminocopiapite showed a rhombus plates (Fig. 2a), whereas copiapite presented a tabular shape (Fig.2b). The chemical composition analysis indicated slight differences between the concentration of Al and the presence of Mg in the case of the aluminocopiapite. The methods used to characterize these samples did not show the presence of As or other potentially toxic elements. So, for future work, it will be essential to characterize the chemical composition with other techniques, to assess ability to retain PTE.

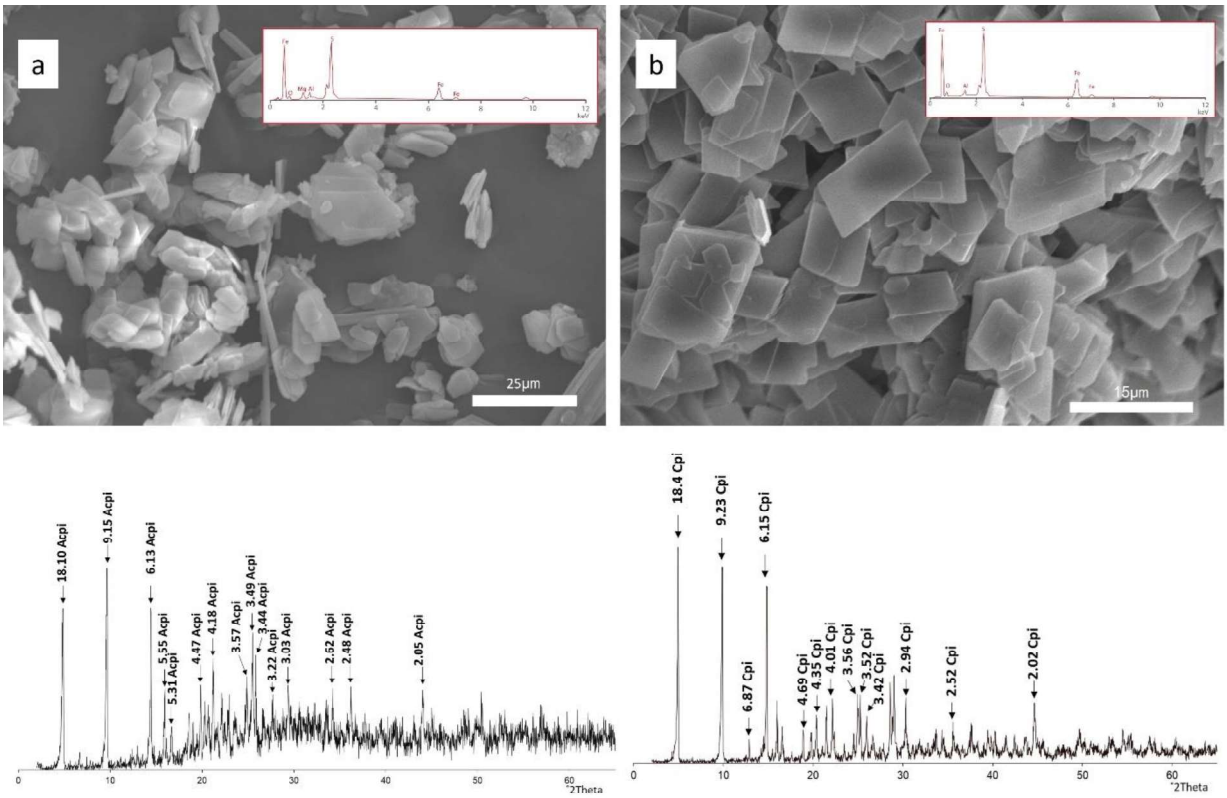

Fig. 2. SEM-EDX image with respective EDS spectra, and XRD pattern of copiapite samples collected in abandoned mining areas: encrustation (a) and gel coating (b).

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