**Sustainable Beneficiation of Lithium Hard Rock Ores: Aiming at zero-waste from single to multi metal/mineral processing – A Case Study**

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Lithium (Li) occurs naturally in various geological settings around the world. The most common lithium-bearing minerals are spodumene, lepidolite, and petalite, which are typically found in igneous rocks, pegmatites, and sedimentary deposits. According to the International Energy Agency (IEA), lithium demand will increase more than 40 times in less than 20 years.

Lithium (Li) plays a critical role in various industries and applications due to its unique properties. Some significant uses of lithium are batteries, electronics, automotive, aerospace, glass and ceramics, pharmaceutical, among others.

Spodumene is the most common lithium-bearing mineral. It is a pyroxene mineral that contains lithium aluminum inosilicate. Spodumene is usually found in lithium pegmatite deposits and can occur in massive, granular, or crystalline forms. Lithium has good recycling potential, and recycling of lithium-ion batteries and other lithium-containing products reduces environmental impacts associated with traditional mining (viz., urban mining).

The extracted lithium ore involves crushing, grinding, and separating the ore to remove impurities and increase the lithium concentration. This can be done through physicochemical methods, such as gravity separation, magnetic separation, or froth flotation, depending on the characteristics of the ore. Flotation, dense medium separation (DMS) and magnetic separation are the main beneficiation approaches used for hard rocks ores. Note that the close similarity in chemical and physical properties between lithium minerals and associated gangue minerals makes the beneficiation of lithium minerals from ores challenging.

This contribution addresses the separation approach used with a side stream of lithium ore processing from Savannah Mine in Portugal. The work consisted of an ore characterization (i.e., chemical, mineralogical and screen size profile) and dense medium separation testing. The focus of the study has been on defining boundary conditions and process configuration at laboratory scale. The state-of-the-art indicates that DMS studies of Li-bearing ores are limited. Consequently, this work will help expand the use of DMS for lithium hard rock ores. In addition, the metric design to quantify performance is traceable, precise, and consistent. It goes without saying that as soon as the process configuration is established, the upscaling of it will be developed. The purpose of the project is to establish an integrated, sustainable extraction approach (zero-waste) to recover lithium from pegmatite deposits.

This work is part of the EXCEED project (European Union) which represents a new mining paradigm for the processing of critical raw materials (CRM).

**Keywords**: Critical raw materials, CRM, zero waste, dense medium separation, DMS, Lithium, Savannah.

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