Geophysical Research Abstracts
Vol. 20, EGU2018-16077, 2018
EGU General Assembly 2018

The Gonçalo deposit: a good example of a future sustainable lithium mine

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Across Europe, small scale deposits of critical raw materials, such as Sn, W and Li, are not viable to mine and process using the traditional large scale mining and processing technologies due to their geological characteristics. Project FAME (Flexible And Mobile Economic Processing Technologies, Grant Agreement No. 641650) was created in order to specifically address the technical and environmental challenges to the sustainable processing of pegmatites, greisens and skarns. One of the deposits being investigated on the scope of the concerned project is a lithium pegmatite located at Gonçalo pegmatite field (Central Portugal). The pegmatites are granitic in composition and hosted in a synorogenic Variscan (304.1 $\pm$ 3.9 Ma) porphyritic biotite granite (Beiras/Guarda granite). The majority of the known pegmatites occurs as sills, with a sub-horizontal plunge and ranging up to 3.5 m in thickness. The sills are heterogeneous on what concerns their internal structure, textural aspects, minerals grain size and relative abundance/distribution and correspond to an association of pegmatite and aplite. The pegmatitic component is characterized by lepidolite (the main lithium mineral), albite, Li-muscovite, quartz and K-feldspar as major minerals, and montebrasite, topaz, cassiterite, columbo-tantalite, beryl and zircon as minor minerals. Petalite also occurs, but is scarce due to its alteration to kaolinite, cookeite, pollucite and illite/smectite in late episodes of pegmatite history. Zinnwaldite also occurs, but results from biotite metasomatic alteration on the contact of pegmatite sills with the host granite. The aplitic component is characterized by a sodolithic composition with lepidolite, albite, montebrasite and quartz as major minerals. Some muscovite, topaz, cassiterite and columbo-tantalite also occur. In both components, secondary phosphates from late alteration processes are present.
Currently, the pegmatite is only being exploited for ceramics, aggregates and ornamental purposes. However, it can be exploited for Li2O. The inferred mineral resource of Gonçalo deposit was estimated in 1.5 Mt @ 1.1% Li2O; this is a minimum value, because only Li-rich sills and a maximum quarry front of 10 m were considered for this estimation.
Froth flotation is being tested to produce a lepidolite concentrate. Results showed the possibility to obtain a Li2O grade adequate for the metallurgical production of lithium compounds. The lepidolite flotation rejects, normally stored in tailings dumps, are mainly composed by a mixture of feldspar, quartz and non-recovered lepidolite (very low content), which is, by itself, a very interesting raw material for ceramics. Consequently, mining exploitation of lepidolite, as Li2O ore, from pegmatites sills could comply with the standards of “green mining”, reaching an almost zero waste production, as it can be accomplished in the case of mineral processing of Gonçalo lithium ore. This basic scenario could be improved by applying froth flotation also for feldspar/quartz separation, aiming at obtaining a high content feldspar concentrate (floated) and a quartz product (non-floated): the feldspar concentrate can be used to produce blendings with different ratios feldspar/quartz for sanitary ware and tiles and quartz for other uses, such as glasses and “silica flour”.