Barroso-Alvao Pegmatite-aplite Field: a case study in Northern Portugal

T. C. Martins[1]; A. M. C. Lima[2]; R. A. C. Vieira[3]
1, 2, 3 – Geology Centre, Porto University, Praça Gomes Teixeira, 4099-002 Porto, Portugal;
tmartins@fc.up.pt

Abstract

Dozens of aplitic-pegmatite veins are exposed in the Barroso-Alvao pegmatite-aplite field. Poorly mineralized veins as well as geochemically evolved veins with Li-rich minerals and low-grade cassiterite mineralization have been found. This pegmatite-aplite field has been studied for almost twenty years and it was given special relevance for its Li-bearing pegmatites. These veins have a very particular combination of both Li-aluminosilicates, different spodumene and petalite relations and characteristics, not very common to find in other pegmatite fields.

Introduction

During the geological surveying of the Barroso-Alvao region on the scale 1:25.000 in 1987, numerous lithium-bearing pegmatite-aplite veins (with spodumene and rarely lepidolite) were found by the Fernando Noronha team. Due to the importance of this mineral resource, it was decided by the Portuguese Geological Survey (IGM - Instituto Geologico e Mineiro) to carry out an exploration campaign in the region during the 90´s. Various mineralogical, petrological and geochemical studies were performed in close cooperation between the Fluids and Metalogeny Research Team (GIMEF - Grupo de Investigacao em Metalogenia e Fluidos) and IGM, resulting in evidence that support the importance of these lithium-bearing veins. More recently, during a research project titled "Multidisciplinary studies to promote the spodumene of pegmatite-aplite veins as a fluxing component for the Ceramic Industry" financed by Science and Technology Portuguese Foundation (FCT - Fundação para a Ciencia e Tecnologia), all previous data was used and reinterpreted. This study caused the discovery of more pegmatite-aplite spodumene rich veins and especially petalite ones, unknown until then. The new findings make it necessary to look at all the available data and to devise a new model for this pegmatite-aplite field in order to better understand the occurrence of these lithium bearing veins. All this research work led to several exploration licenses from different companies that recently resulted in the beginning of mining activity for the ceramic and glass industry.

Geological setting

The Barroso-Alvao pegmatite-aplite field contains a large number of aplite-pegmatite veins. Some of them cut throughout the two-mica granites (interior pegmatites) and have not been systematically studied. But there are other types of veins that are found at this pegmatite-aplite field, emplaced into low- to medium-grade metasedimentary rocks of Silurian age in the Galicia-Tras-os-Montes geotectonic zone. Here three phases of Hercynian deformation were recognized (D_1 to D_3), leading to three superimposed schistosities (S_1 to S_3) (Noronha *et al*. 1981). Several types of granites surround the pegmatite-aplite field, differing in mineralogy and timing: biotite or two mica granites and deformed or undeformed granites (Ferreira *et al.* 1987).

Charoy *et al*. (2001) describe two different aplite-pegmatite vein types, both crosscutting the metasedimentary country rock. The first type is represented by countless, meter size (on average), mainly aplitic veins, which contain low-grade (<3Kg/t) cassiterite mineralization and are commonly altered to kaolinite. These veins also have not been systematically studied. The second type is composed of larger aplite-pegmatite veins, irregularly distributed with variable thickness from a few

meters to ten meters across. The orientation of the veins is mainly controlled by S_2 foliation, which has been locally deformed by S_3 (crenulation with subvertical axial planes striking at 120ºE on average).

Petrography and mineralogical aspects

According to Černý's classification (Černý, 1991) these Li-enriched pegmatites are Rare Element Pegmatites of the LCT (Li-Cs-Ta) family. These veins belong to the complex type, and depending on the dominant lithium mineral, are considered spodumene subtype or petalite subtype.

Beside lepidolite bearing veins (not included in this study) Charoy *et al*. (2001) consider the existence of two pegmatite-aplite veins types, as described above. But, in fact, what has been recently observed is that the low-grade cassiterite mineralized veins also contain Li-minerals, predominantly petalite. These two kind of Li-bearing pegmatites (predominant petalite-bearing veins and spodumene-bearing veins) have differing Sn and Fe content that distinguishes them in terms of magmatic composition (Table 1).

Table 1 – Bulk composition values from examples of predominant spodumene-bearing veins (**A**) and predominant petalite-bearing veins (**B**). Data values from IGM´s laboratory.

	SiO_2	Al_2O_3	Fe(t)	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	Li	Rb	Nb	Ta	Sn
A	73,5	16,78	0,77	0,10	0,32	3,87	2,67	0,01	0,36	4857	533	19,6	7	33
B	71,1	17,74	0,18	0,02	0,04	2,58	3,58	<0,04	0,71	8200	1134	34	<15	667

At the predominant spodumene-bearing veins, Lima (2000) and Charoy *et al*. (2001) describe the occurrence of euhedral to subhedral spodumene crystals, with predominant (100) and subordinate (110) development of the prism zone. Simple twins on (100) are common. In these cases, petalite was only identified in thin section and follows spodumene as the stable Li-aluminosilicate. Petalite is partly altered along grain boundaries to a brownish aggregate of eucryptite microcrystals, easily recognized because of its characteristic fluorescence under UV light (Charoy *et al.* 2001). However there are some veins where spodumene is the dominant phase, without surrounding petalite. But petalite may occur in small veins that crosscut these spodumene-bearing ones. Cassiterite has not been found in these veins.

At predominant petalite-bearing veins, petalite occurs as a dominant phase, frequently as centimeter size euhedral to subhedral crystals with some quartz inclusions. Cleavage on (001) as well as simple twins on (001) are common. In some of these veins, spodumene+quartz occur after petalite at a microscopic scale, as the squi sequence refereed by Černý & Ferguson (1972). It is also possible to find petalite-bearing veins that have secondary spodumene+quartz, almost equal in volume, which means that these veins crystalized at PT conditions near the boundary of the stability fields of spodumene and petalite (London 1984). In these veins, cassiterite is a common acessory mineral.

Acknowledgements: The present article is integrated at Geology Centre, Porto University activities, with financial support from FCT (POCTI-FSE). Tania Martins is financed by FCT within the compass of a PhD thesis reference SFRH/BD/17188/2004.

References

Charoy B., Noronha F. & Lima A. (2001): Spodumene-Petalite-Eucryptite: mutual relationships and pattern of alteration in Li-rich aplite-pegmatite veins from Northern Portugal. *Canadian Mineralogist*, vol. 39, pp. 729-746.

Černý, P. & Ferguson, R. B. (1972): The Tanco pegmatite at Bernic Lake, Manitoba. IV. Petalite and Spodumene relations. *Canadian Mineralogist*, vol. 11, pp. 660-678.

Černý P. (1991): Rare-element Granitic Pegmatites. Part I: Anatomy and Internal Evolution of Pegmatite Deposits. *Geoscience Canada,* 18, p. 49-67.

Ferreira, N., Iglesias, M., Noronha, F., Pereira, E., Ribeiro, A. & Ribeiro, M. L. (1987): Granitoides da Zona Centro Ibérica e seu enquadramento geodinâmico. *In* Geologia de los Granitoides y Rocas Associadas del Macizo (F. Bea *et al*., eds.). Libro Homenaje a L. C. Garcia de Figuerola, Hespérico Editorial Rueda, Madrid, Spain (37-51).

Lima, A. M. C. (2000): Estrutura, Mineralogia e Génese dos Filões Aplitopegmatíticos com Espodumena da Região do Barroso-Alvao (Norte de Portugal) PhD Thesis. INPL (Nancy) and Porto University. 270pp.

London, D. (1984): Experimental phase equilibria in the system $LiAlSiO_4$-SiO_2-H_2O: a petrogenetic grid for lithium-rich pegmatites. *Amer. Mineral.,* 69. (995-1004).

Noronha F., Ramos, J. M. F., Rebelo, J., Ribeiro, A. & Ribeiro M. L. (1981): Essai de corrélation des phases de déformation hercyniennes dans le NW de la Péninsule Ibérique. *Leid. Geol. Meded*. **52** (1) 87-91.

[1]

Tania da Costa Martins – Centro de Geologia, Faculdade de Ciências da Universidade do Porto, Praça Gomes Teixeira, 4099-002 Porto, Portugal; +351223401471