The Fregeneda – Almendra pegmatitic field (Spain & Portugal): mineral assemblages and regional zonation

E. RODA[1], R. VIEIRA[2], R. LIMA[2], A. PESQUERA[1], F. NORONHA[2], F. FONTAN[3]

[1] Dpto. Mineralogía y Petrología, Universidad del País Vasco/EHU, Apdo. 644, 48080-Bilbao, Spain, encar.roda@ehu.es
[2] GIMEF – Dpto. Geologia, Faculdade de Ciências, Universidade do Porto, Portugal, romeu.vieira@fc.up.pt
[3] Laboratoire Cristallographie et Minéralogie, URA-067-Université Paul Sabatier, Toulouse, France

ABSTRACT

In the Fregeneda-Almendra area, (Spain and Portugal), several pegmatite bodies occur. Li-bearing pegmatites are common in the northernmost part of the area, where they can be classified in four groups: (a) petalite-bearing pegmatites; (b) spodumene-bearing pegmatites; (c) lepidolite-spodumene-bearing pegmatites; and, (d) lepidolite-bearing pegmatites. An attempt to establish the regional zonation in relation with the degree of evolution attained by the studied pegmatites, as well as the evaluation of the metamorphism influence on the different mineral assemblages is made in this presentation.

Keywords: *lithium-pegmatites, regional zonation, metamorphism, Fregeneda-Almendra, Spain, Portugal.*

INTRODUCTION

In the Fregeneda-Almendra (FA) pegmatitic field, Salamanca (Spain) and Guarda (Portugal), different types of pegmatites have been observed (Roda et al., 1999; Charoy & Noronha, 1999; Lima et al., 2003; Almeida, 2003). A regional zoning for these pegmatites is observed, where the content in lithophile elements of pegmatites increases northwards, as the distance to the Mêda-Penedono-Lumbrales granite becomes greater. The presence of Li-rich bodies, generally in the furthest areas from the granite, is common. Four different Li- and Li-Al-silicates assemblages appear associated with these Li-rich pegmatites, which let us classify them as: petalite-rich pegmatites, spodumene-rich pegmatites, lepidolite-spodumene-rich pegmatites, and lepidolite-rich pegmatites. According to field, mineralogical, petrographic and chemical criteria, the chemistry of the pegmatites depends on the distance to the Lumbrales granite, and the distribution of the Li-Al-silicates assemblages of the different Li-rich pegmatites is consistent with the metamorphic degree attained by the host-rocks.

The aim of this study is to establish the relationships between the degree of evolution of the different pegmatite types and the distance to the Lumbrales granite, as well as to evaluate the relationship between the metamorphic degree attained by the hosting rocks and each type of Li-bearing pegmatite recognized in this area.

GEOLOGICAL SETTING

The FA area is located in the Central-Iberian-Zone (CIZ), in the western part of a narrow metamorphic belt, with an E-W trend. This belt is bordered by the Hercynian Mêda-Penedono-Lumbrales leucogranitic complex (Carnicero, 1981; Ferreira et al., 1987) to the south, and by the Saucelle granite to the NE. Both are two-mica, peraluminous leucogranites (Carnicero, 1981). Granites and pegmatites intruded pre-Ordovician metasediments of the schist-metagraywacke complex.

A first event of regional metamorphism took place prior to the third-Hercynian phase (D_3 – intra-Westphalian in age), between D_1 and D_2 deformation phases, generating a prograde assemblage with garnet, staurolite and sometimes kyanite. A second thermal metamorphic event, related with the syn-D_3 granite intrusion, created an isograd overlapping marked by minerals like andalusite, cordierite and sillimanite (Martinez et al, 1990). In the FA area, the metamorphism shows an isograd distribution increasing to the South parallel to the Mêda-Penedono-Lumbrales leucogranite contact, reaching locally the sillimanite (fibrolite) isograd.

GENERAL GEOLOGY OF PEGMATITES

In the FA area several hundreds of bodies have been identified. These pegmatites show a zonal distribution from barren to enrichment in Li, F, Sn, Rb, Nb>Ta, B, P and Be. Most of these bodies correspond to poorly evolved pegmatites, which may be grouped in two main categories: (i) barren pegmatites with quartz, K-feldspar > albite, muscovite, tourmaline ± andalusite ± garnet, and, (ii) intermediate discordant pegmatites, characterized by the occurrence of Fe-Mn phosphates, montebrasite, and micas and feldspars with higher Rb and Cs contents than those of the barren pegmatites (Roda et al., 1999). A third category of pegmatites is less abundant but also common. It belongs to (iii) fertile discordant pegmatites, mainly rich in Li-minerals and/or cassiterite. These Li-bearing pegmatites may be classified in four different groups:

(a) petalite-bearing pegmatites, without an evident internal zonation. The maximum width is up to 30 m (Bajoca open-pit, Portugal), whereas thicknesses of ≈ 5 m are common (Almeida, 2003). Feldspars, quartz, and petalite are the main minerals, with minor muscovite, montebrasite and cassiterite. Fe-Mn phosphates and apatite appear as accessory minerals. Their outcrops appear between 600 m and 1,5 km north from the granite, in the andalusite-sillimanite (fibrolite) isograd, only in the Portuguese part.

(b) spodumene-bearing pegmatites, also without an evident internal zonation. Variable thicknesses between 4 m and ≈ 15 m. Mineralogy is simple, with feldspars, quartz and spodumene as main constituents; minor muscovite, montebrasite and petalite; and beryl, Fe-Mn phosphates and cassiterite as accessory minerals. They appear between 1 and 4 km north from the granite, near the biotite/chlorite isograd limit. The main member of this group is being mined in the Alberto open-pit (Fregeneda, Spain).

(c) lepidolite-spodumene-bearing pegmatites, with a layered internal structure, where quartz and lepidolite bands alternate with albite and K-feldspar bands. The maximum width is ≈ 15m, but thicknesses of <3m are the most common. Main minerals are quartz, lepidolite, albite > K-feldspar and spodumene. Montebrasite and cassiterite are minor minerals; whereas beryl, apatite, ferrocolumbite, "estannite" and eucryptite are accessory minerals. Outcrops appear only in the Spanish part (Feli open-pit), between 4 and 4,5 km north from the granitic contact, near the chlorite/biotite isograd.

(d) lepidolite-bearing pegmatites, also with a layered internal structure, similar to that of the previous type. Thicknesses are usually < 3 m. Quartz, lepidolite and albite > K-feldspar are the main minerals, with montebrasite and cassiterite as subordinates. They appear between 2 and 4 km north from the granite, in both parts of the field (Spain and Portugal), in the biotite and chlorite zones.

The lepidolite-absent-Li-rich dikes (a and b) appear, generally, in an intermediate zone, between the granitic contact and the lepidolite-rich dikes (c and d) that appear the furthest from the granite.

RESULTS AND DISCUSSION

Chemical analyses of the micas associated with the different Li-bearing pegmatites reveal important differences between them. The F-richest micas are associated with the lepidolite-bearing pegmatites (c and d), with values ranging from 3.69 to 9.02 wt.%. In the petalite-bearing pegmatites (a) and in the spodumene-bearing pegmatites (b) no lepidolite is found. In these cases, muscovite shows F values always <1 wt.%. On the other hand, chemical data on the whole-pegmatitic rocks are available for the petalite-bearing pegmatites (a), with avg. of 2050 ppm in Li and 800 ppm in Rb for the petalite-rich facies (Almeida, 2003); for the lepidolite-spodumene pegmatites (c), with 4730 ppm in Li and 986 ppm in Rb (Martín-Izard et al., 1992); and for the lepidolite-bearing pegmatites (d), with 4960 ppm in Li and 2570 ppm in Rb (Charoy & Noronha, 1999). These data suggest a general trend where the Li- and Rb-richest types, that is, the pegmatites with most differentiated character in the FA area, would be the lepidolite-bearing pegmatites, (c) and (d); with quite similar Li and Rb contents. This agrees with the petrogenetic model proposed by Roda et al. (1999) for the Spanish part of the field. This way, the highest contents in Li, Rb, F, and volatiles are found in the lepidolite-bearing dikes, which are hosted in metasediments showing the biotite and/or chlorite metamorphic facies. In this case, the metamorphic degree seems not to have influenced on the presence of lepidolite. It would be likely related with the Li and F activity and with the water content in the pegmatite-forming melt. However, the occurrence of primary spodumene in the lepidolite-spodumene-bearing dikes (c) could be related with the low thermal-metamorphic degree attained by the hosting rocks in the Feli open pit. In relation with the petalite-rich (a) and the spodumene-rich (b) pegmatites, field, mineralogical and chemical data suggest a lower evolution degree in comparison with the lepidolite-bearing types. The scarcity of micas (only minor muscovite is found) could indicate that crystallization proceeded under water undersaturated conditions, also with lower F contents than the lepidolite-rich pegmatites. Mica composition of both types of dykes is quite similar, which suggests that the evolutionary degree of both, (a) and (b) types, is equivalent. Thus, in this case, it appears to be a close relationship between the metamorphic degree of the hosting rocks and the mineral assemblages, with the petalite-bearing pegmatites in andalusite-sillimanite (fibrolite) isograd, in comparison with the spodumene-bearing veins, spatially associated with lower biotite and/or chlorite metamorphic facies.

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