PETROGENETIC LINKS BETWEEN GRANITES AND PEGMATITES IN THE FREGENEDA-ALMENDRA AREA (SALAMANCA, SPAIN AND GUARDA, PORTUGAL): NEW INSIGHTS FROM ^{40}AR/^{39}AR DATING IN MICAS

Roda-Robles E[1], Vieira R[2]
Lima A[2] & Pesquera-Pérez[1] A

Dpto. Mineralogía y Petrología UPV/EHU, Bilbao, Spain;
2- Centro de Geologia, UP, Porto, Portugal

ABSTRACT

The Fregeneda-Almendra pegmatite field (Spain-Portugal) is characterized by the occurrence of numerous pegmatites of different types. Most of these pegmatites are barren, but Li- and/or Sn-rich bodies are also abundant in the northern part of the field. These pegmatites show a zonal distribution, with the degree of evolution increasing northwards relative to the Meda-Penedono-Lumbrales granite. ^{40}Ar/^{39}Ar geochronology in micas associated to all the pegmatite types, as well as to the granite suggests that the Li-rich pegmatites are not genetically related to the Meda-Penedono-Lumbrales granitic complex, whereas the Sn-rich dykes and the barren pegmatites could be related with the latest facies of this granite.

INTRODUCTION

Different studies have been developed during the last two decades on pegmatite bodies that occur in the Fregeneda-Almendra area (FA), Central-Iberian-Zone, (CIZ), Spain and Portugal, (e.g. Roda et al. 1999, 2007, Vieira et al., 2007). Based on these works 11 different types of pegmatites have been characterized (Fig. 1, Table 1). Five of these types belong to evolved pegmatites, whereas the other six types correspond to barren and intermediate pegmatitic bodies. Most of these pegmatites intruded pre-Ordovician metasediments of the schist-metagraywacke complex (SGC), showing a zonal distribution from barren to enrichment in Li, F, Sn, Rb, Nb>Ta, B, P and Be, with an increase in the evolution degree, as the distance to the Meda-Penedono-Lumbrales (MPL) granitic complex increases northwards (Fig. 1). This zonation suggests, at first sight, a parental relationship between the granitic complex and the pegmatites. Moreover, a geochemical modelization made on the granite and different pegmatites suggested a common origin for the granitic and the pegmatitic melts. According to the trace-element contents and the modal proportions in granite and pegmatites from the FA area, their parent melts could have been formed by different degrees of partial melting of a quartz-feldspatic source, such as the mica schists of the SGC (Roda et al., 1999). However, some features are not consistent with the hypothesis of a petrogenetical link between the most evolved pegmatites in the FA field and the MPL granitic complex. First, the geochemical modelization made on the different granite and pegmatites also supports the existence of at least two different trends of evolution: one for the granite and the barren pegmatites; and the other one for the intermediate and evolved pegmatites (Roda et al., 1999). Second, no more Li-rich pegmatites are observed in relation to the MPL granitic complex along the more than 50 Km of outcrop of this granite, eastwards and westwards from the FA area. Third, some Li-rich dykes with similar mineralogy and internal structure similar to some of the Li-rich dykes in the FA area, occur related to late-tectonic granitic rocks in the CIZ (e. g. Gallego, 1992; Farinha Ramos, 1998). In this way, it is noteworthy that these late-tectonic granites are widespread in the surrounding areas of the FA field.

In order to shed light on the genetic relationships between granites and pegmatites in the FA field, representative micas from the muscovite-lepidolite series were separated from the different pegmatite types, as well as from the MPL granitic complex and from another granite detected by drills in the north of the area. These mica samples have been used to date their hosting rocks by the step-heating ^{40}Ar/^{39}Ar method. In this work we present the preliminary results of this dating, discussing their petrogenetic implications.

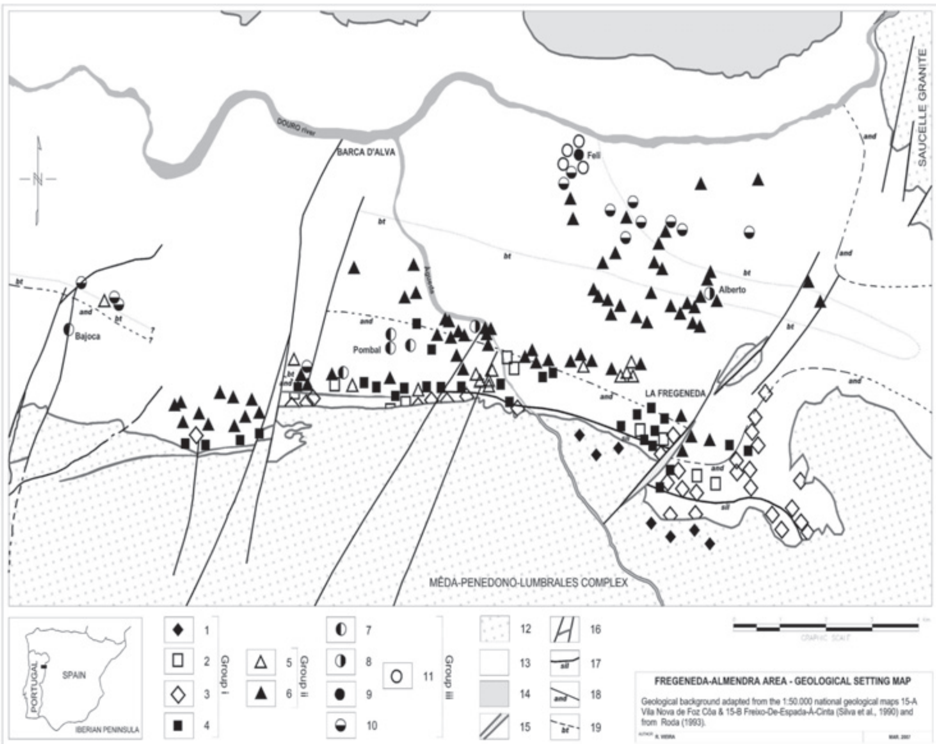

Figure 1 – Distribution of the pegmatite types in the Fregeneda-Almendra area. Legend: Group i) 1– simple interior; 2 – quartz+andalusite conformable dykes; 3 – simple dykes and apophyses; 4 – simple conformable; Group ii) 5– K-feldspar discordant dykes; 6 – simple discordant; Group iii) 7 – petalite-bearing discordant; 8 – spodumene-bearing discordant; 9 –lepidolite-spodumene-bearing discordant; 10 – lepidolite-bearing discordant; 11 – Sn-bearing discordant; 12 – syn-F3 granites; 13 – Pre-Ordovician Schist-Metagraywacke-Complex; 14 – Ordovician formations; 15 – quartz segregations fractures; 16 – porphyry granitic/riolitic and faults; 17 – sillimanite isograd; 18 – andalusite isograd; 19 – biotite isograd.

GEOLOGICAL SETTING AND GENERAL GEOLOGY OF PEGMATITES

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 Variscan MPL granitic complex (Carnicero, 1981) to the south, and by the Saucelle granite to the NE. Granitic rocks in the Central-Iberian-Zone may be classified according to their relationship to the Variscan deformation. This way, two main groups are distinguished: (1) the pre- to syntectonic bodies; and (2) the late- to post-tectonic granitoids. In the case of the MPL and the Saucelle granites, both are two-mica, peraluminous granites, belonging to the first group of syntectonic plutons. These granites and most of the pegmatites intruded pre-Ordovician metasediments of the SGC. In the FA area, the metamorphism shows an isograd distribution increasing to the South parallel to the MPL leucogranite contact, reaching locally the sillimanite (fibrolite) isograd.

Most of the pegmatites from the FA field correspond to poorly evolved pegmatites, which may be grouped in two main categories (Table 1, Fig. 1): (i) barren pegmatites with quartz, K-feldspar > albite, muscovite, tourmaline ± andalusite ± garnet, (types 1, 2, 3 and 4); and (ii) intermediate discordant pegmatites (types 5 and 6), characterized by the occurrence of Fe-Mn phosphates, montebrasite, and both 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 (types 7, 8, 9 and 10) and/or cassiterite (type 11). It is noteworthy that pegmatites from the first category are well intragranitic (types 1 and 3), well conformable to the hosting-rocks and occurring near the contact with the granite (types 2 and 4). On the contrary, pegmatites from categories (ii) and (iii) are clearly discordant, showing similar strikes, close to N10E, and similar dipping, close to the vertical. They occur as fracture filling, being these fractures attributed to a late tectonic event during the Variscan orogeny. These pegmatites occur further from the contact to the granite, northwards (Fig. 1). The main Li-bearing mineral assemblages in the Li-rich pegmatites include petalite (type 7); spodumene (type 8); lepidolite+spodumene (type 9); and lepidolite (type 10). It is remarkable that the Sn-rich dykes (type 11) occur folded and are crosscut by one lepidolite+spodumene dyke (type 9) in the Feli open pit, in the northernmost part of the field (Fig. 1). Some drillings made in this open pit showed the presence of a hidden granitic body under the Sn-rich and the lepidolite+spodumene rich dikes.

Table 1- Main characteristics of the groups of pegmatites recognized in the Fregeneda-Almendra area

TYPE	MINERALOGY Main minerals	 Other minerals	HOST ROCK METAMORPHISM	MORPHOLOGY AND STRUCTURE	REMARKS	ENRICHMENT
(1)	Qtz Kfs	ms ab tur	(intragranitic)	dyke-like thickness < 50 cm	scarce within the Lumbrales	K, Al, Si, (B, P) granite
(2)	Qtz and	ms tur Kfs chl	Andalusite zone	conformable dyke-like thickness < 40 cm	 main minerals	boudinage structures. Al, Si, (B, K) Qtz & and their
(3)	Qtz Kfs ms	ab tur bt	Sillimanite, andalusite and biotite zones	irregular and bulbous masses ellipsoidal, lenticular or turnip-shaped forms	abundant; aplite-pegmatite facies; graphic texture	K, Al, Si, (B)
(4)	Qtz Kfs ms ab tur	and chl grt bt	Sillimanite and andalusite zones	conformable dyke-like locally with internal zonation thickness 1 m	abundant; in some cases internal zoning, graphic texture	B, Al, Na
(5)	Kfs	Qtz ms pyrite	Biotite zone	disconformable dyke-like thickness > 1 m	not very abundant; main component is pink K-feldspar	K
(6)	Qtz Kfs ab ms	±pho ±mbs ±tur	Biotite and chlorite zones	disconformable dyke-like thickness < 10 cm - 2 m	most abundant Near the granite internal zoning can be present	K, Na, Al, Si, (P, Li)
(7)	Qtz pet ab ±ecr	ms cst ±mbs	Sillimanite andalusite and andal/biot limit	disconformable dyke-like without internal zonation thickness 5-30 m	main body mined in the Bajoca open-pit	Li, Sn, P
(8)	Qtz spd ab Kfs	ms mbs pet brl	Biotite/chlorite limit zone	disconformable dyke-like without internal zonation thickness 4-15 m	main body mined in the Alberto open-pit	Li, Sn, P, Be
(9)	Qtz ab, Kfs Li-mica ms spd	mbs cst brl ap ±ecr	Biotite and chlorite zones	disconformable dyke-like internal zoning common thickness <15 m	not very abundant; layered internal structure common Li-bearing minerals	Li, Sn, P, Be (Rb, Cs)
(10)	Qtz ab Li-mica Kfs	ms cst mbs	Biotite and chlorite zones	disconformable dyke-like internal zoning common thickness < 3 m	layered internal struct. lepidolite abundant	Li, Sn, P, Be (Rb, Cs)
(11)	Qtz cst ab	ms Kfs ap	Chlorite zone	disconformable dyke-like, thickness < 50 cm locally with internal zoning	scarce, and folded with a reduction in the vertical length	Sn, K, (P)

Qtz-quartz; Kfs-K-feldspar; ms-muscovite; ab-albite; tur-tourmaline; and-andalusite; chl-chlorite; bt-biotite; grt-garnet; py-pyrite; pho-phosphates; mbs-montebrasite; spd-spodumene; cst-cassiterite; ap-apatite; brl-beryl; ecr-eucryptite.

RESULTS AND DISCUSSION

Micas $^{40}Ar/^{39}Ar$ geochronology from pegmatites of the FA area yielded concordant spectra with overall 295.1 ± 4.2 Ma to 311.2 ± 3.7 Ma (MSWD < 2), and $^{40}Ar/^{36}Ar$ intercept statistically indistinguishable from the atmospheric value of 295.5. The main facies of the MPL granite yields a flat age spectrum and well-defined plateau age of 311.2 ± 3.7 Ma. Intermediate age values are in the range 305.0±3.3 to 300.0±3.1 Ma (hidden granite and Sn-rich dykes of type 11, respectively). Mica spectra for barren pegmatites of the category (i) are mainly composed of concordant steps and yield plateau ages included in this intermediate range. Micas from the (ii) and (iii) pegmatitic categories yield concordant spectra and plateau ages in the range of 295.1±4.2 to 296.4±3.5 Ma. These data are consistent with the Rb-Sr age (292±2.6 Ma) for the lepidolite-rich dyke occurring in the Riba d´Alva scheelite mineralization north from the FA field (Nitschke, 1998). It is noteworthy that all these pegmatites are discordant, (types 6, 7, 8, 9 and 10), showing similar strike, dipping and style.

Based on these results, three different sets of ages have been obtained for the granites and pegmatites from the FA area. The gap between the main facies of the MPL granite and the pegmatites belonging to the (ii) and (iii) categories, close to 15 Ma, makes it difficult to relate the origin of all these pegmatites with this granite. The geochronological results are in agreement with the geological data. The main facies of the MPL is prior to the development of any of the pegmatitic bodies in the FA field. Later granitic facies, with relative ages deduced from structural and mineralogical data, would be more possibly related with the crystallization of the barren pegmatites. In this way, the facies of the hidden granite located under the Feli open pit, with an age of 305.0±3.3 Ma, could be more probably related to the genesis of the barren pegmatites that have ages between 300.0±3.5 and 304.8±4.7 Ma. It is also possible that this granite is linked to the genesis of the Sn-rich dykes, with an age of 300.0±3.1 Ma and that occur as a stockwork over this granite. These Sn-rich dikes are crosscut by a younger lepidolite-spodumene-rich dyke, with an age of 295.3±3.9 Ma. The origin of the youngest pegmatites is likely to be related to a non-outcropping late-orogenic granite, with ages in the range 284-300 Ma, and that are common in this region.

The zonal distribution of pegmatites in relation to the MPL granitic complex in the FA area could be a casual and not causal feature, at least for the most evolved pegmatitic bodies. Anyway, further studies must be done, including dating of all the granitic facies in the MPL complex as well as the nearest late-tectonic granites. Also structural studies on these granites would help the interpretation of the petrogenetic links between the granitic and the pegmatitic rocks.

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