The Rare Element (Li-Rich) Pegmatite-Aplite Veins of the Almendra – Souto Field (Vila Nova de Foz-Côa and Penedono - NE Portugal)

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Summary: The Almendra-Souto (AS) region presents a high potential in geological resources. Surrounded by highly evolved granitoids, it is a region with metalogenic potential, known by its Sn, W and Li mineralization. The lithium mineralization in pegmatite-aplite veins occurs mainly as lepidolite (Charoy & Noronha, 1999), others with accessory spodumene (Gaspar, 1997) and more recently, Lima *et al.* (2003a) and Almeida (2003) mention petalite and montebrasite-amblygonite. Among the potential source granites of such mineralizations, all them with favourable metalogenic indications, we favor the late-F_3 Souto-Ranhados granite (Mêda-Penedono-Lumbrales Complex) and the late- to post-F_3 Arnozelo granite (Numão Pluton). A similar situation is described by Roda *et al.* (1996, 1998 and 1999) in the pegmatite-aplite areas of Fregeneda (Salamanca, Spain, near the border with Portugal) and Pinilla de Fermoselle (Zamora, Spain) with the occurrence of pegmatite veins enriched in rare elements, such as Li, Sn, Rb , Nb>Ta, B and P.

Geological Setting: The region is located in the Central-Iberian Zone (CIZ) (Julivert *et al.,* 1974), which host the rare element pegmatite-aplite veins within the AS, in the low-grade metamorphic Precambrian to Lower Cambrian "Complexo Xisto-Grauváquico" metasediments, mainly in the Rio Pinhão formation, but also in the alochthonous Pinhão and Desejosa formations, in the autochthonous Bateiras, and on the Ervedosa do Douro formations. The pegmatite-aplite field is bordered in the South by syn- to late-Hercynian granites (syn- to late-F_3), of the Mêda-Penedono-Lumbrales Complex, invaded into the "Lamego-Penedono-Escalhão" antiform. In the N-NW area of the field, E of the Vilariça fault, outcrops the late- to post-tectonic (relatively to F_3) Numão and Freixo de Numão granites (Silva & Ribeiro, 1991).

Mineralogy: the lithium mineralization occurs mainly as lepidolite, petalite and montebrasite-amblygonite. The lepidolite-bearing pegmatite-aplite dikes are largely dominated by pink lepidolite (as centimetric crystals or in fine-grained aggregates) and cleavandite. Amblygonite is replaced by secondary phosphates and lepidolite (Charoy & Noronha, 1999). In petalite-bearing pegmatite-aplite veins, the petalite occurs as white microcrystalline mineral masses or in centimetric crystals with perfect cleavage along {001}. Montebrasite-amblygonite appears as accessory mineral in millimetric crystals. In both cases cassiterite is a common accessory mineral.

Geochemistry: the regional granites, syn- to late-F_3 of Souto-Ranhados (ST) (Silva & Ribeiro, 1991); Escalhão (ES) (Silva & Ribeiro, 1994); "Quinta dos Boais" (QB) and the post-F_3 Arnozelo granite (AR) (Oliveira *et al.,* 1982), present typical values of metalogenic potential, according to criteria defined by Černý (1991b), potential mineralization indicators, dominantly lithium-bearing ones. They are enriched in lithophile rare elements (Rb, Cs, Li, F, Be, Nb, Ta but rarely W), peraluminous (ASI and A/CNK>1), calc-alkaline, with exception of ST (more alkaline), with values >70% SiO_2. The Na_2O/K_2O ratio ranges between 0.53 (ES/QB) and 0.77 (ST/AR) and values of CaO<1%. The P_2O_5 content ranges from 0.33% (ES/QB) to 0.73% (ST/AR) with contents of >0.5% most common, according to Bea *et al.* (1992), a good indicator of differentiation, particularly in peraluminous and siliceous granites. Also the ratio among the pairs (Ba, Sr, Zr)/(Nb, Rb, Li) support the granites specialization, for example, the Ba/Rb<1 ratio range between 0.15 (ST/AR) and 0.89.

The lepidolite and petalite-bearing pegmatite-aplite veins are both peraluminous (A/CNK>1), with low SiO_2, especially the lepidolite ones, with $Na_2O > K_2O$, reflecting clearly a dominance of albite over K-feldspar (Charoy & Noronha, 1999; Almeida, 2003). An inverse relationship between Na_2O and Li values is also evident. On the basis of the Černý (1992) K/Rb ratio criteria for the fractionation index, Bobos *et al.* (2004) consider the lepidolite-bearing pegmatite-aplite veins more evolved than the petalite ones. They also present lower values of Fe(total), MgO and CaO, with higher Al_2O_3 content, when compared with the specialized parental granites. The potassic character of the granites opposes to a more sodic composition in the final stages, corresponding to the mineralized pegmatite-aplite veins.

A stream-sediment exploration campaign realized by IGM (Portuguese Geologic Survey) for Sn and W revealed some Li-anomalies in the region. These anomalies have not yet been investigated but are target of

future research for studies those by Lima *et al.* (2003b) with very good results in the Barroso-Alvão pegmatite-aplite field (Northern Portugal).

Petrology: these rare element pegmatite-aplite dykes are classified as members of the LCT (Li, Cs, Ta) family Černý (1991a). They belong to the Complex type, mainly the lepidolite and petalite sub-type.

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