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Plagioclase and biotite compositions tracing granite genesis and evolution – insights from two syntectonic granitoids from Aguiar da Beira (N Portugal)

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The Aguiar da Beira area (N Portugal) is located within the Central-Iberian Zone (CIZ) of the Iberian Variscan Belt. It is mainly composed by granitoids emplaced during (syntectonic) or slightly after (late- to post-tectonic) the last ductile deformation event of the Variscan orogeny (D3). From the petrological and geochemical point of view, the syntectonic granitoids from the CIZ can be included into two genetically distinct suites: (a) calc-alkaline granodiorites and biotite granites, and (b) strongly peraluminous leucogranites and two-mica granites. In the Aguiar da Beira area, the first group is represented by a small intrusion of a medium- to coarse-grained porphyritc biotite granodiorite-granite, emplaced 322 Ma ago, characterized by a slightly peraluminous and moderately evolved composition. The second group comprises a NW-SE elongated pluton of a strongly peraluminous and highly evolved medium- to fine-grained muscovite-biotite granite (317 Ma), showing occasionally a gneissic foliation concordant with the D3 variscan structures.

Based on geochemical and Sr-Nd and $\delta^{18}O$ isotopic data, the biotite granodiorite-granite melt is interpreted either as the result of partial melting of heterogeneous lower crustal materials, or as the product of mixing of mantle derived magmas and lower crustal felsic anatectic melts. In contrast, the muscovite-biotite gneissic granite magma appears to have been exclusively generated by partial melting of upper crustal metasediments and suffered a subsequent evolution dominantly controlled by fractional crystallization processes.

Plagioclase and biotite major and trace element compositions can be used to constrain the origin and evolution of the two granitoids and provide strong evidence in support of the proposed petrogenetic models. In the biotite granodiorite-granite, the plagioclase is characterized by a wide compositional range (An_{20-33}), high Sr (749 − 869 ppm) and Ba (32 − 351 ppm) contents and a Sr discontinuous zonation pattern, whilst the biotite shows high TiO_2 (2.92 − 3.30 wt%), Ba (407 − 589 ppm), V (214 − 234 ppm), and low Al_2O_3 (16.83 − 18.03 wt%), Li (335 − 367 ppm), Zn (262 − 279 ppm) and $Fe^{2+}/(Fe^{2+} + Mg)$ (0.54 − 0.55) contents. These data confirm the typical calc-alkaline affinity of this intrusion and reveal that these phase minerals crystallized under disequilibrium conditions. In contrast, the plagioclase from the muscovite-biotite granite displays a narrower compositional range (An1-7), unzoned or normally zoned compositional patterns and lower Sr (19 − 33 ppm) and Ba (1.1 − 2.0 ppm) contents, reflecting the highly evolved character of this intrusion and near equilibrium crystallization conditions. The biotite crystals from the muscovite-biotite granite plot in the field of the aluminopotassic series in the total Al versus Mg (apfu) diagram (Nachit *et al.*, 1985), supporting a major contribution of metasedimentary rocks for the genesis of this magma. Their total Al contents increase with decreasing Mg suggesting an important role for fractional crystallization processes during magmatic evolution. The range of Al^{VI} and $Fe^{2+}/(Fe^{2+} + Mg)$ values (Al^{VI}: 0.482 − 0.487; $Fe^{2+}/(Fe^{2+} + Mg)$: 0.72 − 0.83) displayed by the biotites show that the muscovite-biotite granite crystallized from a reduced magma (low fO_2), which is consistent with its inferred sedimentary provenance.

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