Geochemical signature of the Pomarinho enclave swarm (Ossa-Morena Zone, Portugal)

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The enclave swarm of Pomarinho is located in the SW edge of Évora granitoid (Carvalhosa, 1983), in the SW sector of the Ossa-Morena Zone (Iberian Variscides). The Granialpa quarry constitutes a privileged exposure of that swarm and, therefore, it was used to collect samples for AMS, petrographic and geochemical studies. The dominant rock in the quarry is a medium-grained granodiorite, composed of plagioclase, quartz, alkali feldspar and biotite. This granodiorite displays a weak N-S planar anisotropy, defined by the arrangement of ferromagnesian minerals (mainly biotite). Dark-colored and fine-grained enclaves, that do not exceed 1% volume of the host rock, can be observed scattered throughout the quarry. However, in the NW part of the quarry, there is a cluster of enclaves which, locally, correspond to 40-50% of the volume of the host rock. These enclaves exhibit a significant variability in modal composition and texture; therefore, they constitute a heterogeneous swarm, according to Tobish et al. (1997). The enclaves correspond to tonalites and granodiorites, with either equigranular or porphyritic textures. Their modal compositions comprise essentially the same minerals found in the host granitoid; the major differences are the higher abundances of biotite and plagioclase and the occurrence of small amounts of hornblende, in the enclaves. AMS measurements on both the enclaves and the host rock are very consistent and show that magnetic lineations (K1) have a N-S trend and a plunge of 36° to the South (Moita et al., 2010). Geochemically, the host granodiorite is very homogeneous considering most of the major elements. It is slightly peraluminous (A/CNK~1.03), corresponding to an I-type granite (White & Chapell, 1977). Regarding trace elements, this granodiorite exhibits negative Nb-Ta anomalies [$(Th/Nb)_N$: 8.59-12.08; $(La/Ta)_N$: 1.73-2.18], slightly LREE-enriched patterns [$(La/Lu)_N$: 12.08-16.43] and negative Eu anomalies (Eu_N/ Eu_N*: 0.73-0.81). The enclaves may be divided into two groups. The first comprises tonalites with SiO2 from 63% to 65%, MgO from 2.2% to 2.4%, Fe_2O_{3t} from 5.1% to 5.8%, CaO from 4.1% to 4.8% and TiO_2 from 0.7% to 0.9%. Their A/CNK ratios lie in the range 0.98-1.03 and, therefore, they may be considered metaluminous to weakly peraluminous. The trace element geochemistry, similarly to the host, is characterized by the negative Nb-Ta anomalies [$(Th/Nb)_N$: 4.45-6.86; $(La/Ta)_N$: 2.02-2.65] and the slight enrichment in LREE [(La/Lu)N:9.12-11.38]. The second enclave group, with granodioritic compositions, is always slightly peraluminous (A/CNK ~ 1.05), and has higher SiO_2 and lower MgO, Fe_2O_3, CaO and TiO_2 values compared to the tonalitic enclaves. Compared to the host rock, the granodioritic enclaves have higher CaO and Na_2O and lower K_2O contents. The multi-element patterns of the second enclave group also show negative Nb-Ta anomalies [$(Th/Nb)_N$: 9.55 and 10.88; $(La/Ta)_N$: 1.35 and 1,58] and a small LREE enrichment [$(La/Lu)_N$: 9.48 and 12.86]. This preliminary geochemical information suggests that the enclaves and the host rock are probably derived of co-genetic magmas. In such a picture, the tonalitic enclaves and the host granodiorite should represent different degrees of fractionation from the same parental magmas. The granodioritic enclaves, on the other hand, may represent a strong mechanical interpenetration, but chemically incomplete, of the host granodiorite and the less evolved tonalite. Other data, such as isotope geochemistry (in progress) and AMS information, are expected to bring new light to the discussion on the Pomarinho enclave swarm genesis and evolution.

References

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Selective crustal segregation during magma hybridization in the mid-crust: Mineralogical and geochemical evidence from Variscan appinites (Avila Batholith, Central Iberia)

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Appinite intrusions represent the only manifestation of mantle-derived magmatism in many segments of the Variscan collision belt. The nature of the primitive liquids is generally hidden by extensive crystal fractionation and hybridization with partially molten crustal materials at depth. The presence of an interstitial melt in the mid-crust may cause selective segregation of more mobile crustal components towards the hybrid appinitic magma. In this work, we present mineralogical and geochemical evidence in Variscan appinites from the Avila Batholith (Central Iberia) for such processes. The appinites appear as meter- to hundred meter-scale enclaves included in peraluminous granodiorites or, less commonly, intruding migmatites. They range from high-Mg gabbros and cortlandtites (13-24 wt % MgO) to medium-Mg gabbros and diorites (8-13 wt % MgO), and low-Mg diorites and tonalites (<7 wt % MgO). Both high- and medium-Mg appinites crop out in the core of the largest bodies surrounded by a shell of low-Mg appinites which develop a brechoid facies at the contact with the host granodiorite. In the brechoid appinite, xenocrysts of quartz, plagioclase and K-feldspar megacrysts derived from the host granodiorite are frequent, suggesting that the host granodiorite probably was extensively crystallized when magma hybridization took place. However, biotite xenocrysts are exceptionally scarce. Medium-Mg appinites show a more primitive isotopic composition ($^{87}Sr/^{86}Sr_{314Ma} \approx 0.7040$-$0.7047$ and $\varepsilon Nd_{314Ma} \approx 0.39$ to -2.48) than high-Mg ones ($^{87}Sr/^{86}Sr_{314Ma} \approx 0.7046$-$0.7070$ and $\varepsilon Nd_{314Ma} \approx -0.61$ to -4.99). Low-Mg diorites present the same isotope composition as these latter. This suggests that Mg-richest appinites may represent cumulates of Mg-rich primocrysts fractionated from a low-Mg dioritic magma. The tonalites show a larger crustal isotopic signature with $^{87}Sr/^{86}Sr_{314Ma} \approx 0.7078$ - 0.7083 and $\varepsilon Nd_{314Ma} \approx -4.40$ to -3.34, which are within the range of variation of the host granodiorite ($^{87}Sr/^{86}Sr_{314Ma} \approx 0.7065$ - 0.7124 and $\varepsilon Nd_{314Ma} \approx -6.92$ to -3.17). However, they are more depleted in K_2O, Ba, Zr, Th and REE than expected by hybridization of the appinitic magma with the host granodiorite. This shows evidence for a significant deviation of the effective composition of the crustal mixing end-member from the mean composition of the host granodiorite during generation of tonalites. Biotite and K-feldspar are major carriers of K_2O and Ba in the host rock. However, the former tends to entrap a large fraction of monazite, xenotime and zircon grains of the host rock (e.g. > 70 wt %; Bea, 1996), and hence physically governs the distribution of Zr, Th, U and REE (see Bea (1996) for details). Therefore, the discrepancy between effective and mean crustal component compositions could be explained if the proportion of biotite of