

The Berlengas Archipelago granitoids within the frame of the Variscan Orogeny, W Portugal: new data and insights

Valverde Vaquero, P.¹, Bento dos Santos, T.^{2,3}, Clavijo, E.G.¹, Díez Montes, A.¹, Ribeiro, M.L.², Solá, A.R.², Dias da Silva, Í.¹

1: IGME, Spain; 2: LNEG, Portugal; 3: Universidade de Lisboa, Portugal

The Berlengas Archipelago, located 15 km west of the Portuguese mainland, constitutes the westernmost exposure of the Iberian Massif (Variscan Belt), being an important focus of controversial for its paleo-geographic position within the Variscan Orogeny. However, no reliable age control or P-T evolution has been provided which focused the discussion on its lithological and structural similarities with the other terrains/zones that constitute the Iberian Massif. The Berlengas crustal block is divided in: a) the Berlengas Group, mainly composed of a biotitic granite; and b) the Farilhões metamorphic complex, composed by an anatectic granitoid and paragneissic migmatites with granulite relics. The Berlengas granite is a medium to coarse-grained biotite-granite with rare K-feldspar phenocrysts, displaying an episenitic alteration and brittle deformation. Two monazite and three zircon fractions were analysed by ID-TIMS, displaying a concordant U-Pb age of 305.2 ± 0.5 Ma (MSWD=0.97). The Farilhões anatectic granite is a medium to fine-grained two-mica granite with quartz, K-feldspar, plagioclase, biotite, muscovite and sillimanite. This granite provided an ID-TIMS U-Pb weighted average age of 376.0 ± 3.0 Ma (three monazite fractions). A zircon fraction overlaps the Concordia at ~ 480 Ma, suggesting Ordovician or Cadomian inheritance (mixing line). The Farilhões granulitic relics are interlayered in the paragneissic migmatites and present an M1 prograde metamorphic paragenesis composed of plagioclase, quartz, type-I grossular-rich garnet and clinopyroxene that defines P-T conditions consistent with $P=8.6 \pm 1$ kbar and $T=915 \pm 50$ °C, followed by a similar M2 paragenesis representative of the metamorphic peak ($T=950 \pm 50$ °C) during decompression to $P=6 \pm 1$ kbar. Retrogressive M3 assemblage shows plagioclase, quartz, biotite, type-II almandine-rich garnet, amphibole, ilmenite and clinopyroxene relics reequilibrated to $T \approx 720$ °C and $P \approx 5$ kbar. Continuous exhumation and thermal readjustment followed to $T \approx 630$ °C and $P \approx 3.5$ kbar. The Farilhões paragneisses show ductile deformation and amphibolite facies metamorphic conditions, displaying migmatized and unmigmatized sectors. The migmatites show a prograde paragenesis composed of plagioclase, K-feldspar, quartz, type-III almandine-rich garnet, biotite and sillimanite consistent with the metamorphic peak at $T \approx 720$ °C and $P \approx 5.5$ kbar, being reequilibrated to $T \approx 600$ °C and $P \approx 4.5$ kbar, very close results to the M3 metamorphic stage of the granulite relics. The Farilhões granulite relics indicate that these rocks sustained abnormally high geothermal gradients, implying an external heat input for the M1-M2 metamorphic event. The M3 amphibolite facies metamorphism and deformation recorded in the Farilhões complex took place at ~ 376 Ma, probably as the result of the emplacement of the granulites in the middle crust. The Berlengas granite is 305 Ma, coeval with the late Variscan plutonism in the Central Iberian Zone and Ossa Morena Zone, whereas the older ages in the Farilhões complex are difficult to interpret. Although some hypotheses have now been discarded (e.g.: Proterozoic basement such as that dragged along Galicia and the continental margin of the Bay of Biscay, as previously suggested), the Berlengas crustal block shows enough geochronological and metamorphic similarities with the other main terrains/zones of the Iberian Massif to definitely assume its tectonic position within the Variscan orogen. Therefore, it should still be considered a suspect terrane (Finisterra).