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Insights into the petrogenesis and petrophysics of vein magmatism in the Lamas de Olo region, northern Portugal

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The onset of the final stages of the Variscan orogeny in the Central Iberian Zone (CIZ) is marked by the emplacement of several late to post-tectonic granite melts. The following transition into an extensional regime is associated with subvolcanic magmatism, commonly represented by veins and masses of rhyolitic porphyries, dolerites, and lamprophyres. In Portugal and Spain, these hypabyssal lithologies are fairly abundant.

The Lamas de Olo region of northern Portugal is located about 100 km to the ENE of Porto. Here, the most significant geological body is the composite, post-tectonic Lamas de Olo pluton. Several fracture systems, whose average trends are NNW-SSE, NNE-SSW, and WSW-ENE, cut through this pluton. The composing facies are known as the Lamas de Olo (LO), Alto dos Cabeços (AC), and Barragem (BA) granites. To the east of the pluton, there are two veins: a microgranite and a lamprophyre. While the microgranite is E-W trending, the lamprophyre is N53°E trending.

The felsic vein is rich in quartz and K-feldspar, which are frequently intergrown in granophyric texture, while muscovite, apatite, biotite, and ilmenite are accessories. The feldspars are intensely kaolinized and muscovitized, and biotite is mostly altered in chlorite and brookite/anatase. Compositionally, the microgranite is identical to the BA facies. It is subalkaline, highly felsic peraluminous, and associated with post-orogenic to transitional settings.

Biotite, K-feldspar, plagioclase, pyroxene, and amphibole are the main minerals composing the lamprophyre. Quartz, hematite, goethite, apatite, monazite, zircon, and magnetite are accessories. Pyroxene uralitization, amphibole biotitization, and biotite chloritization evidence the altered state of this vein. Geochemically, the pluton and lamprophyre have nothing in common. This lithology is metaluminous to weakly peraluminous, shoshonitic, alkaline, and associated with within-plate and post-collisional uplift settings. Zircon SHRIMP U-Pb analyses yield a concordia age of 295 ± 2 Ma (MSWD = 2.1) and the Nd isotopic signature is $\varepsilon Nd = -0.05$.

Considering the geochemistry, the microgranite is more evolved than the LO and AC granites. Most likely, it derived from a plagioclase-rich, crustal source, which was uncontaminated by mantle or young crustal materials. The microgranite melt was presumably derived from the same source that generated the BA granite, and its emplacement was controlled by WSW-ENE trending

fractures. The mineral assemblage is mostly diamagnetic, and the post-magmatic alterations were mainly triggered by meteoric fluids, thus generating an ambiguous magnetic fabric. The microgranite is also associated with a subhorizontal magma flow and shallow roots. On the other hand, the lamprophyre was presumably derived from the lithospheric mantle and strongly contaminated by lower crustal materials. Geochemically, the lamprophyre is unrelated to the pluton, but structurally the NNE-SSW trending fractures probably influenced its emplacement. The petrophysical results point out a ferromagnetic behavior and influence of hydrothermal fluids. Based on our results, the lamprophyre was seemingly generated and emplaced after the microgranite.

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