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Metasomatic enrichment in two-mica granites produced by Li-rich pegmatite intrusion: insights from whole-rock geochemistry in the Gonçalo Pegmatite Field (Portugal)

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Whole-rock geochemistry has been long-stablished in mineral resource exploration. The rising global demand for critical metals has intensified the refinement of this method, particularly for the identification of lithium-rich pegmatites. The open pit from Gonçalo (Guarda, Portugal) represents an exceptional location for the study of geochemical halos associated with the intrusion of Li-rich pegmatites, allowing the quantification of metasomatic anomalies in granitic host rocks. The studied host granite is a relatively homogeneous two-mica porphyritic monzogranite. The non-metasomatized host granite samples show a moderately- to highly-peraluminous composition (A/CNK ≈ 1.2), with Fe+Mg+Ti values (in millications) ranging from 40 to 90. Overall, the non-metasomatized granite displays relatively low CaO (≈ 1.04 wt%) and P_2O_5 (≈ 0.24 wt%) concentrations. In terms of major elements, in the first centimetres from the pegmatite contact some enrichment in P_2O_5, and depletion in Na_2O and CaO, is observed. In contrast, trace element variations are significantly more pronounced between non-metasomatized and metasomatized samples. Those metasomatized granite samples collected at the contact with the pegmatite exhibit enrichment in F, Be, Li, Ta, Rb, Tl, Ge, B, Mo, Cs, As, and Sn. The most prominent anomalies include B (up to 740 ppm), followed by Cs (up to 738 ppm), F (up to 0.91 wt%), and Li (up to 3250 ppm). Observed geochemical anomalies extend up to 3.5 m from the pegmatite contact, marked by Cs enrichment (Cs ≈ 182 ppm), whereas the first Li enrichment is observed at 2 m away from the pegmatite (Li ≈ 700 ppm). Given that the thickness of the studied lepidolite-bearing pegmatite dyke is of about 2.3 m, we conclude that the geochemical anomalies observed in the host granite extend only slightly beyond a distance equivalent to the thickness of the dyke. Considering geochemical halos produced by similar pegmatites in metasedimentary host rocks in Spain and Portugal, it seems that the magnitude of geochemical anomalies in granitic host rocks is more limited (both relative to the thickness of the dyke and in absolute terms). Therefore, geochemical exploration for rare-element-enriched pegmatites in granitic terrains should be supplemented with additional techniques.