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Unraveling the parental magma of the isolated Golpejas rare metal granite via mass balance and trace element modeling

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It is generally accepted that rare metal granites (RMGs) are derived from a less evolved magma, generally of granitic composition. However, most RMGs appear to be isolated, with no direct connection to other less evolved melts, so determining which is the parent magma of the RMGs is mostly an elusive and understudied topic. There is no doubt that knowing the parent magma of the RMGs would be a very valuable exploration criterion. The lack of a spatial relationship with less evolved melts in isolated RMG makes the search for the parent magma is based on: geochemical and isotopic constraints, zircon inheritance, and numerical modeling (e.g., mass balance, Rayleigh, and thermodynamic modeling), among others. Zircon inheritance appears to be a problematic issue in RMGs because they contain metamictized U-rich zircons, making it very difficult to obtain geochronological data that can be compared with the ages of zircons inherited from potential parent granites. Similarly, thermodynamic models (e.g., Rhyolite-MELTS) do a poor job of predicting the liquid lines of descent in RMGs, because they do not account for the effect of fluxing elements. In this work, we use mass balance and Rayleigh modeling as tools to decipher which is the most geochemically suitable magma parent of the Variscan Nb-Ta-rich Golpejas RMG, which appears isolated but in an area with a significant amount of nearby Variscan granitoids. Mass balance modeling was performed to estimate the proportions of fractionated minerals, and Rayleigh modeling was carried out to estimate evolutionary paths using the cumulative mode estimated by mass balance. Modeling excludes intermediate rocks and early granodiorites as parental melts. In contrast, the evolutionary paths of the highly peraluminous granites, especially the tourmaline-bearing leucogranites, match well with the less evolved samples of the Golpejas RMG. This finding provides evidence that areas with tourmaline-bearing leucogranites are a clear target for the search for new RMGs in Iberia.

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