SILICATE LIQUID IMMISCIBILITY IN ALKALI-RICH THOLEIITIC SYSTEMS: The role of unmixing in the petrogenesis of intermediate, layered intrusions and bimodal volcanic suites

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RESUMO

The Paraná Magmatic Province (PMP) represents one of the largest and well-preserved Large Igneous Province on Earth, consisting of tholeiitic basalts/basaltic andesites associated with subordinate silicic rocks, resulting in a bimodal compositional spectrum (the so-called Daly Gap). Although the Daly Gap is a descriptively well-known feature of many volcanic suites, decoding its origin is still a hotly debated issue in international literature, and at least two main causes are most frequently evoked to justify the deficiency or absence in intermediate compositions in the volcanic record (e.g., fractional crystallization and contrasting sources for basic-intermediate and silicic compositions). However, the role of silicate liquid immiscibility and whether it might account for the scarcity of intermediate compositions on Earth's surface remains poorly explored and rarely considered. The finding of natural immiscible Fe- and Si-rich silicate melts entrapped as apatite-hosted silicate Melt Inclusions in the sub-volcanic Limeira Intrusion strongly supports the role of immiscibility in the evolution of this occurrence, and the results could be extended to the PMP and contribute to our understanding of the Daly Gap for the high-Ti suite, suggesting large-scale magmatic differentiation owing to immiscibility. In the plutonic record, the incomplete unmixing within a mush is the best mechanism explaining the origin of intermediate compositions in this intrusion. On the other hand, in the volcanic sequence the LLD may have been interrupted during fractionation due to the onset of immiscibility and only the Si-rich reached the surface, for instance. In this study, we conducted thermodynamic models on experimentally produced and natural immiscible liquids, which revealed that immiscible pairs are indeed the compositions with the smaller free energies but showed contrasting patterns of Gibbs free energy of solutions. Our preliminary results suggest that the mechanism of immiscibility can represent a different way to minimize free energies of magma evolution, supported by the characteristic well-known, but poorly explored, natural tendency of differentiating basaltic magmas to pass rapidly through intermediate compositions. However, which mechanism (*i.e.*, fractionation/immiscibility) should be invoked to explain the Daly Gap must be reassessed, and investigating apatite crystals and natural immiscible liquids can be useful to track both processes by more accurate ‘smoking guns’.

Palavras-chave: Daly Gap, Melt inclusions, Silicate liquid immiscibility, Layered Intrusions, Paraná Magmatic Province.