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Constraints on melt evolution of lamprophyres from the Raniganj and Jharia basins, India: Insights from phlogopite compositions.

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Lamprophyres are volatile-rich ultrapotassic igneous rocks and generally exhibit mica-rich mineralogy with porphyritic textures. Lamprophyres have a wide variety of compositions ranging from alkaline to calc-alkaline to ultramafic types, and these rocks have significant geodynamic implications. We present new mineralogical data and major element chemistry of phlogopites from eight lamprophyre samples in the Jharia and Raniganj basins, India to classify and understand their melt evolutions. Phlogopite major element chemistry displays trends of elevated Al_2O_3 and FeO_T contents (up to 14.78 and 9.61 wt.% respectively), which is consistent with the calc-alkaline to alkaline lamprophyre affinity. Furthermore, the phlogopite grains commonly exhibit diverse compositional zonings (e.g., core-rim) regardless of their size variations, i.e., macrocrysts (>1000 μm), phenocrysts/microphenocrysts (500-1000 μm), and groundmass (<500 μm). Based on texture and chemistry, two different types of cores are identified including i) subhedral- to anhedral-shaped with light grey BSE response and high Ti, Al, Ba, and low Cr, Mg#, termed as “core 1”; ii) euhedral-shaped with darker grey BSE response with low Ti, Al, Ba, and high Cr and Mg#, termed as “core 2”. Internal zones between cores and rims are also observed in a few phlogopite grains with higher Cr and lower Al and Ba contents compared to the core 1 compositions. Moreover, overgrowing rims display large variations in Ti, Cr and Mg# and roughly overlap with core 2 compositions. Based on the sharp boundary between core 1 and rims and the subhedral to anhedral shapes of these core 1 zones, we propose that they represent “antecrysts” from previously failed lamprophyre-related melt intrusion(s). In contrast, core 2 shows diffuse contact with overgrowth rims, and they are the crystallised product of the host lamprophyre melt. The rims host abundant inclusions of apatite, suggesting magmatic origin. Using the insights from phlogopite chemistry, a comprehensive model of lamprophyre melt evolution is proposed. Furthermore, the core 2 zones in phlogopite grains of the studied lamprophyre samples exhibit similar compositions with the antecrystic phlogopite from the coeval adjacent lamproites, possibly pointing towards a genetic connection between lamprophyres and lamproites, which has been observed on very rare occasions.