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Origin of Ti-rich garnets in the groundmass of Wajrakarur field kimberlites, southern India: insights from EPMA and Raman spectroscopy

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Abstract

Although Ti-rich garnets are commonly encountered in the groundmass of many alkaline igneous rocks, they are comparatively rare in kimberlites. Here we report on the occurrence of Ti-rich garnets in the groundmass of the P-15 and KL-3 kimberlites from the diamondiferous Wajrakarur field in the Eastern Dharwar craton of southern India. These garnets contain considerable Ti (11.7–23.9 wt.% TiO2), Ca (31.3–35.8 wt.% CaO), Fe (6.8–15.5 wt.% FeOT) and Cr (0.04–9.7 wt.% Cr2O3), but have low Al (0.2–5.7 wt.% Al2O3). In the case of the P-15 kimberlite they display a range in compositions from andradite to schorlomite, with a low proportion of grossular (andradite(17.7–49.9)schorlomite(34.6–49.5)-grossular(3.7–22.8)-pyrope(1.9–10.4)). A few grains also contain significant chromium and represent a solid solution between schorlomite and uvarovite. The Ti-rich garnets in the KL-3 kimberlite, in contrast, are mostly schorlomitic (54.9–90.9 mol %) in composition. The Ti-rich garnets in the groundmass of these two kimberlites are intimately associated with chromian spinels, perhaps suggesting that the garnet formed through the replacement of spinel. From the textural evidence, it appears unlikely that the garnets could have originated through secondary alteration, but rather seem to have formed through a process in which early magmatic spinels have reacted with late circulating, residual fluids in the final stages of crystallization of the kimberlite magma. Raman spectroscopy provides evidence for low crystallinity in the spinels which is likely to be a result of their partial transformation into andradite during their reaction with a late-stage magmatic (kimberlitic) fluid. The close chemical association of these Ti-rich garnets in TiO2-FeO-CaO space with those reported from ultramafic lamprophyres (UML) is also consistent with results predicted by experimental studies, and possibly implies a genetic link between kimberlite and UML magmas. The occurrence of Ti-rich garnets of similar composition in the Swartruggens orangeite on the Kaapvaal craton in South Africa, as well as in other kimberlites with an orangeitic affinity (e.g. the P-15 kimberlite on the Eastern Dharwar craton in southern India), is inferred to be a reflection of the high Ca- and high Ti-, and the low Al-nature, of the parent magma (i.e. Group II kimberlites)..