New constraints on MARID- and PIC-style mantle metasomatism and their relationship to continental alkaline magmatism

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The LILE-enrichments and radiogenic Sr isotope compositions of lamproites and other alkaline magmas have commonly been attributed to the occurrence of phlogopite-rich rocks such as MARID (Mica-Amphibole-Rutile-Ilmenite-Diopside) in their mantle sources. To provide new constraints on the relationship between mantle metasomatism and alkaline magmatism, we have investigated the major and trace element compositions of MARID and PIC (Phlogopite-Ilmenite-Clinopyroxene) xenoliths, hosted in kimberlites and orangeites from the Kimberley area, South Africa.

As MARID and PIC xenoliths often do not exhibit their complete mineral assemblages, such phlogopite-rich rocks are better classified using geochemical criteria such as mineral major and trace element compositions (e.g. clinopyroxene chondrite-normalised Ce/Yb; MARID = 16-60 vs PIC = 10-21). New data indicate that major element compositions of phlogopite and clinopyroxene grains from PIC xenoliths are similar to those in peridotite xenoliths from the Kaapvaal craton; furthermore, MARID minerals exhibit broader compositional ranges than previously reported, and also partly overlap those in peridotites. These results necessitate the reconsideration of a genetic link between MARID/PIC rocks and metasomatised peridotites.

Importantly, similarities in the trace element compositions of MARID and other on- and off-craton peridotitic clinopyroxene indicate that MARID-like metasomatic fluids may be a ubiquitous feature of the lithospheric mantle. Comparing bulk-rock and average mineral trace element ratios suggests that melting of the silicate components of MARID rocks may contribute to the trace element enrichments in alkaline magmas (specifically magmas in the “lamproite clan”).