

Tracking sub-continental mantle evolution using unconventional stable isotopes: a case study of the Kaapvaal craton.

FRANCESCA INNOCENZI¹, PENG NI², HUGO ABE²,
MAXWELL C DAY¹, DAVIDE NOVELLA¹, PROF.
FABRIZIO NESTOLA¹, GRAHAM PEARSON³, SAMUELE
AGOSTINI⁴ AND MARTHA G. PAMATO¹

¹University of Padova

²UCLA

³University of Alberta

⁴CNR- IGG Institute of Geosciences and Earth Resources

Kimberlites represent a rare, ultramafic and ultrabasic rock-type that likely form from a H₂O- and CO₂-rich peridotitic mantle source [1]. The rapid ascent rate of kimberlitic melts, coupled with a high concentration of volatile elements, is conducive to violent eruptions and subsequent entrainment of abundant lithospheric and sub-lithospheric mantle xenoliths and xenocrysts. Thus, kimberlites are one of the most powerful tools to characterize the composition and structure of the sub-lithospheric cratonic mantle.

The Cretaceous kimberlite field in north Lesotho (southern Africa) hosts 17 pipes that intrude along the southeastern margin of the Kaapvaal Craton [2]. A set of nine mantle xenoliths, from three different kimberlites (i.e., the Letseng-la-Terai, Matsoku and Likhobong pipes), have been chosen for petrographic, mineral chemical and isotopic analyses to reconstruct the metasomatic history of the underlying lithospheric mantle. Samples range from garnet to spinel peridotite (lherzolite and harzburgite) composition ($\pm$ phlogopite). In particular, unconventional stable isotope systematics (e.g., H, K, B and Fe) were used to track the processes associated with different styles of mantle metasomatism. These data, coupled with radiogenic isotopes (Sr, Nd, Pb, Hf, Os) and major and trace element compositions point towards late refertilization of the depleted mantle by recycled crustal materials [2].

[1] Giuliani, Dalton & Pearson (2024). In *Treatise of Geochemistry, 3rd edition: Earth's Interior*, 159-230.

[2] Simon, Irvine, Davies, Pearson & Carlson (2003). *Lithos* 71, 289-322.

FI, MCD and MGP acknowledge funding from the European Union (ERC, INHERIT, Starting Grant No. 101041620).