Isotopic and Trace Element Signatures of Calcite, Apatite and Zircon from Carbonatite Liquid Associated with Cu-Ni-PGE Mineralization

Maria Cherdantseva, Marco Fiorentini
Centre of Exploration Targeting, School of Earth Sciences, The University of Western Australia, Perth, WA, Australia

Based on previous detailed mineralogical, petrological and experimental studies, we put forward a model whereby immiscible volatile-rich carbonatite liquid may play a key role in the transportation of Ni-Cu-PGE-rich sulfides from the mantle to the crust. The crystallized product of carbonatite liquid forming haloes surrounding magmatic sulfide globules generally comprises plagioclase, clinopyroxene, amphibole, phlogopite, carbonate, apatite, ilmenite and zircon. This paragenetic association can be found in many examples of magmatic sulfide deposits globally. To further refine our model, we have investigated and present here isotopic and trace element composition of accessory minerals (calcite, apatite and zircon) from three mineralized intrusions located at variable depths: lower crustal intrusion - Valmaggia pipe, Italy; middle crustal intrusion – Broken Hill, Australia; upper crustal intrusion – Rudniy, NW Mongolia. Results allowed us to confirm the carbonatitic origin of the haloes surrounding the magmatic sulfide globules and link their signatures in REE distributions among different phases to the depth of emplacement of the individual intrusions. The isotopic signatures of sulfur, carbon and oxygen in apatite, calcite and zircon, respectively, support a mantle source origin for the carbonatite liquid in mineralized intrusions emplaced at different depths and within very different country rocks. The proposed model of carbonatite-enhanced physical transport of magmatic sulfides may lead to a reconsideration of existing paradigms on the formation of orthomagmatic systems, enhancing the predictive and detective capability of exploration techniques to target elusive mineralized systems enriched in nickel, copper and the valuable platinum group metals.