Probe into the lithospheric mantle: platinum-group and trace element geochemistry of alkaline magmas in Yilgarn Craton, Western Australia

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Abstract

Our current understanding of the whole- lithosphere architecture is predominantly based on the image provided by a number of geophysical datasets and on the radiogenic isotope (e.g., Lu-Hf, Sm-Nd) composition of felsic, mafic and ultramafic rocks. This research aims to integrate existing knowledge by investigating the poorly documented mineralogical and geochemical features of alkaline rocks (lamprophyres, kimberlites, and carbonatites) as probes to unravel the composition of both the asthenospheric and lithospheric mantle under the Yilgarn Craton.

Geology of the Yilgarn Craton

- Igneous rocks that are rich in alkali metal contents (Na, K, P) and poor in silica (SiO2)
- Small volume occurrence in Proterozoic and Archean cratons
- Unique geochemistry: high contents of LREE (La, Ce, Pr, Nd), Middle Re (Sm, Eu, Gd), HREE (Lu, Yb, Lu)
- Minor tight distribution of PGE (Rh, Pd, Au) in Lamprophyre
- Kimberlite: Igneous rocks occurring in orogenic settings or plumes in the origin of kimberlites: U/Pb for the Yilgarn alkaline rocks

Alkaline Rocks as a Probe of the Mantle

- Carbonatites: Igneous rocks composed of more than 50 vol. % carbonate minerals
- Ultramafic Lamprophyre (ULM): Porphyritic igneous rocks with phenocryst of amphibole, phlogopite or clinopyroxene, and felsic matrix
- Calc-alkaline Lamprophyres (CAL): Porphyritic igneous rocks with phenocryst of amphibole, phlogopite or clinopyroxene, and felsic matrix

Major & Trace Element Data of Whole Rock

- Strong trace element enrichment
- Nb-Ta-Ti anomalies in CAL
- Overall similarity in trace element compositional trend of worldwide alkaline rocks

Platinum Group Element Results

- Strong depletion in PGE (Rh, Pd, Au) of lamprophyres
- Enriched Au contents in Yilgarn alkaline rocks
- Significant fractionation of IPGE and PPGE (Rh, Pd, Au) in Lamprophyres
- Similar PGE contents of Yilgarn kimberlites with Karriean kimberlites

Preliminary Results & Future Works

1. Major, trace and PGE geochemistry shows that the various types of alkaline rocks in the Yilgarn craton have different magma sources (e.g., lithospheric and asthenospheric mantle) and crystallization processes.
2. Trace element data of Yilgarn alkaline rocks are generally correlated with worldwide alkaline rocks, reflecting that the alkaline rocks are derived from the lithospheric mantle.
4. Strong Au positively anomalies of the alkaline rocks suggest that the lithospheric mantle is enriched, which could be related to orogenic Au deposits in the craton.

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