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Classification of Diamond Source Rocks in the Wajrakarur Kimberlite Field of Southern India: A Mineral Genetic Approach

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The mostly diamondiferous Wajrakarur Kimberlite Field (WKF) of Southern India comprises of about 30 kimberlites. These represent widespread Mesoproterozoic, potassic intracratonic magmatism, emplaced mostly as pipes in Archean granites and gneisses. The nomenclature of these rocks remains controversial and has been variously assigned as kimberlites (Group I), orangeites (Group II), lamproites and ultramafic lamprophyres. For the present study, twenty reasonably fresh kimberlites from the WKF field were examined in detail, and then classified using a mineralogical-genetic classification based on the IUGS classification scheme for igneous rocks [1, 2]. All the pipes exhibit an inequigranular rock texture, with macrocrystic and megacrystic olivines occurring in a finer grained matrix of phenocrystic olivine, as well as variable quantities of groundmass spinel, perovskite, monticellite, carbonate, phlogopite, clinopyroxene and Ti- rich garnets. The presence of abundant olivine (macrocrysts + phenocrysts), primary calcite, perovskite, monticellite, along with the Al- and Ti-poor nature of phlogopites and diopsides, as well as the absence of sanidine and K-richterite, precludes their classification as lamproites.

The presence or absence of groundmass clinopyroxene in these rocks (for example) has been used to discriminate Group I kimberlites from orangeites, lamproites and ultramafic lamprophyres. In the present study the distinction is based on mineral compositions. Groundmass clinopyroxene is abundant in 11 of the pipes, while it is absent in the remainder. The 9 pipes which do not contain clinopyroxene have low phlogopite abundances, along with strong Al_2O_3 enrichment (up to 20 wt. %) in the phlogopite, typical of Group I kimberlites. Spinels are mostly aluminous with Cr/(Cr+Al)<50 (molar) and falls into the 'magnesian ulvöspinel-trend' (kimberlite trend 1) on the projected front face of the reduced spinel prism, again confirming a classification as Group I kimberlites. In contrast, one pipe in the Lattavaram cluster shows an Al and Ti enrichment trend in phlogopite and diopside which is typical of ultramafic lamprophyres (UML). In this instance the spinels are restricted to the 'titanomagnetite trend' (kimberlite trend 2) and are compositionally similar to those in the Sarfartoq UML's of West Greenland. The presence of amphiboles, diopside and Ti-Zr rich garnets in the rock groundmass supports classification as UML.

Clinopyroxene in the remaining 11 pipes are phenocrystic Al-Ti poor diopsides. These intrusions are also characterized by comparatively Al-poor phlogopite (up to 3 Wt. % Al_2O_3) which is typical for orangeites. Spinels are mostly chromian spinels with compositions Cr/(Cr+Al)>50, and fall into 'kimberlite trend 2' compositions, again typical of orangeites. Hence it is concluded that these intrusions are all closely related to orangeites. This argument is supported by the presence of the Cretaceous TK1 pipe in the Timmasamudram cluster, which has an orangeite affinity [3]. Based on radiogenic isotope systematics, it is clear from this kimberlite that metasomatized subcontinental lithospheric mantle (the source of orangeite magmatism), was already in existence at ~1100 Ma in the mantle below the WKF.

References:

[1] Le Maitre R (2002) *Igneous Rocks: a Classification and Glossary of Terms.* Cambridge University Press, 236.

[2] Tappe S et al. (2005) J Petrol 46:1893–1900
[3] Chalapathi Rao NV et al. (2015) Gondwana Res. *http://dx.doi.org/10.1016/j.gr.2015.06.006*