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Evolution of the central Kaapvaal cratonic lithospheric mantle: A platinum group element and Re-Os isotope study of peridotites from the Premier Mine, S. Africa

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Determining the processes responsible for the formation and modification of sub-continental lithospheric mantle (SCLM) is key to understanding early crust formation and stabilisation. The SCLM, as a residue from partial melting, is characterised by depletion in basaltic melt components (Al, Ca, Fe), but contains high silica and incompatible trace element contents (LREE, Ba) indicative of metasomatic enrichment. Recent studies have shown that Kaapvaal SCLM records a complex melt-fluid enrichment history that has continued from the Archaean until recent time (e.g., Griffin et al., 2003; Kelemen et al., 1998).

Tomographic studies have establish that Kaapvaal SCLM forms a thick buoyant lithospheric root except for a NW-SE trendy region in Central Kaapvaal where a marked seismic anomaly coincides with the region of a major magmatic activity that formed the Bushveld Province at 2.05Ga.

This study aims to establish the exact effect of this major magmatic event on the SCLM through a study of mantle xenoliths from the Premier diamond mine that occurs in the centre of the seismic anomaly. The specific goal is to determine if new SCLM was formed at 2.05 Ga or if there was a major modification of existing SCLM. Results of combined petrology, major and trace element Hf-Os isotope study will be reported. Combination of PGE and Os isotope ratios are particularly powerful because extensive melting will cause fractionation among the PGE's and be recorded by an Os isotope ratio characteristic of the time of Re depletion (Walker et al., 1989).

Peridotites range from highly melt depleted spinel and garnet harzburgites to garnet lherzolites. The Premier suite is characterised by two PGE patterns: 1) Pd, Pt depleted comparable to many other Kaapvaal xenoliths and 2) almost flat chondrite normalised pattern and very consistent concentrations. Os model ages of the former group are generally Archaean whereas the latter clusters at ca. 2.0 Ga. A model will be presented to explain the observed depth vs. age melt depletion relationships which will constrain amount of new vs. modified SCLM beneath Premier.

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