Hf and Nd Isotope Systematics of 3.5 Ga Komatiites from ICDP Drilling in the Barberton Greenstone Belt, South Africa

J. BLICHERT-TOFT[1], G. COETZEE[2], A. WILSON[2] AND N. ARNDT[3]

[1]ENS Lyon, 69007 Lyon, France (jblicher@ens-lyon.fr)
[2]University of the Witwatersrand, Johannesburg, South Africa
[3]Université de Grenoble, 38400 St. Martin d'Hères, France

We measured major and trace element concentrations and ^{147}Sm-^{143}Nd and ^{176}Lu-^{176}Hf compositions for 18 komatiites from the ICDP core in the Barberton Greenstone Belt, South Africa. Two fractions of magmatic clinopyroxene (cpx) from a surface sample were also analyzed. All samples are of the Al-depleted Barberton-type komatiite and all show the geochemical signature of residual garnet in the source (low Al/Ti, depleted HREE). One sequence, however, is unusual in that it reveals petrographic and geochemical evidence that orthopyroxene (opx), as well as olivine, was on the liquidus. For the Lu-Hf isotope system, the whole-rocks and cpx define a linear array whose slope corresponds to an age of 3419±25 Ma, which is within error of the accepted age of the rocks (3.48 Ga). The Sm-Nd whole-rock and cpx data likewise fall along a linear array but yield a younger age of 3371±20 Ma. The high MSWD values for both systems indicate substantial scatter likely owing to element mobility that disturbed even these relatively robust isotopic systems. The average initial $\varepsilon_{Nd(T)}$ and $\varepsilon_{Hf(T)}$ for the whole-rocks are +0.2 and +1.5, respectively, while the cpx separates have $\varepsilon_{Nd(T)}$ = -1.1 and -1.5 and $\varepsilon_{Hf(T)}$ = +3.3 and +4.1. Given the scatter of the whole-rock data, and the evidence of secondary processes, the most robust constraint on the composition of the komatiite source comes from the two cpx. Their positive $\varepsilon_{Hf(T)}$ is in line with other results from komatiites from the Barberton Greenstone Belt but their negative $\varepsilon_{Nd(T)}$ is surprising in that it indicates an enriched source with low Sm/Nd. The peculiar characteristics of this source – low Sm/Nd and high Lu/Hf – is also found in the trace element compositions of the komatiites, which have moderately enriched LREE and negative Hf anomalies. The enriched LREE are consistent with that of a liquid extracted after deep melting but the origin of the Hf deficit is uncertain. The opx-phyric komatiites are isotopically indistinguishable from the other komatiites indicating that their Si-rich character was acquired during melting rather than derived from an older source. All the komatiites were produced by about 30% batch melting, at about 300 km depth, under conditions in which garnet remained in the residue during the melting process.