Geophysical Research Abstracts
Vol. 16, EGU2014-2330, 2014
EGU General Assembly 2014

Melting conditions and sources of 3.5 Ga komatiites from ICDP Drilling in the Barberton Greenstone Belt, South Africa

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We measured major and trace element concentrations and Sm-Nd and Lu-Hf isotope systematics in 18 samples of komatiites from the core recovered from the ICDP drilling project in the Barberton Greenstone Belt, South Africa. Two fractions of magmatic clinopyroxene from a surface sample were also analysed. 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 as well as olivine was on the liquidus. For the Lu-Hf systems, the whole-rock data and the clinopyroxene separates 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 scatterchron gives a younger age of 3371±20 Ma. Initial isotopic values for the clinopyroxene separates provide high-precision results, with epsilon Nd(T) = -1.1 and -1.5 and epsilon Hf(T) = +3.3 and +4.1. The positive epsilon Hf value is in line with other results from komatiites from the Barberton Belt but the negative epsilon Nd value 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 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 remains uncertain.

The orthopyroxene-phyric komatiites are isotopically indistinguishable from the other komatiites indicating that its Si-rich character probably was acquired during melting rather than being derived from an older source. All these 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.