Lu-Hf isotope systematics of 3.47Ga Barberton basalts: Constraints on early crust-mantle evolution

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The early evolution of the Earth's crust-mantle has been studied by applying the ^{176}Lu-^{176}Hf system to Archean mafic rocks since 1980 (e.g., [1]). Early studies showed that some early-middle Archean rocks have high ε^{176}Hf values, suggesting that the ancient mantle was greatly depleted in incompatible elements. This interpretation is only valid if the Lu-Hf system has not been disturbed during post-magmatic events. Recently, a whole-rock isochron approach has been utilized to test whether the Lu-Hf systems are primary or not: a Lu-Hf whole-rock isochron age comparable to the independantly derived emplacement age verifies the primary signature (e.g., [2–4]). Studies based on this approach reveal that ε^{176}Hf values of early-middle Archean rocks are not as high as previously reported. We extend this whole rock isochron approach to the well-preserved 3.47 Ga basalts from the Hooggenoeg and Kromberg Complexes of the Onverwacht Suite of the Barberton Greenstone Belt, South Africa, in order to better constrain the early crust-mantle evolution. Furthermore, we evaluate the origin of Barberton komatiites by comparing our basalt data with previously reported komatiite Lu-Hf data [5].

Our Lu-Hf data for 37 rock samples from both of the complexes yield isochron ages identical to their emplacement ages. We obtained ε^{176}Hf values of 2.30±0.57 (2SD) for these basalts, suggesting that their source mantle had been moderately depleted in incompatible elements. Combined with the Lu-Hf data obtained from other regions tested against the whole-rock isochron approach, we find that ε^{176}Hf of ancient mantle increased gradually from the early to middle Archean. Such gradual increase in ε^{176}Hf may be attributed to the formation of relatively stable continental crust during the period. Our results also reveal that the Barberton komatiites and basalts have identical ε^{176}Hf and ε^{143}Nd within analytical uncertainties. These finding imply that whilst the komatiites and basalts may have formed by different mechanisms (e.g. different degree of partial melting), they were derived from a common mantle source [6].

[1] Patchet&Tatsumoto (1981) *CMP* **78**, 437. [2] Blichert-Toft et al. (1999) *GCA* **99**, 75. [3] Rizo et al. (2011) *EPSL* **312**, 49. [4] Hoffmann et al. (2010) *GCA* **74**, 7236. [5] Puchtel (2013) *GCA*. **108**, 63. [6] Furnes et al. (2012) *SA Journ. Geology, **115**,171*