

Nb/U in komatiites: perspective on Archean crustal volume

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The timing and rate of continental crustal evolution have been extensively examined by the record preserved in zircons, but much of this record has been compromised by crustal reworking and/or recycling. Here, we approach this problem by looking at the residual mantle using a purely chemical tracer, the Nb/U ratio, which can be taken as a measure of the relative proportions of crust and residual mantle existing at any time in the past [1]. Previous attempts to use the Nb/U or Nb/Th tracers [2-4] were hindered by sparse/low quality data or by the effects of crustal contamination and/or alteration. Our recent results for Archean komatiite suites now allow a new assessment. In order to circumvent problems caused by U mobility during alteration and metamorphism of komatiite systems, we infer primary U abundances from Th/U ratios, which, in turn, are obtained from Pb isotopic compositions of well preserved komatiite systems from around the globe. We use a mean modern-mantle Nb/U = 46 from recent MORB averages [5, 6].

Three early Archean komatiite systems from the Kaapvaal Craton in South Africa yield identical Nb/U = 42±4. Seven late Archean komatiite systems from the Baltic and Canadian Shields, the Yilgarn Block, Australia, and the Aldan Shield, Siberia yield a mean Nb/U = 43±5. We infer a “best value” for the Nb/U ratio of the Archean mantle to be 42±4 (2SD), in agreement with ref. [4]. These results, combined with current estimates of crustal Nb and U values [7], allow no significant undifferentiated present-day mantle reservoir and a maximum crustal mass fraction of 0.0053. In Archean times, the amount of continental crust was nearly constant at about 75% of the present-day mass, assuming the size of the mantle reservoir involved in crust production was the same as today. The crustal volume could be smaller if the mantle source reservoir was also proportionally smaller or if the crust was substantially more mafic in the Archean.

[1] Hofmann A.W. et al. (1986) *EPSL* 79, 33-45. [2] Jochum K.P. et al. (1991) *EPSL* 107, 272-289. [3] Collerson K.D. and Kamber B.Z. (1999) *Science* 283, 1519-1522. [4] Campbell I.H. (2003) *Am. J. Science* 303, 319-351. [5] Gale A. et al. (2013) *G3* 14, 4895. [6] Jenner F.E. et al. (2012) *G3* 13.6. [7] Rudnick R.L. and Gao S. (2014) *Treatise on Geochem.* 4.1.