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Archean crust-mantle evolution gleaned from the komatiite record: the Nb-Th-U-Pb perspective

IGOR S PUCHTEL[1] AND ALBRECHT W. HOFMANN[2]

[1]University of Maryland
[2]Max-Planck-Institut für Chemie

The timing and rate of continental crustal growth have been the subjects of extensive studies, mostly using record preserved in zircon. In this study, we address this scientific challenge by investigating the chemical evolution of the crust-mantle system using Nb/U and Th/U ratios in komatiites of various ages, which can be taken as measures of the relative proportions of the continental and oceanic crusts and residual mantle existing at any time in the past. Previous attempts to use these tracers were hindered by low data quality and the effects of crustal contamination and alteration. We analyzed sample sets of the best preserved, contamination-free komatiite systems from around the globe selected on the basis of the high-quality lithophile radiogenic isotope and trace element data. In order to circumnavigate the issues caused by ubiquitous U mobility during seafloor alteration and metamorphism, we obtained the primary U abundances from Th/U ratios derived from high-precision Pb isotopic analyses. In our mass-balance calculations, we used the present-day BSE and DMM Nb/U = 27 and 46, respectively, and Th/U = 4.0 and 2.6, respectively [1].

The early Archean komatiite systems from the Kaapvaal Craton (3.55-3.27 Ga) have a mean calculated Nb/U = 42.8±3.2, whereas the late Archean komatiite systems from the Fennoscandian and Canadian Shields (2.88-2.70 Ga) have a mean Nb/U = 43.9±3.0, with the Archean mantle having an average Nb/U = 43.4±3.1 (2SD). These data imply that in the Archean, the amount of continental crust was nearly constant at about 85±15% of the present-day mass, with a rapid growth up to the present-day mass by 3.55 Ga, followed by a near steady-state evolution of continental crust formation/destruction thereafter. The calculated Th/U ratios varied between 4.19±0.17 and 3.00±0.25 in the early Archean and between 3.51±0.10 and 2.99±0.19 in the late Archean, indicating a continuous extraction of up to 70±15% of the present-day mass by 3.27 Ga and a near steady-state evolution of oceanic crust formation/recycling thereafter, assuming the size of the mantle reservoir involved in the crust production was similar to that of today.

[1] Hofmann A.W. et al. (2022) *G*^{3} 23, e2022GC010339.