Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.19134

Strontium isotopes paradox of Archean komatiites

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The rate of production and recycling of oceanic and continental crust and their link to global tectonics are still largely unknown for the first billion years of Earth's history. One way to study these phenomena is to use radiogenic isotope pairs where parental and daughter isotopes fractionate significantly during the melting process. The ^{87}Rb-^{87}Sr pair is the best in this respect among the lithophile elements. We obtained Sr isotope compositions of komatiite melt inclusions protected by host olivine from alteration from the 3266±9 Ma Weltevreden komatiites (Barberton greenstone belt, South Africa).

Over 110 inclusions of melt in high Mg olivine phenocrysts (Fo95-93) from four komatiite flows were heated to 1350 1400^{o}C at 1 atm and QFM-1 buffer, quenched to homogenous glass and studied by split steam LA-MC–ICP–MS/ICP–QQQ for Rb-Sr isotopes and trace elements. 95 inclusions yield a homogenous group with an average initial ^{87}Sr/^{86}Sr ratio close to BSE (BABI) evolution value for the komatiite's emplacement age (0.70064±0.00009, MSWD = 0.96 vs 70052±0.00005 for BSE for at 3266 Ma). This corresponds to the minimum (Rb=0) BSE model age of komatiites of 3247±76 Ma. A subset of 11 inclusions yields average initial ^{87}Sr/^{86}Sr ratio of 0.69932±0.00028, MSWD = 0.66, corresponding to 4307±224 Ma minimum BSE model age. Both inclusion groups are similar in chemical composition and are strongly depleted in Pb, Th, and U compared to BSE: Ce/Pb = 16.4±1.3, 2se (BSE=9.1, Hofmann, 1988); Nb/U=38±4 (30.4); Nb/Th=11.7±0.9 (7.6). These values suggest that the BSE mantle was involved in the production of oceanic crust, extraction from the latter of continental crust, and recycling residual components deep in the mantle to form plume-produced komatiites by 3266 Ma.

The BSE Sr isotope ratio for highly fractionated mantle forms a paradox. It can be resolved if the explained cycle lasted less than few hundred Ma. The ancient component had to produce the same cycle in the Hadean time. This implies an active, deep subduction and recycling process since the Hadean. We will discuss this and alternative explanations of our results in connection with geodynamic modelling (S. Sobolev et al., and Jain et al., this meeting).