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Evolution of Paleoarchean Singhbhum Craton: Constrains from Sr isotope analysis of apatite inclusions in zircon

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The Rb-Sr isotope system is much more sensitive to chemical fractionation than the Sm-Nd and Lu-Hf systems [1]. However, the Rb-Sr systematics of Archean rocks has not gained much attention in terms of its use to probe the early crust mantle evolution. The main reason being its susceptibility to later modification by alteration and metamorphic overprinting. Recent developments in in-situ techniques are showing the potential for matrix apatite and apatite inclusions within zircon (apatite having near zero Rb/Sr) to preserve the initial $^{87}Sr/^{86}Sr$ of the Archean rocks[2].

A new laser ablation multi-collector inductively coupled plasma mass spectrometry method [2] was used to analyse matrix apatite and apatite inclusions in zircon extracted from rocks of different lithological units from the Paleoarchean Singhbhum Craton to obtain the most pristine initial $^{87}Sr/^{86}Sr$, which coupled with the derived Rb/Sr ratio of the source, constrains the Sr isotopic evolution of the craton and the mantle beneath. For this the data is filtered for the least radiogenic Sr-isotope ratios, eliminating recrystallized and reset apatite grains with higher initial $^{87}Sr/^{86}Sr$ values. Apatite inclusions in zircon systematically preserve more primitive initial $^{87}Sr/^{86}Sr$ values than their matrix counterpart, which advocate towards their chemically primary nature and efficiency in preserving the initial $^{87}Sr/^{86}Sr$.

Initial $^{87}Sr/^{86}Sr$ data from apatite ($^{87}Sr/^{86}Sr$ = 0.70090 to 0.70157) of the 3.44 to 3.20 Ga Singhbhum TTGs (OMG, OMTG) and Singhbhum Granites show extraction from a depleted mantle source with Rb/Sr~0.2 at 3.5Ga, with very short crustal residence time. Initial $^{87}Sr/^{86}Sr$ of the matrix apatite from the older Singhbhum Iron Ore Group show even more primitive values and extraction from a much older mafic source with longer crustal residence time than the TTG source.

[1] Dhuime et al. (2015) Nat. Geosci. 8, 552-555.
[2] Emo et al. (2018) GCA, 235, 450-462.