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Initial $^{87}Sr/^{86}Sr$ from apatite and $^{176}Hf/^{177}Hf$ from zircon - whole rock pair constrain the origin of Archean felsic crust and presence of Archean crustal cycle

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The initial isotope composition of igneous rocks provide geochemical constraints on the age and composition of their source(s). However, determining initial isotope ratios for rock samples can be challenging particularly in rocks with a long and protracted thermal history. This is particularly the case for the Rb-Sr system, that is very sensitive to alteration due to the strong fractionation of Rb from Sr during magmatic and metamorphic processes. In contrast, Sm-Nd and Lu-Hf are less sensitive to fractionation processes in the crust. Initial isotope compositions can be obtained directly from minerals that strongly prefer the daughter element and effectively exclude the parent element of the isotope system of interest. Apatite having a near zero Rb/Sr ratio is ideal for preserving its initial $^{87}Sr/^{86}Sr$ corresponding to the time of last equilibration and zircon records initial $^{176}Hf/^{177}Hf$ compositions.

A newly developed LA-MC-ICPMS method [1] was used to determine the initial $^{87}Sr/^{86}Sr$ from matrix apatites and inclusions in zircon from 3.5-3.2Ga TTGs and granites from the Singhbhum craton. Both the matrix apatite and inclusions in zircon from these rocks efficiently preserve the primitive initial $^{87}Sr/^{86}Sr$, with the inclusions having slightly less radiogenic values. These Sr-isotope compositions in combination with in-situ Hf in zircon [2] and whole rock Hf data [3] from these rocks provide firm constraints on the petrogenesis and origin of the Paleoarchean felsic crust of the Singhbhum Craton.

The Hf-data indicate a mantle extraction age of 3.7-3.8Ga for the TTG suite and granites. In combination with the Sr isotope data from apatite it can be inferred that they had a mafic crustal source with ca. 50 wt% SiO_2 that formed at 3.7-3.8Ga and got reworked at around 3.5Ga, producing the earliest phase of the Singhbhum TTG suite. Sr isotope data further suggest these earliest phase TTGs got quickly reworked in the next 200-300 Ma to produce the next generation of Singhbhum TTG suites and granites, completing the Eoarchean to Paleoarchean crustal cycle in Singhbhum Craton.

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