Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.14477

Titanium Isotope Insights into the Formation and Evolution of Sanukitoid Magmas

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Sanukitoids are magmas that are both compositionally and temporally transitional between sodic Archean tonalite-trondhjemite-granodiorite (TTG) suites and potassic post-Archean granites. They are generally thought to form by partial melting of mantle peridotite that was metasomatized by an incompatible element-enriched component. The identity of this metasomatic agent and its role in creating compositional diversity among sanukitoids are however debated [e.g. 1]. Additionally, the differentiation of sanukitoid parental magmas to form the more evolved rocks of the “sanukitoid suite” is poorly constrained. Previous studies of titanium (Ti) stable isotopes have shown that the $\delta^{49/47}$Ti of magmas can be fractionated when they crystallize Fe-Ti oxides (rutile, Ti-magnetite, ilmenite) and silicate minerals such as amphibole, but is not fractionated during partial melting of typical mantle lithologies [2, 3]. Therefore, the $\delta^{49/47}$Ti of sanukitoid magmas can provide new insights into both the nature of the metasomatic agents in their mantle source, and the conditions of their differentiation.

Here we present titanium stable isotope data for Mesoarchean sanukitoids from the Pilbara Craton, Neoarchean sanukitoids from the Black Flag Group [4], Yilgarn Craton, and Paleoproterozoic sanukitoids from the São Francisco Craton. We compare these to 420 Ma high Ba-Sr granites from Scotland which are considered a Phanerozoic sanukitoid analogue [5]. Primitive sanukitoids and high Ba-Sr granites have significantly heavier $\delta^{49/47}$Ti than the mantle, which may show their mantle source was metasomatized by melts derived from rutile-bearing metabasite and/or sediments. The $\delta^{49/47}$Ti then increases as the magmas become more evolved due to fractional crystallization of amphibole and Fe-Ti oxides. Distinct trends of $\delta^{49/47}$Ti vs indices of differentiation (e.g. SiO_2, Mg#) are seen, both within the Black Flag Group and between suites of different ages, which may reflect differences in the H_2O content and/or oxidation state of the parental magmas.

References:

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