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Thallium isotope constraints on the origins of the 2.66 – 2.69 Ga Black Flag Group Sanukitoids (Yilgarn Craton, Australia)

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Sanukitoids are magmas associated with Archean TTGs (Tonalite Trondhjemite Granodiorite gneisses, widely considered to represent the Earth's earliest continental crust) that are enriched in incompatible elements but have high MgO, Cr and Ni contents [1]. They have been proposed to form by melting of lithospheric mantle previously metasomatised by incompatible-element-rich fluids or melts, derived from either the lower crust or subducted and hydrothermally altered oceanic crust. We present a Tl isotope study of well-characterised sanukitoids and associated lamprophyres from the Black Flag Group (BFG; Yilgarn Craton, Western Australia) [1, 2] with the objective of using Tl isotopes to better constrain the nature of the sanukitoid source metasomatic agent. Thallium stable isotopes (ε^{205}Tl = parts per 10,000 deviation relative to NIST SRM 997 standard) are a useful tracer in this respect because Tl is a highly incompatible element and altered oceanic crust has a distinct ε^{205}Tl signature (-15.5 to -1.9 [3]) relative to rocks derived from the convecting mantle and continental crust (-2 ± 1 [4]).

Thallium isotope analyses were carried out following standard analytical protocols [3, 5] on two sub-groups of BFG sanukitoids, which are distinguished on the basis of La/Th ratios, emplacement, and Nd model ages. Our Tl isotope data for primitive samples from these two groups suggest that they are derived from sources with distinct ε^{205}Tl. Primitive samples from the older (2.69 Ga, U-Pb zircon age) low La/Th BFG group are characterised by relatively light ε^{205}Tl (~ -3.8), whereas primitive samples from the younger (2.66 Ga, U-Pb zircon age) high La/Th BFG group are characterised by mantle-like ε^{205}Tl (~ -2.0). There are no correlations between ε^{205}Tl and indices of alteration or magmatic differentiation. Our preliminary interpretation of the contrasting ε^{205}Tl signatures of these two groups is that they were derived from different lithospheric mantle sources enriched by metasomatic agents of contrasting origins. Additional data and modelling will be presented.

[1] Smithies et al., (2019) Nat Comm; [2] Smithies Geological Survey of Western Australia Report 226 (2022); [3] Nielsen et al., (2006) EPSL; [4] Nielsen et al., (2017) Rev. Mineral. Geochemistry [5] Brett et al., (2018) Geost. Geoanal. Res.