A coupled $\mu^{182}W$-$\delta^{57}Fe$ record of early terrestrial mantle differentiation?

H.M. WILLIAMS[1], H. RIZO[2], I.S. PUCHTEL[3]

[1]The University of Cambridge, UK; hmw20@cam.ac.uk
[2]Carleton University, Canada; hanika.rizo@carleton.ca
[3]University of Maryland, USA; ipuchtel@umd.edu

Archean komatiite and basalt suites provide important windows into the composition of the early Earth mantle and its differentiation history. Komatiites from the Barberton Greenstone Belt (BGB) and metabasalts from the Isua Supracrustal Belt (ISB) document a ~300 Ma magmatic record that can be used to explore secular changes in mantle source region and partial melting processes. Radiogenic Nd and Hf isotopic data for BGB komatiites and the ISB metabasalts, coupled with the presence of ^{142}Nd and ^{182}W anomalies, are consistent with derivation from deep-seated mantle reservoirs generated during magma ocean crystallization involving the fractionation of bridgmanite and Ca-perovskite phases during the first 500 Myr of Earth history [1-3].

Iron stable isotopes are relatively insensitive to the effects of alteration, crustal contamination and late accretion and can be used to explore variations in mantle redox state and source mineralogy [e.g. 4-6] . We present new Fe isotope data for 3.72 Ga ISB metabasalts and komatiites from the 3.48 Ga Komati, 3.26 Ga Weltevreden Formations and 3.55 Ga Schapenburg Greenstone Remnant (SGR) of the BGB. Our data indicate that significant differences in Fe isotope systematics exist between these suites, providing evidence for Fe isotope heterogeneity in the early Archean mantle. Striking positive correlations exist between $\delta^{57}Fe$ and $\mu^{182}W$ in the SGR and ISB samples, which display negative and positive ^{182}W anomalies, respectively. These data suggest that the $\delta^{57}Fe$ and ^{182}W heterogeneity of the ISB and SGR mantle source regions was established by ~3.72 Ga and was likely inherited from core formation and early mantle ocean differentiation processes. The observations provide evidence for the early formation of the positive and negative-$\mu^{182}W$ mantle domains observed in both ancient and modern mantle melts [7].

[1] Puchtel et al., (2013) GCA. [2] Puchtel et al., (2016) G^3 [3] Rizo et al., (2011) EPSL [4] Williams and Bizimis (2014) EPSL. [5] Dauphas et al., (2014) EPSL. [6] Williams et al., (2012) EPSL. [7] Mundl-Petermeier, et al. (2020) GCA.