The stable tungsten isotope composition of some of the Earth's oldest rocks from SW Greenland

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The Isua supracrustal belt and adjacent mafic and ultramafic enclaves in the Itsaq gneiss Complex of SW Greenland consist of a complex assemblage of amphibolites, chemical and clastic sediments and felsic- to ultramafic units. Their geochemical composition provides information on the origin and tectonic evolution of the early Earth's crust. These rocks show a homogeneous ^{182}W excess, which was explained by either a missing late veneer component [1] or by early silicate differentiation during the lifetime of short-lived ^{182}Hf, respectively [2]. The homogeneity in the ^{182}W excess is attributed to a W-rich metasomatizing agent that carried this excess. However, it remains ambiguous whether Eoarchean mantle rocks carried the observed ^{182}W excess already prior to the metasomatizing event.

Here, we present the first stable W isotope data for various Eoarchean rocks from the Isua supracrustal belt and enclaves in the Itsaq Gneiss south of Isua. Mafic units that are enriched in W show lower $\delta^{186/184}W$ values down to -0.072 ± 0.018 ‰. Closely related felsic units show significantly higher $\delta^{186/184}W$ values up to +0.156 ± 0.018 ‰. Since fractional crystallisation has minor effects on the stable W isotope composition of magmas [3], this observed variation indicates distinct W sources for felsic and mafic magmas, respectively. Accordingly, the homogeneous excess of ^{182}W that is observed in felsic and mafic units was widespread and not limited to late-stage metasomatizing agents. Furthermore, the observed range in $\delta^{186/184}W$ values is clearly distinct from the rather homogeneous modern mantle stable W isotope composition (+0.085 ± 0.019 ‰) [3]. The range, however, overlaps compositions of young subduction-related lavas [3], possibly calling for modern-like horizontal plate tectonics in Eoarchean times, at least on a regional scale.

[1] Willbold *et al.* (2011) Nature **477**, 195-198. [2] Touboul *et al.* (2012) Science **335**, 1065-1069. [3] Kurzweil et al. (2019) Geochim. Cosmochim. Acta **251**, 176-191.