Large ^{182}W anomalies in Eoarchean residual mantle rocks from northern Labrador, Canada

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High-precision (< ±5 ppm 2σ SD) W isotopic ratio measurements have boosted recent exploration of early Earth processes[1,2,3]. W isotope anomalies have been reported for the 3.8 Ga Isua rocks[1], the 2.8 Ga Kostomuksha komatiites[2] and the ≥3.8 Ga Nuvvuagittuq rocks[3]. All these rocks exhibit up to 15 ppm ^{182}W enrichments, which are inferred to lie within the estimated mantle composition prior to addition of 0.3 to 0.8 wt.% to Earth of late accreted materials[4]. However, the calculated higly siderophile element (HSE) contents of the mantle source for the Kostomuksha komatiites are similar to modern mantle, inconsistent with a source dominated by a pre-late accretionary mantle reservoir. Thus, their mantle source must have incorporated an ancient (when ^{182}Hf was still extant; i.e., <50 Ma after Solar System formation), high Hf/W component[2].

We have determined the first W isotope measurements on *bona fide* mantle rocks using high-precision (3.7 ppm 2σ SD) N-TIMS, for >3.8 Ga ultramafic rocks (i.e., residual lithospheric mantle peridotites and supracrustal meta-komatiites) from northern Labrador, Canada. Within the peridotitic suite, 9 samples show well-resolved, variable ^{182}W enrichments ranging from +9 to +22 ppm, while three meta-komatiites have uniform ~+9 ppm enrichments. Such W isotope anomlies are consistent with the estimated isotopic composition of the mantle prior to late accretion. However, the relative and absolute HSE abundances in both suites are similar to their late Archean equivalents, indicating the delivery of late-accreted materials prior to 3.8 Ga. Prominent W enrichments, relative to elements with similar incompatibilities suggest that W in these rocks was not dominated by their mantle sources. Some W must have been added via metasomatism of W-rich fluids from subduction-related mantle or crust component. HSE and W elemental and isotopic systematics for the Labrador ultramafic rocks can be accounted for by a model where an Eoarchean mantle wedge, with modern mantle-like HSE abundances and μ^{182}W ~0, was overprinted by fluids derived from a metasomatic component with μ^{182}W ~+20. The ^{182}W enrichment of this component could be inherited from a pre-late accretionary or early depleted (i.e., high Hf/W) parental mantle reservoir.

[1] Willbold M. *et al* (2011) *Nature* **477**, 195-198. [2] Touboul M. *et al* (2012) *Science* **335**, 1065-1069. [3] Touboul *et al* (2014) *Chem.*