Constraints on late accretion from W, Os, and Nd isotopes in 2.4 Ga komatiites

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Recent studies have shown that ^{182}W isotope heterogeneities present in the Earth's mantle were long-lived and can be used to explore key processes in the early evolution of the Earth, such as mantle differentiation by magma ocean crystallization, crustal extraction, and late accretion [1-3]. The 3.8 Ga Isua rocks [1], the 2.8 Ga Kostomuksha komatiites [2] and the >3.6 Ga Nuvvuagittuq supracrustal rocks [3] all have ~15 ppm ^{182}W excesses, which are similar to the predicted W isotope composition of the mantle prior to late accretion. However, the mantle source of the Kostomuksha komatiites had highly siderophile element (HSE) contents similar to primitive mantle (PM) estimates [4], which is inconsistent with derivation from a mantle reservoir with pre-late accretionary abundances of HSE. Instead, their mantle source likely contained either an ancient component formed by magmatic differentiation or via metal-silicate equilibration during the lifetime of ^{182}Hf [2]. The absence of a genetic relationship between W and HSE in the Nuvvuagittuq samples most likely reflects open-system behaviour with regard to W, precluding discrimination between late accretion and early magmatic differentiation mechanisms [3].

Here, we present new ^{182}W, ^{142}Nd, and ^{186}Os data for 2.4 Ga komatiites from the Vetreny belt, which are characterized by calculated HSE abundances in their mantle sources of ca. 60% of the PM estimates [5]. All Vetreny komatiites analyzed so far show small ^{182}W excesses of +5.9±1.6 ppm (2σ SE) but no ^{142}Nd anomalies (μ^{142}Nd = +0.2±1.0, 2σSE) and chondritic initial ε^{186}Os = +0.03±0.02 (2σSE). Correlations between W and MgO or Cr contents indicate that variations in W abundances of Vetreny komatiites are largely controlled by fractional crystallization after lava emplacement, and, hence, are primary. Although the parental melt of the Vetreny komatiites experienced a small degree of crustal assimilation *en route* to the surface (~7%, [6]), these effects must have been minor with respect to W isotopic composition because the TTGs underlying the Vetreny Belt are characterized by low W contents (54-170 ppb). Consequently, the ^{182}W excesses in the Vetreny komatiites must reflect the anomalous W isotope composition of their mantle source. The lack of ^{190}Pt-^{186}Os and ^{146}Sm-^{142}Nd fractionations suggests that the mantle source of the komatiites was not a by-product of early mantle differentiation or metal-silicate equilibration. Based on coupled W and HSE data, the source likely included a mantle reservoir partially preserved from late accretion, suggesting long-term preservation of pre-late accretionary mantle.

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