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Tungsten in Taishan Komatiites: Evidence for Alloy Saturation

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This study reports the first high precision W concentrations and ^{182}W isotopic compositions for the ca. 2.7 Ga Taishan komatiites in the North China Craton. Geochemical characteristics of the analysed komatiites reveal olivine fractionation as a major control on their composition, although a minor crustal contamination effect on La is detected. The Taishan komatiites have unusually high W content ranging from 1.0 to 15.2 ppm, exceeding the W budget of all the known W-rich reservoirs. The overabundance in W also lead to highly elevated W/Th and relatively restricted Hf/W ratios that are rarely seen in ultramafic-mafic rocks closely affiliated with deep mantle. Another striking feature is that W is positively correlated with MgO and Ni, but inversely correlated with Na_2O, indicating a compatible behaviour of W during komatiitic magma differentiation. Therefore, the strong W overabundance must be a pristine feature of the Taishan komatiites and not caused by secondary enrichment by post-magmatic processes. The Taishan komatiites have μ^{182}W values averaging at -2.3 ± 1.6 ppm (2 SD, n = 18), falling within the present upper mantle range, but distinct from the ^{182}W excess found in the Archean TTG rocks from the Northeast North China Craton. The near-neutral ^{182}W compositions of the Taishan komatiites indicate that by ~2.7 Ga, the regional mantle homogenization beneath the North China Craton has been achieved, but the global mantle heterogeneity persisted. Our data provide strong evidence for W being a compatible trace element, probably in the form of metal alloy, during the early-stage fractionation of komatiitic magma. The significance of the crystallization of non-silicate phases from the deep mantle lies in their extraordinary capability of scavenging siderophile elements, especially W, from the parental melt. The unique geochemical composition of the Taishan komatiites provides hints on the presence of the rarely seen but potentially widespread metal alloy phase segregation and, more importantly, its role in the elemental and isotopic behavior of W and other siderophile elements during early melt extraction and subsequent magma differentiation.