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Remobilization of Tungsten in Archean Cratons: Insights from W Isotope Compositions of Volcanic Rocks from the Kaapvaal and Singhbhum Cratons

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The extinct ^{182}Hf-^{182}W isotope system is an important tracer for Hadean components in the source of mantle-derived rocks [1]. However, the fluid mobile behaviour of W during metamorphic events may obscure primary μ^{182}W signatures in the ancient geological record. Remobilization of W may thus result in homogenization of W isotopic compositions in a variety of lithological units accompanied by ubiquitous enrichments in W concentrations [2]. To investigate W remobilization within Archean cratons and to identify possible sources of W-rich fluids, we measured the W isotopic compositions of a variety of felsic and mafic volcanic rocks from the 3.55 - 3.53 Ga old Sandspruit and Theespruit Fomrations of the Onverwacht Group (Kaapvaal Craton, South Africa) and time-equivalent (>3.51 Ga) volcanic rocks from the Badampahar Group (Singhbhum Craton, India). In both cratons, mafic samples least affected by metasomatic processes (i.e., W/Th < 0.24) indicate magmatic sources without any resolvable W isotope anomalies. Serpentinized ultramafic rocks from the Onverwacht Group, on the other hand, record W isotope deficits. Their isotopic composition matches nearby granitoid intrusions that likely represent a source of W- rich fluids. Our inference is supported by covariations of MgO, LOI, and W/Th ratios in the mafic rocks, which is regarded as evidence for an effective control of secondary hydrous minerals on the scavenging of W in metasomatic fluids. Within the Badampahar Group the volcanic rocks exhibit limited W isotope variability. Well-resolved negative μ^{182}W values are only found in a single komatiite sample indicating the presence of an unidentified fluid source characterized by negative W isotope anomalies, likely linked to felsic intrusions. Our data show that felsic intrusions are a major source of W-rich fluids in the Archean which needs to be considered when evaluating the W isotope budget of volcanic rocks. The absence of W anomalies in the least altered mafic rocks implies that the protoliths of sodic granitoids are likely the only magmatic sources characterized by W isotope deficits observed in the Archean record so far.

[1] Willbold et al. (2011), *Nature* 477, 195-198.
[2] Liu, J. et al. (2016), *EPSL* 448, 13-23.