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Origin of ^{182}W Excesses in Pilbara Komatiites and Basalts

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Prior studies have reported small mass-independent variations in ^{182}W/^{184}W for mantle-derived rocks from the Archean and Phanerozoic [e.g., 1-4]. The processes that resulted in variable ^{182}W/^{184}W among different mantle reservoirs remain unclear, but crystal-liquid fractionation in a magma ocean [2], metal-silicate equilibration at the base of a magma ocean [2], and/or heterogenous distribution of late accreted components with low ^{182}W/^{184}W [1] may have played roles. The observed ^{182}W/^{184}W variations must have been produced within the first ~60 Ma of Solar System history, as ^{182}Hf is a short-lived radionuclide (^{182}Hf → ^{182}W + β^-; $t_{1/2}$=8.9 Myr). Further, the preservation of these ^{182}W/^{184}W variations until the Archean and Phanerozoic indicates that some early-formed reservoirs remained chemically isolated for billions of years. In order to further constrain the frequency and origin of ^{182}W/^{184}W variations in the mantle sources of early Archean rocks, we investigated the ^{182}W/^{184}W of komatiites and basalts from the Pilbara Craton of Western Australia, including the Corruna Downs suite (3.4 Ga) of the Warrawoona group and the Ruth Well formation (3.3 Ga).

The μ^{182}W values (part per million deviations of ^{182}W/^{184}W from terrestrial standards) reported here for the Corruna Downs suite and Ruth Well formations are *ca.* +10 to +15, which provides additional evidence that some early formed mantle reservoirs were preserved for billions of years. Positive μ^{182}W values of similar magnitude have commonly been reported for rocks from other localities, including Kostomuksha, Isua, and Nuvvuagittuq [1,2,5], indicating that a common process may be responsible. If crystal-liquid fractionation in a magma ocean caused the positive μ^{182}W values in the source of the Pilbara volcanics, coupled positive μ^{142}Nd values would also be expected. However, [6] reported that komatiites from the Dresser Formation (3.5 Ga) of the Warrawoona Group have μ^{142}Nd of about 0. Additionally, coupled ^{182}W-^{186,187}Os isotopic evidence that reflects metal-silicate equilibration at the base of a magma is so far restricted to komatiites from Kostomuksha. Thus, we speculate that the mantle sources of the Archean rocks from the Pilbara Craton investigated here contain a comparatively small amount of late accreted components with low ^{182}W/^{184}W, resulting in the observed positive μ^{182}W values. However, data for highly siderophile element abundances, as well as ^{142,143}Nd and ^{186,187}Os isotopic systematics will be obtained to further test whether heterogenous distribution of late accreted components is indeed a viable scenario.

References:

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