イスア表成岩帯変成岩の微量元素およびタングステン同位体分析への酸洗浄法の適用

Application of acid-washing to trace element and tungsten isotope analyses of Eoarchean rocks from the Isua Supracrustal Belt

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The short-lived ^{182}Hf–^{182}W decay system has been widely used to understand early Earth chemical evolution. Recently, ^{182}W anomalies have been found from many Archean terranes (e.g., Willbold et al., 2011; Touboul et al., 2012). These W isotope variations should be produced by the chemical fractionation of Hf/W on the Earth while ^{182}Hf was extant, or contribution of extraterrestrial materials having different W isotope compositions after core formation. While the W isotopic anomalies potentially provide valuable insights into processes on the early Earth, the exact cause of the isotopic anomalies is not yet clearly understood. As the possible causes, early silicate differentiation, early metal-silicate equilibrium at various conditions, and late veneer have been proposed, but these hypotheses respectively are inconsistent with the lack of correlations with Nd, Os isotopic data, and highly siderophile elements abundances (e.g., Rizo et al., 2016b; Puchtel et al., 2018; Touboul et al., 2012). Alternatively, the apparent lack of the correlations may be attributed to secondary disturbance in the W isotope compositions of the Archean rocks, given that W is highly fluid-mobile during metasomatism (e.g., Bali et al., 2012).

In this study, we applied an acid-washing method to Eoarchean metamorphosed rocks from the Isua Supracrustal Belt, with the aims to evaluate the possible effect of metasomatism on the W isotope systems, and to obtain their original W isotope compositions. We measured trace element compositions and W isotope ratios of acid-washes and residues of the metamorphosed basalts using ICP–MS.

The acid-washes show enrichments in light REE, whereas the residues exhibit enrichments in heavy REE. This suggests that acid-washing selectively removed a secondary component gained during metasomatism, given that light REE are relatively fluid-mobile as compared to heavy REE. Negative ^{182}W anomalies were found in the washes showing light REE enrichments. By contrast, non-resolvable ^{182}W anomaly was obtained for the residues displaying heavy REE enrichments. These findings suggest that the Isua metamorphosed basalts have a W isotope heterogeneity even in a single rock sample. Moreover, our results imply that the W isotope compositions of Isua supracrustal rocks could have been modified secondarily as a result of metasomatism. This can account for the lack of correlation between W isotopic data and other geochemical or isotopic data.

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