Trace element and W isotope systematics of acid-washed Archean meta-basalts

*Hatsuki Enomoto[1], Tsuyoshi Iizuka[1], Yoshitaka Homma[1]

1. Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo

^{182}Hf decays to ^{182}W with a half-life of 8.9 Myr. Because Hf and W are both refractory and can fractionate from each other during metal-silicate separation and partial melting/crystallization of silicates, the Hf–W system can potentially be used to trace early silicate differentiation and core-segregation, as well as accretionary history, for planets. Recently, ^{182}W isotopic anomalies have been found from some Archean rocks in the Nuvvuagittuq Supracrustal Belt, Acasta Gneiss Complex, Isua Supracrustal Belt, Kostomuksha Greenstone Belt, and Saglek Block.

While the W isotopic anomalies provide robust evidence for long-term preservation of products of chemical fraction on early Earth, the exact cause of the isotopic anomalies is not yet clearly understood. There are three hypotheses to account for the W isotopic anomalies: (1) early silicate differentiation; (2) late veneer; (3) metal-silicate equilibrium. Each hypothesis has a difficulty in reconciling with other geochemical or isotopic data. For instance, the lack of correlation between ^{182}W and ^{142}Nd anomalies is not consistent with the first hypothesis, whereas the enrichment of highly siderophile elements (HSE) in the rocks having ^{182}W anomalies contradicts to the second hypothesis. The apparent lack of correlation between W and Nd or HSE data can be attributed to secondary disturbance of the isotopic systems. In particular, because W is a highly fluid-mobile element under oxidized conditions, the uniform positive ^{182}W anomalies irrespective of rock types in the Archean terranes (ultra-mafic, mafic or felsic) may reflect preferential W isotopic homogenization within the regions. Evaluating the possibility of W isotopic disturbance is crucial for understanding the cause of the W isotopic anomalies in the Archean rocks. In this study, we applied the acid-leaching technique to early Archean meta-basalts from the Isua Supracrustal Belt, with the aim to evaluate the possible effect of metasomatism on W isotopic and trace element systematics and, by extension, to obtain original ^{182}W isotopic compositions of these rocks.

We measured trace element concentrations of acid-washes and residues using ICP–MS. According to REE patterns of acid-washes and residue of a 3.7–3.8 Ga meta-basalt, 0.5 M HNO_3 wash shows an enrichment in light REE as compared to heavy REE, and a negative Eu anomaly. This pattern is similar to that of phosphates that can be readily dissolved in 0.5 M HNO_3. The pattern of 6 M HNO_3+ 6 M HCl wash is strongly enriched in light REE relative to heavy REE with no prominent Eu anomaly. The residue is characterized by moderate enrichment in light REE and weak positive Eu anomaly with nearly flat middle-heavy REE pattern. The slight positive Eu anomaly can be attributed to plagioclase enrichment in the residue compared to the washes. Given that light REE are more fluid-mobile than heavy REE, the restricted light REE enrichment with the flat middle-heavy REE pattern in the residue, compared to the washes, may reflect that the acid-leaching technique can at least partly remove a secondary component gained during metasomatism. W isotopic ratio measurements were performed on a multi collector ICP–MS. Our preliminary W isotope analyses of the washes and residue suggest that while the washes exhibit ^{182}W excesses compared to the standard solution, the residue has no resolvable anomalies with relatively large analytical uncertainty. We are still in the process of acquiring more precise W isotopic data for acid-washed residues by increasing the amount of analyzed samples.

