High-precision Zr isotopic analysis of ancient terrestrial zircons

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The radionuclide ^{92}Nb decays to ^{92}Zr with a half-life of 37 Ma [1]. Because Nb and Zr can fractionate from each other during partial melting of the mantle and mineral crystallization as well as metal-silicate differentiation, Nb-Zr isotope systematics can potentially place chronological constraints on early planetary differentiation. Considering the initial abundance of ^{92}Nb in the solar system (^{92}Nb/^{93}Nb = 1.7×10^{-5}), yet, the possible Zr isotopic variation on the Earth would be highly restricted [2]. For instance, even a 4.53 Ga reservoir having a Nb/Zr ratio four times higher than that of CHUR is expected to display a ^{92}Zr anomaly of only +10 ppm. Such reservoir with an elevated Nb/Zr ratio might be formed if Fe-Ti oxide and sulfide minerals presented as a liquidus phase during differentiation on the infant Earth.

Here we report our search for a Zr isotopic vestige of early Earth differentiation using ancient terrestrial zircons. Zirconium isotopic ratios in single zircon grains were measured using MC-ICP-MS with the desolvating nebulization technique, which allows us to achieve analytical precision of ±<10 ppm. So far, the high-precision Zr isotopic analysis has been applied to zircons from the 4.0–3.6 Ga orthogneisses in the Acasta Gneiss Complex, northwestern Canada. These rock samples were previously studied for zircon Lu–Hf isotope systematics and the results indicated that their magmatic sources contained Hadean crustal components [3]. Our Zr isotopic data for the Acasta zircons display no resovable ^{92}Zr anomalies at the level of analytical precision, suggesting that the sources did not contain an extremely old (~4.53 Ga) component characterized by an elevated Nb/Zr (~0.3). We are currently extending the application of the Zr isotope systematics to Hadean zircons from Jack Hills of Western Australia. In the presentation, we will explore the relevance of our Zr isotopic data to other isotope systematics such as ^{176}Lu–^{176}Hf, ^{146}Sm–^{142}Nd and ^{182}Hf–^{182}W, and further discuss its implications for early Earth differentiation.

[1] Holden (1990) *Pure Appl. Chem.* 62, 941–958. [2] Iizuka et al. (2016) *Earth Planet. Sci. Lett.* 439, 172–181. [3] Iizuka et al. (2009) *Chem. Geol.* 259, 230–239.