Constraints from the ^{92}Nb-^{92}Zr chronometer on the timing of early terrestrial silicate differentiation

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It is evident that early global differentiation of the silicate Earth occurred more than 4.47 Gyr ago based on the extinct ^{146}Sm-^{142}Nd chronometer [1, 2]. The short-lived ^{92}Nb -^{92}Zr decay system (half-life of 36 Myr) is another excellent tool for dating early silicate differentiation owing to the different compatibilities of Nb and Zr during magmatic processes. Although its half-life is about one third of that of ^{146}Sm-^{142}Nd, Nb/Zr fractionation is likely an order of magnitude higher than for Sm/Nd during silicate differentiation [3]. Therefore, the Nb-Zr chronometer has the potential to better constrain the timing of the earliest silicate differentiation.

High-precision Zr isotope data of 10 Archean rocks (8 amphibolite and 2 dyke samples) from the Isua Supracrustal Belt were obtained. These samples exhibit well-resolved variations in ^{142}Nd/^{144}Nd, indicating that they inherited this signature from their sources that formed more than 4.47 Ga [2]. The Zr isotope ratios were measured on a Neptune Plus MC-ICPMS at ETH Zürich. The average ε^{92}Zr value, and associated external precision (2SE) of this technique [4] for the USGS basalt BHVO-2 is 0.00 ± 0.02 (n = 56).

The samples from the Isua Supracrustal Belt show no resolvable variation in ε^{92}Zr. They yield an average ε^{92}Zr of 0.00 ± 0.05 (2SD) for the amphibolites and 0.04 ± 0.05 (2SD) for the dykes. This indicates that early silicate differentiation preserved in these samples occurred later than 20 - 60 Myr after the formation of the first solids in the solar system, assuming that the Earth's Nb/Zr ratio is the same as chondrites and the initial solar system ^{92}Nb/^{93}Nb is between (2.5 - 5.3) x 10^{-5} based on internal isochrons of the achondrites [5]. Combining evidence from the ^{146}Sm-^{142}Nd and ^{92}Nb -^{92}Zr chronometer indicates that silicate differentiation for the Isua mantle reservoir occurred 4.51 - 4.47 Gyr ago.

[1] Boyet and Carlson (2005). *Science* **309**: 576-580; [2] Rizo et al. (2012). *Nature* **491**: 96-100; [3] Jochum et al. (1986). *GCA* **50**: 1173-1183; [4] Lai et al. (2014) 77th *Meteoritical Society meeting abs*. 5139; [5] Iizuka et al. (2015) this volume.