THE TIMING OF EARLY PLANETARY SILICATE DIFFERENTIATION BASED ON THE Nb-Zr CHRONOMETER

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Introduction: Short-lived decay systems are powerful tools to date early planetary differentiation. One of these systems is ^{92}Nb, which decays to ^{92}Zr with a half life of 36 Myr. During magmatic processes Nb is more incompatible than Zr. This renders the Nb-Zr decay system an excellent tool for dating early silicate differentiation on Earth and other planetary bodies. The chronological interpretation of Nb-Zr data, however, critically depends on the initial ^{92}Nb/^{93}Nb ratio of our solar system, which has been controversial [1-7]. The goal of this study is to better constrain the initial ^{92}Nb/^{93}Nb ratio in order to determine the early formation of planetary silicate reservoirs. To this end, we present new evidence on the initial ^{92}Nb/^{93}Nb using internal isochrons of achondrites in addition to high-precision Zr isotope data of Archean rocks (Isua, Greenland). The latter rocks exhibit well-resolved variations in ^{142}Nd/^{144}Nd [8].

Method: The analytical procedure follows the technique developed in previous studies [9, 10] with some modifications. A third column was added to separate Zr and Hf, which is based on Münker et al. (2001) [11]. The Zr isotope ratios were measured on a Thermo Finnigan Neptune Plus MC-ICP-MS coupled with an Aridus II introduction system at ETH Zürich. All five Zr isotopes were simultaneously monitored, in addition to ^{95}Mo, ^{99,101}Ru to correct for isobaric interferences (masses 92, 94, 96). The instrumental mass bias was corrected relative to ^{94}Zr/^{90}Zr = 0.3381 using the exponential law. The average and external precision (2SE) of this technique for USGS basaltic standard BHVO-2 is 0.03 ± 0.04 for ε^{92}Zr (n = 25).

Results and Discussion: Six amphibolite and two dyke samples from the Isua Supracrustal Belt were analyzed and these samples show no resolvable variation for ε^{92}Zr. They yield an average ε^{92}Zr of 0.01 ± 0.03 (2SD) for the amphibolites and 0.05 ± 0.05 (2SD) for the dykes. This indicates that early silicate differentiation on Earth occurred later than 45 – 100 Myr after the formation of 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 1.1×10^{-4} – 3.8×10^{-5} [2, 8]. More internal isochrons from equilibrated achondrites will be obtained to improve the constraints on the initial ^{92}Nb/^{93}Nb ratio, which is currently the most limiting factor on our interpretation.

References: [1] Münker C. et al. 2000. *Science* 289:1538-1542. [2] Schönbächler M. et al. 2002. *Science* 195:1705-1708. [3] Hirata T. 2001. *Chemical Geology* 176:323-342. [4] Sanloup C. et al. 2000. *Earth and Planetary Science Letters* 184:75-81. [5] Schönbächler M. et al. 2003. *Earth and Planetary Science Letters* 216:467-481. [6] Yin Q.Z. et al. 2000. *Astrophysical Journal* 536:L49-L53. [7] Iizuka T. et al. 2012. *Mineralogical Magazine* 76: 1878. [8] Rizo H. et al. 2012. *Nature* 491: 96-100. [9] Schönbächler M. et al. 2004. *Analyst* 129: 32-37. [10] Akram et al. 2013. *Astrophysical Journal* 777:169-180. [11] Münker C. et al. 2001. *Geochemistry, Geophysics, Geosystems* 2: 10.1029/2001GC000183.