Constraints on early silicate differentiation of Mars from Nb-Zr systematics

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It has been proposed that core formation on Mars occurred within the first few Myr of our solar system, while first silicate differentiation took place within the first 30 Myr based on ^{182}W - ^{142}Nd systematics [e.g. 1, 2]. The short-lived ^{92}Nb-^{92}Zr decay system with half-life of 37 Myr is another excellent tool for dating early silicate differentiation because of the different compatibilities of Nb and Zr during magmatic processes. Therefore, it has the potential to provide new information on early silicate differentiation on Mars and improve previous ^{182}W - ^{142}Nd constraints obtained from Martian meteorites.

High-precision Zr isotope data of 4 Martian meteorites (3 depleted and enriched basaltic shergottites, and 1 orthopyroxenite ALH84001) were obtained so far and analyses on nakhlites are planned. The Zr isotope ratios were measured on a Neptune Plus MC-ICPMS at ETH Zürich [3]. The average $\varepsilon^{92}Zr$ value, and associated external precision (2SE) of this technique for the USGS basalt BHVO-2 is 0.01 ± 0.02 (n = 74) during the course of this study. To improve the analytical uncertainty (< 3ppm), the samples were analysed at least 5 times when sufficient material was available.

The analysed Martian samples exhibit well-resolved variations in $^{142}Nd/^{144}Nd$ and $^{182}W/^{183}W$, which indicate that the source of the shergottite reservoir formed at ~4525 Ma [1]. Nevertheless, all shergottites show $\varepsilon^{92}Zr$ values identical to the terrestrial basalt BHVO-2. The identical $\varepsilon^{92}Zr$ values of the shergottites from the depleted reservoir (EETA 79001 and DaG 476) and enriched reservoir (Zagami) could be due to the limited Nb/Zr fractionation in the shergottite source combined with the low initial $^{92}Nb/^{93}Nb$ ratio of the solar system (1.7×10^{-5}) [4]. However, the nakhlite source has formed prior to that of the shergottites [1, 2] and likely involved of garnet. This should lead to larger Nb/Zr fractionation. If correct, we predict small ^{92}Zr variations in these rocks and we will present Zr isotope data of nakhlites at the meeting.

[1] Foley et al. (2005) *GCA* **69**: 4557-4571; [2] Debaille et al. (2009) *Nature Geosci*. **2(8)**: 548-552; [3] Lai et al. (2014) 77th *Meteoritical Society meeting abs*. 5139; [4] Iizuka et al. (2016) *EPSL* **439**: 172-181.