Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.11830

Effects of spreading rate, crystal fractionation and source heterogeneity on Fe isotope systematics in ocean floor lavas

MARIANNE RICHTER[1], OLIVER NEBEL[1], MARTIN SCHWINDINGER[1], YONA NEBEL-JACOBSEN[1] AND HENRY J B DICK[2]

[1]Monash University

[2]Woods Hole Oceanographic Institutuion

Presenting Author: marianne.richter@monash.edu

The global mid-ocean ridge (MOR) system extends for more than 60,000 km and is showing a wide range in spreading rate, from ultraslow in the Arctic Ocean (6 mm/a) to super-fast in the Pacific Ocean (150 mm/a). The difference in spreading rate of >100 mm/a, between ultraslow and super-fast ridges has vast effects on the ridge structure and magma supply [1]. Ultraslow spreading ridges are generally characterized by a low magma supply with rapid melt transport from small mantle upwelling cells into crustal levels without interaction in sub-oceanic melt lenses, as proposed for faster ridges [2,3,4]. Multiple geochemical approaches e.g., petrographic studies of lower oceanic crust rocks, studies of xenocrysts in ocean floor lavas or using stable isotope systematics are useful tools to understand magmatic differentiation processes - from its source to crust – at MOR. In this study, we use Fe isotope systematics (expressed in ‰ and given as δ^{57}Fe relative to IRMM-524a) to investigate the extent to which source heterogeneity and igneous differentiation affects iron isotope composition and its link to spreading rate. For this, samples from the ultraslow spreading Gakkel Ridge, Arctic Ocean, were analysed and compared to existing Fe isotope data from faster spreading ridges (e.g., East Pacific Rise [5]). Results show that Gakkel lavas yield systematically heavier iron isotope composition compared to the East Pacific Rise for a given degree of igneous differentiation. This is primarily due to partial melting processes that appear to be superior to igneous differentiation at ultraslow spreading rates as opposed to faster spreading rates where partial melting is negligible and the Fe isotope composition is controlled by fractional crystallization. Gakkel lavas further indicate that upper mantle Fe isotope heterogeneity can be transmitted into erupting basalts in the absence of homogenisation processes in sub-oceanic magma chambers, which may not be the case for faster spreading regimes.

[1] Rubin et al. (2009), Nat.Geosci., 2,321. [2] Rubin & Sinton (2007), EPSL, 260, 257-276. [3] Dick et al. (2003) Nature, 426, 405-412. [4] O'Neill & Jenner (2012), Nature, 491, 698-704. [5] Chen et al. (2019), GCA, 267, 227–239.