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Investigating the late accretion history and convective homogenization of the terrestrial mantle – new perspectives from coupled Ru isotope and HSE abundance data

MR. JONAS TUSCH[1], MARIO FISCHER-GÖDDE[2], J. ELIS HOFFMANN[3], CARINA GERRITZEN[4], PATRICK GANS[3], WOLFGANG MAIER[5], MARTIN J. VAN KRANENDONK[6], HUGH SMITHIES[7], HARRY BECKER[3] AND CARSTEN MÜNKER[2]

[1]Department of Geoscience, University of Cologne
[2]Universität zu Köln
[3]Freie Universität Berlin
[4]Vrije Universiteit Brussel
[5]School of Earth and Ocean Sciences, Cardiff University
[6]Australian Centre for Astrobiology, University of New South Wales
[7]Geological Survey of Western Australia

Presenting Author: j.tusch@uni-koeln.de

It is widely accepted that the relative and absolute abundances of highly siderophile elements (HSE) present in the modern terrestrial mantle has been set during late accretion of meteoritic materials that the Earth received after cessation of core formation. In particular komatiites were investigated to assess the HSE content of the mantle for reconstructing the late accretion history of Earth and for assessing the mixing timescales of the convecting mantle through time. In this regard, the study of HSE abundances in komatiite melts that erupted between 3.5 and 2.9 Ga revealed the slow mixing of HSE-rich late accreted material into the terrestrial mantle and the progressive homogenization of primordial domains by continuing mantle convection [1]. However, mantle source calculations that asses the HSE budget from komatiitic melt compositions were shown to be affected by complexities arising from the prevalent physico-chemical conditions and may therefore systematically underestimate mantle source HSE contents [2].

Here, we report new Ru isotope and HSE abundance data for komatiitic rocks from the 3.46 Ga Dwalile greenstone remnant in the Kaapvaal Craton, SW Swaziland and from 3.5-3.2 Ga old komatiitic rocks from the Pilbara Craton, NW Australia. In contrast to ^{100}Ru excesses identified in 3.5-3.2 Ga old komatiites from the Pilbara, contemporaneous komatiites melts from Swaziland were found to have ^{100}Ru values indistinguishable from the modern mantle. Although HSE abundances in Dwalile komatiites show up to 2 times enrichment compared to primitive mantle estimates, the modern mantle-like Ru isotope composition of these rocks constrains that the Dwalile mantle source already fully equilibrated with the late accreted components by 3.5 Ga. These findings ultimately demonstrate that apparent HSE enrichments compared to the modern mantle may not necessarily reflect mass excesses of late accreted components. Therefore, our new data reveal that calculated HSE contents of mantle domains should be carefully interpreted with regard to the late accretion history of Earth and ideally combined with other sensitive tracers such as ^{100}Ru isotope systematics.

[1] Maier et al. (2009) *Nature* **460**, 620-623
[2] Waterton et al. (2021) *GCA* **313**, 214-242