Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.19506

Molybdenum isotope variations in terrestrial samples: Analytical challenges and constraints on late accretion

MR. JONAS TUSCH[1], MARIO FISCHER-GÖDDE[2], FRANK WOMBACHER[3], KRISTOFFER SZILAS[4] AND CARSTEN MÜNKER[3]

[1]University of Cologne

[2]Institut für Geologie und Mineralogie, University of Cologne

[3]Universität zu Köln

[4]University of Copenhagen

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

In the last few years, several novel isotope tracers were applied to study late accretion, comprising the addition of approximately 0.5 wt.% of Earth's mass received after core formation. Beyond Earth Sciences, late accretion is seen as a potential key event for the Earth to develop oceans and an oxygen-rich atmosphere. However, so far elemental, and isotopic investigations of samples representing the Earth's modern and Archean mantle compositions yielded contrasting constraints on the nature of late accreted material (LAM), specifically whether LAM was derived from volatile-rich carbonaceous chondrite-like or volatile-depleted inner solar system materials [e.g.,1-3].

The most promising approach for assessing the source of LAM relies on nucleosynthetic isotope variations of (highly) siderophile elements among meteorites and comparison with the isotope composition of the silicate Earth [e.g.,2]. For instance, a recent study utilized Ru isotopes to identify missing LAM contributions in Archean mantle sources and to determine the LAM composition [3]. Similarly, owing to systematic nucleosynthetic isotope variations among meteorites and the siderophile nature of Mo, Mo isotopes were shown to have a high potential for placing constraints on the Earth's late stage building blocks [4,5]. However, the authors subsequently acknowledged that apparent Mo isotope anomalies in terrestrial samples may result from non-exponential mass fractionation behavior during isotope analyses [6].

In this contribution we present high-precision Mo isotope data for terrestrial silicate rocks, including reference materials, that underwent chemical purification procedures prior to measurement by MC-ICPMS and unprocessed Phanerozoic-Archean molybdenites. Our data reveal that, after internal normalization using the exponential law, Mo isotope patterns in terrestrial samples exhibit analytical artifacts induced by a nuclear field shift effect and residual equilibrium isotope fractionation. We will show that complex corrections are mandatory for accurately assessing the Mo isotope composition of terrestrial rocks and for proper interpretation of Mo isotope data in a planetary context and at the ppm level of precision that is required in such an approach.

[1] Wang&Becker (2013), Nature[499]

[2] Dauphas (2017), Nature[541]

[3] Fischer-Gödde et al. (2020), Nature[579]

[4] Budde et al. (2019), Nature Astronomy[3]

[5] Burkhardt et al. (2011), EPSL[312]

[6] Budde et al. (2022), Goldschmidt abstract[9700]