Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.18052

Siderophile volatile element inventory of lunar low-Ti mare basalts: constraints on magmatic processes and mantle sources

PHILIPP GLEISSNER AND HARRY BECKER

Freie Universität Berlin, Institut für Geologische Wissenschaften

Presenting Author: gleissner@zedat.fu-berlin.de

Since the era of the Apollo missions, the Moon was thought to be highly depleted in volatile elements relative to Earth and chondrites. This view was recently challenged by studies of pyroclastic glasses and olivine-hosted melt inclusions in such glasses and mare basalts [1], in which elevated concentrations of moderately volatile elements and water were detected. New estimates of the lunar mantle composition suggest only moderate depletion when compared to the bulk silicate Earth [e.g., 1]. However, recent data on siderophile volatile elements [2] and stable isotopes [e.g., 3] in lunar magmatic rocks suggest that the lunar interior is strongly volatile depleted and that most of the volatiles were lost early on.

In order to constrain magmatic processes and mantle source compositions, we obtained new data on mass fractions of the siderophile volatile elements Cu, Se, Ag, S, Te, Cd, In, and Tl by isotope dilution ICP-MS on samples from five low-Ti mare basalt suites. Mass fractions of Cu, S, Se, and Ag in each suite are mainly controlled by fractional crystallization. In contrast, Te, Cd, In, and Tl display disturbed fractional crystallization trends, most likely due to late magmatic degassing and recondensation of volatile element species [2]. All low-Ti mare basalt suites display similar siderophile volatile element ratios (e.g. Cu/Ag, Cu/Se, S/Se), which we interpret as characteristics of their mantle sources. Since the studied low-Ti mare basalt suite stem from variably incompatible element-depleted source regions (as gauged from their variable εNd values), we conclude that the siderophile volatile inventory of lunar mantle sources is independent of the fraction of trapped magma ocean melt or KREEP component. The new estimates of mantle source compositions reveal consistently low mass fractions of Cu, S, Se, and Ag for five different low-Ti mare basalt suites. Our new data support the hypothesis of volatile loss prior to formation of the lunar mantle sources and reveal element ratios in the lunar mantle that are significantly different from the terrestrial mantle.

[1] Ni et al. (2019) GCA, 249, 17-41.

[2] Gleißner et al. (2022) EPSL, 593, 117680.

[3] Gargano et al. (2022) Am. Min., 107, 1985-1994.