

# Ga Isotopic Heterogeneity in Lunar Highland Rocks

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The Moon is known to be highly depleted in volatile elements compared to both chondritic meteorites and the Earth, and this is generally attributed to a global-scale evaporation event [*e.g.*, 1-2]. Mass-dependent isotope fractionation signatures of moderately volatile elements can provide key insights into the nature of this devolatilization because light isotopes are expected to preferentially enter the vapor phase during evaporation, leaving behind an isotopically heavy solid residue. One of these moderately volatile elements is gallium (Ga), which is lithophile, has two stable isotopes, and a 50% condensation temperature of 968K [3]. Indeed, previous work has shown that lunar mare basalts are isotopically heavy ( $\delta^{71}\text{Ga} = 0.33 \pm 0.16\%$ , [4-5]) compared to the bulk silicate Earth ( $\delta^{71}\text{Ga} = 0.00 \pm 0.06\%$ , [6]), whereas the limited number of lunar highland rocks that have been analyzed to this day appear to be far more variable in their Ga isotopic signatures. Considering that highland rocks make up ~80% of the lunar crust, these samples are crucial to understand the lunar volatile depletion.

In this work, we report Ga isotopic as well as major and trace element data for seven ferroan anorthosite suite (FAS) and four magnesian suite (MGS) rocks to shed light on the origin of this isotope heterogeneity and to better estimate the Ga isotopic signature of the bulk Moon. Comparable to previous studies, we find that MGS rocks are isotopically similar to mare basalts, whereas FAS display a range of Ga isotopic compositions that is both lighter and heavier compared to the BSE. Interestingly, the Ga isotope signatures of FAS rocks do not appear to be related to volatile redistribution or impact metamorphism. Instead, when combining these data with concentrations for major and trace elements of the individual ferroan anorthosites, it is apparent that these isotopic signatures are related to igneous differentiation processes.

Refs: [1] Canup and Asphaug, 2001 [2] Day and Moynier, 2014 [3] Lodders, 2003, [4] Kato and Moynier, 2017, [5] Wimpenny et al., 2022 [6] Kato et al., 2017.