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# The nickel isotopic composition of the Moon

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Investigations of the stable isotopic compositions of planetary bodies entail critical insights for our understanding of Solar System processes, planetary differentiation, and the meteoritic building blocks involved in their accretion. For example, a recent study found that the nickel (Ni) isotopic composition of the bulk silicate Earth (BSE) is marginally lighter compared to chondritic meteorites and suggested this sub-chondritic Ni isotopic composition could have been inherited from the Moon-forming impactor [1]. To further explore this possibility, we here examine the Ni isotopic compositions of lunar samples from the Apollo missions, including 12 low-Ti mare basalts, 3 high-Ti mare basalt, and one impact melt.

An average of all lunar samples investigated here is $\delta^{60}$Ni = 0.17 ± 0.37 ‰ (where $\delta^{60}$Ni is the permil deviation from our SRM-986 reference standard), demonstrating a higher degree of Ni isotope heterogeneity compared to chondrites ($\delta^{60}$Ni = 0.23 ± 0.11 ‰, [1-2]) and terrestrial rocks, which typically range between -0.1 and 0.3‰ in $\delta^{60}$Ni [1-3]. This considerable heterogeneity suggests that the Ni isotopic compositions of lunar samples have been affected by geological processes, which must be untangled to determine the isotopic composition of the bulk Moon. The Ni isotopic ratios of the samples measured here do not appear to be strongly controlled by mixing with an urKREEP component or with impact metamorphism. Based on the data obtained so far, however, we assess that the bulk lunar Ni isotopic composition may be slightly heavier compared to current estimates for the terrestrial Ni isotope value of $\delta^{60}$Ni ≈ 0.11‰ [1-2]. Considering that the Moon is generally assumed to be comprised of >80% impactor material [e.g., 4], this suggests that the Moon-forming giant impactor itself was isotopically heavy compared to Earth, which is opposite to what has been suggested based on the sub-chondritic Ni isotopic composition of the BSE [1]. Isotope data for additional lunar samples are anticipated to further complement and evaluate these preliminary conclusions at the conference.

[1] Wang et al (2021), Nature Comms
[2] Klaver et al (2020) GCA
[3] Saunders et al (2022) GCA
[4] Borg et al (2022) PNAS