Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.30377

Cosmogenic isotope evidence for the exposure history of Chang'e-6 soil

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The Chang'e-6 (CE-6) mission returned 1935.3 grams of lunar soil from the southern rim of the Apollo Basin within the South Pole-Aitken (SPA) basin, offering key insights into the crust-mantle evolution of farside of the Moon. Understanding the migration and exposure histories of these clasts is crucial for tracing their lithological associations and sources. This study investigates the cosmogenic Sm and Hf isotopic compositions and the cosmic-ray radiation (CRE) age of CE-6 surface soil and nine rock clasts picked out from the soil.

The lunar soil exhibits $\varepsilon^{149}Sm$ = -48.0 ± 0.8 and $\mu^{180}Hf$ = -491 ± 19, with an calculated CRE age exceeding 400 Ma[1], indicating prolonged irradiation compared to Chang'e-5 soil. The cosmogenic isotopic compositions varied from 1.6 to -66.9 for $\varepsilon^{149}Sm$ and from -118 to -689 for $\mu^{180}Hf$ among the rock clasts , indicating a mixing of multiple ejecta materials. Among the clasts, basaltic clasts CE6-C005, C009, and C048 show similar cosmogenic Sm and Hf isotopic compositions slightly larger than the soil. These results highlight their local basalt origin. Three KREEP-enriched clasts, CE6-C001, C004 and C049, show significant variations in their elemental and cosmogenic isotopic compositions, reflecting their different CRE histories. The different CRE age of these foreign KREEP-enriched clasts may imply they come from different sources or from different ejection events.

[1]Hu, J. Y., Leya, I., Dauphas, N., Rae, A. S., & Williams, H. M. (2024), *Geochimica et Cosmochimica Acta*, *375*, 201-216.