Copper Isotopic Composition in Lunar Samples

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Lunar samples reveal that the Moon is highly depleted in volatiles compared with the bulk silicate Earth (BSE) [1]. Comparing stable isotopic ratios of moderately volatile elements (MVEs) between lunar and terrestrial samples could provide new insights into the volatile depletion processes among the terrestrial planets and during the formation and evolution of the Moon. Copper is an MVE with a 50% condensation temperature (Tc_{50}) of 1037 K [2]. Previous studies have indicated that lunar samples display a notable Cu depletion, coupled with an enrichment of heavy Cu isotopes with respect to the BSE [3]. However, the sample size was rather small, and limited to mare basalts. We report new Cu isotope data for 10 Apollo lunar rocks and 12 bulk soils. All samples were measured using an MC-ICP-MS. Results are expressed relative to the NIST SRM 976 Cu standard as per mil deviations in $^{65}Cu/^{63}Cu$ ($\delta^{65}Cu$).

Our data show that lunar basalts have a wide range of $\delta^{65}Cu$ between 0.19 and 1.16‰, confirming that there is a consistent enrichment of heavy Cu isotopes compared with terrestrial basaltic rocks (0.07 ± 0.10‰) [4]. The average $\delta^{65}Cu$ of lunar basalts is 0.66‰, which is slightly higher than previously reported [3]. There is no clear Cu isotopic difference between High-Ti and Low-Ti mare basalts. Two norites have $\delta^{65}Cu$ of 0.31 and 0.35‰ respectively. Bulk lunar soils exhibit a substantial $\delta^{65}Cu$ variation from 0.61 (partially shaded soil) to 4.79‰ (surface trench soil), with an average of 2.81‰, much higher than that of lunar basalts. The $\delta^{65}Cu$ values of lunar soils display a positive correlation with K isotopic composition ($\delta^{41}K$) [5]. Noticeably, the lunar soil $\delta^{41}K$ and $\delta^{65}Cu$ both positively correlate with soil maturity (*Is/FeO)*. Possible processes for such heavy Cu isotopic composition in lunar soils include micrometeorite vaporization and sputtering. More lunar sample data will be presented and discussed to better constrain the average $\delta^{65}Cu$ of the bulk silicate Moon and to understand the mechanisms for generating the heavy and scattered $\delta^{65}Cu$ values of lunar rocks and soils.

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