The Origin of Chromium Isotopic Anomalies in Lunar Rocks

L. Qin, J. Liu, N. Dauphas, R. W. Carlson, W. Xu, and H. Huf

- CAS Key Laboratory of Crust – Mantle Materials and Environments, University of Science and Technology of China, Hefei 230026, China
- Origins Laboratory, Department of the Geophysical Sciences and Enrico Fermi Institute, The University of Chicago, Chicago IL 60637, USA
- Carnegie Institution for Science, Washington, DC 20015, USA
- Purple Mountain Observatory, Chinese Academy of Sciences, Nanjing 210034, China
- School of Earth Sciences and Engineering, Nanjing University, Nanjing 210023, China

The most plausible model for the formation of the Moon is that a Mars-sized planetary embryo impacted the Earth late in its accretion and the Moon accreted mainly from the impactor [1]. However no large isotopic anomalies have been detected for Ti and O, which would be definitive evidence for the presence of extraterrestrial materials in the Moon [2,3]. Another element that could provide further constraints on the origin of the lunar material is Cr [4]. A recent study found that the Cr isotopic composition of the Moon was compromised by cosmogenic effects, which was corrected by correlating Cr isotopic shifts in lunar samples with variations in 150Sm/152Sm ratio [5]. The issue with this approach is that Sm isotopic variations are produced by capture of secondary thermal neutrons while 54Cr is primarily a product of spallation on Fe targets.

In this study, we revisited the Cr isotopic composition of the Moon by analyzing a series of lunar samples and meteorites. We found notable excesses in both ɛ53Cr (~0.4ɛ) and ɛ54Cr (~1.1ɛ) in the lunar samples. The anomalies of ɛ53Cr and ɛ54Cr are positively correlated, with a slope of ~3, similar to the slope found in iron meteorites [4], indicating that they have a cosmogenic origin. We have devised a new method to correct Cr isotope measurements for the presence of cosmogenic effects. This approach allows us to ascertain the pre-exposure lunar ɛ54Cr value. The implications of this new determination will be presented.