Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.7182

Terrestrial planet formation inferred from Sr isotope anomalies in meteorites

JONAS SCHNEIDER, CHRISTOPH BURKHARDT AND THORSTEN KLEINE

University of Münster, Institut für Planetologie

Presenting Author: jonas.m.schneider@uni-muenster.de

Determining the amount of outer Solar System material accreted by the terrestrial planets is crucial for understanding their origin [1–3]. Nucleosynthetic isotope anomalies can distinguish between non-carbonaceous (NC) and carbonaceous (CC) meteorites, representing the inner and outer Solar System, respectively [4], and so comparing the isotopic compositions of Earth and Mars to those of NC and CC meteorites makes it possible to determine the amount of outer Solar System material accreted by the terrestrial planets. However, using this approach prior studies arrived at both a low [2] and high [3] CC fraction in Earth and Mars. These disparate results reflect inherent uncertainties arising from isotopic variations among NC meteorites, which depending on the assumed starting composition of the NC reservoir result in very different estimated CC fractions in the terrestrial planets. Here we address this issue using ^{84}Sr anomalies, which are distinct in NC and CC meteorites, but show little variations among NC meteorites. We obtained new high precision ^{84}Sr data for 35 samples including NC and CC meteorites as well as several samples from Earth, Mars, and the Moon. The new data show that there are no resolvable ^{84}Sr variations among NC meteorites and that Earth, Mars, and Moon have the same ^{84}Sr composition as NC meteorites. By contrast, most CC meteorites exhibit variable ^{84}Sr excesses, which predominantly reflect the variable admixture of isotopically anomalous refractory inclusions. The Sr isotope homogeneity among NC meteorites enables an estimate of the amount of CC material accreted by Earth and Mars and implies that both accreted predominantly from inner Solar System material. This is inconsistent with a recent proposal that the terrestrial planets grew by accreting sunwards-drifting pebbles from the outer Solar System [1], but in line with the classical model of terrestrial planet formation involving collisional growth from planetary embryos originating in the inner Solar System.

[1] Johansen, A. et al. (2021) *Science Advances* 7, eabc0444. [2] Dauphas, N. (2017) *Nature 541*, 521–524.

[3] Schiller, M. et al. (2020) *Science Advances 6*, 1–8. [4] Kruijer, T.S. et al. (2017) *Proc. Nat. Acad. Sci.* 114, 6712-6716.