Evidence for recent disturbance of the ^{176}Lu-^{176}Hf system in meteorites

R. Bast*[1], E. E. Scherer[1], P. Sprung[2] & K. Mezger[3]

[1] Institut für Mineralogie, Westfälische Wilhelms-Universität Münster, Correnssstr. 24, D-48149 Münster, Germany (*correspondence: Rebecca.Bast@uni-muenster.de)

[2] Institut für Geologie und Mineralogie, Universität zu Köln, Zülpicher Str. 49b, D-50674 Köln, Germany

[3] Institut für Geologie, Universität Bern, Baltzerstraße 1+3, CH-3012 Bern, Switzerland

Early solar system chronology is largely based on short-lived radioisotope systems that provide only relative ages. Anchoring these ages to the absolute timescale requires long-lived chronometers that are accurate and precise. With the exception of Pb-Pb, such chronometers are based on the measured proportion of a radioactive isotope to its decay product. A large range in parent-daughter ratios among minerals and a high closure temperature are attributes of a potentially precise and robust chronometer. The ^{176}Lu-^{176}Hf system is promising in this regard, but several meteorite “isochrons” exhibit excessive scatter and yield dates up to 300 Myr older than the solar system [1-3].

To determine the cause of this discrepancy, we have collected mineral isochron data for 6 achondrites. Samples from different parent bodies reveal similar patterns of scatter, with low-Hf phases (e.g., plagioclase) being most displaced from regressions. Different splits of the same meteorite, however, yield contradictory results (e.g., D’Orbigny, this study vs. [4]). These observations are difficult to explain by irradiation [5-6] or diffusion [7-9] events in the early solar system. Instead, we infer that 1) recent parent-daughter fractionation caused by terrestrial weathering and 2) terrestrial contamination are more plausible disturbance mechanisms. The Lu-Hf system may be particularly susceptible to weathering because phosphate minerals, which can host significant amounts of Lu (and radiogenic ^{176}Hf), are soluble in weak acids [10]. For precise and accurate Lu-Hf chronology, it is therefore crucial to identify and avoid weathered or contaminated portions of a sample.

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