ZIRCONIUM ISOTOPE HETEROGENEITIES IN THE SOLAR SYSTEM.
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Introduction: Evidence for isotopic anomalies in bulk carbonaceous chondrites relative to other meteorites, the moon and Earth have recently been reported for several elements (Sm, Nd, Ba, Ti and Cr[1, 2, 3]). The nature of these heterogeneities is not very well understood. The isotopic composition of Zr mainly reflects a mixture of different *s*- and *r*-process nucleosynthetic components. The *s*-process is capable of producing ^{90}Zr, ^{91}Zr, ^{92}Zr and ^{94}Zr, while ^{96}Zr needs higher neutron fluxes, making the *r*-process a more likely mechanism for producing most of ^{96}Zr. Earlier work on bulk samples showed that the Zr isotope compositions of various solar system materials (e.g. chondrites, eucrites, moon and Earth) do not vary outside of the analytical uncertainty and concluded that Zr isotopes were distributed evenly in the solar system at the bulk rock and larger scale. However, studies of bulk carbonaceous chondrites hinted at a potential enrichment in ^{96}Zr/^{90}Zr compared to Earth [4]. Such anomalies would be indicative of a nucleosynthetic heterogeneity in the solar nebula, characteristic of incomplete mixing of gas and dust. In the present study, we improved the analytical uncertainty of Zr isotope measurements using a Nu Plasma MC-ICPMS.

Analytical technique and results: All five Zr isotopes were analyzed simultaneously and the instrumental mass fractionation corrected using the exponential law relative to ^{94}Zr/^{90}Zr. Molybdenum and Ru corrections were applied to account for isobaric interferences on ^{96}Zr (and ^{94}Zr, ^{92}Zr for Mo). Samples were measured using sample-standard bracketing. The Zr isotope compositions are given in epsilon relative to a Zr standard solution acquired from Alfa Aesar. The previously reported analytical uncertainty [4, 5] was significantly improved by measuring Zr solutions at higher ion beams (~9 x 10^{-11} A for ^{90}Zr). This yielded an external reproducibility (2 sd) of ~ ±18 ppm, ±20 ppm and ±50 ppm for ^{91}Zr/^{90}Zr, ^{92}Zr/^{90}Zr and ^{96}Zr/^{90}Zr, respectively, which represents an improvement of more than a factor of two compared to previous results for ^{96}Zr/^{90}Zr. We report high precision Zr data for four zircons from Jack Hills (Australia), a lunar whole rock sample (15555) and ilmenite separated from 70035. All measured ε(^{96}Zr/^{90}Zr) values are found to be identical within the analytical uncertainty. However, these measurements are different from the previously reported value for the carbonaceous chondrite Allende (ε(^{96}Zr/^{90}Zr)=1.00 ± 0.82) [5]. Thus, there are indications of non-uniformity in the isotopic composition of ^{96}Zr between the primitive meteorites and the spectrum of terrestrial and lunar material. Similar heterogeneities in carbonaceous chondrites showing a r-process component have also been reported for Ba isotopes [1], while Sm and Nd heterogeneities are restricted to isotopes formed by the *p*-process only, suggesting different *r*-process sources for Zr/Ba and Sm/Nd, respectively. We will also discuss new results for carbonaceous chondrites.

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