$^{238}U/^{235}U$ VARIATIONS IN METEORITIC MATERIALS: EVIDENCE FOR CURIUM-247 IN THE EARLY SOLAR SYSTEM AND IMPLICATIONS FOR Pb-Pb DATING.

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Introduction: The longstanding assumption that the $^{238}U/^{235}U$ ratio is invariable in meteoritic material (=137.88 [1]) is a cornerstone of the high precision Pb-Pb chronometry that has defined the absolute ages of early Solar System materials. In this study, we present U isotope ratio measurements obtained from samples of the Allende and Murchison meteorites challenging this assumption. We additionally provide evidence that $^{238}U/^{235}U$ variations result from live ^{247}Cm in the early Solar System.

Samples and Methods: Several calcium-aluminum-rich inclusions (CAIs), including both type-A and type-B inclusions, were separated from different sections of the CV3 Allende meteorite. Samples were crushed and dissolved in HNO_3, HF, and $HClO_4$ acids, with approximately 5% of each sample being reserved for trace element measurements. Uranium from the remaining sample solutions was separated from the matrix for measurement of the $^{238}U/^{235}U$ ratio, following a procedure outlined in Weyer et al., (2008) [2]. Whole rock samples of Allende and Murchison (CM2) were processed using the same methods.

Measurement of the $^{238}U/^{235}U$ ratio was performed by MC-ICPMS on ThermoFinnigan Neptune instruments at both Arizona State University and the University of Frankfurt, utilizing a $^{236}U/^{233}U$ double spike to correct for instrumental mass bias. Multiple samples and standards were measured on both instruments independently to ensure the quality and reproducibility of the data. The U isotopic compositions of the samples are reported as $^{238}U/^{235}U$ ratios calculated relative to the U isotope standard SRM950a ($^{238}U/^{235}U$=137.88).

Results, Discussion and Implications: The whole rock $^{238}U/^{235}U$ ratios of Allende and Murchison meteorites are 137.816±0.012 and 137.866±0.017, respectively. $^{238}U/^{235}U$ ratios of Allende CAIs of this study range between 137.41±0.08 and 137.886±0.012. These values range from being within error to substantially lower than the value previously assumed for all Solar System materials (i.e., 137.88). This difference of up to -3.5‰ implies that a correction of up to -5 Ma would be required if the Pb-Pb ages of these CAIs were obtained using the previously assumed uniform value. Our results demonstrate that the $^{238}U/^{235}U$ ratio of Solar System materials can be highly variable and that high precision Pb-Pb dating, in particular of CAIs, requires the additional measurement of the $^{238}U/^{235}U$ ratio in order to obtain the correct age.

Evidence of ^{247}Cm. Because Th and Nd are chemically similar to Cm, they can be used as proxies for the extinct *r*-process only nuclide, ^{247}Cm, which decays to ^{235}U ($t_{1/2}$ ~15.6 Ma) [3, 4]. The CAIs analyzed thus far in this study, with one exception, display a negative correlation of $^{238}U/^{235}U$ with Th/U or Nd/U. This evidence strongly suggests that ^{247}Cm was present in the early Solar System, producing ^{235}U excesses in some CAIs.

References: [1] J. Chen and G. Wasserburg, 1980. *Geophysical Research Letters*, 7:275-78 [2] S. Weyer et al., 2008. *Geochim. Cosmocimica Acta*, 72:345-59. [3] J. Chen and G. Wasserburg, 1981. *Earth and Planetary Science Letters*, 52:1-15 [4] C. Stirling et al., 2005. *Geochim. Cosmocimica Acta*, 69:1059-71.