Er, Yb, and Hf isotope systematics of early Solar System materials

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The formation and evolution of the Solar System can be explored by examining the isotopic compositions of primitive chondrites and their components. For example, comparing the isotopic compositions of calcium-aluminum-rich inclusions (CAIs), the first solids to condense in the protoplanetary disk, to later formed bulk chondrites can inform researchers about how reservoirs in the protoplanetary disk evolved over time. For many elements, normal (non-FUN) CAIs have uniform and distinct isotopic anomalies relative to terrestrial and bulk meteorite isotope signatures [e.g., 1], indicating CAI formation in a broadly homogenous reservoir that was distinct from later formed solids [2]. Furthermore, isotopic anomalies in CAIs can be explained by excesses/deficits in material produced by the *r*-process of nucleosynthesis [2-3]. In contrast, previous studies of bulk chondrites [e.g., 3-6], and studies that utilized step-wise leaching of primitive chondrites [e.g., 7] have shown that isotopic anomalies in bulk meteorites are best attributed to variable contributions of material produced by the *s*-process of nucleosynthesis. However, it is not well understood how or why this change in nucleosynthetic character exists between CAIs and bulk meteorites.

Many elements have been studied in both CAIs and bulk meteorites, but a knowledge gap exists for heavier isotopic systems (A>154). To this, we have developed new methods using both TIMS and MC-ICPMS to investigate the isotopic systems Er and Yb using previously investigated CAIs [e.g., 2], and have measured Hf isotopes using published methods [8]. Compared to terrestrial rocks, CAIs are characterized by uniform deficits in *r*-process material for Er, Yb, and Hf of 9, 18, and 17 ppm, respectively. By comparing the isotopic fingerprint of this integrated CAI dataset to data for presolar grains, we show that no single presolar phase can explain the isotopic difference between CAIs and later formed solids, and the difference must be caused by a broad mixture of materials. Additionally, isotopic data of Er, Yb, and Hf from step-wise leaching of primitive meteorites will be discussed.

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