STRONTIUM, MOLYBDENUM, AND BARIUM ISOTOPES IN THE MATRIX OF ACFER 094

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Introduction: Silicates are pervasive throughout the universe and are therefore integral to understanding the life cycle of matter. The silicate components of different primitive samples may represent various related stages in silicate dust evolution. Unfortunately, isotopic studies of these grains have been limited due to their small sizes (~250 nm) and analytical limitations. We have begun a thorough isotopic study of presolar silicates, GEMS (Glass with Embedded Metal and Sulfides), and Acfer 094 matrix grains with the unparalleled analytical capabilities afforded by the Chicago Instrument for Laser Ionization (CHILI)[1] in order to reveal the ancestral connections, or lack thereof, between them. We previously reported the first trace element isotopic study of Sr, Mo, and Ba in seven Acfer 094 matrix grains [2]. All but two measurements were isotopically normal within errors except one grain with a possibly resolved depletion in ^{84}Sr and another with a possibly resolved depletion in ^{134}Ba (3σ). Molybdenum isotopes showed a tendency towards negative delta values, similar to that observed in SiC grains from AGB stars (but lower in magnitude). Here we report new measurements on an additional seven matrix grains.

Methods: Acfer 094 is an ungrouped carbonaceous chondrite with a high abundance of presolar silicates and is considered to be one of the most primitive meteorites [3]. Aliquots of disaggregated and size separated Acfer 094 grains were dispersed onto Au foil[4]. The isotopic composition of trace elements Sr, Mo, and Ba were measured using CHILI, a new resonance ionization mass spectrometer designed to achieve an unprecedented lateral resolution of 10 nm and a useful yield of ~40% [1]. CHILI's high spatial resolution, improved sensitivity, and ability to eliminate isobaric interferences makes it far better equipped than current SIMS instruments to resolve the isotopic composition of nanometer-sized grains. Measurements were carried out using a Nd:YLF desorption laser beam, frequency-tripled to 351 nm, and focused to ~1 µm [1].

Results: A summary of all Sr, Mo, and Ba isotopic measurements with CHILI in submicron primitive silicate matrix grains is shown in Fig. 1. No measureable Sr, Mo, or Ba were found in the matrix in preliminary measurements. EDS mapping of the sample was later used to locate phases more likely to host these elements, such as Ca-, K-, or Al-rich phases. These phases were subsequently confirmed to be carriers of Sr, Mo, and Ba while the surrounding phases contributed no signal.

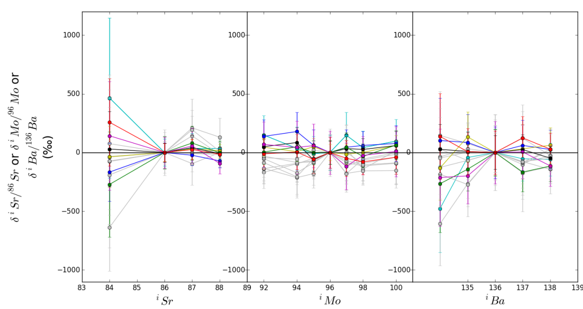

Figure 1: Isotope patterns for Sr, Mo, and Ba measured in 14 Acfer 094 matrix grains using CHILI. Uncertainties are 2σ. ^{130}Ba and ^{132}Ba not shown as too low in abundance. Gray points previously reported in [2] for reference.

Unlike the previous measurements [2], all seven matrix grains analyzed for this study are isotopically normal within errors for all isotopes. The trend toward negative delta values in Mo [2] is also no longer observed with the expanded data set. Large uncertainties were found due to the small grain sizes paired with the low abundance of trace elements in silicates.

Outlook: While no anomalies were resolved in the Acfer 094 matrix grains, it is possible that resolvable Sr, Ba, and/or Mo isotopic anomalies are preserved in presolar silicates. We therefore plan to study these elements in presolar silicates previously identified by NanoSIMS in our Acfer 094 sample. We are also prepared to analyze the Fe and Ni isotopic in presolar silicates, matrix grains, and GEMS. Iron and Ni are highly abundant in these grains [e.g., 5]. Future analyses will benefit from the installation of a Ga ion gun in the upcoming months that will provide sub-100 nm lateral resolution. An isolation and lift-out technique has also been developed for isolating small grains [2].

References: [1] Stephan T. et al. (2016) *International Journal of Mass Spectrometry* 407:1–15. [2] Villalon K. L. et al. (2017) *Lunar & Planetary Science XLVIII,* #3029. [3] Greshake A. (1997) *Geochimica et Cosmochimica Acta* 61:437–452.[4] Nguyen A.N. and Zinner E. (2004) *Science* 303:1496–1499. [5] Ong W.J. and Floss C. (2015) *Meteoritics & Planetary Science* 50:1392–1407.