MOLYBDENUM, RUTHENIUM, AND BARIUM IN PRESOLAR SILICON CARBIDE AND GRAPHITE—*s*-, *r*-, AND *p*-PROCESSES AND THE ROLE OF CONTAMINATION.

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Introduction: We have measured Mo, Ru, and Ba isotopes in 49 presolar SiC and 21 graphite grains from the Murchison CM2 meteorite with the Chicago Instrument for Laser Ionization (CHILI) [1]. Each of these elements has seven stable isotopes, which allow study of the *s*-, *r*-, and *p*-processes. Correlated nucleosynthetic effects observed for several elements in single grains can provide tighter constraints for modeling of their parent stars. Furthermore, analyzing more than one element can help to decipher the role of contamination for these grains. Surface-related C and N contamination has been reported for SiC grains. It can often be identified by high-resolution imaging techniques and, at least, partially be removed by presputtering [2]. However, the removal of surface contamination by sputtering depends on particle and instrument geometry and might not be complete [3].

Samples and Analytical Procedures: All SiC grains were classified using C, N, and Si isotopic measurements with the NanoSIMS at the Max Planck Institute for Chemistry. Of the 49 grains, 40 were mainstream (MS), three Y, one Z, one X1, and four AB (one AB1 and three AB2). Only six of the graphite grains had NanoSIMS C and N data available. CHILI uses resonance ionization mass spectrometry (RIMS) to measure isotopic abundances from a cloud of atoms liberated from a sample via laser desorption, which are then selectively ionized with lasers tuned to element-specific electronic transitions. CHILI's six tunable Ti:sapphire lasers allow simultaneous analysis of three elements, each with independent two-photon resonance ionization schemes. Mo and Ru isobars were separated by firing respective ionization lasers on alternate desorption laser shots. Ba ionization lasers were fired together with the Ru lasers. Mo and Ru data for 25 of the SiC grains and 11 of the graphite grains have been reported previously [4, 5].

Results and Discussion: Mo was detected in all 49 SiC grains, confirming previously observed trends for SiC grain types [6, 7], except for the AB1 grain, which showed a slight depletion in *s*-process isotopes. Ru was detected in 38 SiC grains (30 MS, three Y, one Z, and four AB) and showed *s*-process-dominated isotope patterns for all grains except for the AB1 grain, which also showed *s*-process depletions for Ru. The Ru and Mo *s*-process isotope enrichments for all other grains are strongly correlated. At least some Ba isotopes were detected in 23 of the SiC grains (20 MS, one X1, and two AB2), also confirming previously observed trends [7]. The X1 grain showed a neutron burst isotopic signature for Mo and a strong enrichment of ^{138}Ba, as has been observed in X grains before [7, 8].

The graphite grains suffered from strong contamination with terrestrial or solar Mo, and the majority had no detectable Ru and Ba. We suspect the Mo contamination is related to the reagents used during separation of the grains from the host meteorite. However, four graphite grains showed clear *s*-process signatures in Mo and Ru, and three of them also in Ba. Depth profiles taken while ablating the grains revealed that *s*-process-enriched Mo is concentrated together with Ru and Ba in inner portions of the grains, while their surfaces predominately showed Mo contamination. Comparing Mo and Ru results for the grains revealed that some Mo contamination was still present even in the most *s*-process-enriched steps of the depth profiles, exemplifying the difficulty to completely remove contamination.

For the SiC grains, however, Mo contamination is much less severe than for the graphite grains, which suggests that it is specific to the chemical separation of the graphite grains. Deviations from otherwise strongly correlated *s*-process enrichments in Mo and Ru show that only a few SiC grains had been contaminated with Mo.

Conversely, the observation that for SiC grains coming from asymptotic giant branch (AGB) stars, three isotope plots for Mo and Ru show data lying along straight lines going through the origin (solar), confirms that the initial composition of the grains' parent stars had fixed ratios of *p*- and *r*-process Mo and Ru isotope contributions and that these ratios are identical to those of the Solar System. Furthermore, the strong correlation between Mo and Ru isotope anomalies in M, Y, Z, and AB SiC grains indicates that *s*-process nucleosynthesis for these two elements happens simultaneously in AGB stars.

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