C2 FOSSIL MICROMETEORITES IN KAPOETA: A PERSPECTIVE FROM PRESOLAR GRAIN ABUNDANCES

N. Liu[1] and R. C. Ogliore[2], [1]Washington University in St. Louis, St. Louis, MO 63130, USA
(nliu@physics.wustl.edu)

Introduction: Howardites are achondritic breccia from Vesta [1], and contain relatively abundant carbonaceous chondrite clasts (C-clasts), which were likely added into Vesta from impacts into the regolith early in the solar system after the formation of Vesta [2]. These C-clasts represent an important additional resource of primitive meteoritic material. Previous studies showed that the C-clasts in howardites have affinities to C2 chondrites and are mainly composed of fine-grained matrix material [2]. Fine-grained matrix, in fact, is the dominant host of presolar grains in primitive chondrites. According to extensive *in situ* survey, the abundance of presolar SiC in matrix is quite similar across primitive chondrite classes [3], while the abundance of presolar silicates varies widely among different classes, largely reflecting the degree of secondary processing experienced by the hosting matrix [4]. Information on the abundances of presolar SiC and silicates in the C-clasts of howardites, therefore, can provide a stringent test to the genetic affinities of these C-clasts to the fine-grained matrix in C2 chondrites inferred from their mineralogies.

Methods: We first obtained backscattered electron (BSE) and qualitative energy dispersive X-ray (EDX) images of a Kapoeta thin section with a total area of ~ 5 cm^2 in a scanning electron microscope, based on which a large number of micro C-clasts (~20 ×20 − ~100×100 µm) were identified. We then carried out NanoSIMS C and O ion imaging measurements in four CR2-like [2] clasts. The measurements were made in semi-automated mode and involved rastering a ~1 pA Cs^+ ion beam over 10 × 10 µm sized areas within larger (12 ×12 µm) areas presputtered to remove the C coat. We followed the criteria for identifying presolar grains given in [5], and searched for presolar grains using the L'Image software. The total area of the four C-clasts measured was 5,000 μm^2.

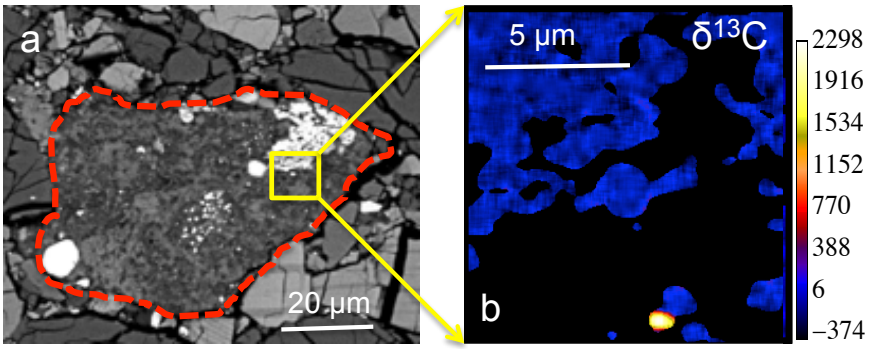

Fig. 1. (a) BSE image of C-clast 032-011 (outlined by the red dashed line), and (b) isotope image in delta-notation of a 10 × 10 µm area in (a) that is highlighted by the yellow box. A presolar C-rich grain (420 × 530 nm) stands out in yellow in (b).

Results & Discussions: Out of the 5,000 μm^2 analyzed, we identified two C-rich presolar grains but no O-rich presolar grains. The two C-rich presolar grains, which are identified in two C-clasts (024-011 and 032-011), are both enriched in ^{13}C ($^{12}C/^{13}C$ = 69.5±5.6 (360 nm × 400 nm in size), 27.2±2.0 (2σ, Fig. 1b), respectively). According to the population distributions of different presolar C-rich phases as well as different presolar SiC groups [e.g., 3, 5], these two C-rich grains are most likely presolar mainstream SiC grains of asymptotic giant branch (AGB) stellar origin. The identification of presolar grains in this study thus strongly supports the affinities of these C-clasts to the fine-grained matrix in primitive meteorites [2]. Based on the two C-rich grains identified in the 5,000 μm^2 area, the presolar SiC abundance is 76^{+203}_{-67} ppm (2σ) in these C-clasts, which is in good agreement with the abundance (~30 ppm) seen across primitive chondrite classes [3]. On the other hand, no O-anomalous presolar grains were identified. The one-sided 2σ upper limit on the abundance of presolar silicates and oxides is ~50 ppm, assuming a presolar grain size of approximately 300 nm. The inferred presolar silicate/oxide upper limit is in fact lower than those reported for the majority of carbonaceous chondrites in the literature and is most consistent with the numbers for several CM2 and CR2 meteorites [4], thus providing further support to the CM2- and CR2-like mineralogies identified by [2]. Prior to the meeting, we will obtain additional isotopic (e.g., N, Si) and elemental (e.g., Si) data on the two presolar C-rich grains to verify their phases and stellar origins, and also continue our NanoSIMS survey of more identified C-clasts to increase the counting statistics and also to investigate heterogeneities among different C-clasts.

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