PRESOLAR SiC GRAINS OF TYPE C

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Introduction: Presolar SiC grains found in primitive meteorites are placed into groups defined by their C, N, and Si isotopic compositions, thought to be indicative of their astrophysical origin [1]. Over time, some of these groups have been refined (AB grains were once thought to be separate [2]) and subgroups have been identified in the general X grain populations, e.g., X0, X1, and X2 grains [3]. For some time, only one grain with extreme enrichments in ^{29,30}Si has been known [4]; however, recent Si isotopic measurements of SiC inclusions in presolar graphite grains [5] and of small (<500 nm) SiC grains from the Murchison [6] and Indarch [7] meteorites have uncovered more grain of similar compositions ($\delta^{29,30}$Si $\gtrsim$ 1000 ‰), suggestive of a new grain type, termed Type C by [5]. We report C, N, Si, and S isotopic compositions of a similarly ^{29,30}Si enriched Type C SiC grain (e2-3-4) with a probable supernova (SN) origin.

Experimental: Grains from a SiC-Si_3N_4 rich separate (IH6) from the Indarch enstatite chondrite were mapped for their ^{12,13}C, ^{12}C^{14}N, ^{12}C^{15}N, and ^{28,29,30}Si isotopes in multi-collection by an automated measurement system [8] with the Carnegie NanoSIMS 50L. For grain e2-3-4, the automated measurement included a nearby Si_3N_4 grain, so C, N, and Si isotopic compositions were manually re-measured in imaging mode (the nearby grain was too close to sputter away) and confirmed the SiC grain as a Type C grain. In a separate session, the grain was imaged in ^{28,29,30}Si and ^{32,33,34}S isotopes in multi-collection: all reported values are calculated from the images.

Results: The ^{12}C/^{13}C ratio of grain e2-3-4 is 3290, its ^{14}N/^{15}N ratio is 32, and it has large enrichments in both ^{29}Si and ^{30}Si of 1608 ‰ and 1283 ‰, respectively. As noted previously [5, 6], such substantial enhancements in the heavy Si isotopes most likely point to a SN origin. The grain's S isotopic composition is also highly anomalous, with δ^{33}S/^{32}S = –331 ± 129 ‰ and δ^{34}S/^{32}S = –323 ± 56 ‰. These values are likely upper limits since in the S ion ratio images, the isotopic anomalies are primarily located in the center of the grain, with the grain's true composition diluted by surface contamination. Grain B of [6] also has a large depletion in ^{34}S (-520 ‰) relative to ^{32}S. Grains of such unusual Si and S isotopic compositions raise several outstanding questions: How can these grains be understood in the context of the SN models [9], which predict correlated excesses of ^{28}Si and ^{32}S from the Si/S zone? In what form does S condense into these grains – as CaS, which has been observed in TEM sections of an AB grain [10]? Hopefully, measurement of the isotopic compositions of more elements (e.g., Mg-Al) in grain e2-3-4 can further refine our understanding of these unique grains.

References: [1] Hoppe P. and Ott U. (1997) in *Astrophys. Impl. Lab Study of Presolar Mat.* pp. 27-58. [2] Amari S. et al. (2001) *ApJ* 559, 463. [3] Lin Y. et al. (2010) *ApJ* 709, 1157. [4] Amari S. et al. (1999) *ApJ* 517, L59. [5] Croat T.K. and Stadermann F.J. (2008) *LPSC* 39, 1739. [6] Hoppe P. et al. (2010) *LPSC* 41, 1082. [7] Zinner E. et al. (2010) *LPSC* 41, 1359. [8] Gyngard F. et al. (2010) *ApJ* in press. [9] Rauscher T. et al. (2002) *ApJ* 576, 323. [10] Hynes K.M. et al. (2010) *LPSC* 41, 2074.