HIGH-DENSITY, CARBON-13 ENRICHED GRAPHITE GRAINS FROM ORGUEIL

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Introduction: A previous study [1] showed that some high-density (HD) graphite grains from Orgueil exhibit very unique C, Ca, and Ti isotopic ratios. This work established that HD graphite grains can have multiple stellar sources: supernovae and low-metallicity AGB stars. Further, the $^{12}C/^{13}C < 20$ and extremely large Ca and Ti anomalies of some grains indicate an origin in born-again asymptotic giant branch (AGB) stars, which are stars that experience a very late He flash. In order to better understand grains with such diverse isotopic characteristics, we analyzed a new set of HD graphite grains from Orgueil.

Experimental: Thirty-nine, large (average size ~ 5 μm) HD graphites from the OR1f (ρ ~ 2.02-2.04 g cm^{-3}) density fraction were picked with a micromanipulator and transferred to a gold-foil mount. Carbon, N, O, and Si isotopic ratios were measured by using a Cs^+ primary beam in the NanoSIMS. We also obtained full Raman spectra (100-4000 Δcm^{-1}) of 22 HD grains.

Results and Discussion: The $^{12}C/^{13}C$ ratios of the grains on this mount range from 12 – 2947. Twenty-eight grains have $^{12}C/^{13}C$ ratios larger than 100 and four grains are normal or close-to-solar. Six grains have low $^{12}C/^{13}C$ ratios ranging from 12 – 28; and one (grain OR1f3m-33) has an intermediate value of $^{12}C/^{13}C = 73$. All, except one of the grains, with low $^{12}C/^{13}C$ ratios have close-to-solar O isotopic ratios, as is common in HD graphites [2, 3, 4]. OR1f3m-33 has an ^{18}O excess ($^{16}O/^{18}O = 368$) and a ^{14}N excess ($^{14}N/^{15}N = 403$). The grain with the lowest $^{12}C/^{13}C$ ratio also has a slight ^{14}N excess, while all other grains have solar or close-to-solar N isotopic ratios. Grain OR1f3m-33 has a large ^{28}Si excess; two ^{13}C-enriched grains, one ^{12}C enriched grain and one grain with close-to-solar C isotopic ratio also exhibit ^{28}Si excesses. Most previously studied HD graphite grains contain $^{29,30}Si$ excesses that often correlate with large $^{12}C/^{13}C$ ratios [2, 4]. We only found two such grains with ^{30}Si excesses and large $^{12}C/^{13}C$ ratios. Such a correlation indicates an origin in low-metallicity AGB stars [2, 4]. The ^{18}O and ^{28}Si excesses in OR1f3m-33 indicate an origin in a type II SN [5, 6]. The Raman spectra show that HD grains are indeed (well crystalline) graphite, whereas spectra of low-density "graphite" grains from Orgueil are characteristic of disordered carbonaceous material.

We plan to obtain Al-Mg, K, Ca, and Ti isotopic data on these grains before the meeting. These isotopes will better determine the nucleosynthetic sources for the grains. The present C, N, O, and Si measurements confirm that HD graphites have multiple stellar sources: SNe and low-metallicity AGB stars. It remains to be seen if we find extreme Ca and Ti anomalies in the ^{13}C-enriched grains that can be attributed to an origin in born-again AGB stars.

References: [1] Jadhav M. et al. (2008) *ApJ, 682*, 1479-1485. [2] Jadhav M. et al. (2006) *New Astron. Rev., 50*, 591-595. [3] Zinner E. et al. (1995) *Meteoritics,* 30, 209. [4] Amari S. et al. (2005) *MAPS,* 40, A15. [5] Travaglio C. et al. (1999) *ApJ,* 510, 325. [6] Woosley S.E. and Weaver T.A. (1995) *ApJS*, 101, 181.