DO SiC GRAINS IN ORGUEIL DIFFER FROM THOSE IN MURCHISON?

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Studies of individual presolar SiC grains have shown that most are enriched in ^{29}Si, ^{30}Si, and ^{13}C, and depleted in ^{15}N, compared to solar-system abundances, and that many have large excesses of ^{26}Mg, most plausibly from *in situ* decay of ^{26}Al [1–5]. Stone *et al.* [2,3] observed that Si from a family of platy SiC grains define a linear array on a 3-isotope plot that does not pass through normal solar-system Si. In contrast, Si-isotope data from over 100 3–4 μm SiC grains from Murchison form an elongate ellipse enclosing the Stone *et al.* linear array but also including 'normal' solar-system Si [6]. To investigate whether this difference in Si isotopes indicates different populations of SiC in the two meteorites and to improve the characterization of Orgueil SiC, we used the PANURGE ion microprobe to measure Si, C, N, and Mg isotopes and Al and Na concentrations in a suite of 2–5 μm SiC grains from a new sample of Orgueil.

With the exception of one grain, the combined Si-isotope data from this study and that of Stone *et al.* lie within three standard deviations of a single array indistinguishable from that defined by the Stone *et al.* data alone. Fig. 1 shows the regression through our data and a slope 1/2 line passing through normal Si. This behavior contrasts with the ellipse of data obtained by Amari *et al.* [6] for Murchison SiC of similar size (KJG+KJH) and demonstrates that the adherence of the Stone *et al.* data to a single array was not an artifact of the relatively small sample size. Relative to this array, one Orgueil grain is enriched in ^{29}Si with a Si isotope composition more typical of sub-micron SiC [3]. Orgueil data are distributed uniformly along the linear array, as are the Murchison KJG and KJH data [6]. This contrasts with the clustering exhibited by larger (>6 μm) Murchison SiC grains (LS, LU) measured by Virag *et al.* [4]. We found no SiC with 'normal' Si, whereas both Murchison KJG+KJH and LS+LU populations included 'normal' grains [4, 6].

All measured Orgueil SiC grains are enriched in ^{13}C and highly depleted in ^{15}N relative to solar-system abundances (Figs. 2, 3), in general agreement with Murchison data [4, 6]. The distributions of C, N, and Si isotopes among the Orgueil SiC are generally uncorrelated and exhibit none of the clustering of C and Si isotopic compositions observed for the larger Murchison LS+LU grains [4]. Among Orgueil grains, ^{13}C-rich C tends to accompany ^{30}Si-rich Si (Fig. 2). No Orgueil SiC was found with 'normal' C, in contrast to SiC from Murchison [4,6]. Orgueil SiC is, on average, more ^{15}N-poor. Murchison KJG+KJH grains have a continuous distribution of $^{15}N/^{14}N$ ratios ranging from about 0.0045 to 0.0002 ($\delta\,^{15}N$ = +200 to -950‰) [6] ('normal' is 0.0037). We found no grains with $^{15}N/^{14}N$ higher than 0.0015 ($\delta\,^{15}N$ = -590‰) (Fig. 3), and any correction for multiplier background or extraneous N would serve to lower the ratios.

Three Orgueil SiC grains had resolvable $^{26}Mg^*$ excesses, corresponding to $^{26}Al/^{27}Al$ ratios of $(5.0\pm0.4)\times10^{-4}$ to $(1.8\pm0.2)\times10^{-3}$. $^{26}Mg^*$ was detected in grains with the highest Al contents. Other grains gave upper limits roughly comparable to the amounts detected in our resolved grains, so failure to resolve $^{26}Mg^*$ does not demonstrate the absence of $^{26}Mg^*$. The three grains with detectable $^{26}Mg^*$ also have the three most extreme ^{15}N depletions and the grain with the highest $^{26}Al/^{27}Al$ ratio has the heaviest Si. Murchison KJG+KJH grains show a rough correlation between the $^{26}Al/^{27}Al$ ratio and $^{12}C/^{13}C$ ratios [6], but our limited data cannot confirm this trend.

The Orgueil SiC exhibit a striking correlation between the abundance of Al (as Al^+/Si^+) and N (as CN^-/Si^-) (Fig.4), similar to that reported for Murchison SiC [5] but with much less scatter. This correlation is consistent with the suggestion that Al and N are present in SiC as AlN, either in solid solution or inclusions, but the low condensation temperature of AlN, ≥350 K below that of SiC, makes it difficult to understand how AlN is incorporated into SiC.

Brown and Clayton [7,8] proposed a model to explain the Si correlation line (Fig. 1) in which ^{29}Si is over-produced by $^{26}Mg(\alpha,\gamma)\,^{29}Si$ in hot-bottom burning at 450×10^6 K. A side effect of this mechanism is almost complete destruction of ^{22}Ne, which, along with other noble gases, is abundant in SiC. They suggest that ^{22}Ne was trapped as ^{22}Na and require a Na/Si ratio in SiC of ~5×10^{-3} to produce the observed ^{22}Ne [8]. Na measurements were made to test this hypothesis, but because Na is an ubiquitous contaminant, only upper limits were established. Measured Na^+/Si^+ ratios ranged from 5×10^{-3} to 2×10^{-1}. However, Na^+ forms much more efficiently than Si^+ and, using an ion-yield ratio of ~20, we calculate Na/Si ratios of 3×10^{-4} to 1×10^{-2}. But most of the measured Na did not come from the grains, as determined by ion imaging before and after the measurements. Thus our preliminary data appear to limit the Na/Si ratios of Orgueil SiC to $\leq 5\times10^{-3}$, with the Na contents of most grains 10 to 50 times lower.

In summary, we have more than doubled the number of grains measured by Stone *et al.* and find that their Si-isotope correlation does not dissolve into an ellipse as observed for similar-sized Murchison SiC. N in Orgueil SiC seems to be more ^{15}N-poor than in similar-sized Murchison SiC. No X or Y grains have been found, but our numbers are still small. These observations tentatively suggest that 2–5 µm Orgueil SiC may have a more limited range of compositions than similar SiC from Murchison.

[1] Zinner *et al.* (1989) *GCA* **53**, 3273–3290. [2] Stone *et al.* (1991) In (Taylor, O'Neil, and Kaplan, eds) Stable Isotope Geochemistry: A tribute to Samuel Epstein, 487–504. [3] Stone *et al.* (1991) *EPSL* **107**, 570–581. [4] Virag *et al.* (1992) *GCA* **56**, 1715–1733. [5] Zinner *et al.* (1991) *Nature* **349**, 51–53. [6] Amari *et al.* (1992) *Ap. J.* **394**, L43–L46. [7] Brown and Clayton (1992) *Ap. J.* **392**, L79–L82. [8] Brown and Clayton (1992) *Science* **258**, 970–972. Supported by NASA, NAGW 3040. Division contribution #5234 (798).

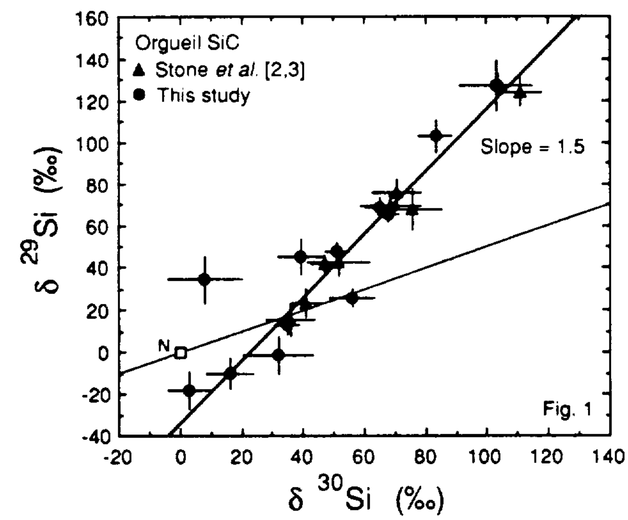

Fig. 1

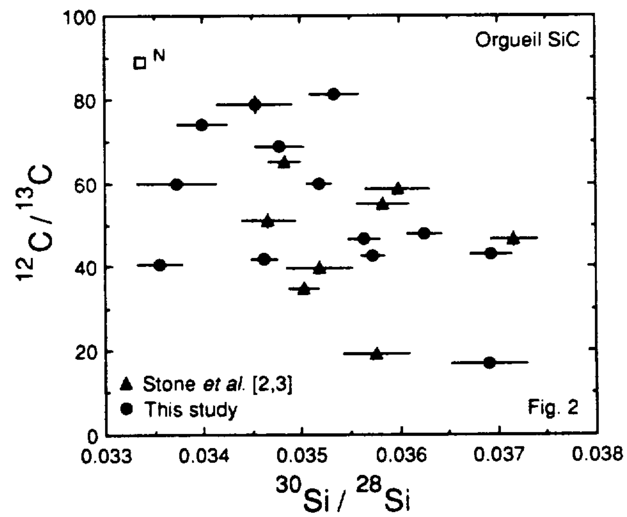

Fig. 2

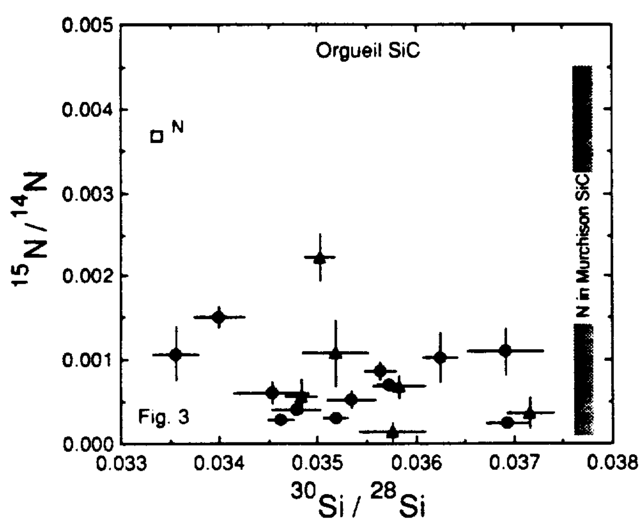

Fig. 3

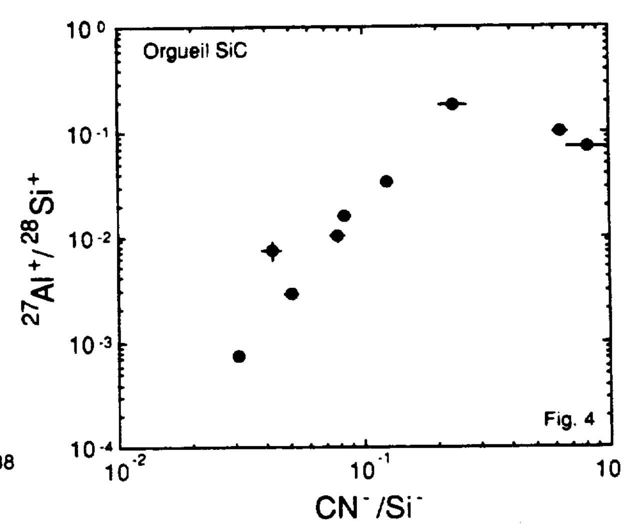

Fig. 4