NANOSIMS ISOTOPIC ANALYSIS OF SMALL PRESOLAR SIC GRAINS FROM THE MURCHISON AND INDARCH METEORITES. S. Amari[1,2], C. Jennings[1,3], A. Nguyen[1,3], F. J. Stadermann[1,2], E. Zinner[1,2], and R. S. Lewis[4], [1]Laboratory for Space Sciences, [2]Physics Department, [3]Earth and Planetary Science Department, all at Washington University, St. Louis, MO 63130, USA (sa@wuphys.wustl.edu), [4]Enrico Fermi Institute, University of Chicago, Chicago IL 60637 USA.

Introduction: Studies of presolar SiC grains have shown that their elemental and isotopic properties vary with grain size [1-3]. A wealth of isotopic measurements of single grains has been obtained with the ion microprobe [4]. However, most analyses were made on grains larger than 1 µm in diameter [e.g., 5, 6], which represent only a small fraction of all grains. Furthermore, they were made on SiC grains from Murchison, which, on average, are larger than those from other meteorites. A new type of ion microprobe, the NanoSIMS, with its high spatial resolution, high sensitivity, and multidetection capability [7] allows isotopic analysis of much smaller grains (down to 0.1µm). We have made C and N isotopic measurements on small presolar SiC grains from the Murchison and Indarch chondrites and compare them with data on larger Murchison grains.

Experimental: The measurements were made in multidetection mode by counting secondary C^- and CN^- ions produced by Cs^+ bombardment in four electron multipliers. A 5th detector was used to count $^{28}Si^-$ ions. Grains to be analyzed were identified from a 20µm×20µm raster image of secondary electrons and ions produced by the Cs beam. For an isotopic measurement, which lasted 60 sec, the primary beam was deflected onto the grain and rastered over a 0.8µm×0.8µm area. We added 219 new analyses to the 91 previously made [8] on SiC grains from Murchison separate KJB (diameters 0.25-0.45µm) and measured 182 grains from the Indarch separate IH6 (diameters 0.25-0.65µm).

Results and discussion: The results are plotted in Fig. 1-3 and compared with previous measurements on grains from Murchison separate KJG (diameters 1.8-3.7µm) [5, 8]. There exist some isotopic data on individual SiC grains from Indarch [9, 10] but the data are too limited to make a comparison meaningful. While we did not detect any Si nitride among the Murchison grains, a sizeable fraction of Indarch grains have large Si/C ratios and 23 of them with $^{28}Si^-/^{12}C^- > 4$ (Fig. 3) were classified as Si_3N_4.

The distributions of the C and N isotopic ratios do not vary much among the three grain populations in Fig. 1. The ranges of the C and N ratios are quite similar as are the fractions of different grain types. A+B grains ($^{12}C/^{13}C<10$): 7% for KJG, 6.5% for KJB, 5% for IH6. Y grains ($^{12}C/^{13}C>100$): 6% for KJG, 6.5% for KJB, 4% for IH6. The only noticeable difference in the C isotopic distributions is the fraction of grains with $10<^{12}C/^{13}C<40$, which is 7% for KJG, but 15% for KJB and 16% for IH6.

Another clear difference between large and small grains is the range and distribution of N concentrations (expressed by the measured CN^-/C^- ratios) and of the Si^-/C^- ratios (see Fig. 3). Si_3N_4 grains have variable C contents and it is no surprise that their CN^-/C^- ratios are higher than those of SiC grains. While Si_3N_4 grains have smaller anomalies than SiC grains (Fig. 1), within the analytical errors (1σ in Fig. 2) about half of them have anomalous N ratios and most have anomalous C isotopic ratios. It could be that the anomalous ratios are due to small attached SiC grains but in some cases we can rule this out. For example, for grain A, the most anomalous Si_3N_4 grain (Fig. 2), the Si/C ratio remained constant during the analysis and the $^{14}N/^{15}N$ and CN^-/C^- ratios are so high that even if a putative SiC grain had only ^{14}N, the $^{14}N/^{15}N$ ratio of the Si_3N_4 would still be anomalous. Si_3N_4 grains with isotopic signatures of X-grains, indicative of a supernova origin, have been observed before [11-13]. We conclude that there exist also presolar Si_3N_4 grains with the isotopic signatures of mainstream SiC grains.

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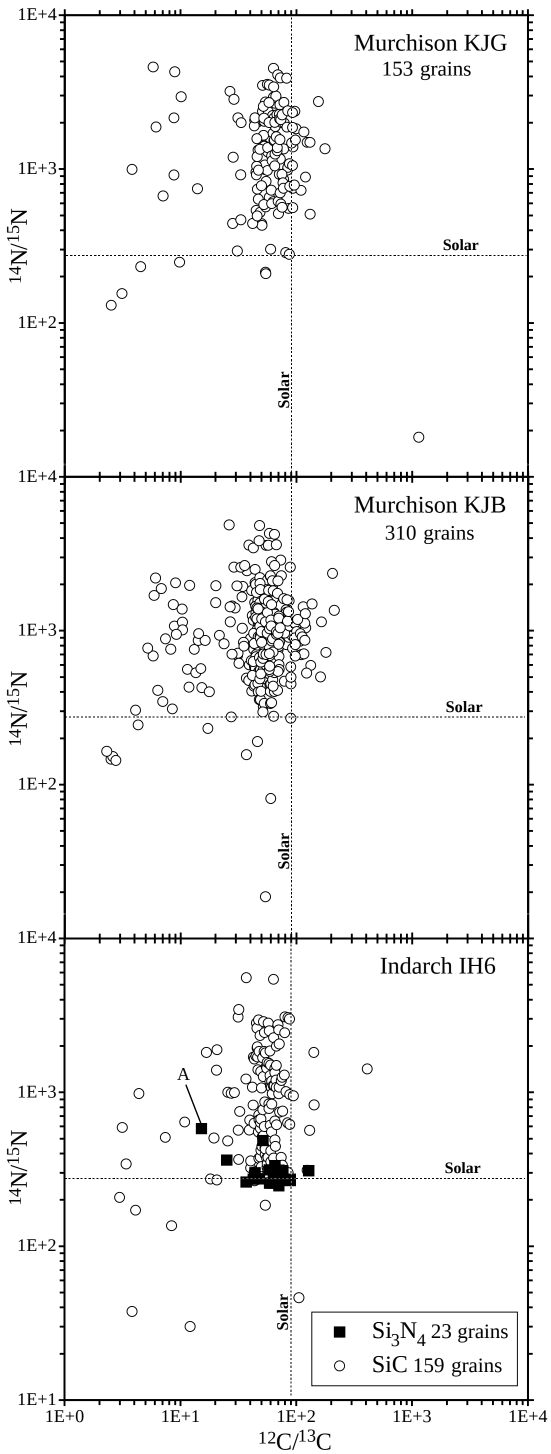

Figure 1

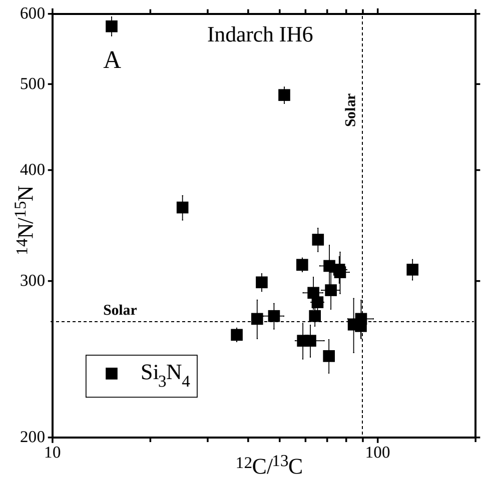

Figure 2

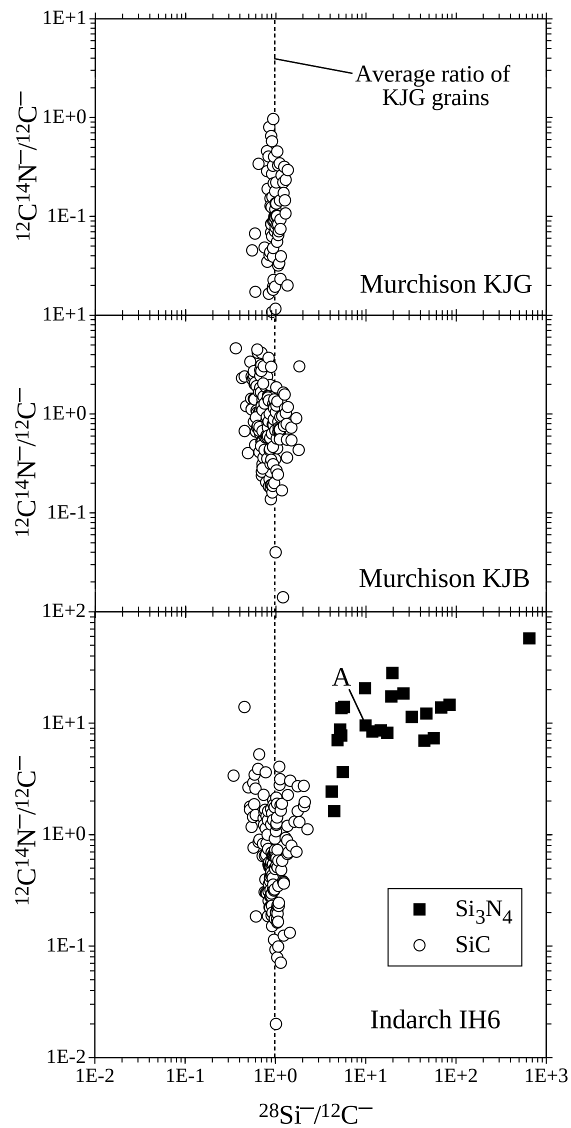

Figure 3