EVIDENCE FOR AN INTERSTELLAR NITRIDE GRAIN WITH HIGHLY ANOMALOUS ISOTOPIC COMPOSITIONS OF C, N AND Si; P. Hoppe, R. Strebel, and P. Eberhardt, Physikalisches Institut der Universität Bern, Sidlerstr.5, CH-3012 Bern, Switzerland; S. Amari, McDonnell Center for the Space Sciences and Physics Department, Washington University, St. Louis, MO 63130-4899, USA; R. S. Lewis, Enrico Fermi Institute, University of Chicago, Chicago, IL 60637-1433, USA.

We have analyzed the C-, N- and Si-isotopic compositions of 795 individual grains from the Murchison SiC separate KJE (average size 1.14 μm [1]) with the University of Bern ion microprobe. Results for a subset of these grains have been reported previously [2]. Subsequent analyses revealed one grain that contained only little carbon with an atomic abundance ratio of C/Si ~ 0.006. Its CN^-/C^- ratio, a qualitative measure for the nitrogen content, is very high, ~ 30x higher than that of a typical SiC grain (cf. Fig. 4), suggesting that this grain is a refractory nitrogen-bearing mineral. The isotopic compositions of C, N and Si are highly anomalous and similar to those of the very rare SiC component grains X [3].

Silicon nitride (Si_3N_4) and silicon oxynitride (Si_2N_2O) are silicon- and nitrogen-rich minerals. Both minerals are known to occur in meteorites. Silicon nitride has been identified in ordinary as well as in enstatite chondrites [4, 5, 6], and silicon oxynitride has been found in enstatite chondrites [7, 8]. Since we do not have information on the detailed mineralogy of our silicon- and nitrogen-rich grain we measured the elemental ratios of C, N and Si in synthetic Si_3N_4 and synthetic Si_2N_2O that contained carbon in varying small amounts. As nitrogen is measured as CN^- the CN^-/Si^- ratio strongly depends on the C^-/Si^- ratio and on the mineralogy (Fig. 1). Unfortunately, the CN^-/Si^- and C^-/Si^- ratios of our silicon- and nitrogen-rich grain (KJE853) plot in a region where the correlation lines found for synthetic Si_3N_4 and Si_2N_2O do not allow a differentiation between these two minerals. However, regardless of the presence of oxygen, in grain KJE853 nitrogen is a major element and carbon is a minor constituent.

The isotopic properties of grain KJE853 are shown in Figs. 2 and 3. It is characterized by light C ($^{12}C/^{13}C = 157\pm33$), heavy N ($^{14}N/^{15}N = 18\pm1$) and light Si ($\delta^{29}Si = -43\pm56$ ‰, $\delta^{30}Si = -271\pm50$‰). Such an isotopic pattern is the signature of the rare SiC component called grains X [3]. As grain KJE853 is isotopically related to grains X the same type of stellar source, namely, type II supernovae is suggested. The formation of silicon nitride or silicon oxynitride requires a nitrogen-rich environment such as the H-burning shell of pre-supernova stars. While the ^{15}N enrichment could originate from explosive nucleosynthesis in this layer, the isotopic signatures of C and more significantly Si require admixture of material from underlying layers, namely, the He-burning shell (rich in ^{12}C) and the O-burning shell (rich in ^{28}Si).

Five of the SiC grains X found in separate KJE have a very high nitrogen content, ~ 5x higher than that of a typical SiC grain from KJE (Fig. 4). The fact that the Al-concentration of interstellar SiC roughly correlates with the N-concentration led Zinner et al. [9] to suggest that nitrogen is present as AlN. However, as grain KJE853 is isotopically related to grains X it appears not unrealistic that the very high nitrogen content of some grains X can be attributed to silicon nitride or silicon oxynitride that is present either as subgrains (such as TiC found within interstellar graphite grains [10]) or in solid solution with SiC.

While the Murchison grain KJE853 resembles isotopically the rare SiC grains X, it has a distinctive chemistry and is a further indication of the variety of stardust that can be found.

This work was supported by the Swiss National Science Foundation and by NASA.

INTERSTELLAR NITRIDE GRAIN: Hoppe P. et al.

REFERENCES: [1] Amari S. et al. (1993) *Geochim. Cosmochim. Acta*, in press. [2] Hoppe P. et al. (1993) *Meteoritics* **28**, 363-364. [3] Amari S. et al. (1992) *Astrophys. J.* **394**, L43-L46. [4] Lee M. R. et al. (1992) *Meteoritcs* **27**, 248-249. [5] Stone J. et al. (1991) *Earth Planet. Sci. Lett.* **107**, 570-586. [6] Alexander C. M. O'D. et al. (1991) *Lunar Planet. Sci.* **22**, 5-6. [7] Andersen C. A. et al. (1964) *Science* **146**, 256-257. [8] Keil K. and Andersen C. A. (1965) *Nature* **207**, 745. [9] Zinner E. et al. (1991) *Nature* **349**, 51-54. [10] Bernatowics T. et al. (1991) *Astrophys. J.* **373**, L73-L76.

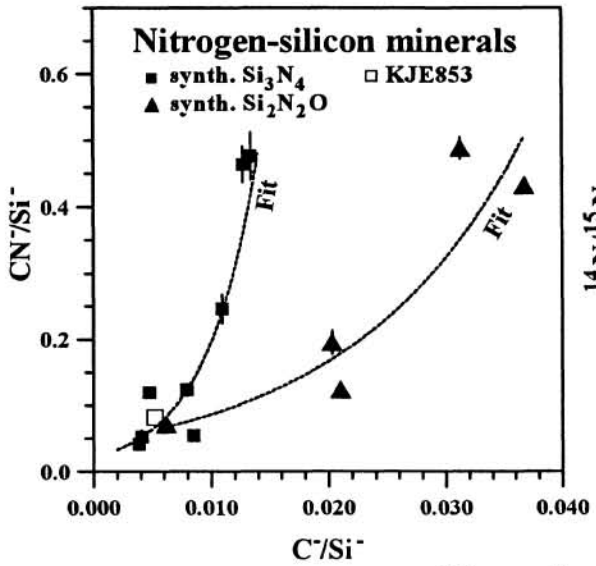

Figure 1

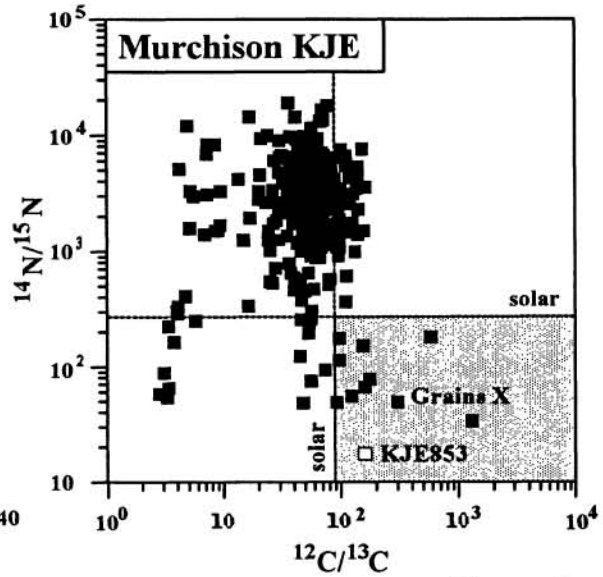

Figure 2

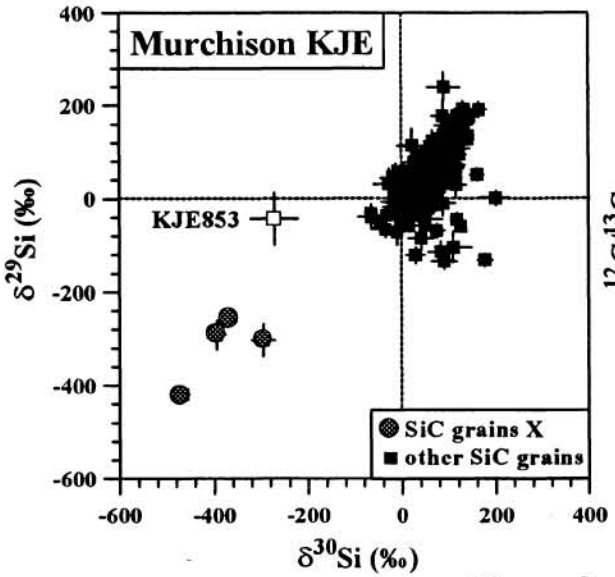

Figure 3

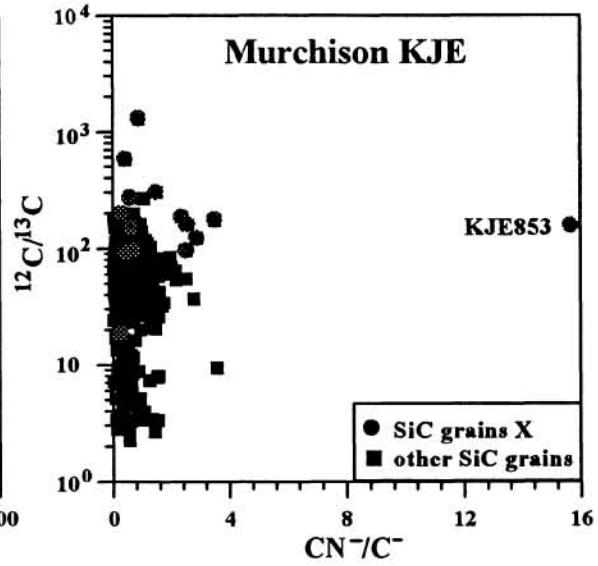

Figure 4