NOBLE GASES AND THE NOT SO UNUSUAL SIZE OF PRESOLAR SiC IN MURCHISON.
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Introduction: Among the presolar phases found in primitive meteorites, silicon carbide has been investigated in most detail. The most extensive studies - including a detailed analysis of the grain size distribution - have been performed on separate KJ from the Murchison meteorite [1]. Most of the *mass* was found to be contained in grains in the size range ~0.4 to ~1 µm, with the grain distribution by *number* roughly compatible with either the sum of three log-normal distributions or a power-law distribution which falls off at the low and high ends [1].

There is some doubt, however, whether the size distribution determined for Murchison KJ is representative for presolar SiC in meteorites, in general. Evidence to the contrary comes from a comparison of noble gas nuclide ratios that have been shown to correlate with grain size [2]. Most sensitive is the ratio of ^{22}Ne-E(H) to *s*-process ^{130}Xe. In KJ it is ~3500, while, judging from the data in [3] and [4] a lower ratio of ~600 seems to be more typical for SiC from primitive meteorites. The difference could be indicative of a relatively smaller fraction of fine-grained SiC in Murchison, and size sorting in the solar nebula has been considered by [4] as a possible explanation for the difference. But a more mundane possibility – loss of fine-grained SiC during the extremely extensive chemical and physical separation of the KJ separate - could not be ruled out. The possibility of changes in the size distribution including loss of fine material is indicated by a number of observations: a) the surfaces of chemically isolated SiC grains are strongly affected by etching [5]; b) non-negligible amounts of fine-grained SiC are found in separates of presolar diamond [6]; c) the different polymorphs of SiC show different stability towards acid treatment (Merchel, unpublished). We have addressed the problem by analyzing noble gases in a *minimally* processed Murchison acid-resistant residue.

Experimental: To reduce the extent of losses as much as possible, we applied only the absolutely necessary chemical treatment to the meteorite sample, namely HCl and mixtures of HF/HCl in order to dissolve the silicates, and CS_2 to remove sulfur. Such a "classical HF/HCl residue" [7] contains not only SiC, but also the diamonds, organic material, spinel, graphite etc., including the noble-gas-rich Q phase. Therefore, in order to resolve the various noble gas components present, it was necessary to employ a combination of pyrolysis and combustion extraction steps [8], making use of the different thermal and chemical stability of the carrier phases. Gas extraction was done by pyrolysis at 500°C, followed by a series of combustion steps (400-1200°C). A high temperature extraction for complete gas release is to follow.

Results: Results after preliminary data reduction (where the extraction blanks, essentially atmospheric in composition, have not been subtracted) are shown in Figs. 1 and 2.

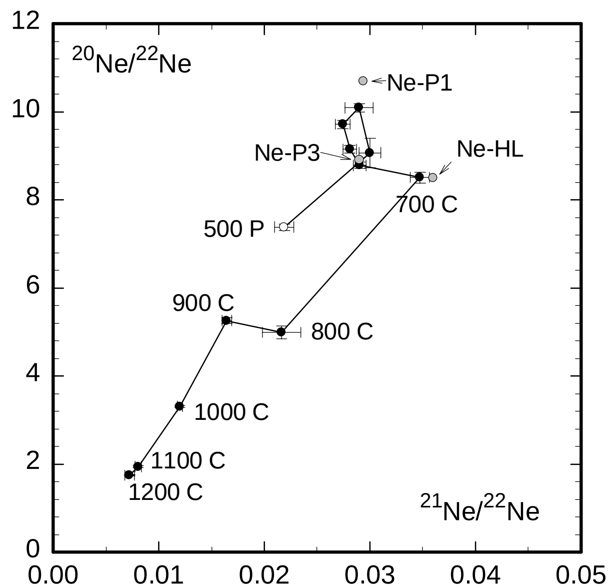

Fig. 1: Isotopic composition of Ne released from minimally processed Murchison acid-resistant residue. Data points are connected starting from the first (500°C pyrolysis) towards the last (1200°C combustion) extraction step. Labels indicate extraction temperature and mode of gas release (P=pyrolysis, C=combustion).

The Ne data in Fig. 1 show evidence for the presence of Ne-E(L) and hence its graphite carrier in the initial 500°C pyrolysis step. The following extractions (combustion up to 700°C), where most of the gas is released, are dominated by Ne-P3 and Ne-HL from interstellar diamond, with an excursion towards Q-Ne (Ne-P1) in intermediate steps. Starting with the 800°C combustion, the data points move towards the origin, providing clear evidence for the presence of Ne-E(H) and hence presolar SiC.

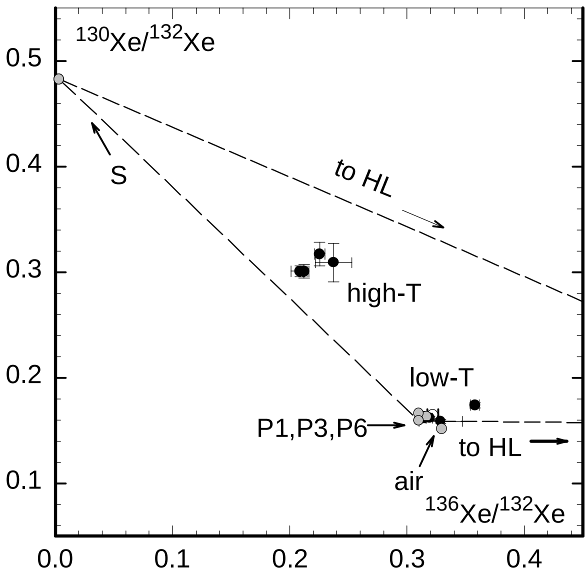

Fig. 2: Isotopic composition of Xe released from minimally processed Murchison acid-resistant residue. In this plot of $^{130}Xe/^{132}Xe$ vs. $^{136}Xe/^{132}Xe$ data points fall into two groups for low- (≤ 800°C) and high-temperature extraction. The high-T extractions clearly contain Xe-S.

Xenon data are shown in Fig. 2 in a $^{130}Xe/^{132}Xe$ vs. $^{136}Xe/^{132}Xe$ plot. The data points form two different clusters. The “low-temperature” release points plot in the vicinity of the isotopically “normal” P1, P3 (and possibly P6) components hosted by Q and the presolar diamonds, with only a small excursion towards Xe-HL in the diamonds, whereas the high-temperature combustion points (≥ 900°C) clearly indicate the presence of Xe-S from SiC.

Ratios of ^{22}Ne-E(H)/^{130}Xe-S calculated from these data are listed in Table 1. Note that while there is strong evidence for the presence of Xe-S also in the 800°C combustion, a formal calculation of its abundance produces a large error and we list only an approximate value.

Table 1: Ne-E/Xe-S in minimally processed Murchison.

combustion T [°C]	^{22}Ne-E/^{130}Xe-S
800#	~300
900	313 ± 69
1000	559 ± 82
1100	672 ± 103
1200	665 ± 23
total: 900-1200	521 ± 48
total: 800-1200	479 ± 105

#Xe-S only marginally visible due to large contributions from other components

Implications: Inclusion of gases to be released in the final high temperature pyrolysis step after previous combustion at 1200°C is likely to change (increase) the total ^{22}Ne-E/^{130}Xe-S ratio only slightly (cf. release patterns from Murchison SiC in [9]). Hence it appears that Murchison SiC - like SiC from other primitive meteorites [4] - is characterized by (^{22}Ne-E/^{130}Xe-S) ~600 and that the protracted treatment of Murchison KJ has led to loss of fine-grained SiC from this separate. This conclusion is also supported by the fact that our data imply an at least four times higher abundance of Xe-S in Murchison bulk than inferred from the Murchison KJ noble gas data of [2].

A puzzling result of the grain size distribution found for Murchison KJ by [1] has been that - if interpreted as a power-law distribution - the exponent was significantly higher (~5.7) than the one for the grain size distribution of interstellar grains according to astronomical observations (~3.3; [10]). Whether this holds for the majority of meteoritic SiC grains which must be finer-grained than typical for KJ (and in the size range of the astronomically observed grains) remains to be investigated.

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References: [1] Amari S. et al. (1994) *GCA, 58,* 459-470. [2] Lewis R. S. et al. (1994) *GCA, 58,* 471-494. [3] Huss G. R. and Lewis R. S. (1995) *GCA, 59,* 115-160. [4] Russell S. S. et al. (1997) *Meteoritics & Planet. Sci., 32,* 719-732. [5] Macke R. J. et al. (1999) *LPS XXX,* #1435. [6] Daulton T. L. et al. (1996) *GCA, 60,* 4853-4872. [7] Lewis R. S. et al. (1975) *Science, 190,* 1251-1262. [8] Ott U. and Lugmair G.W. (1998) *Meteoritics & Planet. Sci., 33,* A119-A120. [9] Ott U. et al. (1988) *LPS XIX,* 895-896. [10] Mathis J. S. et al. (1977) *Astrophys. J., 217,* 425-433.