COMPLETE RARE GAS STUDY OF A VERY LARGE UNMELTED COSMIC DUST PARTICLE FROM GREENLAND. Ph. Sarda, Th. Staudacher and C.J. Allègre. Laboratoire de Géochimie, Institut de Physique du Globe, tour 14 3è étage, 4 place Jussieu, 75252 Paris Cedex 05, France.

Cosmic dust is known to display a range of particle sizes, from very small of 1-10µm, up to large sizes of 50 or 100µm. Recently, Maurette at al. found in sediments from the Greenland sheet a number of surprisingly very large unmelted fragments which were shown to be extraterrestrial, and hence to have survived atmospheric entry. These particles are less abundant than the small ones and they attain sizes of 300-500µm [e.g. 1].

Here we report the first all-noble gas study of such a very large unmelted fragment. We used a part of a bigger particle, which turned out to contain enough gas for the analyses to be possible. Before analysis, we weighted the fragment using a micro balance, and its mass was 2.3 10^{-4} g (230 µg). We analysed the particle using ARESIBO II, an all glass Reynolds-type mass spectrometer that was only used for terrestrial samples before this study.

The particle was heated in three temperature steps: 750, 1100, and 1500°C. The results are given in the table. The salient features are the following.

1) A large fraction of each gas is released in the 1500°C temperature fraction, and is the most isotopically anomalous compared to air (44% ^{4}He, 26% ^{20}Ne, 87% ^{36}Ar, 56% ^{84}Kr, 69% ^{132}Xe). This suggests that extraterrestrial gases are fairly tightly trapped in this material, and confirm a similar observation from the study of cosmic material embeded in deep-sea sediments [e.g.2,3,4,5].

2) The rare gas concentration pattern normalised to cosmic abundances is clearly "planetary".

3) Very low $^{4}He/^{3}He$ ratios (high $^{3}He/^{4}He$), down to 8400±1800, appear in the 1500°C step, a value close to the so-called "planetary ratio" found in chondrites (≈7000). In terms of $^{3}He/^{4}He$ the maximum value is (1.18±0.25)10^{-4} or (86±18)xRa, where Ra is the atmospheric ratio of 1.38 10^{-4}. Large errors are due to blank correction.

4) $^{20}Ne/^{22}Ne$ and $^{21}Ne/^{22}Ne$ isotopic ratios very close to the meteoritic component called Ne-C appear in the 1500°C fraction: $^{20}Ne/^{22}Ne$ = 10.6±0.3, $^{21}Ne/^{22}Ne$ = 0.038±0.004. Planetary neon (Ne-A) was not found; in the 750°C step, the neon isotopic composition is close to air, probably due to interaction with air during entry.

5) The $^{40}Ar/^{36}Ar$ is very low: 136±35, 151±4, and 14.7±0.2 for the three temperature steps successively, which is expected for extraterrestrial material. The $^{38}Ar/^{36}Ar$ ratio is close to atmospheric within error, but slighltly high, perhaps due to a tiny spallogenic component.

6) The xenon isotopic composition is very anomalous, and strikingly mimics the one measured in carbonaceous chondrites, such as for example Murray.

These data make this particle a typically chondritic material, with the expected He, Ar and Xe isotopic composition. The neon isotopic composition suggests that neon (and hence perhaps helium), is dominated by an implanted solar component analogous to solar flare, as was proposed for Ne-C, or to Solar Energetic Partices (SEP-Ne). Conversely, the Ar, and especially the xenon isotopic composition are very close to the components which are usually found in carbonaceous chondrites and are called "planetary" (AVCC-Xe [6]). It is remarkable that the neon here is not the same as in the case of cosmic material from deep sea sediments where neon looks more like solar [2,4], although the data show variations [3,5].

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	750°C	1100°C	1500°C
^{3}He (cm^3STPg^{-1})	-	(3.1 ± 1.8) 10^{-10}	(7.5 ± 2.1) 10^{-10}
$^{4}He/^{3}He$	-	10,200 ± 4400	8440 ± 1800
$^{3}He/^{4}He$, R/Ra	-	71 ± 30	86 ± 18
^{20}Ne (cm^3STPg^{-1})	(2.42 ± 0.02) 10^{-7}	(1.32 ± 0.14) 10^{-8}	(8.80 ± 0.15) 10^{-8}
$^{20}Ne/^{22}Ne$	10.01 ± 0.16	-	10.6 ± 0.3
$^{21}Ne/^{22}Ne$	0.0295 ± 0.0013	-	0.0385 ± 0.0037
^{36}Ar (cm^3STPg^{-1})	(1.37 + 0.13) 10^{-8}	(1.14 ± 0.01) 10^{-8}	(1.707 ±0.006) 10^{-7}
$^{40}Ar/^{36}Ar$	136 ± 35	151 ± 4	14.7 ± 0.2
$^{38}Ar/^{36}Ar$	0.19 ± 0.03	-	0.190 ± 0.001
^{84}Kr (cm^3STPg^{-1})	(1.19 ± 0.05) 10^{-9}	(1.78 ± 0.29) 10^{-10}	(1.76 ± 0.05) 10^{-9}
$^{82}Kr/^{84}Kr$	-	-	0.215 ± 0.010
$^{83}Kr/^{84}Kr$	-	-	0.207 ± 0.010
$^{86}Kr/^{84}Kr$	-	-	0.308 ± 0.018
^{132}Xe (cm^3STPg^{-1})	(1.05 ± 0.03) 10^{-9}	(7.75 ±0.62) 10^{-11}	(2.57 ± 0.05) 10^{-9}
$^{128}Xe/^{130}Xe$	0.43 ± 0.03	-	0.49 ± 0.02
$^{129}Xe/^{130}Xe$	6.2 ± 0.3	-	6.32 ± 0.19
$^{131}Xe/^{130}Xe$	5.01 ± 0.25	-	4.98 ± 0.16
$^{132}Xe/^{130}Xe$	6.32 ± 0.31	-	5.99 ± 0.17
$^{134}Xe/^{130}Xe$	2.51 ± 0.13	-	2.37 ± 0.07
$^{136}Xe/^{130}Xe$	2.15 ± 0.11	-	1.95 ± 0.06