ANTARCTIC MICROMETEORITES (AMMs): SEARCH FOR CORRELATION BETWEEN C/O RATIOS AND ELEMENTAL ABUNDANCES ON A SCALE OF 100 NANOMETERS. C.Engrand and M.Maurette. CSNSM, Bat.104, F-91405 Orsay-Campus, France.

We have used an analytical TEM equiped with both an electron energy loss spectrometer and an EDS to measure C/O ratios and element abundances on spot size of ≈100nm, in a random selection of micron-size crushed fragments from AMMs, Orgueil and Murchison. In this paper we extend our previous investigations, increasing the number of analyses, and searching for correlation between C/O ratios and major element abundances. With the exception of both rare (<1%) vesicles with sizes ≈100nm observed in AMMs, that only contain C and O, and AMMs from the "crystalline" type, most grains show detectable C/O ratios (>0.05) and EDS spectra indicating that the carbonaceous material is closely associated with some mineral components on a scale <100nm. C/O values are not correlated to either the abundances of Al, Mg, Fe, Ca and Ni measured on the same spots, or specific textural features of the grains. These observations should help identifying the processes responsible for the formation, the "injection" and/or reprocessing of the C-rich components found in the fine-grained matrices of both AMMs and carbonaceous chondrites.

One advantage of AMMs is their large size, allowing to split them into several fragments for coordinated studies: (a) one of the fragment is crushed in micrometer-sized grains onto a gold electron microscope grid, and about 30 grains are selected at random for measurements of C/O ratios on ≈100nm size spots, with a Gatan electron energy loss spectrometer attached to a 400kV TEM. The scale of the analyzed volume (≈100nm x 50nm) is thus comparable to the size of dust grains analyzed in the tail of Comet Halley. The selection of spots for analysis is simply made on the basis of a double peak structure of the oxygen peak which is indicative of a properly thin sample (< 50nm). Simultaneously, we characterize the chemical composition by analysing for major elements of the same spot with the EDS of the TEM; (b) another fragment is mounted in epoxy and polished for investigations with an analytical SEM and an electron microprobe at the Naturhistorisches Museum of Vienna in collaboration with G.Kurat. For each AMM we can thus look for correlations between average C/O ratios, textural features, the mineralogy of the major crystalline phases (with sizes >5µm), and the bulk chemical composition of the fine-grained matrix on a scale of ≈10µm.

In table 1 we give a summary of our most recent C/O measurements for Orgueil, Murchison and 33 AMMs belonging to 3 distinct size fractions (100-400µm; 50-100µm; 25-50µm), reporting for each object the average and the highest values (within parenthesis). The validity of the "TEM" method, is deduced from the ratio of the average values determined for Orgueil and Murchison (≈1,35), which well corresponds to that (≈1.20) of their bulk C/O ratios as inferred from the C/Si and O/Si atomic abundances compiled by Mason (1). Our results indicate that AMMs from both the largest and smallest size fractions contains "on the average" ≈2,5 times as much carbon than Orgueil. But about 15% of these AMMs show much higher C contents (>4xCI) approching the range of values determined for Halley grains. We still do not understand why AMMs from the intermediate size fraction (50-100µm) show a smaller average C/O ratio (0.27), exactly similar to the value measured for Orgueil.

As illustrated in figure 2, with the exception of the very rare (<1%) vesicles with sizes of ≈100nm observed in AMMs (only containing C and O), the grains with detectable C/O ratios (C/O > 0.05) are always associated with a mineral matrix on a scale of <100nm. We were expecting to identify a dominant component somewhat related to the abundant C-rich poorly crystallized ferrihydrites already observed in carbonaceous chondrites (2). But there is no correlation between C/O ratios and the abondance of Al, Mg, Fe, Ca and Ni (relative to Si), and only ≈10% of the C-rich grains yielded the diffraction rings of ferrihydrites, which are quite distinct from their meteoritic analogs, in being much more enriched in P. In fact, textural observations of ultramicrotomed sections confirm the invasion of the AMMs structure by a dominant diffuse component, which has still to be clearly identified. Although we did not systematically recorded the EDS spectra of the meteoritic grains, the few available analyses reveal a similar lack of correlation between the C/O ratios and other elemental abundances.

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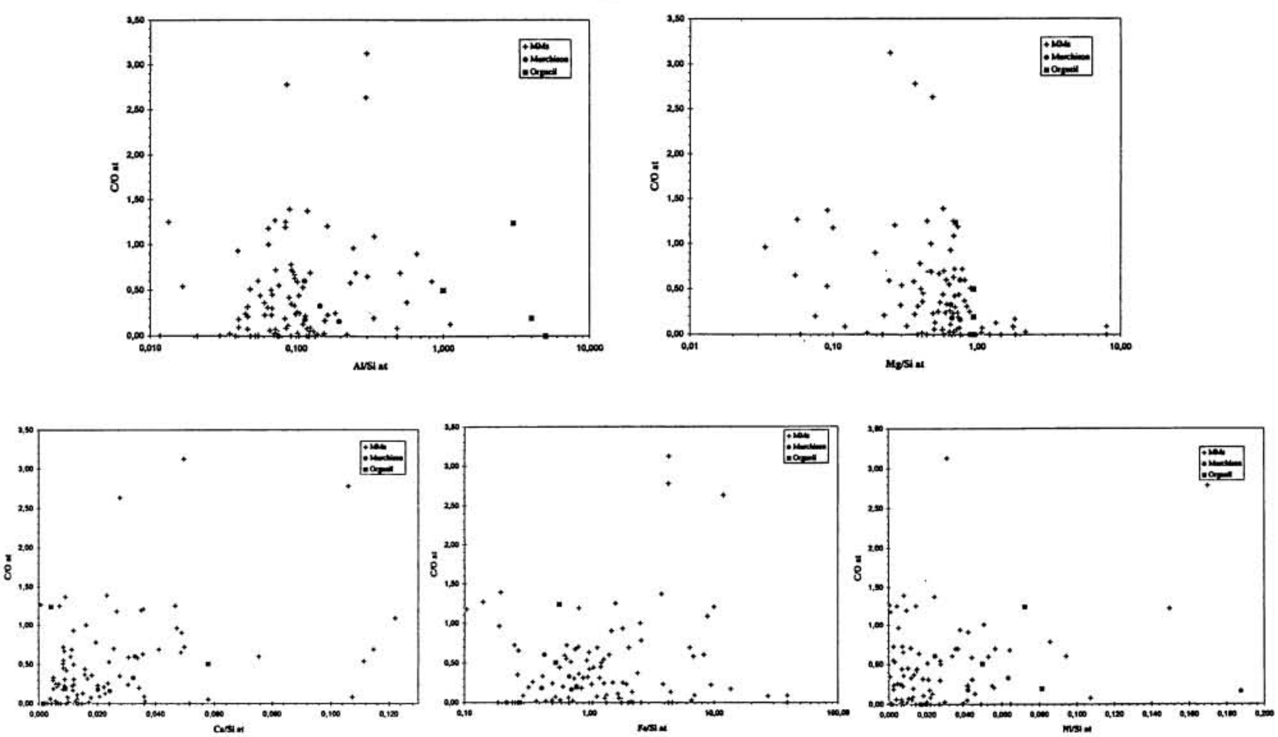
A large fraction of AMMs contain on the average much more carbonaceous material than primitive meteorites, and a similar trend was reported for IDPs (3). This would add to the mounting evidence that the micrometeorite flux contains new families of solar system objects not represented yet in the meteorite collection. It is important to identify the nature of the major diffuse carbonaceous components of AMMs and IDPs, relying possibly on selective dissolution experiments to leach out ferrihydrites from AMMs and primitive meteorites.

Table 1 : Mean values of C/O atomic ratios for AMMs and CCs

Orgueil	**0,27**											
(Max.)	*(1,24)*											
Murchison	**0,20**											
(Max.)	*(1,2)*											
100-400µm	**0,55**	**1,14**	**1,08**	**0,46**	**0,12**	**0,61**	**0,32**	**0,05**	**0,87**	**0,88**	**0,36**	**0,18**
(Max.)	*(2,17)*	*(3,13)*	*(2,44)*	*(1,49)*	*(0,65)*	*(1,22)*	*(1,63)*	*(0,25)*	*(2,56)*	*(3,33)*	*(0,89)*	*(1,22)*
	1,63	**1,08**	**0**	**1,00**								
	(2,27)	*(1,54)*	*(0)*	*(2,27)*								
				Average value for 16 AMMs : 0,65								
50-100µm	**0,05**	**0,73**	**0,45**	**0,37**	**0,22**	**0**	**0,08**	**0,05**	**0,10**	**0,22**	**0,61**	**0,30**
(Max.)	*(0,58)*	*(1,39)*	*(1,00)*	*(2,78)*	*(0,91)*	*(0)*	*(0,64)*	*(0,25)*	*(1,64)*	*(0,94)*	*(1,25)*	*(0,73)*
				Average value for 12 AMMs : 0,27								
25-50µm	**0,26**	**0**	**0,79**	**1,75**	**0,70**							
(Max.)	*(0,58)*	*(0)*	*(2,13)*	*(2,78)*	*(1,92)*							
				Average value for 5 AMMs : 0,70								

Figure 2



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References: (1) B.Mason, in "Data of Geochemistry", 6th Edition, 1979 (Ed. M.Fleischer); (2) T.E.Bunch and S.Chang, *G.C.A.* 44, 1543 (1980); (3) L.P. Keller et al, in "Analysis of Interplanetary Dust", AIP Conf. Proc. 310, 159 (1994).

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