CLASSIC AND EXOTIC PARTICLES IN THE 2006 CONCORDIA ANTARCTIC MICROMETEORITE COLLECTION. E. Dobrica[1], C. Engrand[1], H. Leroux[2], J. Duprat[1] and M. Gounelle[3], [1]CSNSM CNRS-Univ. Paris Sud, F-91405 Orsay Campus, France (Elena.Dobrica@csnsm.in2p3.fr), [2]LSPES CNRS-Univ. Sci. Techno., F-59655 Villeneuve d'Ascq, France, [3]LEME, MNHN, 57 rue Cuvier, CP52, 75005 Paris MNHN, France.

Introduction: We have analyzed CONCORDIA Antarctic micrometeorites by scanning and transmission analytical electron microscopy. These samples were collected in January 2006 from snow at Dome C near the CONCORDIA station in central Antarctica. We confirm that more than 50% of the 30-500 µm dust collected at Dome C (including cosmic spherules) are extraterrestrial [1]. The particles are well preserved from terrestrial weathering, as they exhibit soluble minerals (carbonates and sulphides) that are rare in previous micrometeorite collections from the blue ice fields. In this work, we concentrate on unusual features not previously described in Antarctic micrometeorites (AMMs) from Cap Prud'homme or CONCORDIA.

Samples and methods: In January 2006, we recovered micrometeorites from central Antarctic snow at Dome C (73°S 123°E, see [1]). Compared to the previous campaign in 2002, the filters containing the micrometeorites were quickly dried in the field using a primary vacuum pump and then carefully stored under dry nitrogen to be shipped back to France. Back in Orsay's clean-room, we extracted all particles from melt n°9 performed during the 2006 field trip, that corresponds to melting and sieving of 3 m^3 of snow. Each particle was extracted from the filter, with no pre-sorting. All grains (except cosmic spherules) were split into several fragments. The smallest fragment of each grain was mounted for analysis of its external surface with analytical scanning electron microscopy (SEM + EDX) at 15kV. We have also started the characterisation of one fragment of AMM DC06-08-26 at the transmission electron microscopy (TEM) using FEI Tecnai G2 20 at CSNSM (Orsay) and at LSPES (Lille).

Results: We identified by SEM imaging and EDX analysis a total of 290 AMMs and 119 cosmic spherules (CSs) from 515 grains analyzed (80% are of extraterrestrial origin). Assuming an average density of 2.5 for unmelted AMMs and of 3 for cosmic spherules, and using a spheroid approximation, the total mass of extraterrestrial material recovered from this filter is estimated at 328 µg. Using the same procedure as in Duprat et al. [2], we calculate a cosmic dust flux at Dome C of 7300 tons/yr for this sample, a value compatible with the one previously obtained, given the large uncertainty associated to this calculation. All extraterrestrial particles have sizes ranging from 30 to 300 µm and ~ 70% of them are unmelted (or only partially melted). Using the classification defined by [3-5], 30% of all ET samples are fine-grained (Fg); 7% are crystalline micrometeorites (Xtal), 33% scoriaceous particles (Sc) and 30% cosmic spherules (CS). Among the Fg particles, 8% are fine-grained fluffy – FgF (Fig.1) and 22% are fine-grained compact – FgC.

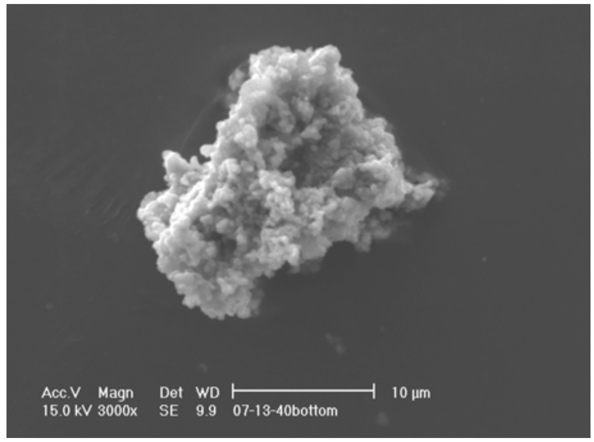

Figure 1: Secondary electron micrograph of a fragment of fine-grained fluffy (FgF) Concordia micrometeorite #07-13-40.

Using SEM, we have identified minerals like forsteritic olivine, pyroxenes (enstatite and diopside), sulphides, magnetite, carbonates, and Fe-Ni metal. The presence of sulphides and carbonates (Figure 2) in unmelted micrometeorites are indicative of a mineralogy unmodified by their terrestrial residence [e.g. 1].

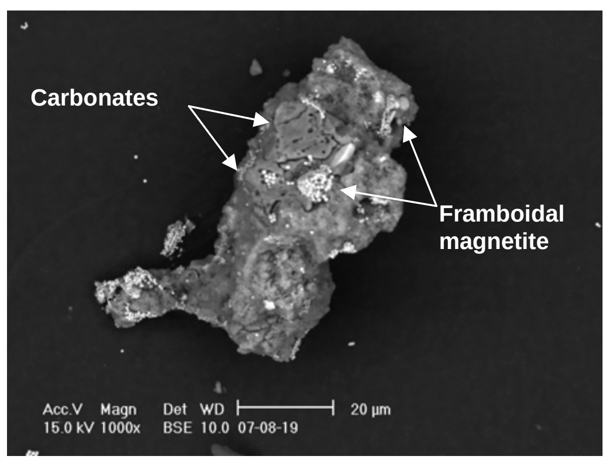

Figure 2. Backscattered electron image of a fragment of CONCORDIA micrometeorite #07-08-19 exhibiting carbonates and framboidal magnetite.

In four CONCORDIA AMMs, we found large amount of carbonaceous material (Figure 3) that resemble the description of ultracarbonaceous micrometeorites by Nakamura et al. [6].

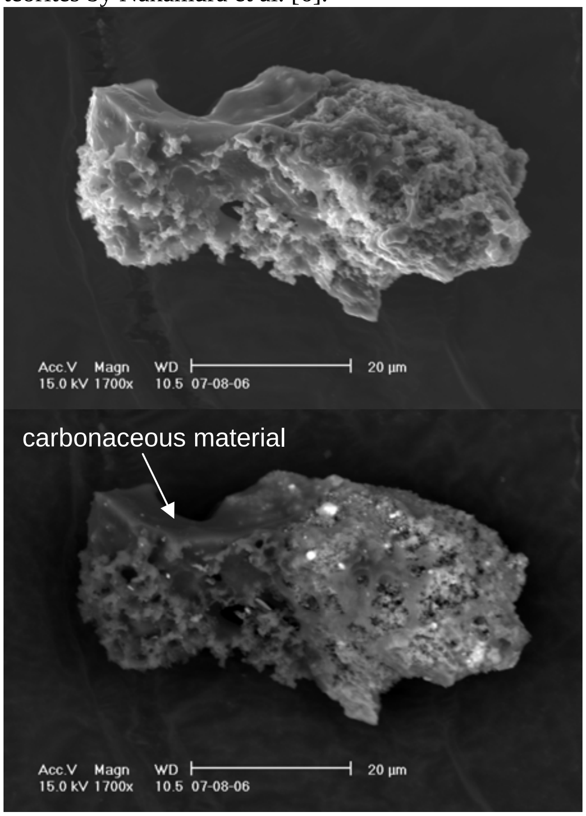

Figure 3. Secondary (top) and backscattered (bottom) electron images of a fragment of a fine-grained compact CONCORDIA AMM exhibiting a large amount of carbonaceous material.

We used transmission electron microscopy (TEM) to study the FgF micrometeorite #DC06-08-26. Another fragment of this AMM was observed with SEM (see Figure 1 in [7]). It shows a porous texture with a high number of small Fe-Ni sulphides in the matrix and a $Fo_{99.5}$ olivine crystal. The porosity seems indigenous and not related to atmospheric entry heating. The mineralogy of this FgF AMM at the TEM scale shows a high abundance of SiO_2-rich glass: all mineral phases are embedded in an amorphous vesicular SiO_2-rich matrix. We have identified in particular an enstatite whisker with stacking defects in this AMM (Fig. 4). Other mineral phases identified by TEM in this particle include diopside, Mg-rich pyroxene (En_{92-98}), forsteritic olivine ($\sim Fo_{95}$) and numerous low Ni (< 5 at.%) Fe-Ni sulphides.

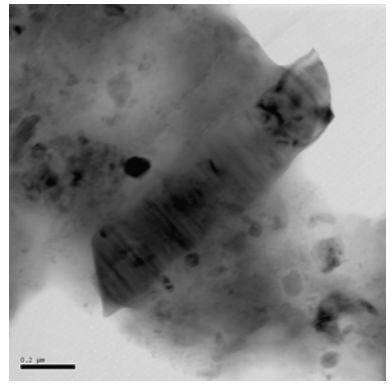

Figure 4. Bright field TEM image of an enstatite whisker in fine-grained fluffy micrometeorite #DC06-08-26. Scale bar is 0.2 µm.

Discussion and conclusions: In addition to 'classic micrometeorites', the CONCORDIA micrometeorite collection contains objects which were not present in previous blue ice field micrometeorite collections: fluffy particles, grains with fragile (soluble and volatile) phases, micrometeorites with large amounts of carbonaceous phases, and peculiar minerals such as the enstatite whisker identified in AMM #DC06-08-26 by TEM. Such minerals observed in IDPs are believed to have condensed in the solar nebula or in presolar environments [e.g. 8].

These exotic grains will deserve special attention in order to assess their possible genetic differences with other types of AMMs. We aim at identifying cometary micrometeorites among the collection of CONCORDIA AMMs, although the distinction between asteroidal and cometary matter might not be as clear as previously thought [e.g. 9, 10-12].

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