THE CONCORDIA-COLLECTION : PRISTINE CONTEMPORARY MICROMETEORITES FROM CENTRAL ANTARCTICA SURFACE SNOW.

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Introduction: In January 2000 and January 2002, we recovered micrometeorites (MMs) trapped in surface snow close to the French-Italian station CONCORDIA at Dome C (S 75°, E 123°). The central regions of Antarctica present substantial advantages for cosmic dust collections. Dome C is located at 1100 km from the margin of the continent and the surface snow is separated from the bedrock by more than 3km of ice. Because the dominant winds are blowing from the centre of the continent to the coast this snow is well preserved from terrestrial dust contamination within the MMs size range (25-500 µm). Moreover, the temperature stays below –20 C° throughout the year. The MMs are expected to be much better preserved in a cold and clean snow from both mechanical stress and aqueous weathering compared to previous Antarctic collections. In order to take advantage on this, we developed and optimised a new technique of collection based on a stainless steel double-tank snow smelter of 300 l, working with a 35kW-propane gas boiler. This device enabled us to melt and filter in clean conditions (down to 25 µm) surface snow from different snow layers up to a depth of 5 m. A total of 25 m^3 of snow was processed. During the melting procedure, the MMs were in contact with liquid water for only a few hours and our melting-sieving procedure does not involve any mechanical pumping. The results presented here are still preliminary because only 40 extraterrestrial particles have been characterized so far.

Two other collections of MMs have been performed in central Antarctica so far : the collection extracted from the Water Well of the South Pole Station (SPWW) [1] and from the Water Well of Dome Fuji Station (DF) [2].

Search for new types of particles : Because the snow of Dome C is extremely pure it reduces significantly the bias of the pre-selection under a binocular microscope. The CONCORDIA-collection is characterized by a high proportion of fine grained-particles. Within the 100-400µm size range, the unmelted MMs/cosmic spherules ratio is about 1 and 80 % of the unmelted MMs are fine grained particles. Within the same size range, in the collections we performed in the ice of Cap-Prudhomme (CP) these ratio were ¼ and 30% respectively. Moreover, we found a highly friable particle as displayed in figure 1. The EDX analysis indicates that the particle has chondrite-like major element (Mg, Al, Si, Fe) abundance. The lack of friable fine grained particles in previous collections can be explained because they can be easily destroyed by mechanical pumping. Concerning the CP collections, these particles could also have been destroyed mechanically during transport in their host ice and/or during the freezing/thawing process at the surface of the Blue Ice field (see below).

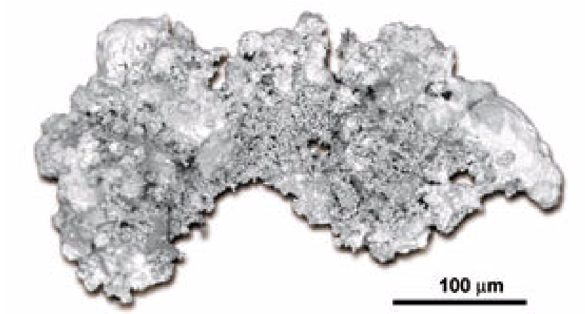

Figure 1 : A highly friable micrometeorite from CONCORDIA-Collection.

Possible connection with IDPs : An advantage of the Antarctica central regions is their low and regular precipitation rate : the falling age of extraterrestrial particles can thus be well constrained. The particles described in this paper have been recovered from surface snow (0-80cm). Given the average Dome C precipitation rate (3,5 $g/cm^2/yr$ [3]), they belong to the contemporary dust flux encountered by our planet within the last decade. They overlap the time period of stratospheric interplanetary dust collections (IDPs). The SPWW and the DF collections have depositional ages of 1,000-1,500 [1] and 1950-1970 respectively [2], while the CP collection sampled MMs captured about 50,000 years ago. These collections from central Antarctica are therefore opening the possibility to compare the stratospheric IDPs collection to particles from the same contemporary flux reaching the Earth's surface.

Minimal terrestrial weathering : One of the main feature of the CONCORDIA-collection is that 65% of the MMs are loaded with Fe-sulfide grains, compared to 10-20% in the CP collections. The sulfides exhibit various morphologies ranging from small melted spheres (1-5 µm) at the surface of MMs to a large rugged grain (20 µm) that survived to the pulse-heating during atmospheric entry. We have analysed 16 Fe-sulfide grains using JEOL 7400 analytical electron microscope at the Natural History Museum in Vienna and the CAMECA SX50 electron microprobe at Jussieu. Most of these Fe-sulfide are pyrrhotites, except one which has a composition intermediate between that of pyrrhotite and pentlandite. This high content of Fe-sulfides seems to be a characteristic of collections from central Antarctica snow. Indeed, Fe-sulfides are reported in both unmelted MM and cosmic spherules from SPWW [1], and 70% of the MMs from Dome Fuji contains more than 1 wt-% of sulfides [4]. Pyrrhotite is known to be a reactive sulfide in water [5]. This suggests that the collections performed in Antarctic snow experienced a lower aqueous alteration than the one performed in Blue Ice fields.

Moreover, this observation supports the scenario proposed to explain the high MMs concentration observed at the surface of Blue Ice Fields. In CP, the regular erosion of both wind and sun slowly ablates the ice and MMs trapped in the ice flow are reaching the surface. Then, the solar thermal wave can melt a thin water shell around black particles such as MMs. They can then sink and re-freezze at a given depth (probably between a few cm and a few dm, depending on the weather conditions, the resulting ablation rate, the size/density of the particle, …). During these freezing/thawing cycles in the top layer of the ice, the particles should undergo an aqueous alteration in a confined environment that can dissolve the Fe-sulfides. This provides an explanation for the lower abundance of Fe-sulfides in the CP collections as compared to Dome C. Because the Fe-sulfides grains are straightforward to identify, their proportion can yield a powerful index for terrestrial weathering of polar MMs.

Within the same micrometeorite polished section where the sharp rugged pyrrhotite was identified, we found a dolomite grain with a size of 4-5 µm. It is the first time a carbonate has been identified in a micrometeorite. Again, this is a consequence of minimal terrestrial aqueous alteration. This opens the possibility to compare carbonates from MMs to the ones previously studied in IPDs and carbonaceous chondrites.

Conclusion and future prospects : The results obtained on the CONCORDIA-collection illustrate the major advantages of central polar regions for cosmic dust collection. With an appropriate extracting/melting/sieving procedure, it is possible in such clean and cold snow to recover and identify MMs which experienced minimal terrestrial weathering, including highly friable particles. These fine grained MMs have experienced a lower heating upon atmospheric entry than most of the MMs recovered so far. They should have kept a noble gas composition close its pre-atmospheric value. Noble gas analysis provides a powerful tool to identify micrometeorites with very short exposure time in space (a few centuries) such as those coming from cometary dust trails [6].

We already reported on the potential advantages of central regions of both Greenland and Antarctica for recovery of MMs from identified meteor showers like the *Leonids* [7]. Thanks to the logistical support of the Danish Natural Science Research Council, we are currently planning to collect MMs from the central regions of Greenland (NGRIP site, 75°N,42°W) relying on the technique that we developed at Dome C. Recently, S. Messenger examined the opportunities for stratospheric collection of dust from short-period comets [8]. He pointed out that dust from the Grigg-Skjellerup comet provides the highest flux at Earth orbit for dust showers with an impact velocity below 25km/s. The collection technique we used makes it possible to recover fine grained particles which should have an enhanced survival probability with such a low entry velocity compared to the 70 km/s for the *Leonids*. Moreover, this shower is expected to be dominated by 40-100 µm-sized particles with a maximum signal/background ratio (5-10%) for ≈80 µm particles [8]. This size is well above the typical IDPs size range (5-40µm), but falls right within the polar MMs size range. Yet, it is worth pointing out that Greenland is not the best place to recover MMs from the Grigg-Skjellerup shower because it's apparent radiant is located in the Southern Hemisphere. Nevertheless, we could benefit from a unique time opportunity because the highest shower rate is expected for 23-24 April 2003 [8] while we should be in the field in May-June 2003. Thus, if a sufficient amount of these particles is reaching the Greenland ice sheet, they will be trapped in a thin layer right at the surface of the snow. This could be a major advantage since it allows to recover dust from a maximum exposition area with a minimal amount of snow.

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