SEARCH FOR PAST AND FUTURE "FROZEN" LEONID SHOWERS IN ANTARCTICA AND GREENLAND. J. Duprat[1], C. Hammer[2], M. Maurette[1], C. Engrand[1], G. Matrajt[1], G. Immel[1], M. Gounelle[3], G. Kurat[4]. [1]CSNSM, Bat.104, 91405 Orsay Campus, France (duprat@ipno.in2p3.fr), [2]Department of Geophysics, Niels Bohr Institute, Copenhagen, DK-2100 Denmark, [2]Department of Mineralogy, The Natural History Museum, Cromwell Road, London SW7 5BD, UK, [4]Naturhistorisches Museum, Postfach 417, A-1014 Wien, Austria

Introduction: In 1997 we launched a long-term program to collect micrometeorites from historical Leonid showers in both Greenland and the Antarctic ice caps. The major importance of these particles is their well-certified cometary origin (from comet Temple-Tuttle). The basic idea is to melt a large quantity of snow collected from the annual layers where the Leonid grains are trapped and kept in deep frozen conditions, in both central Antarctica and Greenland. Our first choice was the 1966 Leonid shower ranked at about 100,000 visible shooting stars per hour, corresponding to particles with sizes in excess of a few mm.

In 1998 we also assessed the possibility to look for "stones" from the same shower, which should be extremely rare, relying on a radar sounder with aperture and pulse synthesis which could explore a large snow surface up to a depth of 20 m. Unfortunately, based on a preliminary feasibility study it seems extremely difficult to detect with a reasonable efficiency punctual stones of diameter < 5 cm because of the high background noise due to discontinuities between snow layers.

Work at the Concordia station in central Antarctica : Since 1994 France (IFRTP) and Italy (PNRA) are jointly constructing the Concordia Station located at Dome C (S 75°, E 123°), 1100 km from the margin of the continent. The great advantage of this central location in Antarctica for our project is the well-characterized and very small rate of annual precipitation (≈ 3.5 cm of equivalent water per year). Thanks to the logistic and financial support of IFRTP, two of us (JD and GI) made an expedition at Dome C in January 2000 to assess the difficulties to recover several m^3 of snow from the annual layer corresponding to the 1966 Leonid shower. For this purpose, we worked in a 5 m deep trench located at the vicinity of the station. A total of 9 m^3 of snow was extracted from 4 different layers between depths of 2.5 m and 4 m. The snow was melted and filtered in the station and the analysis of the dust collected is in progress. The average depth of the 1966 layer can be deduced with the help of glaciologists, using the average snow accumulation rate and thanks to the fact that this layer is located just above the 1965 level that did trap volcanic ashes from the Agung eruption.

A second goal of this expedition was to measure the sporadic flux of micrometeorites in very recent time (i.e., over the last few years). Thus, we collected 4 m^3 of surface snow up to a depth of 80 cm. A preliminary analysis revealed 26 extraterrestrial particles with diameters ranging from 50 to 270 µm. From this result, an extrapolation would give a global terrestrial flux of micrometeorites of about 6,000 tons per year. This preliminary value must be considered with caution as it corresponds to a rather small surface*time exposition parameter (17 m^2.yr). It can be undervalued because the collection efficiency of our device still has to be determined with accuracy (a first estimation gave a value of ~ 30%, which is the number adopted for this calculation).

Finally, the last goal of the expedition was to search for very friable micrometeorites that may have been destroyed in our previous collections in blue ice fields near the margin of the Antarctica ice sheet, but could survive in the snow layers of central Antarctica. Particles collected in blue ice fields were submitted to : i) high pressures during their transport in the ice flow; ii) cycles of melting and freezing when they reach the top surface of the blue ice; iii) a possible disaggregation during their recovery from melt ice water pockets with a mechanical pump.

In a preliminary study of our first "Concordia-2000" collection we indeed discovered a new family of friable particles, and we were hoping that they could be related to the porous class of stratospheric IDPs, because they looked similar during SEM observations. However, J.P. Bradley investigated ultramicrotome sections of such a friable micrometeorite with an analytical STEM. He showed that they are not related to IDPs [1]. In particular the typical GEMS phase [2], which is abundant in chondritic porous IDPs, was not observed in the Concordia particle. In fact, with the exception of their friability, these micrometeorites are similar to the unmelted fine-grained micrometeorites recovered in our previous collections from pre-industrial ices with ages of 50,000 years.

The mystery of the marked differences between IDPs collected by NASA since 1981 and Antarctic micrometeorites is just deepening, because the terrestrial ages of the micrometeorites collected at Concordia are within the last decade and comparable to that of the latest collections of IDPs, but both types of micrometeorites are still very different. Messenger and Walker [3] suggested that these differences might reflect a recent change in the composition of the flux of interplanetary dust particles, which would be related to the arrival of the very dusty comet Schwassmann-Wachmann 3 in the inner solar system. The preliminary results from our "Concordia-2000" collection does not show any sign of such a change in the flux composition. This result would rather indicate that the collection of stratospheric IDPs greatly favors the least dense and most porous particles, rather than the more compact ones found in all Antarctic collections. Such particles would have the lowest sedimentation rates in the stratosphere and consequently the highest concentrations there, even so they might represent a rare component of the micrometeorite complex, which is dominated by a "hydrous-carbonaceous" material essentially related to C2 meteorites [4].

In the coming years, we are planning to go back to the Concordia Station. From this first successful attempt to recover micrometeorites at Dome C, several improvements can already be considered. A new and more efficient stainless steel snow smelter is currently under construction. Most of the snow extraction must be carried out in rather rough conditions in the shadow at the bottom of the trench where the temperature is around -50° C, and improvements on both the gear and the tools to extract the snow layers are currently made. Taking advantage from this first experience, we are planning to search for the famous 1833 Leonid shower in a new 15 m deep trench. Thanks to the logistics of IFRTP such a trench can be realized in the vicinity of the Concordia Station.

Central Greenland for ice cores studies and the capture of the future Leonid showers of 2001 and 2002 : Another approach is aimed at Greenland. Two of us (CH and MM) have been collaborating since 1984 to exploit the Greenland ice sheet. This collaboration still continues thanks to the support of the Danish Natural Science Research Council. Three members of our team at CSNSM already spent two weeks in June 2000 in Copenhagen with a new device to melt the remaining ice core from a deep drilling (Dye 3) made in Greenland in 1979-81. This operation gives us the unique possibility of monitoring the variation of the micrometeorite flux both in composition and in mass flux over a time scale of about 40,000 years, with time windows of about 1000 years.

Concerning the search of the Leonid showers, and despite a higher snow accumulation rate than in Antarctica, Greenland has the great advantage to be in the northern hemisphere where the radiant of the Leonid shower is located. This makes the Greenland ice cap a much better “ Leonid collector ” than Antarctica where their shallow incidence could reduce their incoming flux. We got the requested financial and logistic support to get ready to collect in 2002 and/or 2003 a few tons of surface snow in central Greenland (Summit) that will have at this time collected the future Leonid showers of November 2001 and 2002. For these two years, high hourly rates (more than 10,000) are predicted by D. J. Asher [5].

We thus make a multi-approach to collect large micrometeorites with a well-certified cometary origin before the "STARDUST" mission. This mission should return to Earth in 2006 small cometary dust particles captured with aerogel in the tail of comet Swift-Tuttle. But their sizes (a few µm) will certainly be much smaller than those of Antarctic micrometeorites. Thus, the comparison of the Leonid particles with sizes comparable to those of Antarctic micrometeorites is necessary to carry on our EMMA scenario, which postulates that Antarctic micrometeorites have a cometary origin, and which has astonishing applications in planetology [6]. Indeed, it is not clear whether very small stratospheric IDPs and large Antarctic micrometeorites have a similar origin and/or whether they will be forwarded to the Earth with the same efficiency.

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