THE COMET EXPERIMENT: FIRST RESULTS. J-P Bibring (1), J. Borg (1), A. Katchanov (2), Y. Langevin (1), P. Salvetat (3), Y.A. Surkhov (2) and B. Vassent (1); (1) CSNSM, Orsay, France; (2) Vernadsky Institute, Moscow, USSR; (3) LPSP, Verrières-Le-Buisson, France

The C.O.M.E.T. experiment (Collecte en Orbite de Matière ExtraTerrestre) has been designed to allow the collection of grains by impacts in terrestrial orbit, from a Space Station (1). It has been developed in cooperation between France and USSR (where the experiment is named KMP). We report here on COMET-1, which allowed a collection in october 85 on board Salyout-7 and the recovery of the samples in july 86. The samples were returned to Orsay, preliminary examined and prepared for analyses in an ultraclean room dedicated to this experiment. Some have been delivered for analyses to the Vernadsky Institute for Geochemistry.

The collectors consist in high purity (>99.99 %) Au or Ni modules, covered with either self-supporting gold films with thickness 1000 Å or 2 μm thick mylar films coated on both sides (500 Å Au inside and 100 Å Pd-Au ouside). 576 such modules, of ~ 2 cm^2, have been mounted within 4 boxes and maintained under vacuum from the lab to space. The attach outside Saliout 7 has been performed in August 85. The 4 boxes have been opened for collection October 4 by the cosmonauts using a command unit inside the Station. Three of the boxes were closed October 10, after the encounter with the stream associated with the Comet Giacobini-Zinner. The 4th box was left open until October 26, to allow the encounter with the stream associated with Halley/P.

When returned to Orsay, all boxes were still under vacuum, which ranged from 1 to 5 mbar. This indicates that the sealing was good enough to avoid large contamination during the several weeks seperating the re-entry inside the Station and the arrival in the lab. The boxes were then filled with dry nitrogen up to atmospheric pressure to allow their opening. It appeared that all the covering films, either metallic or plastic, had resisted perfectly well. They did not exhibit any macroscoping modifications that might have resulted from vibrations, thermal constraints or pressure differences.

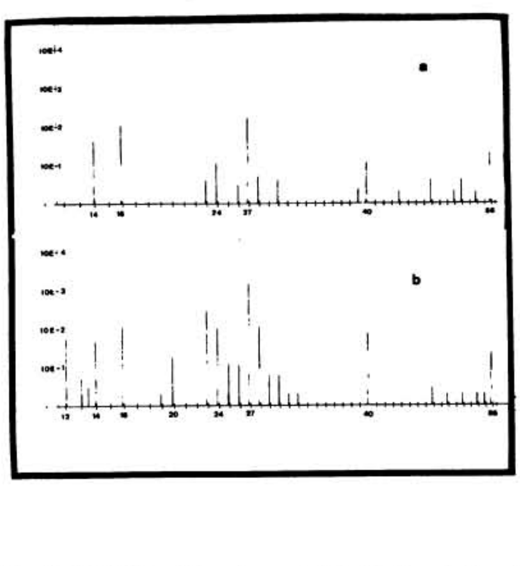
Our manufacturing of the thin gold films, self-supporting onto metallic grids, although improved, is responsible for the existence of some pinholes, on a micron scale, with number densities of 1 to 5 mm^{-2}. In order to discriminate between these holes and those resulting from the impact of an encountered grain, we have conceived a device allowing the automatic scanning and data storage of all holes larger than 1 μm. The samples are optically scanned with a CCD linear array mounted on a Zeiss microscope, and the data processed by a 68000 based microcomputer. All the collectors have been scanned before and after the flight. The comparison leads to the following conclusions: the pre-existing pinholes are recovered in position and size, with very high accuracy. A number of new holes are observed, with rounded habits, likely to result from the impacts of encountered grains. There are ~ 7 cm^{-2} holes with diameters 2 - 10 μm, 4 cm^{-2} for holes with diameter 10 - 20 μm and 3 cm^{-2} for diameters in excess of 20 μm, for a 7 days exposure time. They correspond to a cumulative flux ~ 0.1 $m^{-2} s^{-1}$ for particles responsible for impacts holes of a few μm. This number is at least 3 times larger than that corresponding to the craters observed on surfaces of the Solar Maximum Mission, exposed during 4.15 years, and recovered on April 84 (2). This discrepancy may be interpreted if holes formed in thin gold films are larger than the corresponding impact craters. It is also possible that the space debris flux has significantly increased over the past 5 years.

The SEM analysis of the modules at positions corresponding to the new pinholes exhibits impact features similar to those we have obtained by simulation, using the Heidelberg grain accelerator facility. In particular, we observe numerous (5 to 10) distinct impacts in the module for each individual hole in the film, resulting from the disruption of the incident grain within the film.

Down to the submicronscale, the craters can be chemically analysed by the use of X-ray detectors coupled with scanning microscopes. Most of the results obtained by the french team used a JEOL 840 SEM equipped with a Tracor detector system, at Orsay. So far, several families of grains have thus been identified by their composition in major elements, in the size range 0.1 - 5 µm essentially. The most numerous measurements are in agreement with a space debris origin: they contain either Al as the most abundant element, or a mixture including metals as Ti, Zn or Cr. Among the impacts which have a composition compatible with an extraterrestrial origin, some have a chondritic type composition, with Si, Mg, Al, Ca and Fe present, whereas others are essentially constituted of (Fe + Ni), with Fe/Ni ~ 5. Several impacts have no signatures at all in their X-ray spectrum, thus containing low Z elements exclusively.

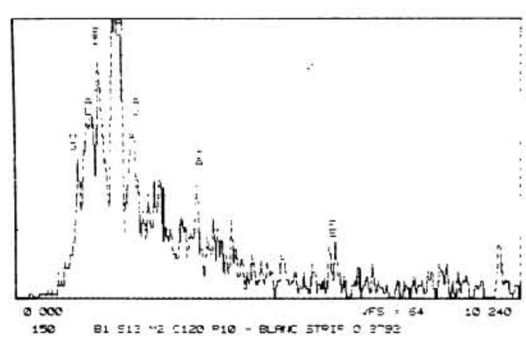
We have also used a CAMECA IMS 300 ion analyser, at the IPG of Paris, in order to correlate the X-ray elemental analyses to isotopic measurements, down to low masses. One of the most important results is the presence of carbon in several spectra, associated with other major elements. It thus appears that a fraction at least of the encountered extraterrestrial grains do contain carbon as a major constituent. Some spectra resemble closely those corresponding to the "mixtures" of CHON and silicates, detected in the environment of Halley/P by the PUMA and PIA experiments (3).

Consequently, the presence of CHON particles would not be limited to the Halley nucleus but might represent a general component of the primitive carbon-rich matter. Moreover, this material appears refractory enough to survive over long periods of time within the cometary streams, in spite of the energetic solar wind and UV field.



IMS spectra (left) of a carbon-rich collected grain (b) compared with the cooresponding blank (a).

X-ray spectrum (below) of a silicate type collected grain.



(1) Bibring et al., LPS XVI, 55, 1985 (2) Laurance and Brownlee, Nature 323, 136, 1986 (3) Langevin et al., Astron. Astrophys. 187, 761, 1987