THE "C.O.M.E.T." EXPERIMENT (Collecte en Orbite de Matière ExtraTerrestre). J-P Bibring, J. Borg, Y. Langevin, F. Rocard, B. Vassent, Laboratoire René-Bernas, 91406 Orsay, France.

INTRODUCTION. A new experiment is scheduled to fly on board Saliout, to collect interplanetary grains whenever the Earth crosses a meteor stream or a cometary tail. For each corresponding comet, the analyses of the collectors should provide data on the mass and velocity distribution as well as the chemical and isotopic composition of the grains. The first experiment will occur in 1984, the systematic recovery program taking place in 1985 and 1986.

THE COMETARY GRAINS. Comets are among the most primitive objects in the solar system: they have remained at very low temperatures since their accretion, thus preventing any differentiation. They consist in grains imbedded into an icy matrix; when approaching the Sun, the outer layers sublimate, thus releasing the grains. Radiation pressure modifies their orbits (dust tail). These grains are injected in the corresponding meteor stream above a critical size, which depends on the orbit of the comet (a few micrometers typically). The smallest grains are swept away from the solar system. Cometary grains are the most likely source of interplanetary grains collected either in the stratosphere or in sea bottom sediments. However, these "natural" collecting procedures integrate over long periods of time, and consequently over all possible extraterrestrial sources. A specific interest of our experiment lies in the possible selection of collecting windows corresponding to given cometary sources, either in the dust tail or the associated stream. We plan to expose the collectors during favorable stream encounters, for which the integrated number of micrometeorites larger than 1 μm should exceed 30 on the exposed surface. In particular, in a few cases, the Earth will cross the stream shortly after the periodic return of the comet, which might lead to a supply of fresh cometary grains (e.g. the Draconides, associated with Giacobini-Zinner, in 1985).

THE COLLECTORS. The experimental requirements on the design of the collectors are the following: they must completely trap the encountered grain material, and allow their chemical and isotopic characterization; each individual impact must be identified and precisely located; contamination on an atomic layer scale must be avoided at all stages of the pre-flight, deployment and recovery procedures; finally, the collecting surface should be large enough to ensure a significant number of impacts. We thus selected 1000 cm^2 collectors, consisting of a square array of 1 mm^2 microcells. Each cell is a truncated pyramid stamped in ultrapure gold. A 0.1 μm thick gold film covers the whole surface, so as to retain species volatilized by the impact, as well as to

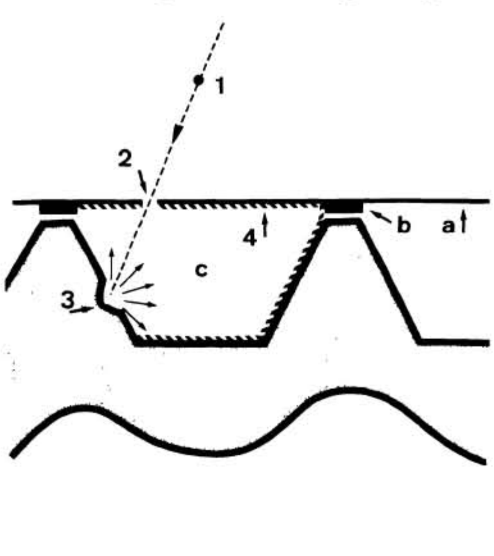

Figure 1: Schematics of the micro-cell structure of the collector: upon impact, the micrometeorite (1) penetrates a 1 mm wide cell through a film (a) supported by a grid (b), leaving an entry hole (2) further used for localization. It produces an impact crater (3) on the bottom or a wall of the cell (c), vaporizes and forms a deposit on all opposite surfaces (4) which can be analyzed.

allow its unambiguous localization (fig. 1). The collectors will be placed under vacuum in a hermetic box in the lab; this box will be automatically opened in orbit, then closed and maintained under vacuum until its return to the lab.

LOCALIZATION OF THE MICROMETEORITIC IMPACTS. The expected proportion of cells containing impact generated deposits is extremely low (from 30 to a few hundreds out of 100,000 cells). Furthermore, each impact results in a crater typically less than 100 µm in diameter, which is very difficult to observe. Thus, in order to locate these cells, we have investigated the possible use of the damage produced in the overlying film. Simulations performed with the high velocity dust accelerator at Heidelberg showed that micrometeoritic entry holes are easily identifiable from pin-holes formed during the film deposition process: the shock generated by the impact induces a partial recrystallization over an area much wider than the entry hole; this zone is readily observable under an optical microscope (fig. 2b). Consequently, an automatic optical scanning at low magnification will enable us to rapidly locate the punctured cells from the dark circular spot decorating each impact.

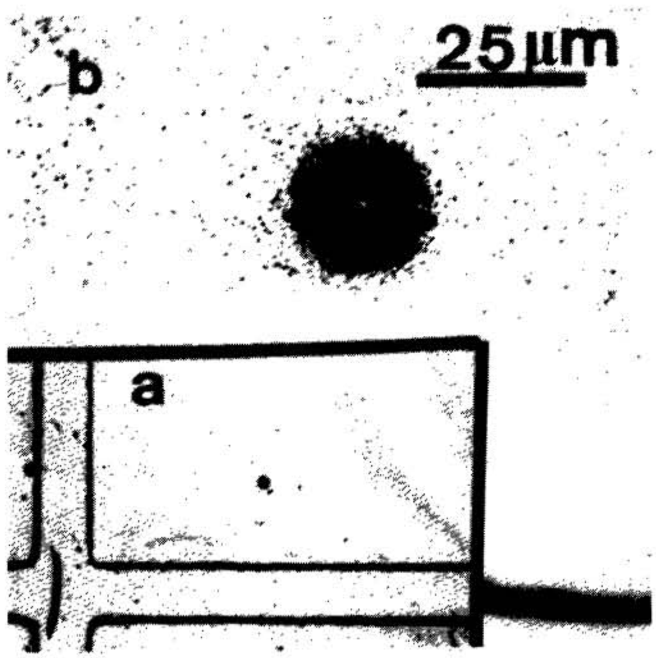

Figure 2. The inset (a) shows part of a 1 mm square of the grid covered with the gold film, after its bombardment by 2 µm iron particles at Heidelberg. The small circular dark spots surround the entry holes of the impacting grains, as shown on the enlargement (b). They can thus be used as markers of the cells containing deposits to be analyzed.

CHEMICAL AND ISOTOPIC ANALYSES. After removal of the cover grid, the walls of the cell as well as the inner surface of the film will be analyzed with an Auger microscope and an ionic analyzer. The grains will be sorted according to their chemical composition in the major elements; the isotopic composition of elements of interest such as nitrogen, oxygen and magnesium will be determined for the largest grains (larger than 10 µm). Dilution by gold from the substrate should not hamper these determinations. We therefore hope to bring out possible systematic differences between cometary streams, and thus between the corresponding parent comets.

SPEED AND MASS DETERMINATIONS. We will measure the total volume of each impact crater with a scanning electron microscope. The kinetic energy of the corresponding micrometeorite will then be derived, using calibrations with the dust accelerator in Heidelberg. The mass of the incoming micrometeorite may be independently derived from the amount of meteoritic material in the deposit. These measurements will yield the speed of the particle, which can be compared with the orbital velocity of the cometary stream. Such informations would be very valuable in investigating the dynamics of the smallest grains in meteoritic streams.