SEARCH FOR STRATOSPHERIC DUST GRAINS IN POLAR ICES

M. de Angelis[1], L. Fehrenbach[2], C. Hammer[3], C. Jehano[4], M. Maurette[2]

[1]Laboratoire de Glaciologie, Université de Grenoble.
[2]Laboratoire René Bernas, Faculté des Sciences d'Orsay.
[3]Isotope Geophysical Laboratory, University of Copenhagen.
[4]Centre des Faibles radioactivités du CNRS, Gif sur Yvette.

I. INTRODUCTION.

The smallest size fraction (i.e. the " 10μm-residue") of the $\lesssim 1$ ppb dust concentration deposited in ice samples from the central region of Antarctica (Dome C ; Vostock) should be enriched in stratospheric dust initially injected into the stratosphere by "giant" historical events such as "cataclysmal" volcanic eruptions and the impact of large extraterrestrial bodies on Earth. Such grains can slowly migrate toward polar regions and be subsequently deposited in snow samples. The microanalysis of such a "stratospheric" dust component should in turn help in both determining important characteristics of major historical events (and/or discovering them) and finding new clues about stratospheric circulation and soforth.

In 1981 we began studies pertaining to several distinct polar dust fractions. We now present in two companion papers a selection of our preliminary findings and/or speculations. This paper deals mainly with micron-size volcanic glassy lamellae that we have found in a variety of samples including the El Chichon stratospheric aerosol collection of NASA, recent snow samples from Greenland which could possibly contain El Chichon stratospheric fall-out, and antarctic ices formed at the time of historical volcanic eruptions.

II. THE EL-CHICHON ERUPTION : A CALIBRATION STANDARD FOR INVESTIGATING BOTH STRATOSPHERIC DUST INJECTION IN POLAR ICES AND HISTORICAL VOLCANIC ERUPTIONS.

Thanks to the generous cooperation of J.L. Gooding and D.S. McKays (NASA-LJC) we analyzed El-Chichon stratospheric samples from the NASA collection (including the sulfuric aerosol) by using a high voltage electron microscope (HVEM) and a SEM equiped with an EDAX system. For this purpose we improved our analytical technique, in developing for example a new type of holey carbon film with hole diameters of about 0.6μm. These films were fixed on numbered gold grids, and directly used as a "filter" to both collect and rinse all grains with sizes $\gtrsim$ 0.6μm, initially imbedded in silicone oil. Next a very thin C-film was evaporated on top of the grains, which were thereby firmly encapsulated into a carbon "microcrucible" "drilled" with 0.6μm-holes on one face. The grain encapsulation into the microcrucible, which is astonishingly good, allowed us to melt the grains and/or dry out the sulfuric acid dropplets by electron beam heating for the purpose of characterizing them further.

Our major results are : 1. <u>May 1982 NASA collection.</u> As already found by the preliminary examination teams (1) the glassy grains are very abundant ($\gtrsim$ 80%). They also show peculiar textural features such as sizes $\gtrsim$ 5 μm, ultra-thin deposits and voids and/or gas bubbles. These "large" glassy grains

were in fact ultra-thin lamellae ($\lesssim 1$ μm-thick). This was confirmed through the generous cooperation of B. Doyle (Sandia National Laboratories), who shot a microbeam of 5 MeV α-particles on individual grains and recorded the corresponding Rutherford Back Scattering energy spectra of the incident particles, which showed in turn the characteristic peak expected from a very thin target; 2. March 1983 NASA collection. In this collection the collector plates were flooded with sulfuric acid dropplets. Most of the dropplets dried out quickly via electron beam heating in revealing two types of dropplets : The most abundant ones only showed an homogeneous S-rich deposit while the remaining ones revealed a residue of tiny crystallites enriched in Ti, Fe, Cr and embedded in the S-rich deposit. A few isolated mineral grains (but no glass) were also observed.

We next searched for the fall out of El-Chichon glassy lamellae in a 90 cm-thick slab of Greenland snow formed during the period August 1982-June 1983. This snow sample was first divided into 16 aliquots. Each aliquot was melted for about 1 minute in a microwave owen and about 20-50 g of water was then promptly filtered onto the holey-membrane "filters". The results of this investigation are still not understood. First we only found glassy lamellae in the 4 deepest (and thus oldest) layers of the trench, which can hardly originate from the El-Chichon stratospheric grains fall-out. But then all these grains (~ 10) gave EDAX chemical composition very similar to that of El-Chichon fine grained tephra, which are in turn slightly different from the stratospheric glasses with regard to both their SiO_2 (69.1%vs 72.8%) and Al_2O_3 (17.6%vs16.1%) contents. Ion microprobe measurements will hopefully help in understanding this paradox, which is possibly related to a fast tropospheric transport of the earlier dust cloud.

III. MICRON-SIZED GLASSY LAMELLA FROM HISTORICAL VOLCANIC ERUPTIONS.

We investigated the very few ice levels which had survived the extensive studies of the antarctic Dome-C core. In both the Tambora (1815) and the Agung (1963) levels the position of the parent volcanic ash layers was well identified from peaks in the acidity measurements. For the Taupo eruption (~ 180 AD) the "age" of the ice level was not as well determined and it is still debatable whether we detected grains from this eruption. Finally A. Godichet kindly lent us one electron microscope grid containing glassy grains, that she found in a 6,000 years-old ice level from the Dome-C core. The background abundance of glassy grains in antarctic ice is very small (~ 0.1 %). But in these few volcanic levels the proportion increased to at least 10 %. In particular for the Tambora eruption the proportion of glassy grains reached the highest value (~ 50 %) yet observed. So far all glassy grains appear as thin lamellae very similar to those collected in the May 82 El Chichon stratospheric plume.

The discovery of the micron-size glassy lamellae in antarctic ice is first relevant to various terrestrial topics such as the past activity of cataclysmal volcanic eruptions. It also bears relevance on the search for extraterrestrial dust grains in polar ice. For example during our search for Tunguska ashes we have looked for grains with peculiar "glider" microstructures (flakes ; lamellae) which could have assisted their long stratospheric flight to Antarctica.

REFERENCE : (1) Gooding J.L., Clanton U.S., Gabel E.M. and J.L. Warners (1983) Geophys. Res. Lett., 10, 1033.