Types Of Micrometeorites Accreting at South Pole, Antarctica. S. Taylor[1], G. Matrajt[2], J.H. Lever[1], D.E. Brownlee[2], D. Joswiak[2], [1]CRREL, 72 Lyme Road, Hanover, NH 03755, [2] University of Washington, Seattle, WA 98195.

Introduction: Micrometeorites are terrestrially collected extraterrestrial dust particles smaller than about two millimeters. Their flux, size distribution and composition bear on numerous studies including deducing the compositions of parent bodies, calibrating terrestrial sedimentation rates and interpreting the isotopic record of seawater, and assessing the role of extraterrestrial materials in life processes.

We collected micrometeorites from the South Pole water well (SPWW) in 1995 and 2000. From the 1995 collection, taken from 1100–1500 AD ice, we computed a terrestrial accretion rate for melted micrometeorites (cosmic spherules) of 1600 ± 300 tons/yr [1] or 4 ± 2 percent of the flux measured above the atmosphere [2]. Well contaminants prevented us from quantifying unmelted micrometeorites.

Between 1995 and 2000 the bottom of the well deepened from 105 m to 134 m, which corresponds to an ice depositional age of 800–1100 AD [3]. The iron oxide contamination of the 2000 sample was much lower and we were able to find and quantify unmelted micrometeorites. We have identified and mounted 3272 melted and unmelted micrometeorites. Here we describe the distribution of micrometeorite types collected in the 2000.

Methods: The samples were collected in Nov 2000 from the SPWW, a 4,000-m^3 reservoir melting pre-industrial ice. The well's central plateau was vacuumed and yielded ~ 10 g of material. We sieved this sample into >425, 250–425, 150–250, 106–150 and 53–106µm size fractions. Using a binocular microscope we sorted 100% of the >150-µm fractions, 29% of the 106-150 fraction and 8.9% of the 53–106µm fraction and removed all potential ET grains. Altogether we mounted in epoxy and sectioned over 4000 particles.

Using a SEM/EDAX we checked each particle for composition and found that 3272 particles had compositions and textures consistent with those seen in micrometeorites. Transmitted light microscopy was used to measure the major and minor axis of each micrometeorite and both transmitted and reflected light was used to classify them based on their cross-sectional textures [4]. Chondritic micrometeorites are ordered from most heated to least heated: CAT=Ca,Al,Ti-rich, Glass, CC=Cryptocrystalline, BO=barred olivine, PO=Porphyritic, RGB=Relict Grain Bearing, Scoriaceous, FgUm=Fine-grained Unmelted, CgUm=Coarse-Grained Unmelted. The last four types are not chondritic: G-type (glass with magnetite dendrites), Iron-type, SM=Single Mineral and Chon=Chondrule fragments.

Results: Figure 1 plots the number versus type of micrometeorite for particles 0-100µm, 100-250µm and >250µm in diameter. For all these analyses the numbers of micrometeorites in the smallest two size fractions have been increased to account for the fact that only a portion of each size fraction was sorted.

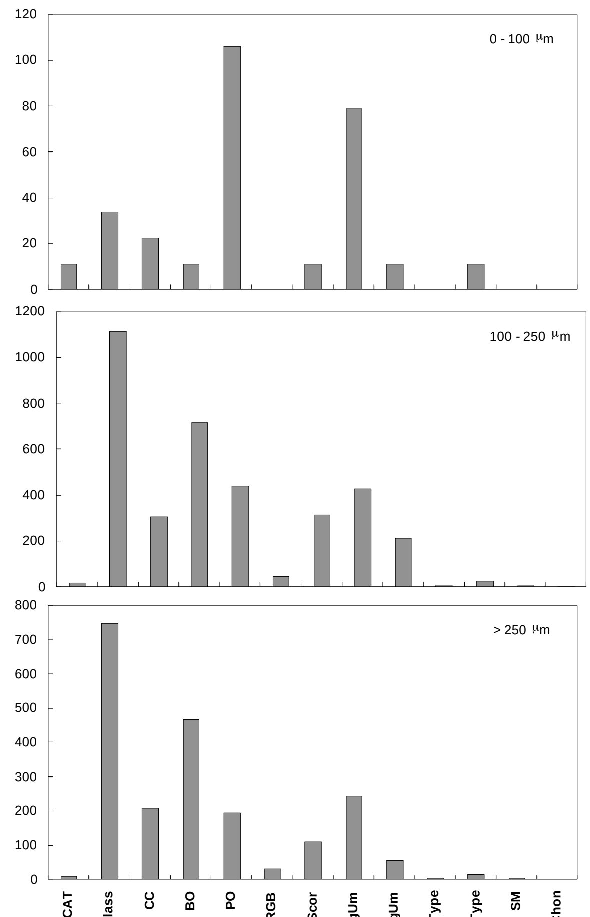

Figure 1.Type of micrometeorite versus number for three size clases.

For the two largest size classes glass cosmic spherules are most common followed by barred olivine, fine-grained unmelted and porphyritic micrometeorites. Cryptocrystalline are transitional between glass and BO types. For micrometeorites 0-100µm in diameter, porphyritic and fine-grained unmelted are the most common types. The smallest size class also has proportionally more CAT (high Ca, Al, Ti) and I-type spherules but no micrometeorites with relict grains, composed of a single mineral or containing chondrule fragments. Only 3 micrometeorites contain chondrule fragments (Figure 2) and these are in 100-250µm size fraction.

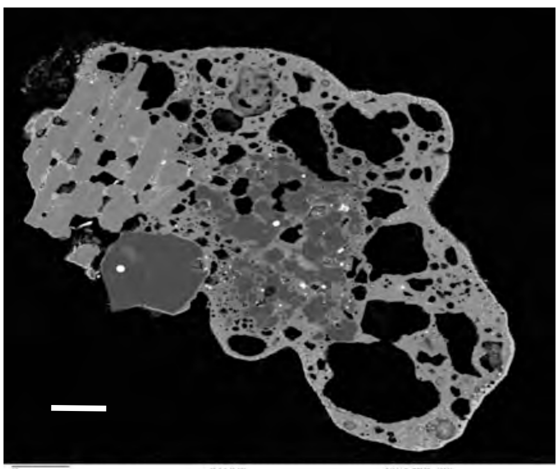

Figure 2. Micrometeorite with a barred olivine chondrule in the upper left. Scale bar= 20µm.

Figure 3 shows the percentage of micrometeorites in each class: 1% CAT, 33% Glass, 9% cryptocrystalline, 21% Barred olivine, 8% porphyritic, 1% relict grain bearing, 8% scoriaceous, 13% fine-grained unmelted, 5% coarse-grained unmelted, 1% I type, 0.2% G-type, 0.1% single mineral micrometeorites and 0.05% containing chondrule fragments.

Discussion: The resemblance of the type distributions for the 100-250 and >250µm micrometeorites (Figure 1) suggests that the precursors and degree of entry heating are similar. For the 0-100µm size fraction, less heated micrometeorites type dominate, as predicted by heating models [5], but they could have similar precurors to the larger micrometeorites.

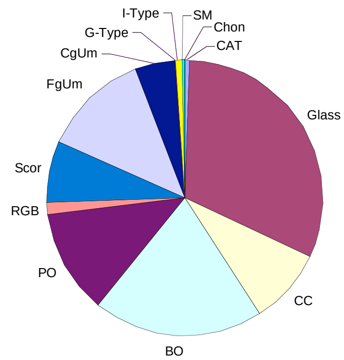

Figure 3. Types and proportions of micrometeorites in the 2000 plateau collection.

However, the 0-100µm fraction also has a greater proportion of the most highly heated micrometeorites, the CAT spherules and I-type both of which show isotopic fractionation[6,7]. These highly heated spherules are clearly remnants of larger particles that did not completely evaporate during atmospheric entry.

Also of note is that fine-grained unmelted micrometeorites are the most common unmelted micrometeorite type. From the percentages shown in Figure 3 we suggests that at least two thirds of the precursors are matrix rich particles, an idea that is consistent with the low numbers of micrometeorites containing relict grains, chondrule fragments or ones composed of single minerals. The proportion may be higher because fine-grained micrometeorites generally have lower melting temperatures than the anhydrous silicates found in coarse-grained micrometeorites, and may have produced many of the cosmic spherules.

References:

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