SIZE DISTRIBUTION OF ANTARCTIC MICROMETEORITES. S. Taylor[1], G. Matrajt[2], J.H. Lever[1], D.J. Joswiak[2], and D. E. Brownlee[2], [1]Cold Regions Research and Engineering Laboratory, 72 Lyme Rd., Hanover NH 03755, [2] Department of Astronomy, University of Washington, Seattle WA 98195. Susan.Taylor@erdc.usace.army.mil

Introduction:

Micrometeorites are terrestrially collected extraterrestrial dust particles smaller than about a millimeter. The accretion rate, size distribution and composition of micrometeorites bears on numerous studies including: deducing the compositions of parent bodies; calibrating terrestrial sedimentation rates; interpreting the isotopic record of seawater; linking influx to global climate change; and assessing the role of ET materials in life processes.

In 1995 Taylor et al. [1] retrieved ~ 200g of material from the bottom of the South Pole water well (SPWW) of which about 0.1% were cosmic spherules (melted micrometeorites). Using the particle size distribution, area suctioned and age of ice melted (1100–1500 AD) they computed a terrestrial accretion rate for cosmic spherules 50–700 µm in diameter of 1600 ± 300 tons/yr [1] or 4 ± 2 percent of the flux measured above the atmosphere [2].

We are repeating this analysis using samples collected in 2000 from the SPWW. Compared with 1995 collection, the 2000 samples have less iron-oxide contamination allowing us to find unmelted micrometeorites. We are analyzing the deployment dedicated to the central plateau. Because this area was vacuumed in 1995 the 2000 sample should contain only those particles derived from the older, 700–1100 AD, ice [3] and allow us to calculate a flux for a second time period.

We have found and mounted 3272 micrometeorites from the central plateau sample. We present a preliminary size distribution (as not all micrometeorites have yet been measured) and an estimate of unmelted to melted ratio for the different size fractions.

Methods:

The samples studied were collected in 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 the106-150 fraction and 9% of the 53–106-µm fraction and removed all potential ET grains. We mounted and sectioned over 4000 particles. Using a SEM/EDAX we checked each particle for composition and found that 3272 of particles mounted were micrometeorites. Optical microscopy was used to size the particles and to classify them based on their cross-sectional textures.

Results:

The size distributions for the 1995 and for the 2000 plateau samples are shown in Figure 1. For the 2000 collection we show individual data points for micrometeorites >250µm, as these have all been sized, and plot the cumulative number of micrometeorites for the three smallest size fractions. 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. The best-fit line to the tail of the 2000 plateau sample has a slope of -4.5 slightly less steep than the -5.2 tail-slope calculated for the 1995 plateau sample [2]. Nevertheless the two curves are quite similar indicating that the size distributions from the two collections are similar.

The 2000 collection has more micrometeorites than the 1995 collection. The addition of the unmelted component cannot explain the increased number as the unmelted micrometeorites would predominantly change the number of micrometeorites in the smaller size fractions. The fact that we found an order of magnitude more >250µm micrometeorites in the 2000 collection may be due to an increase in the plateau area as the well deepens or to an increase in the flux rate. Although we have not yet measured the plateau area our video records do not show an order of magnitude increase in the plateau area.

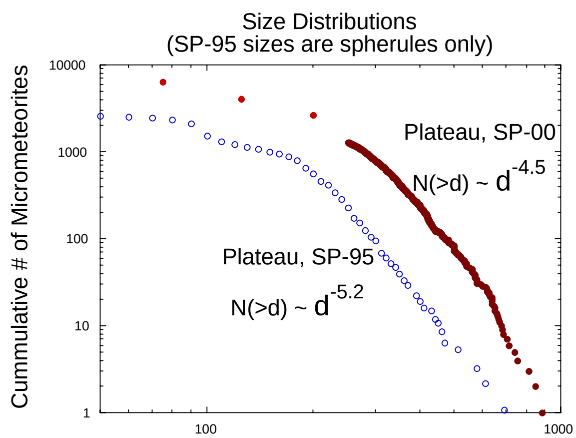

Figure 1. Cumulative size distributions for micrometeorites collected for two different time intervals from the bottom of the South Pole water well.

The numbers of melted and unmelted micrometeorites in each size fraction are given in Table 1. As expected, and noted by others [e.g. 4], the number of unmelted micrometeorites generally increases as the size fraction decreases. We found very few unmelted micrometeorites in the >250µm size fractions and similar number of melted and unmelted micrometeorites in the < 150µm size fractions.

We compare our results with those given for other collections (Table 1). From Greenland ice, Maurette et al. [4] found more un-melted than melted micrometeorites in the <100µm size fraction and about half the number of unmelted as melted in the 100-300µm range. From ice at Cap Prudhomme, Antarctica Maurette et al. [5] found 5 times as many unmelted micrometeorites in the <100µm size fraction and close to half as many unmelted to melted micrometeorites in the 100-400µm size range. Terada et al. [6] sampled ice of three different ages in Antarctica (16, 30 and 60 thousand years before present) and found a range in the unmelted to melted ratio from 0.5 to 4.5 for micrometeorites 40–238µm in diameter. Genge and Grady [7] extracted over 500 micrometeorites from Cap Prudhomme samples and found an unmelted to melted ratio of ~3. For similarly sized particles, 53–250µm this study, 50–300µm [4] and 40–238µm [6] the unmelted to melted ratios are 0.2, 0.5 and 0.6 respectively. These preliminary results indicate that SPWW collection has a lower number of unmelted micrometeorites than the other two collections. Possible explanations include variations in the types of micrometeorites being deposited, destruction or masking of the unmelted micrometeorites in the SPWW samples and differences in the way micrometeorites are classified. There are many micrometeorites that are transitional between melted and unmelted (Figure 2). How these are tallied can change the unmelted to melted ratio. We intend to photograph all the micrometeorites from the plateau collections and to document how we classified each particle so that the third possibility can be assessed.

Reference	Size fraction (µm)	Number unmelted	Number melted	U/M
This study	>425	1	135	7.41E-03
	250-425	23	1138	2.02E-02
	150-250	134	1288	1.04E-01
	106-150	169	174	9.71E-01
	53-106	70	135	5.19E-01
Maurette et al. 1987	50-100	1500	1060	1.42E+00
	100-200	265	570	4.65E-01
	200-300	45	101	4.46E-01
Maurette et al. 1991	50-100			>5
	100-400			~0.3
Terada et al. 2001	40-238	101	78	1.29E+00
	40-238	134	138	9.71E-01
	40-238	172	84	2.05E+00
	40-238	18	4	4.50E+00
	40-238	30	53	5.66E-01
Genge & Grady 2002	50-400	412	138	2.99E+00

Conclusions:

We expect to calculate a flux for the 700–1100 AD time interval and to complete the particle size distribution for the 2000 SPWW collection this year. Next year we hope to image and classify all the micrometeorites. When complete this collection-level analysis will allow us to place an individual micrometeorite in context and determine how a micrometeorite relates to the population of micrometeorites as a whole.

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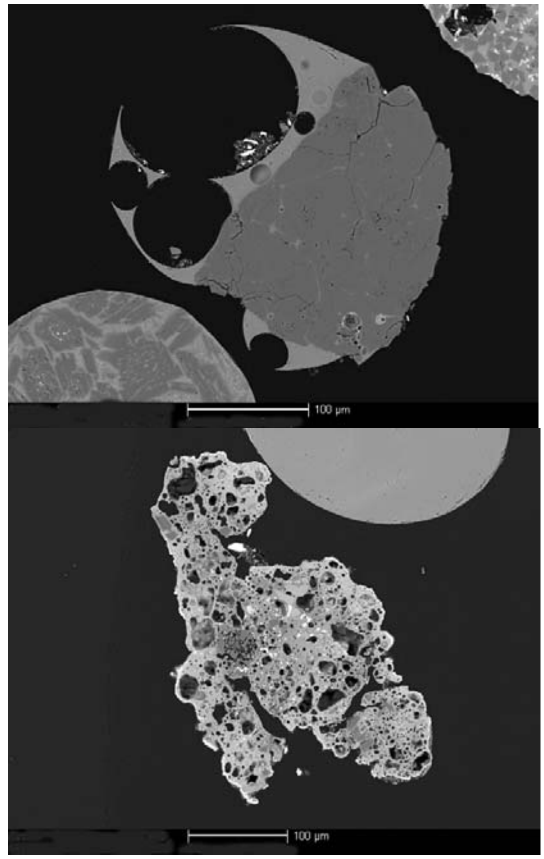

Figure 2. Transitional forms: Relic grain bearing and scoriaceous micrometeorites.

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