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BUBBLE DISTRIBUTION IN FUSED OBSIDIAN AND SLIDE GLASS

by

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Introduction

In this report we obtain further data about the distribution of bubbles in glass. It gives the results obtained from the microscopic study of obsidian samples heated with an oxyacetylene torch and from powdered microscopic slide glass re-fused in an electric oven.

This report continues our earlier study of the distributions: Badri Aghassi, 1961, B.U. Tektite Project, Research Report No. 11.

Preparation of Samples

Two fragments, about ten grams each, of obsidian were heated by an oxyacetylene torch at temperatures of 2200±300°C for fifteen minutes and five minutes respectively. These two samples will be referred to in this report as Obsidian I and Obsidian II respectively. The heating process, although quite intense, was uneven. The temperatures mentioned above are those of the gas just emerging from the torch tip. Outside the blue cone at the tip the temperature falls off rapidly.

A microscopic slide glass was powdered and the powder was placed in a platinum crucible inside an electric oven which reaches a maximum temperature of about 2000°F. After twenty minutes the "Slide Glass" re-fused into a light pink mass. This is due to trace impurities introduced accidentally into the powder. As the study of this glass under the microscope showed, the powder did not melt completely, nor homogeneously. Small fragments of the size of the larger powder fragments were preserved in shape and did not exhibit the pinkish coloring that the fused samples showed in general. The powder must have coalesced after having been just softened enough.

These three samples, Obsidian I, Obsidian II and "Slide Glass" were sliced. The slices were mounted on microscopic slides and studied under the microscope in the same manner described in Report No. 11. The reader is asked to refer to Report No. 11 for the mathematical analysis used in the present and the mentioned reports.

A short reminder of our notation:

M_o' is the intercept of the curve $M = M_o\, e^{-b\rho}$ with the M-axis as plotted for the volume searched.

$b = -\, \mathrm{Log}_e 10 \times$ slope of $\mathrm{Log}_{10} M$

$\alpha = 1 -$ slope of $\mathrm{Log}_{10} M$

(b and α correspond to the exponential constants of the large and small regimes, Report No. 11, eqs. (1) and (2) respectively.) M'_R is the cumulative number of bubbles for the total volume searched at that value of the diameter where the regime starts to prevail. This value of the diameter (R) is referred to in Report No. 11 as the "upper limit of diameter."

Results

All three glasses showed the superposition of the "two regimes" described in Report No. 11, and in all three the small regime was of the form $\rho^{-\alpha}$. In all three the bubble content was higher than that of natural glasses. Table IV gives the bubble content and other pertinent constants, M'_o, b, α , R, etc. Eqs. (8) and (9) of Report No. 11 were used to calculate the bubble content.

Conclusions

Tektites are still the only glass that exhibits a single regime. All other show the superposition of two distributions. Tektites also have the smallest bubble content.

Reference

Aghassi, B. (1961), B.U. Tektite Project, Research Report No. 11.

TABLE I. BUBBLE DISTRIBUTIONS from OBSIDIAN I
Volume searched 270mm^3

INCREMENTAL NUMBERS			CUMULATIVE NUMBERS	
No. of bubbles	with diameter (mm) between	and	No. of bubbles	with diameter (mm) greater than
15	0.006	0.009	594	0.006
29	0.009	0.012	579	0.009
98	0.012	0.018	550	0.012
75	0.018	0.024	452	0.018
72	0.024	0.030	377	0.024
42	0.030	0.036	305	0.030
37	0.036	0.042	263	0.036
22	0.042	0.048	226	0.042
25	0.048	0.060	204	0.048
27	0.060	0.072	179	0.060
18	0.072	0.084	152	0.072
10	0.084	0.096	134	0.084
12	0.096	0.108	124	0.096
7	0.108	0.120	112	0.108
10	0.120	0.132	105	0.120
3	0,132	0.156	85	0.132
7	0.156	0.168	82	0.156
4	0.168	0.180	75	0.168
5	0.180	0.192	71	0.180
11	0.192	0.216	66	0.192
9	0.216	0.240	55	0.216
4	0.240	0.264	46	0.240
7	0.264	0.288	42	0.264
7	0.288	0.312	35	0.288
4	0.312	0.336	28	0.312
5	0.336	0.360	24	0.336
9	0.360	0.420	19	0.360
3	0.420	0.480	10	0.420
5	0.480	0.600	7	0.480
1	0.600	0.720	2	0.600
1	0.720	greater	1	0.720

TABLE II. BUBBLE DISTRIBUTION from OBSIDIAN II
(Volume searched 167 mm^3)

INCREMENTAL NUMBERS			CUMULATIVE NUMBERS	
No. of bubbles	with diameter (mm) between	and	No. of bubbles	with diameter (mm) greater than
14		0.006	382	0.003
18	0.006	0.009	368	0.006
29	0.009	0.012	350	0.009
31	0.012	0.015	321	0.012
24	0.015	0.018	290	0.015
29	0.018	0.024	266	0.018
25	0.024	0.030	237	0.024
10	0.030	0.036	212	0.030
17	0.036	0.042	202	0.036
9	0.042	0.048	185	0.042
6	0.048	0.054	176	0.048
4	0.054	0.060	170	0.054
13	0.060	0.072	166	0.060
25	0.072	0.096	153	0.072
23	0.096	0.120	128	0.096
14	0.120	0.144	105	0.120
13	0.144	0.168	91	0.144
14	0.168	0.192	78	0.168
12	0.192	0.216	64	0.192
12	0.216	0.240	52	0.216
16	0.240	0.300	40	0.240
14	0.300	0.360	24	0.300
9	0.360	0.480	10	0.360
0	0.480	0.600	1	0.480
1	0.600	0.720	1	0.600

TABLE III. BUBBLE DISTRIBUTION from fused microscopic SLIDE GLASS POWDER (Vol. searched 40 mm^3)

INCREMENTAL NUMBERS			CUMULATIVE NUMBERS	
No. of bubbles	with diameter (mm) between	and	No. of bubbles	with diameter (mm) greater than
268		0.006	1023	0.003
167	0.006	0.009	755	0.006
136	0.009	0.012	588	0.009
118	0.012	0.018	452	0.012
114	0.018	0.024	334	0.018
104	0.024	0.036	220	0.024
27	0.036	0.042	116	0.036
26	0.042	0.048	89	0.042
19	0.048	0.060	63	0.048
15	0.060	0.072	44	0.060
4	0.072	0.084	29	0.072
4	0.084	0.096	25	0.084
4	0.096	0.108	21	0.096
8	0.108	0.120	17	0.108
2	0.120	0.132	9	0.120
3	0.132	0.144	7	0.132
1	0.144	0.204	4	0.144
2	0.204	0.216	3	0.204
1	0.216	0.228	1	0.216

TABLE IV

BUBBLE CONTENT and
other constants

	OBSIDIAN I	OBSIDIAN II	SLIDE GLASS
Volume searched	270 mm^3	167 mm^3	40 mm^3
Total No. of bubbles	594	382	1023
M_o' for 0.1mm regime	250	270	410
(b)	3.68 ± 0.1	4.00 ± 0.1	12.8 ± 0.2
Volume content	$5.8 \pm 0.5\%$	$8.0 \pm 0.5\%$	$1.55 \pm 0.5\%$
M_R' for 0.1mm regime	85	150	17
(R)	0.144mm	0.072mm	0.12mm
(α)	1.8 ± 0.05	1.4 ± 0.05	2.8 ± 0.05
Volume content	$0.02 \pm 0.005\%$	0.0025 ± 0.001	$0.06 \pm 0.005\%$
Total Volume content	$5.8\% \pm 0.05$	$8\% \pm 0.05$	$1.6\% \pm 0.05$

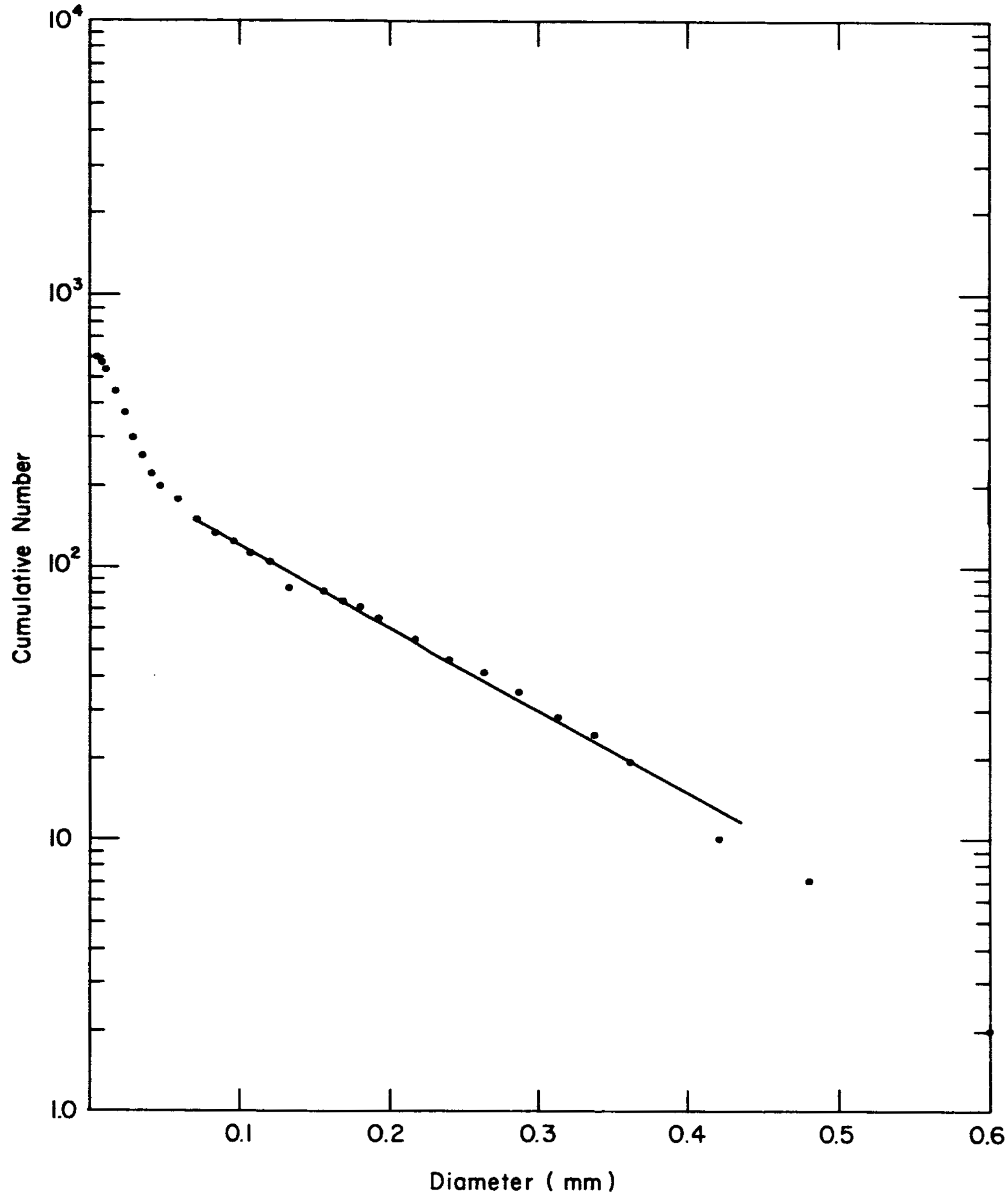

FIGURE 1a. Cumulative Number versus Diameter, OBSIDIAN I

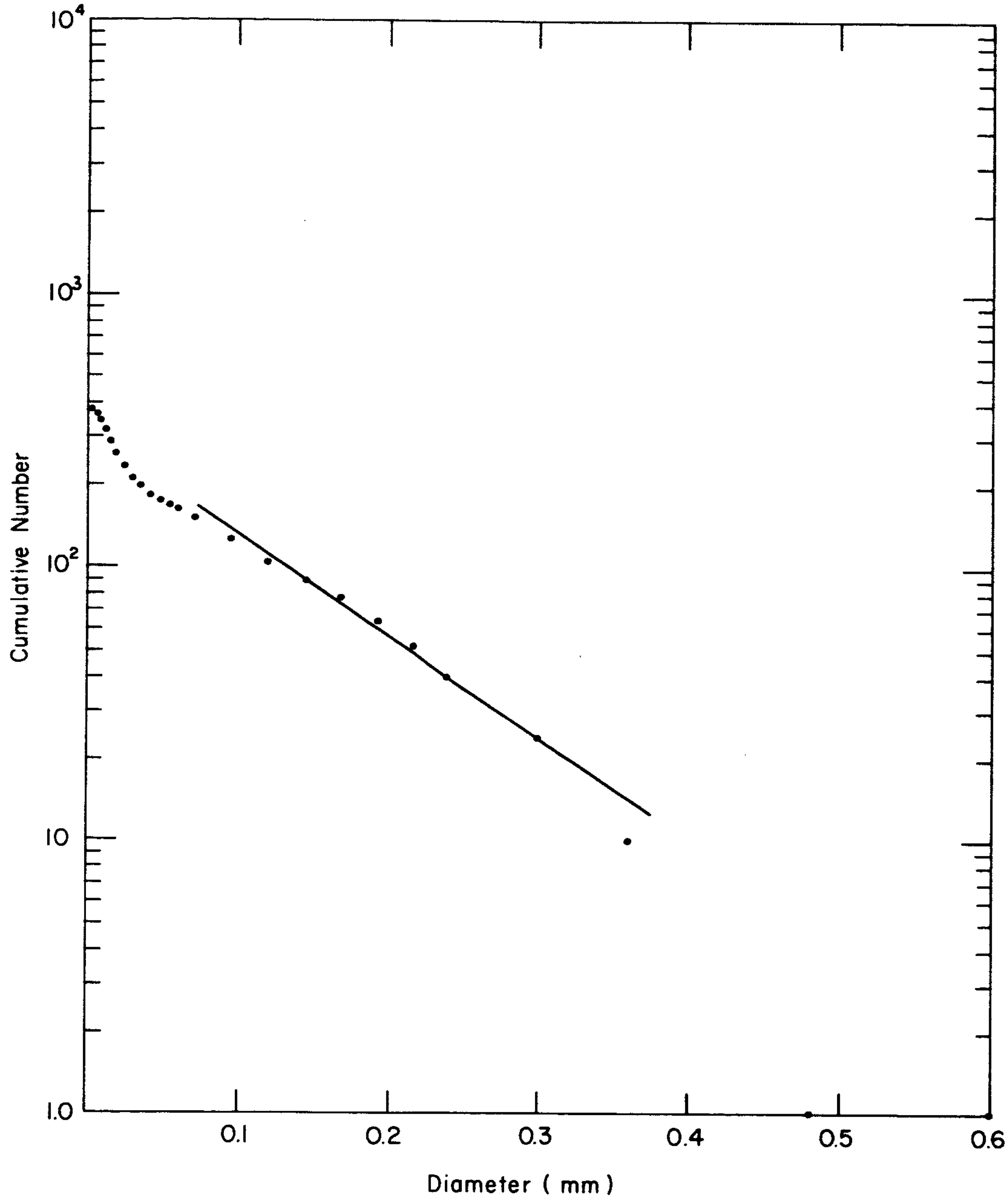

FIGURE Ib. Cumulative Number versus Diameter, OBSIDIAN II

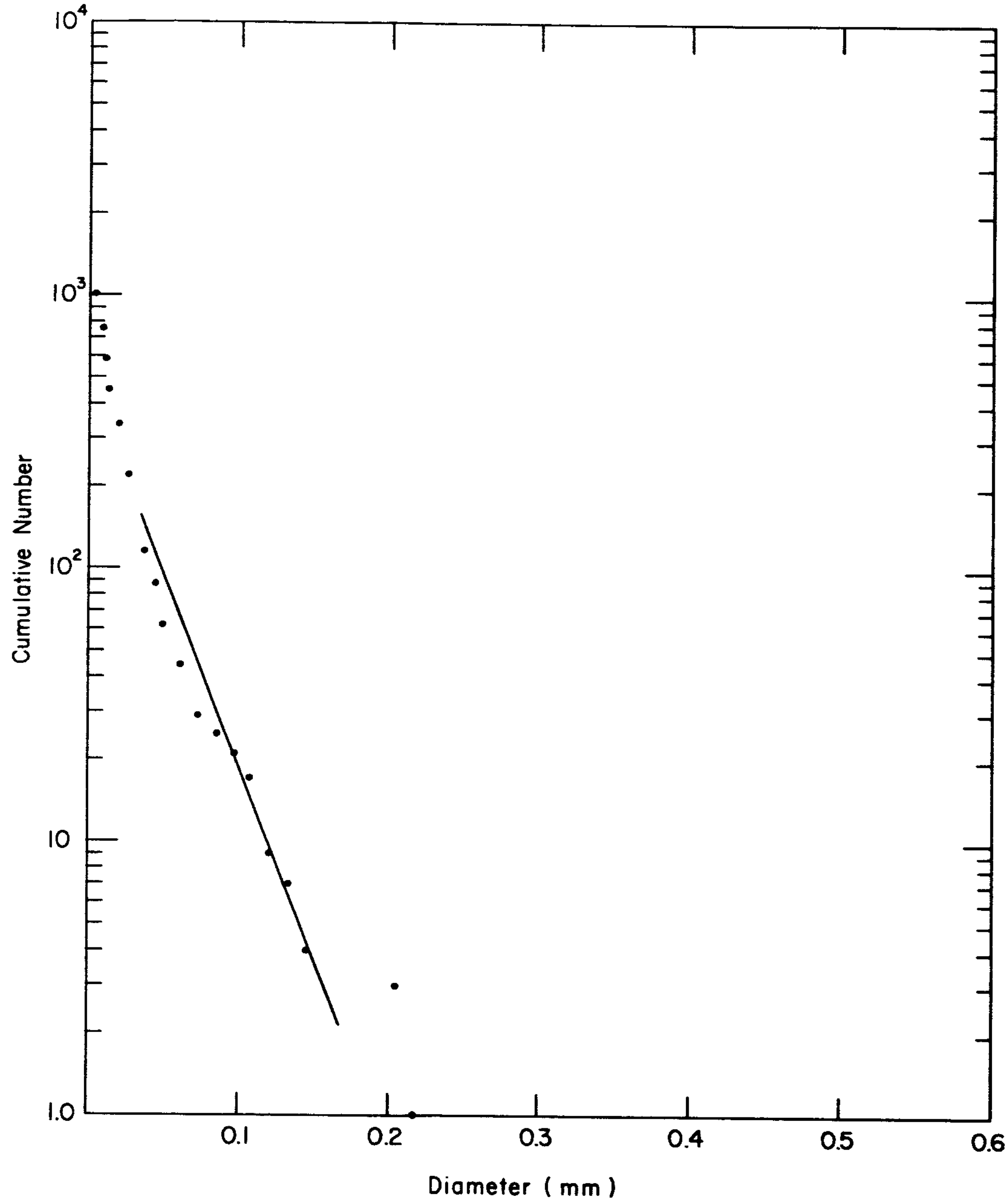

FIGURE 1c. Cumulative Number versus Diameter, SLIDE GLASS

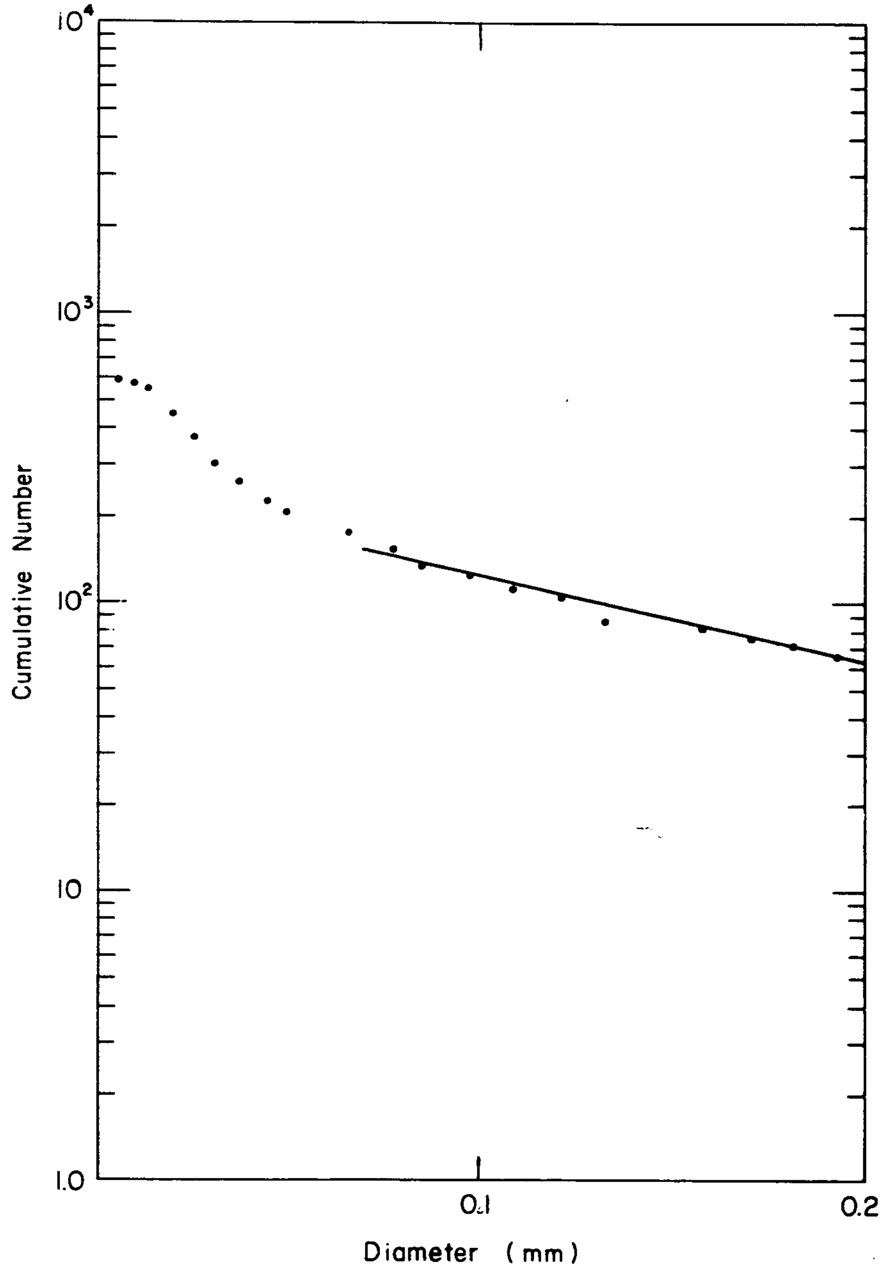

FIGURE 2a. Cumulative Number versus Diameter, OBSIDIAN I

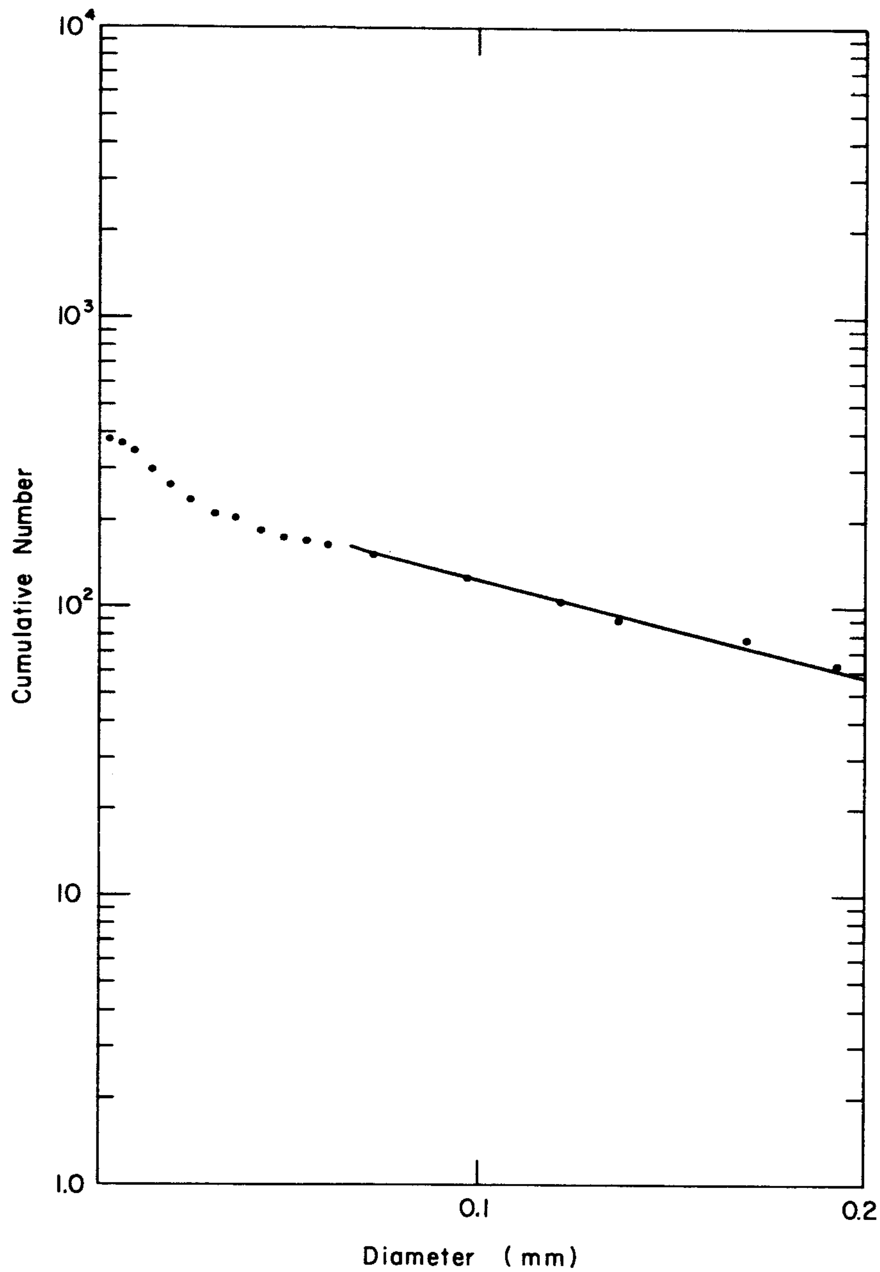

FIGURE 2b. Cumulative Number versus Diameter, OBSIDIAN II

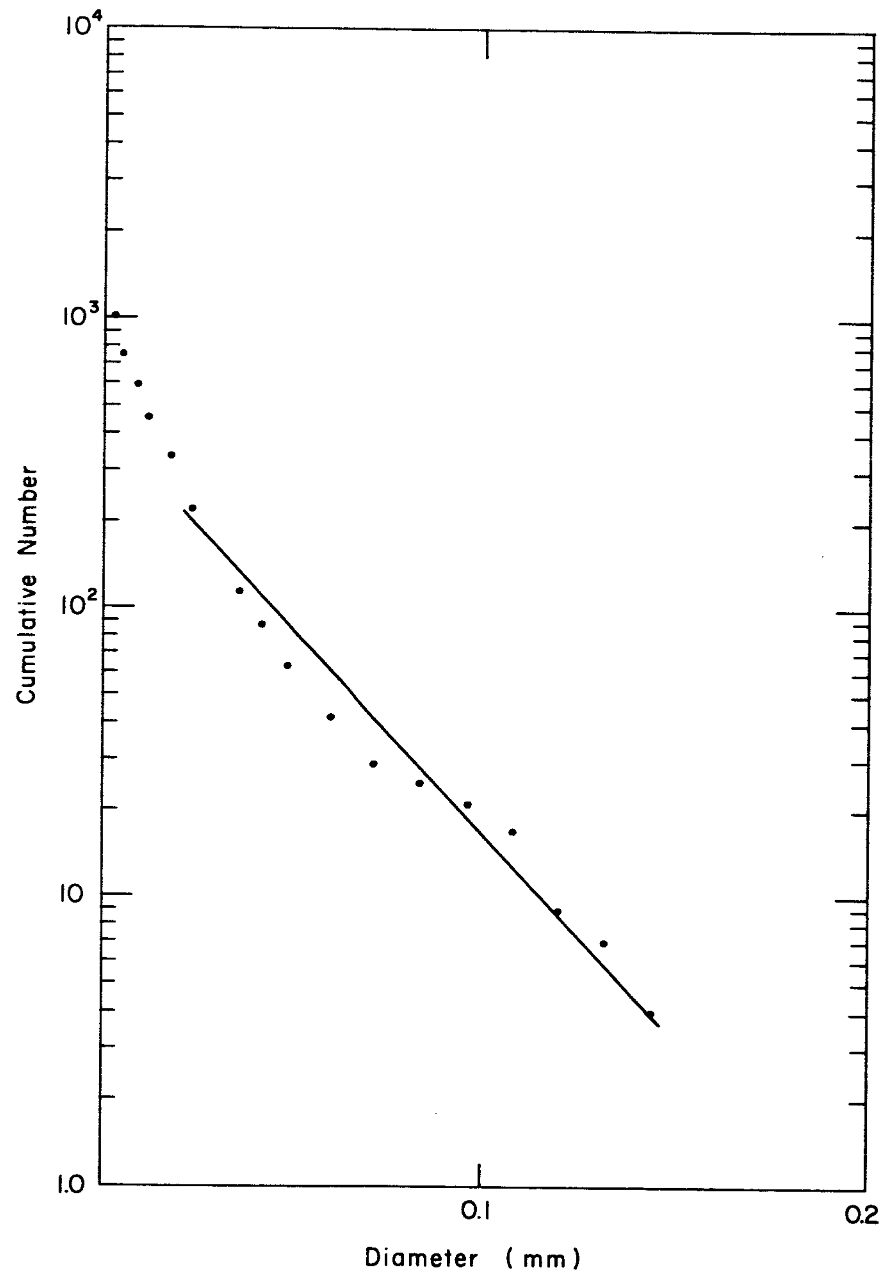

FIGURE 2c. Cumulative Number versus Diameter, SLIDE GLASS

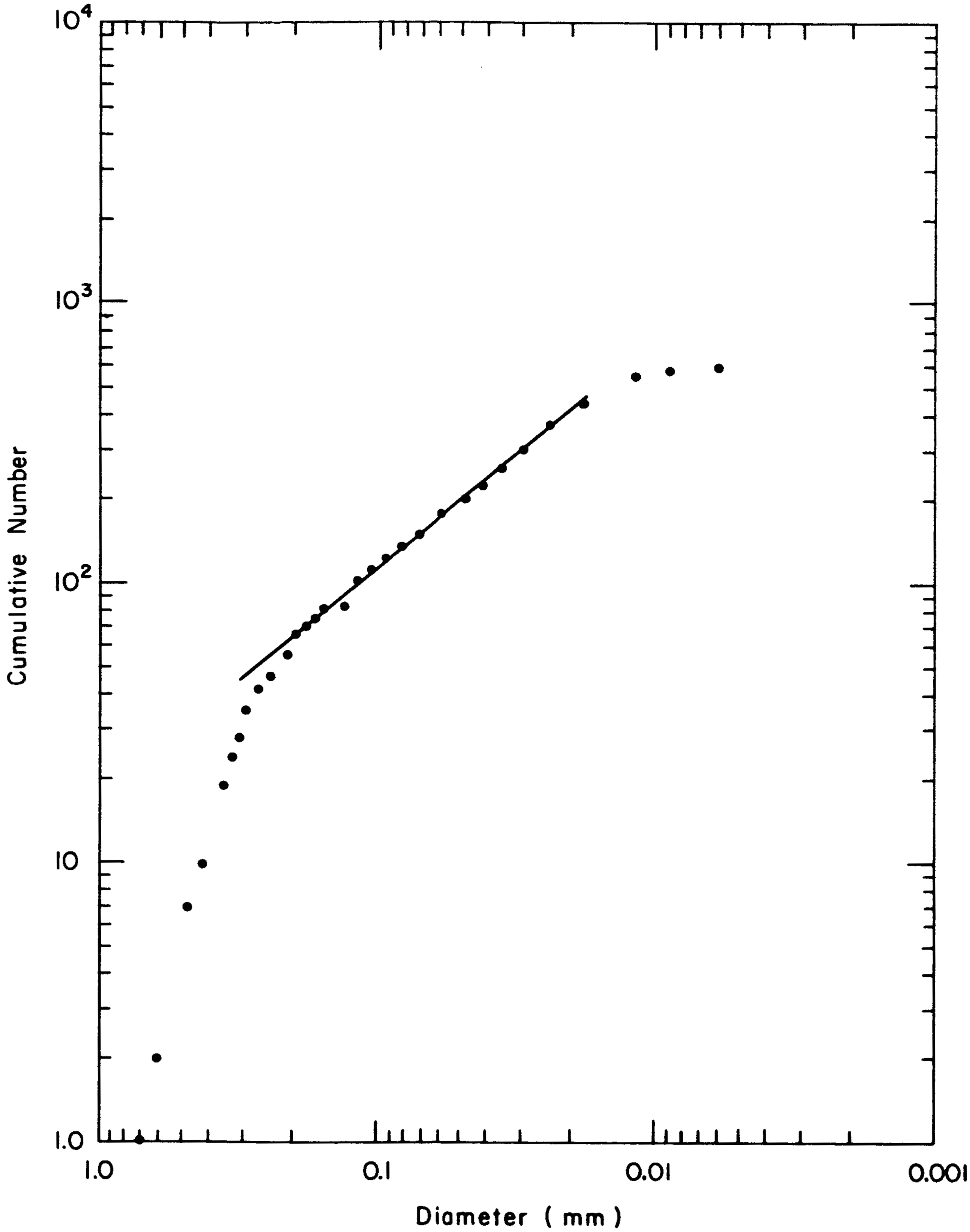

FIGURE 3a. Cumulative Number versus Diameter, OBSIDIAN I

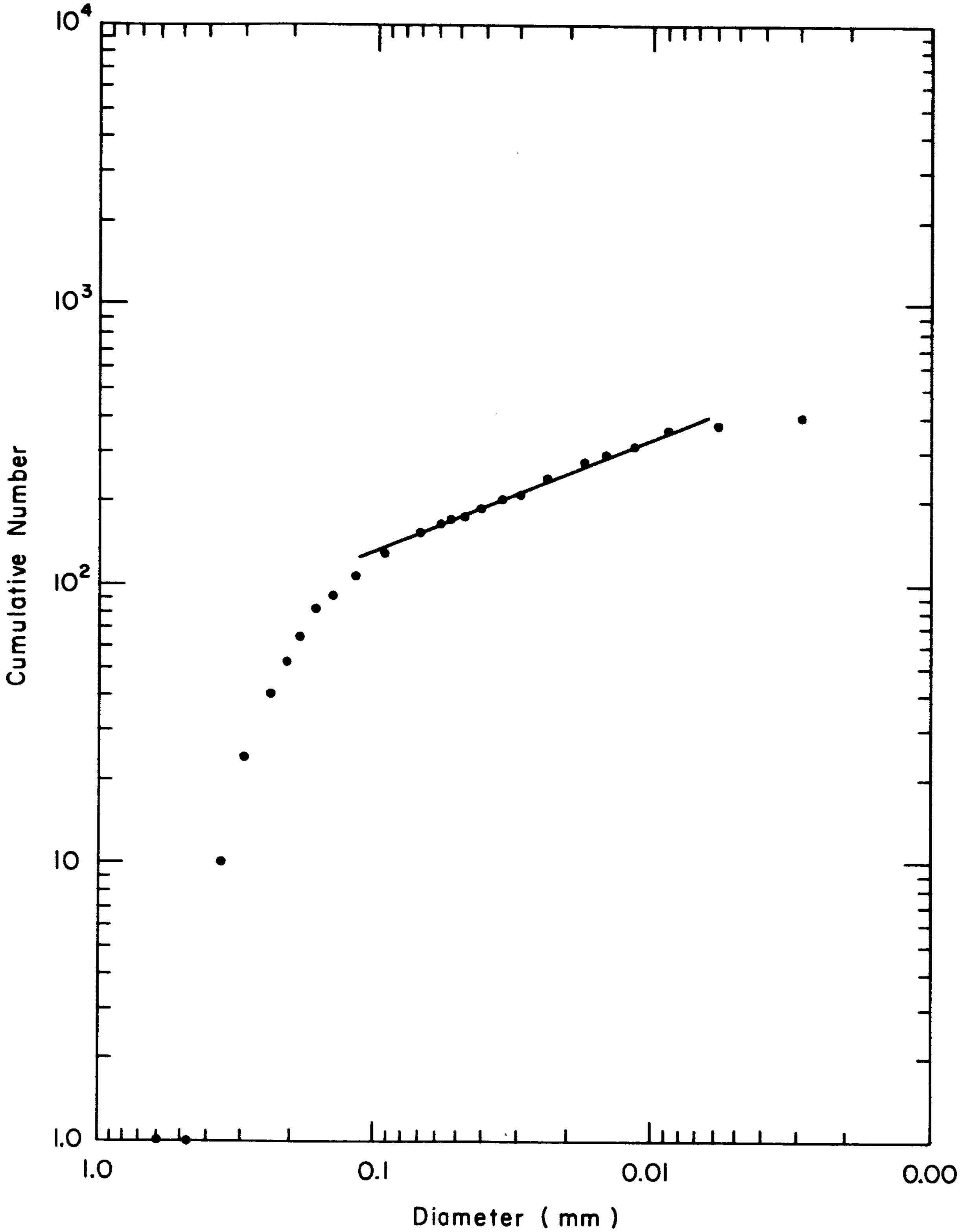

FIGURE 3b. Cumulative Number versus Diameter, OBSIDIAN II

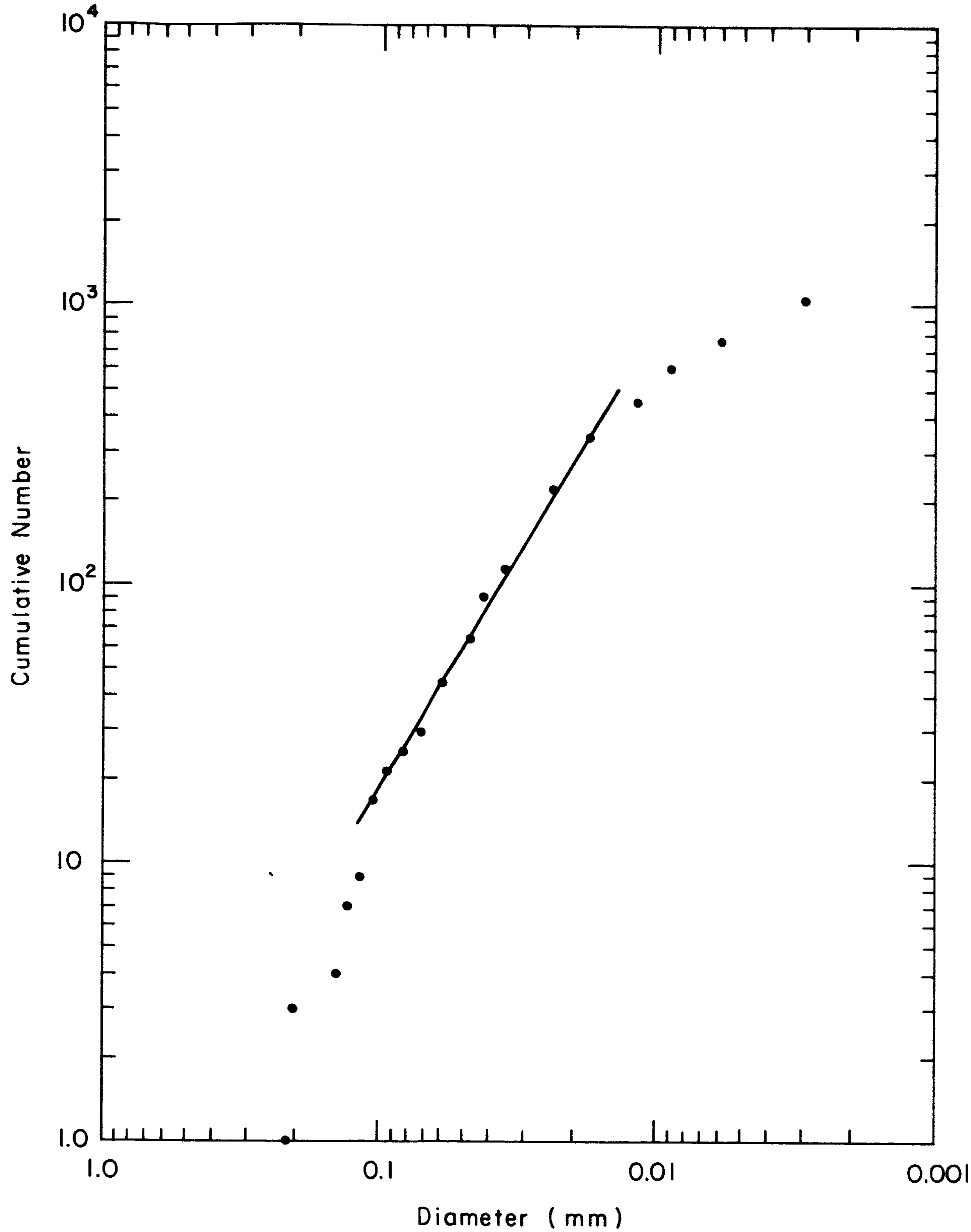

FIGURE 3c. Cumulative Number versus Diameter, SLIDE GLASS