APPENDIX D
COLLOIDAL SUSPENSION STUDY REPORT
MATERIALS AND CHEMISTRY LABORATORY, INC. (MCLinc)

January 11, 2005

Mr. Pat Blau
Kaiser Aluminum
Trentwood Works
Post Office Box 15108
Spokane, Washington 99215-5108

Certificate of Analysis
MCLinc Project #: KAW001513
SEM/EDS Analysis of Particle Suspension

On August 11, 2004, a liquid sample consisting of six 1 Liter glass containers were received at Materials and Chemistry Laboratory, Inc. (MCLinc) and given MCLinc identification number 04-1715. A Hitachi S-5000 Scanning Electron Microscopy (SEM) and associated Tracor-Northern Voyager Energy Dispersive Spectroscopy (EDS) were used to characterize the sample for grain size and chemical composition.

Introduction

The water sample was identified as HL-MW-5 and submitted by Pat Blau, Environmental Manager at the Kaiser Aluminum - Trentwood Works for SEM sizing and x-ray fluorescence elemental analysis (EDS). The sample was collected on 8/9/04 from monitoring well HL-MW-5 and shipped to MCL on 8/10/04. Well HL-MW-5 is located within what has been defined as the Casting Plume, a groundwater area impacted by low level PCBs (nominally 100 ng/L "100ppt"). The well is constructed such that the intake screen is located below the surface of the aquifer. Groundwater samples collected in the HL-MW-5 area do not appear to be impacted by petroleum hydrocarbons or typical resulting parameters such as low dissolved oxygen. The water sample provided to MCL was collected using a dedicated down-hole sampling pump. The well was purged for approximately 5 minutes prior to sample collection to assure that conditions had stabilized and that the sample was representative of site conditions. The sample as received by MCL appeared to be clear to the naked eye with no visually identifiable particulate matter. The primary objective of this laboratory work was to identify the size ranges and elemental constituents of colloidal material in the sample for use in evaluation of site remediation issues.

Procedure

Samples of the suspension were prepared for the SEM by filtering approximately one liter each of the sample through three different filters. This resulted in three sub-samples (A, B, and C). The type of filter used was an Anotop 25 from Whatman, with a diameter of 25 millimeters and an effective pore size of 0.02 micrometer (Figure 1). The filter is an inorganic filter consisting of a hexagonal network of aluminum oxide. A portion of the filter was excised from its holder, carbon coated, and introduced to the SEM. Size and chemical data were acquired for 100 grains on sub-sample A and 50 each for sub-samples B and C. The results of the characterization are tabulated in Tables 1-3.

Figures 2-4 illustrate the uneven particle loading on the filters. This is likely due to the relatively large size of particles as compared to the pore size of the filter. Note the range in grain size (Tables 1-3) from smaller than 0.3 micrometers to over 25 micrometers in length. The length and width (measured at 90 degrees to the length) values were used to calculate an effective particle diameter. The effective particle diameter is what is shown in Figures 5-8 as histograms of the three sub-samples and the composite (Figure 8). The effective particle diameter is calculated by using the length and width measurements as the major and minor axes of an ellipse, calculating the area of the ellipse, and then using that area to calculate an effective particle diameter as if the area was a sphere. This calculation technique is applicable since the particles are effectively equant (nearly uniform in diameter in all dimensions).

The EDS chemistry is shown in Tables 1-3. Aluminum and oxygen are generally present in all of the analyses because of the presence of the aluminum oxide substrate. What is also shown is the presence of silicon, carbon, sodium, iron, calcium, phosphorous, and magnesium. The majority of the grains are silicon and oxygen.

Conclusion

Based on the chemistry, most of the material appears to be a silicon dioxide, i.e. quartz.

The particles found on the filters had a range in grain size from smaller than 0.3 micrometers to over 25 micrometers in length. Most of the particles were under 1.6 micrometers in effective diameter. Based on the number and size of particles (i.e., high surface area) there may be sufficient surface area for sorption of organic compounds

Thank you for choosing MCLinc. If you have any questions or need additional information, please contact us at (865) 576-4138.

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Robert J. Stevenson, Ph.D. Date
Materials and Chemistry Laboratory, Inc.

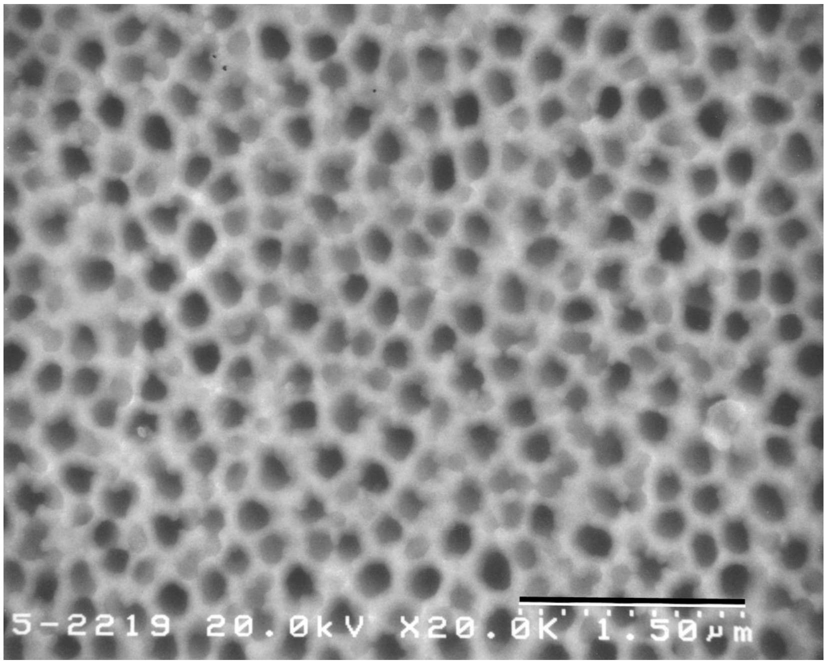

Figure 1. Photomicrograph of aluminum oxide filter surface. Scale bar is 1.5 micrometers in length.

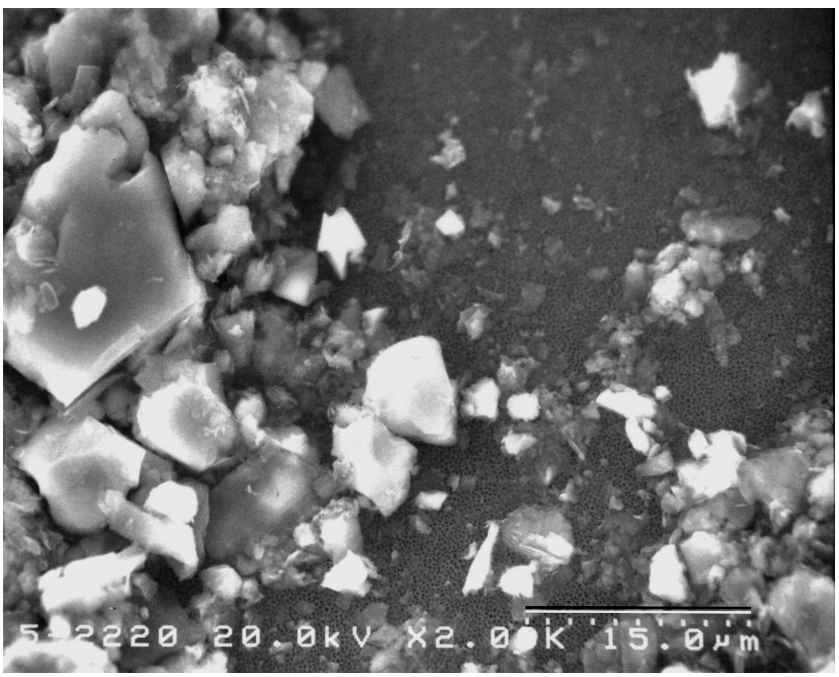

Figure 2. Photomicrograph of aluminum oxide filter surface with particles found on sub-sample A. Scale bar is 15 micrometers in length.

Figure 3. Photomicrograph of aluminum oxide filter surface with particles found on sub-sample B. Scale bar is 15 micrometers in length.

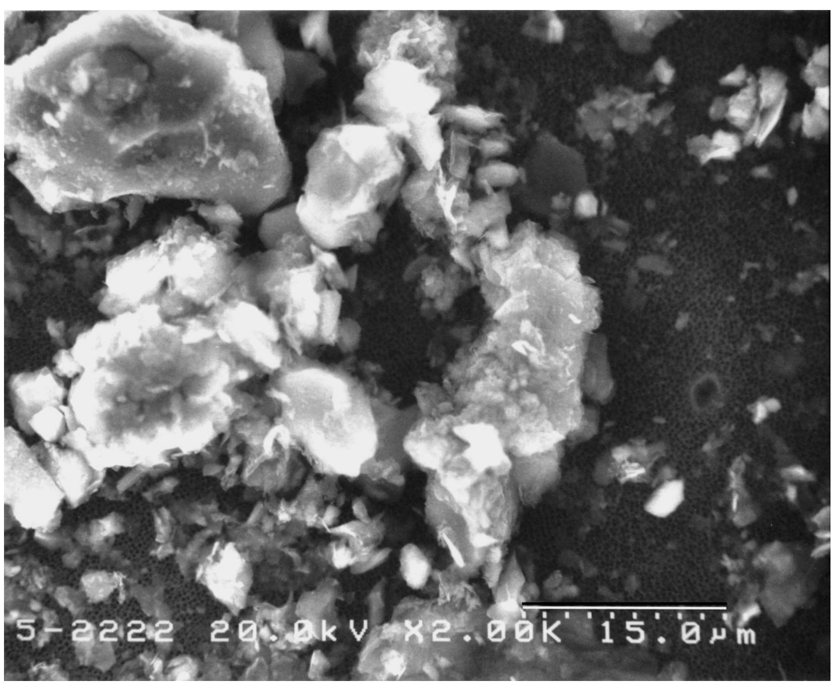

Figure 4. Photomicrograph of aluminum oxide filter surface with particles found on sub-sample C. Scale bar is 15 micrometers in length.

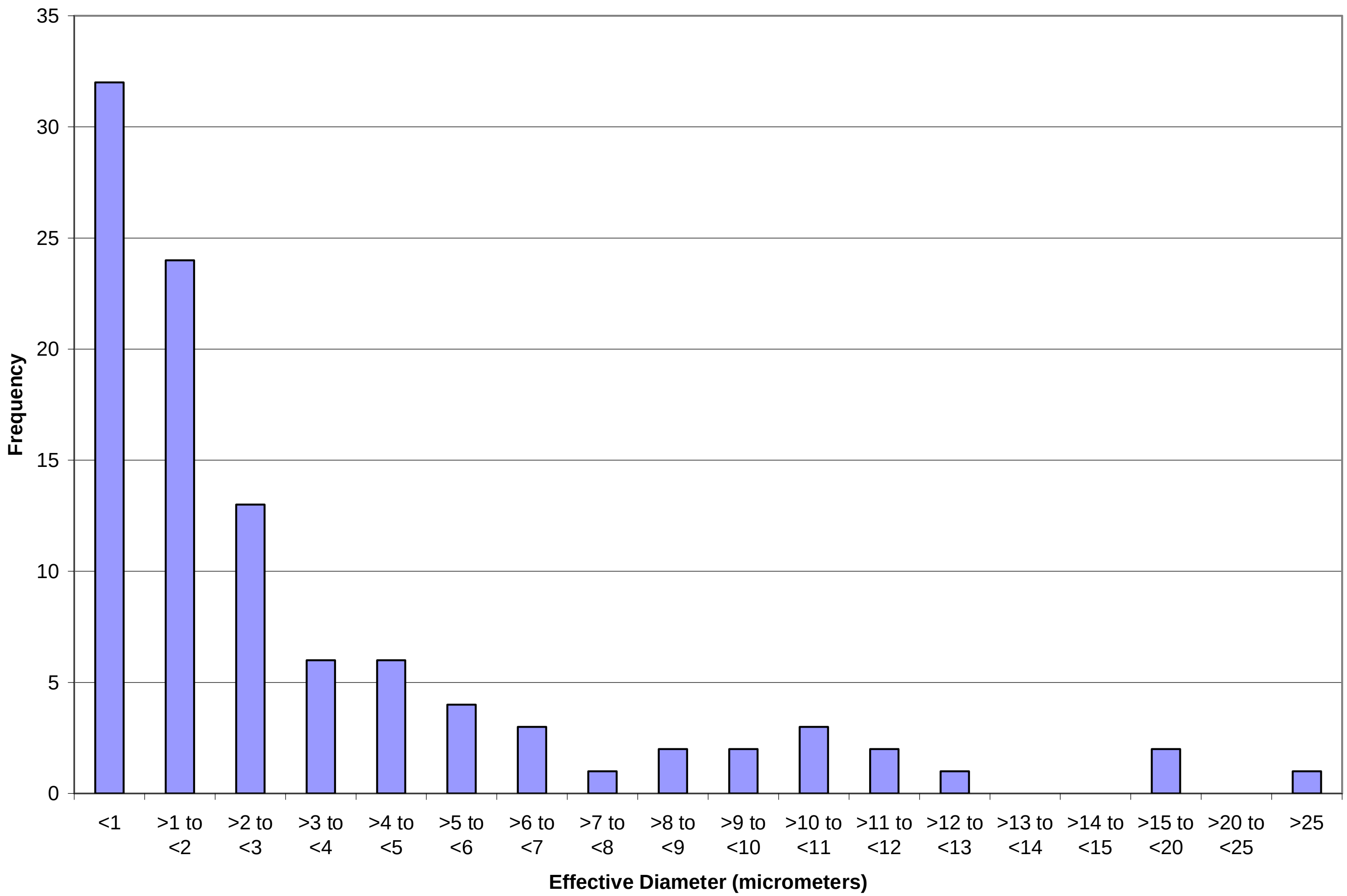

Figure 5. Histogram showing effective diameter from 100 particles in sub-sample A.

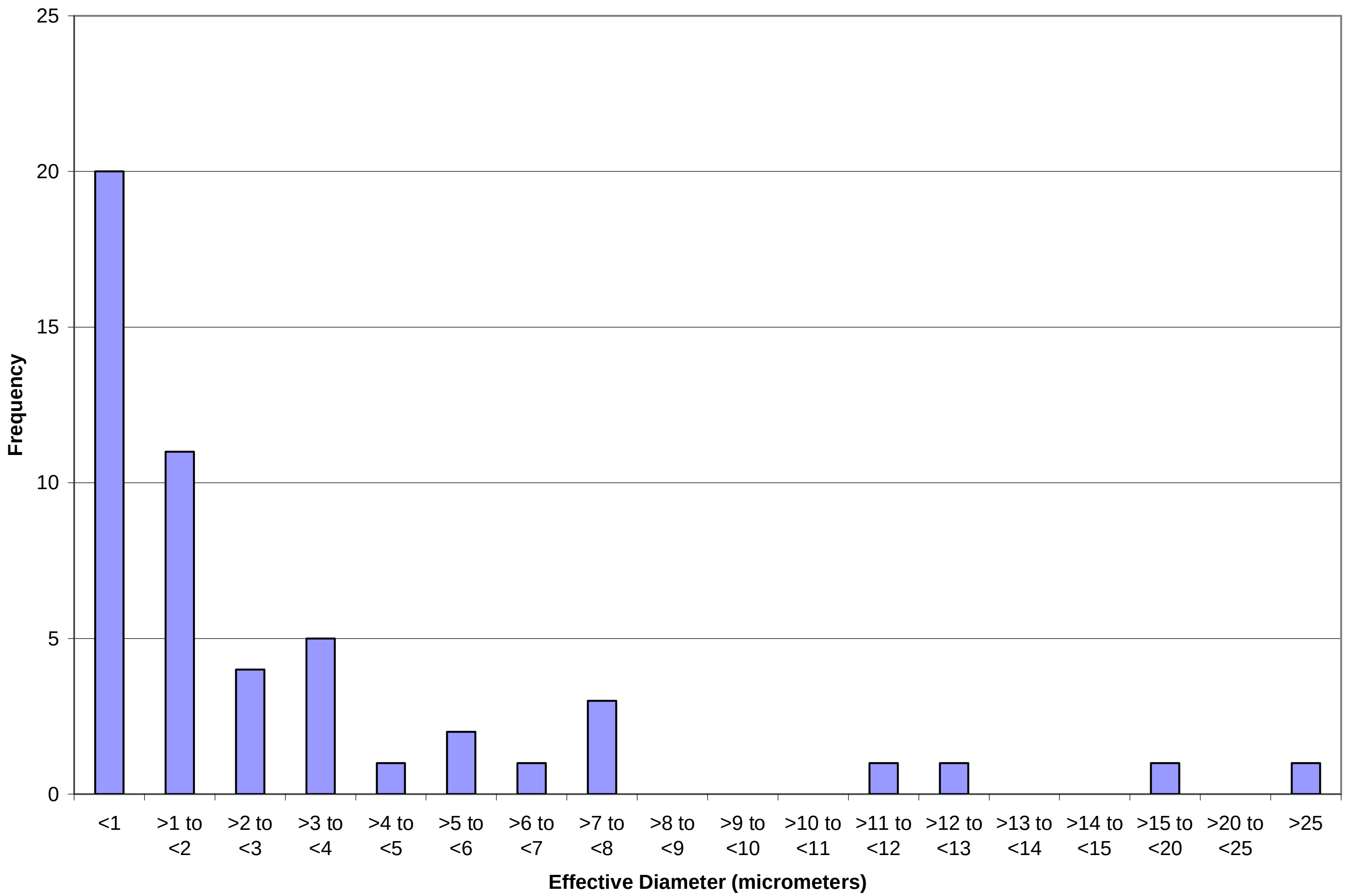

Figure 6. Histogram showing effective diameter of 50 particles in sub-sample B.

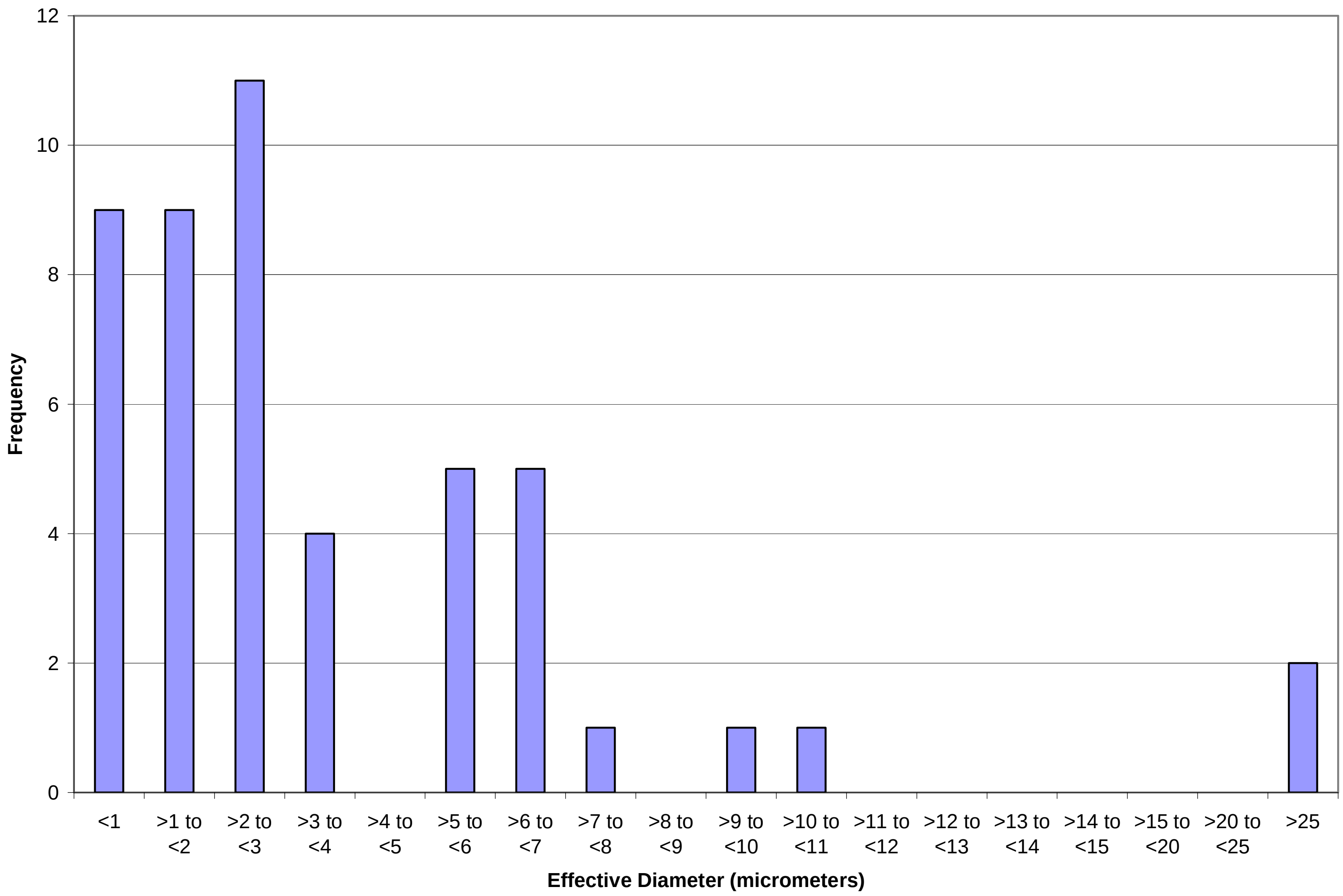

Figure 7. Histogram showing effective diameter of 50 particles in sub-sample C.

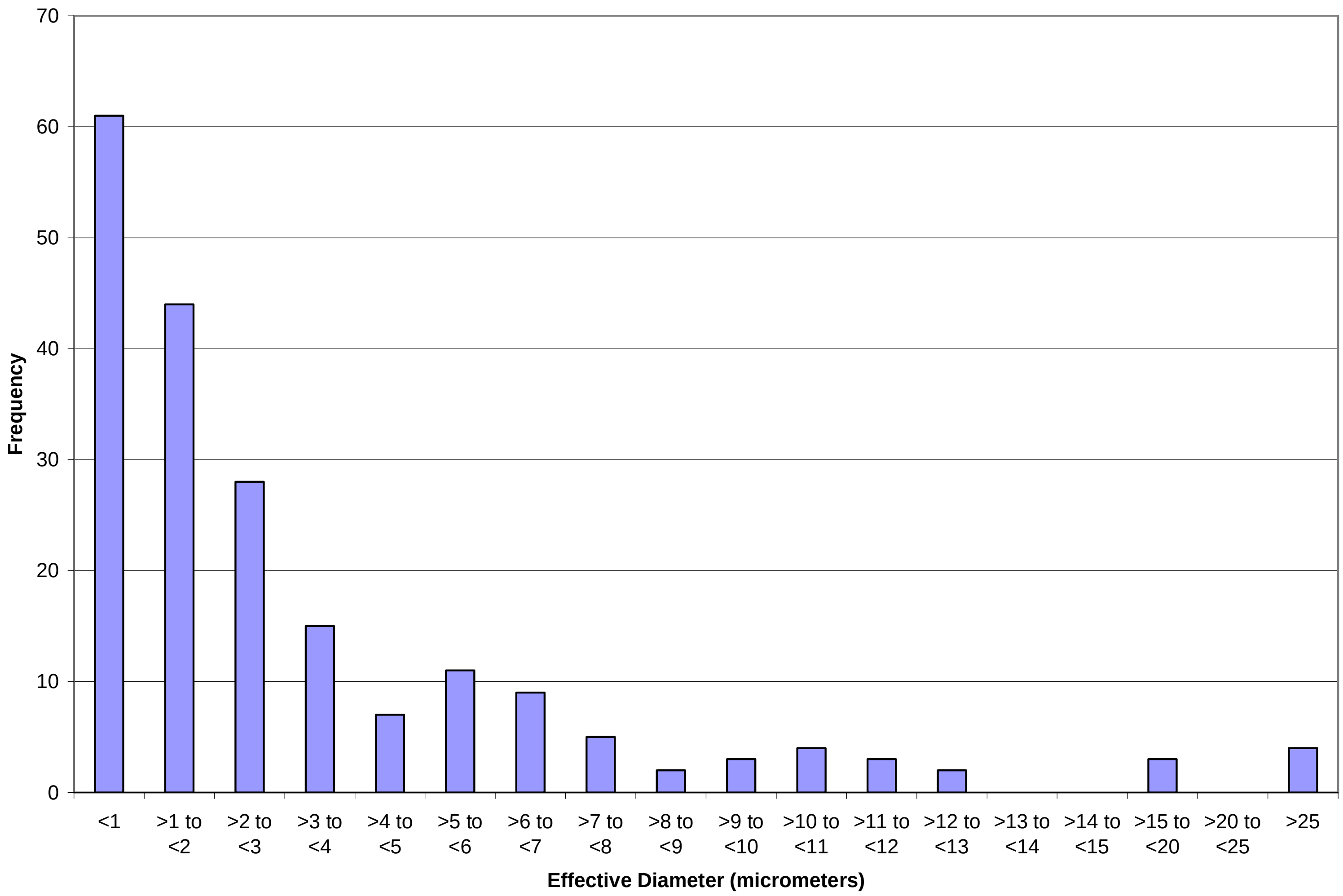

Figure 8. Histogram showing effective diameter of 200 particles in all sub-samples.

Table 1. Data from Sub-sample A

Grain Number	Size (µm)	EDS Chemistry
1	11.0 x 8.5	Al>O, Si>Mg, Ca, C>Fe, K
2	0.5 x 0.35	Al>O>C
3	1.4 x 1.3	Al>O, Si>C
4	2.7 x 2.6	Al>O>Si
5	1.0 x 0.7	Al>O
6	1.7 x 0.8	Al>O>Si>K
7	1.75 x 1.1	Al>O>>Si
8	2.7 x 2.2	Al>Si, O>Na, C
9	1.5 x 1.1	Al>O>Si
10	0.7 x 0.5	Al>O
11	1.0 x 0.8	Al>O
12	2.2 x 1.3	Al>O>Si, Na
13	3.1 x 1.3	Al>O>Si
14	1.3 x 0.6	Al>O
15	1.2 x 0.6	Al>O>Si
16	2.2 x 0.7	Al>O, Si>K, C
17	2.5 x 2.2	Al>O, Si
18	11.5 x 8.0	Al, Si>O>Mg, C>Fe, K, Ca
19	1.25 x 1.0	Al>O, Si>C
20	3.6 x 2.5	Al, Si>O>C
21	1.9 x 1.8	Al>O, Si>C
22	5.0 x 3.5	Al>O, Si>C
23	2.4 x 1.0	Al>O>>Si
24	1.2 x 0.7	Al>O>Si>C>Na
25	2.2 x 1.3	Al>O>Si
26	3.3 x 2.2	Al>O>Si>C, Na
27	2.9 x 2.2	Al>Si, O>C
28	3.9 x 3.6	Al>O>Si, Fe>K, P
29	0.6 x 0.5	Al>O>>C, Si
30	0.5 x 0.4	Al>O>>C, Si
31	1.3 x 0.8	Al>O>Si, C
32	9.0 x 2.5	Al>O>Si, C
33	3.6 x 2.3	Al>Si, O>C, Na
34	0.9 x 0.8	Al>O>Si>C, K, P
35	7.5 x 4.5	Al>Si, O>Na>C
36	1.4 x 1.2	Al>O
37	13.0 x 6.0	Al>Si, O
38	1.7 x 1.0	Al>O>Si>K, C
39	2.4 x 1.2	Al>O>Si, Fe, C, P
40	5.0 x 3.0	Al>O>Si, C
41	16.0 x 8.0	Al>O>Si, Mg>Fe, C, K
42	36.0 x 21.0	Si>O

43	6.0 x 4.5	Si>Al>O>Mg>C, Ca>Fe, K
44	13.0 x 8.0	Al>O, Si>C, P, Fe
45	4.5 x 3.5	Al>Si, O>K, C>Fe
46	1.35 x 1.35	Al>O>>Si, C
47	2.6 x 1.9	Al>O, Si>C, K
48	4.0 x 2.5	Al>O>>Si, C
49	6.5 x 6.0	Al>Si, O>K, C>Fe, P
50	0.3 x 0.3	Al>O>C
51	2.7 x 2.0	Al>O, Si>Ti>P
52	0.8 x 0.5	Al>O>Si, Na
53	1.0 x 0.5	Al>O>>C, Si
54	0.5 x 0.3	Al>O>>Si, C, P
55	0.85 x 0.6	Al>O>C, P>Fe
56	0.9 x 0.4	Al>O>>C, P
57	0.7 x 0.4	Al>O
58	8.0 x 4.0	Al>O>Si>K, C>Fe
59	2.7 x 2.4	Al>O>P, C
60	12.5 x 10.0	Al>Si>O>K>C
61	1.2 x 1.0	Al>O>P, K
62	1.25 x 0.2	Al>O>P
63	3.0 x 0.9	Al>O>>Si, C
64	0.5 x 0.35	Al>O>Fe, C
65	2.2 x 1.1	Al>O>>C, Si, P, K
66	4.5 x 3.0	Al>C, O>>P
67	0.85 x 0.5	AL>O>>Si, C
68	0.45 x 0.35	Al>O>>C
69	0.6 x 0.45	Al>O>>C
70	5.0 x 5.0	Si>O, Al>C
71	1.3 x 0.6	Al>O>C
72	0.6 x 0.6	Al>O>C
73	0.65 x 0.5	Al>O>>C
74	2.6 x 1.4	Al>O>>C
75	0.6 x 0.4	Al>O>P, C
76	1.0 x 0.9	Al>O>Si
77	0.6 x 0.3	Al>O>>P
78	5.0 x 3.5	Al>O>Si, P
79	2.0 x 1.25	Al>O
80	13.5 x 4.5	Al>Si, O>Mg>Ca, P, C
81	7.5 x 6.0	Si>Al>O>C
82	2.0 x 1.35	Al>O>C
83	2.8 x 1.8	Al>O>Si
84	3.0 x 1.8	Al>O, Si>K>>C
85	13.0 x 8.0	Al, O, Mg, Si>Fe
86	3.0 x 2.4	Al>O, Si>Ca
87	7.5 x 5.5	Si>Al>O
88	4.0 x 4.0	Al>O, Mg>Si

89	2.0 x 1.6	Al>Si>O>C
90	12.0 x 10.0	Si>O, Al
91	7.0 x 3.5	Al>O>Si, Mg
92	8.0 x 8.0	Al>O>Si, C, Fe>Mg>Ca, K, P
93	1.4 x 1.2	Al>O>SI, C, P
94	0.5 x 0.45	Al>O>>Si, C
95	0.35 x 0.3	Al>O>C, Si
96	1.8 x 1.6	AL, O>>Si, P, C
97	0.5 x 0.5	Al>O>C>>P, Si
98	5.0 x 4.0	Al>O, Si>C, K
99	0.4 x 0.35	Al>O>Si, P>Fe
100	13.0 x 12.0	Al>O>Mg>Fe, K, C

Table 2. Data from Sub-sample B

Grain Number	Size (µm)	EDS Chemistry
1	18.0 x 7.0	Al>O>Si>Mg, C
2	2.8 x 2.2	Al>O, Si>C
3	1.1 x 0.6	Al>O, Si>C
4	2.8 x 2.2	Al>O>Si, C>Fe
5	1.8 x 1.4	Al>O, Si>C
6	2.6 x 1.0	Al>O, Si>C
7	1.9 x 1.2	Al>O, Si>C, Na
8	0.9 x 0.7	Al>O>Si, C
9	0.8 x 0.5	Al>O>Si, C
10	1.3 x 0.9	Al>O>Si, Na, C
11	4.4 x 3.6	Al, Si>O, C
12	1.7 x 1.6	Al>O>Si>C
13	0.9 x 0.6	Al>O>Si, C
14	0.9 x 0.65	Al>O>Si, C
15	2.9 x 2.7	Al>O, Si>C
16	1.4 x 1.4	Al>O>C, P
17	0.65 x 0.4	Al>O>Si, C>Si, P
18	0.7 x 0.25	Al>O>C
19	10.0 x 5.0	Si>Al>O>C
20	3.4 x 2.9	Al>O>Si>C
21	1.0 x 0.75	Al>O>Si>C
22	1.3 x 1.2	Al>O>Ca, Mg, C>Si, Fe, P
23	1.7 x 1.25	Al>O>Si, C
24	9.5 x 3.0	Al>O>Si, C
25	0.9 x 0.85	Al>O>Si, C, Ca, P
26	0.75 x 0.65	Al>O>Si, C
27	0.6 x 0.2	Al>O>C
28	0.75 x 0.6	Al>O>Si, C
29	8.0 x 7.0	Al>Si, O>C, K, Fe

30	0.8 x 0.5	Al>O>Si>C
31	4.5 x 3.5	Al>O>Si>K, C, Mg
32	1.2 x 0.7	Al>O>Si>C
33	15.0 x 11.0	Al, Si>O>K, C>Fe
34	2.8 x 2.0	Al>Si, O>C, Na
35	0.9 x 0.8	Al>O>Si>C
36	0.5 x 0.45	Al>O>>C
37	5.5 x 3.5	Al>Si, O>C>Fe, K
38	2.1 x 1.1	Si, Al, O>C, K, Fe
39	33.0 x 21.0	Si>Al, O>Ca, C>K, Fe
40	9.0 x 6.0	Ca>O>Al, C Si>K, Mg
41	7.0 x 4.0	Al>O, Ca>Si, C
42	1.5 x 0.9	Al>O, Si>C
43	0.4 x 0.2	Al>O>>C
44	0.7 x 0.45	Al>O>Si>C
45	4.0 x 2.5	Al>O, Si>C
46	0.85 x 0.45	Al>O>>Si, C
47	3.6 x 0.4	Al>O>Si, C
48	8.0 x 6.0	Al, Si>O>K> C, Fe
49	5.0 x 3.0	Si>O, Al>C>Na
50	0.5 x 0.45	Al>O>Si, C

Table 3. Data from Sub-sample C

Grain Number	Size (µm)	EDS Chemistry
1	7.0 x 6.5	Al, Si, O>K, C, Mg
2	3.7 x 1.1	Al>O, Si>C
3	1.5 x 1.2	Al>O>Si>C, P
4	1.0 x 1.0	Al>O>Si>C, Na, Ca
5	2.3 x 1.7	Al>O>Si>C, P
6	5.15 x 5.1	Ca>Al, O>C, Si>K
7	3.0 x 1.5	Al>O>>C
8	1.1 x 0.9	Al>O, Si>C
9	9.0 x 5.0	Si>Al, O>C, Na
10	30.0 x 27.0	Si>O>Al>C, K
11	2.0 x 1.8	Al>O, Si>C
12	3.3 x 2.0	Al>O>C, Si
13	1.3 x 0.7	Al>O>Si>C
14	3.4 x 1.8	Al>Si, O>C
15	3.0 x 2.0	Al>O>>C
16	3.0 x 1.6	Al>O>C, P
17	2.8 x 2.2	Al>O>C, Si, Ca>P
18	3.4 x 2.6	Al>O>C, Si, P
19	12.0 x 7.0	Al>Si, O>K>C
20	8.0 x 5.0	Al>O, SI>K, C

21	3.4 x 3.0	Al>O, Si>K, C>P
22	2.3 x 1.6	Al>O, Si>C
23	21.0 x 14.0	Si>O, Al>Ca, Mg>C, Fe< K
24	1.8 x 1.7	Al>O, Si>C,K, P
25	8.0 x 3.5	Al>O, Si>Mg, K, Fe>C>Ti
26	1.6 x 1.0	Al>O>Si>C, K
27	4.8 x 2.8	Si>O, Al>C
28	8.0 x 7.0	Si>O, Al>C
29	0.7 x 0.6	Al>O>C, Na, Si
30	6.0 x 5.0	Si>O, Al>C
31	20.0 x 12.0	Si, O>Mg, Al>C, Fe>Na>K, Ca
32	7.0 x 5.0	Si>O>Al>C
33	3.6 x 3.3	Al>O>Si>Na, C
34	1.0 x 0.8	Al>O>C, P, Si
35	0.7 x 0.7	Al>O>C>P
36	3.1 x 1.6	Al>O>Si>C, P
37	0.5 x 0.25	Al>O>C, Si, P
38	1.4 x 0.5	Al>O>>Si, C
39	4.0 x 3.0	Al>O>Si, C
40	13.0 x 8.0	Si>O, Al>Mg, C
41	7.5 x 6.5	Al>O>Si, P, C
42	1.5 x 1.0	Al>O>Si>C
43	3.2 x 2.2	Al>O>C>Si>K
44	1.3 x 0.8	Al>O>Si, Mg>C
45	8.0 x 4.5	Si>Al, O>C
46	6.0 x 4.5	Al>Si>O>C
47	0.7 x 0.45	Al>O>C, P
48	2.3 x 2.0	Al>O, Si>C, P>K
49	0.5 x 0.25	Al>O>C, Si
50	46.0 x 22.0	Si, Al>O>Mg, Fe>K, Ca, C