

# **Preparation of Nonasbestiform Amphibole Minerals for Method Evaluation and Health Studies**

## **Summary Report**

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## Abstract

Procedures for crushing and grinding raw amphibole minerals have been developed by RTI International (RTI) for the Centers for Disease Control (CDC/NIOSH). Procedures have also been developed for preparing filters loaded with the fibrous amphibole minerals for characterization by phase contrast microscopy (PCM) and transmission electron microscopy (TEM). A goal of this project was to produce minerals similar in size to those found in the workplace where these minerals are processed. A total of six amphibole minerals have been processed and characterized using these procedures. The results of the characterization of samples of nonasbestiform actinolite, cummingtonite, riebeckite, grunerite, anthophyllite, and a nonasbestiform NIEHS tremolite are presented, with summaries of fiber length, width, and aspect ratio (length:width) as determined by PCM and TEM. Three hundred fibers were counted by PCM and by TEM for the characterization. Most of the fibers produced using these procedures met the target values for fiber length ( $> 5 \mu\text{m}$ ), width ( $< 3 \mu\text{m}$ ), and aspect ratio ( $\geq 3:1$ ). XRD analysis proved to be important for confirming the identity of each amphibole material prior to processing. A second goal of collecting the fiber residue from filtration onto mixed cellulose ester (MCE) filters to provide 2 Kg of material for future studies proved impractical since less than 0.3 grams of material was obtained in the most productive process run. This yield would require about 7,250 filtrations to collect the 2 Kg total.

## Disclaimer

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### Acronyms, Abbreviations, and Symbols

PCM	-	phase contrast microscopy
PCME	-	phase contrast microscopy equivalent
PLM	-	polarized light microscopy
TEM	-	transmission electron microscopy
XRD	-	x-ray diffraction
MCE	-	mixed cellulose ester
L	-	liter
mL	-	milliliter
Kg	-	kilogram
$\mu\text{m}$	-	micrometer



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## 1. Introduction and Background

The Centers for Disease Control and Prevention/National Institute for Occupational Safety and Health (CDC/NIOSH) contracted with RTI International (RTI) to develop a source of well characterized fibrous asbestiform and nonasbestiform amphiboles for use in assessing analytical methods and studying the health effects from exposure to these minerals. Samples of raw amphibole ores, including asbestiform and nonasbestiform materials, were collected and supplied to RTI by CDC/NIOSH.

This initial study addresses only the preparation and characterization of the nonasbestiform varieties of these amphiboles. CDC/NIOSH requested that a procedure developed to process these raw minerals into respirable fiber size ranges similar to those encountered in workplace atmospheres. Fibers monitored in workplace atmospheres are by protocol greater than 5  $\mu\text{m}$  in length and have an aspect ratio (length to width) of 3:1 or greater. CDC/NIOSH requested that most of the fibers generated be less than 3.0  $\mu\text{m}$  in diameter. CDC/NIOSH also asked that procedures for producing up to 2 Kg of each amphibole material be developed for use in further studies.

## 2. Minerals Preparation

### A. Preparation of massive amphibole minerals

Eleven samples of nonasbestiform amphibole were received from CDC/NIOSH in this initial phase of the work. The samples were identified by CDC/NIOSH as follows. The weights of the materials as received by RTI are also noted.

Actinolite (Near Wrightwood, CA) weight 99.451 grams  
Anthophyllite (Winchester, CA) weight 252.021 grams  
Cumingtonite with biotite (Homestake Mine, SD) weight 76.354 grams  
Grunerite with magnetite (Michigamme, MI) weight 144.655 grams  
Tremolite (Near Baker, CA) weight 108.718 grams  
Riebeckite (Colorado Springs, CO) weight 12.0 grams  
Grunerite (Portugal) weight 146.45 grams  
Anthophyllite, Phlogopite mica and garnets (Brazil) weight 171.763 grams  
Anthophyllite (Sweden) weight 23.0 grams  
Actinolite (Chester, VA) weight 63.41 grams  
Tremolite (Balmat, NY) weight 156.86 grams

CDC/NIOSH requested these specimens be processed to produce fibers that predominantly have diameters in the respirable size range (for fibers of silicate composition this relates to less than 3.0  $\mu\text{m}$  width). In addition, a length greater than 5

$\mu\text{m}$  and a 3:1 aspect ratio (length to width) was used to define "fiber." These dimensions are currently used in NIOSH Method 7400, "Asbestos and Other Fibers by PCM," "A" counting rules, to define "respirable fibers" in workplace atmospheres as measured by phase contrast microscopy (PCM)

Each mineral specimen was processed following Appendix 1, "Procedure for Preparation of Massive Amphibole Samples for NIOSH Amphibole Cleavage Fragment Study." Each massive mineral specimen was crushed to centimeter-sized fragments using a hydraulic press fabricated by RTI. The mineral fragments and dust were collected and stored in labeled Petri dishes. The crushed material was then sieved progressively through 1 mm (No. 18), 364  $\mu\text{m}$  (No. 45), and 250  $\mu\text{m}$  (No. 60) sieve pans. The collected fines were then ground by hand in a clean mortar and pestle using minimal hand pressure for 1 minute intervals. After each minute interval a glass slide mount was prepared with the mineral and a 1.550 refractive index liquid to provide maximum contrast. The slide was then inspected by polarized light microscopy (PLM) to observe the range of particle sizes present. Once mineral fragments measuring a minimum of 5 microns long and a maximum of 3 microns wide were observed (but also including a smaller fraction of larger and equant particles), the grinding was stopped. The resultant material was weighed and reserved for suspension, filtration, and eventual characterization by PCM and TEM.

### **B. Preparation of filters for sample characterization**

The massive materials processed as described above were prepared for characterization following Appendix 2: "Procedure for Preparation of Filters for Characterization of Amphibole Samples by PCM and TEM for NIOSH Amphibole Cleavage Fragment Study." A measured weight of the processed material was suspended in 100 mL of deionized water and 100 ml of isopropyl alcohol. This suspension was sonicated for 15 minutes using a sonic dismembrator. The resulting suspension was transferred to a 2 L graduated cylinder and two drops of Liquinox<sup>®</sup> detergent/surfactant were added. The suspension was diluted to a volume of 2 L and stirred with a magnetic stir bar for 5 minutes. The stirring was stopped, and a timer was started. A 0.5 - 1 mL aliquot was withdrawn from the 1200 mL level of the cylinder at settling time increments of 5 minutes, 10 minutes, 30 minutes, and 1 hour. Each aliquot was immediately pipetted onto a 25 mm diameter 0.45  $\mu\text{m}$  pore size mixed cellulose ester (MCE) filter. Portions of the filter were prepared for analysis by PCM using NIOSH 7400 and for analysis by TEM using NIOSH 7402<sup>2</sup>, "Asbestos by TEM."

## **3. Mineral Characterization**

### **A. XRD Analyses**

Each massive material was analyzed by XRD using RTI SOP 0801-001, "X-Ray Diffraction (XRD) Analysis of Bulk Materials." XRD diffractograms and peak analysis

data were reported for each material chosen for processing and characterization. Only XRD diffractograms are presented for the other minerals that were not used for study.

#### **B. PLM Analyses**

Following the crushing, sieving, and grinding, the mineral particles were assessed by PLM using "Method for the Determination of Asbestos in Bulk Building Materials" (EPA/600/R-93-116)<sup>3</sup> to indicate when the desired fiber dimensions had been achieved.

#### **C. PCM Analyses**

A portion of each filter was prepared for analysis by PCM at 400x using microscope calibration procedures described in NIOSH 7400. A calibrated visual estimate of the length and diameter was performed on 300 particles using a standard Walton-Beckett graticule for reference. Measurement of an additional 100 particles was performed with the Walton-Beckett graticule scale.

For the measurements to characterize the material, each filter was analyzed by two analysts following the NIOSH 7400 counting protocol.

#### **D. TEM Analyses**

A portion of each filter was analyzed by TEM using NIOSH 7402 and a magnification of 10,000x. The length and width of each fiber were measured using a calibrated image displayed on the microscope screen. A total of 300 particles were sized by TEM and a subset of phase contrast microscopy equivalent (PCME) fibers meeting the 7400 criteria was extracted from the total fiber count. Each of the amphibole minerals was analyzed by energy dispersive spectroscopy (EDS).

### **4. Results and Discussion**

Some preliminary work was done to determine if procedures used by RTI in processing mineral samples were appropriate for the minerals provided by CDC/NIOSH. The actinolite specimen was the first mineral chosen for processing because it appeared the most fibrous and homogenous. The actinolite specimen readily produced fibers with the desired dimensions. The tremolite specimen was the second sample to be processed but it did not produce fibers as readily as the actinolite. The tremolite sample was then analyzed by XRD and diffractograms suggested the material was more consistent with the mineral "inesite" than tremolite. The sample was removed from further study and replaced with a sample of tremolite prepared by the U. S. Bureau of Mines<sup>4</sup> for the National Institute of Environmental Health Sciences (NIEHS) for use in oral ingestion studies. The NIEHS tremolite was available from the RTI asbestos repository. Based on these findings, it was decided that each mineral selected for this study would be subjected to XRD analysis prior to any processing in order to confirm its identity.

Following the problem with the initial tremolite provided by CDC/NIOSH, the eleven minerals listed in Section 2.a. were first examined by XRD to verify their identities. The XRD diffractograms for each material are shown in Figures 1 – 11. A spectrum for the NIEHS tremolite selected for the study is shown in Figure 12. Some of the mineral samples showed a poor match in the XRD diffractograms for the labeled amphibole and some had other mineral inclusions which made them questionable candidates for this study. Based on the XRD match for the mineral and other observations as to the suitability of the material, the following five samples were selected for processing and characterization by PCM and TEM:

- Actinolite -- (Near Wrightwood, CA)
- Cummingtonite with biotite (Homestake Mine, SD)
- Riebeckite (Colorado Springs, CO)
- Grunerite (Portugal)
- Anthophyllite (Sweden)

Photographs of four of these five minerals are shown in Figures 13 – 16. No photograph is available for the cummingtonite sample. Peak ID and Peak Search Reports for each of the six amphiboles are given in Tables 1 – 12.

The XRD data were examined to determine if the 100% (highest intensity) peak for each of the amphiboles corresponded to the peak representing the (110) crystallographic plane of the mineral as reported in the literature. If the amphibole occurs as cleavage fragments, the beam of the XRD will preferentially interact with the (110) planes of the mineral. This occurs because the amphiboles cleave perfectly with the (110) planes due to the double tetrahedral chain which is parallel to the c-axis of the mineral, and, due to the presence of large cations (Ca, Na, Fe) in the octahedral sites of the structure. The beam intersects with the (110) plane because of the preferred orientation of the cleavage fragments. The (110) peak of the diffractograms corresponds to the 100% peak for each of the monoclinic amphiboles analyzed (actinolite, cummingtonite, riebeckite, grunerite, and tremolite).

The diffractogram obtained from the Swedish anthophyllite sample did not exhibit peaks resulting from (110) reflections. This discrepancy from the patterns obtained from the other amphiboles is due to anthophyllite having an orthorhombic crystal structure caused by its chemistry, i.e., the presence of relatively small cations (Fe, Mg) in the octahedral sites. Anthophyllite exhibits perfect (210) cleavage due to its crystal structure<sup>5,6</sup>. The (210) peak from the Swedish anthophyllite has a reported height% of 21.7% on the diffractogram. This relatively low peak height may be caused by the presence of other mineral phases in the sample with d-spacings close to the 8.2189 Å d-spacing corresponding to the (210) peak of the anthophyllite phase, notably the 100% peak of willemsite with a d-spacing of 9.3790 Å.

The amphibole minerals supplied by CDC/NIOSH were crushed using an RTI-fabricated hydraulic press shown in Figure 17. The massive minerals were crushed, sieved, and ground following the procedure in Appendix 1. Stereomicroscope photographs of the crushed minerals at 3.5x magnification are shown in Figures 18 – 22. The NIEHS

nonasbestiform tremolite sample which did not require crushing is shown in Figure 23. Each crushed material was sieved and ground by hand using a mortar and pestle to produce a fine powder. Multiple samples of each material were taken during the processing and examined by PLM to determine the size of the particles being produced. Photographs of the PLM preparations are shown in Figures 24 – 29. The NIEHS tremolite sample was used as provided with no further processing. The fine powder from each sample was then used to make filter preparations to allow characterization of the samples by PCM and TEM following the procedure in Appendix 2. No further treatment was made to the remaining crushed material but it is plausible to assume additional fine materials could be obtained by further crushing and sieving.

Each filter was analyzed by PCM and TEM. Selected photographs of PCM images for each of the minerals are shown in Figures 30 – 35. Selected photographs of TEM images at two magnifications for each of the minerals are shown in Figures 36 – 47 and EDS spectra for each mineral are shown in Figures 48 – 53. Data sets for each of the six minerals are found in Appendix 3. Filters were also counted by two analysts following the NIOSH 7400 protocol. Data for these counts are found in Appendix 4.

The general format for the data sets in Appendix 3 is outlined below:

**Note:** *The generic term “Amphibole” is used for this illustrative listing. Each data set in the appendix notes the data for a specific amphibole.*

Table A: “Amphibole” Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400x Magnification)

Table A1: Summary Statistics for “Amphibole” Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400x Magnification)

Table A2. Aspect Ratios for “Amphibole” Particles: Calibrated Visual Estimation of Dimensions by PCM (400x Magnification)

Table A3. Lengths for “Amphibole” Particles: Calibrated Visual Estimation of Dimensions by PCM (400x Magnification)

Table A4. Widths for “Amphibole” Particles: Calibrated Visual Estimation of Dimensions by PCM (400x Magnification)

Table B. “Amphibole” Particle Size Data: Dimensions Measured by TEM PCME (10,000x Magnification)

Table B1: Summary Statistics for “Amphibole” Particle Size Data: TEM PCME (10,000x Magnification)

Table B2. Aspect Ratios for 300 “Amphibole” Particles: TEM PCME (10,000x Magnification)

Table B3. Lengths for 300 “Amphibole” Particles: TEM PCME (10,000x Magnification)

Table B4. Widths for 300 “Amphibole” Particles: TEM PCME (10,000x Magnification)

Table B5. Widths for 300 "Amphibole" Particles: TEM PCME (10,000x Magnification) Finer Detail

Table C. Particle Size Data for "Amphibole" Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400x Magnification)

Table C1. Summary Statistics: Particle Size Data for "Amphibole" Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400x Magnification)

Table C2. Aspect Ratios for "Amphibole" Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400x Magnification)

Table C3. Lengths for "Amphibole" Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400x Magnification)

Table C4. Widths for "Amphibole" Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400x Magnification)

The data in the above tables are presented as histograms with cumulative frequency plots generated with Microsoft Excel<sup>®</sup> in the following figures:

Figure 1. Frequency Distribution of Aspect Ratios for 300 "Amphibole" Particles: Calibrated Visual Estimation of Dimensions by PCM (400x Magnification)

Figure 2. Frequency Distribution of Lengths for 300 "Amphibole" Particles: Calibrated Visual Estimation of Dimensions by PCM (400x Magnification)

Figure 3. Frequency Distribution of Widths for 300 "Amphibole" Particles: Calibrated Visual Estimation of Dimensions by PCM (400x Magnification)

Figure 4. Frequency Distribution of Aspect Ratios for 300 "Amphibole" Particles: Dimensions Measured by TEM PCME (10,000x Magnification)

Figure 5. Frequency Distribution of Lengths for 300 "Amphibole" Particles: Dimensions Measured by TEM PCME (10,000x Magnification)

Figure 6. Frequency Distribution of Widths for 300 "Amphibole" Particles: Dimensions Measured by TEM PCME (10,000x Magnification)

Figure 7. Frequency Distribution of Widths for 300 "Amphibole" Particles: Dimensions Measured by TEM PCME (10,000x Magnification) Finer Detail

Figure 8. Frequency Distribution of Aspect Ratios for "Amphibole" Particles: Comparison of TEM PCME and PCM Data

Figure 9. Frequency Distribution of Lengths for "Amphibole" Particles: Comparison of TEM PCME and PCM Data

Figure 10. Frequency Distribution of Widths for "Amphibole" Particles: Comparison of TEM PCME and PCM Data

Figure 11. Frequency Distribution of Aspect Ratios for "Amphibole" Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400x Magnification)

Figure 12. Frequency Distribution of Lengths for "Amphibole" Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400x Magnification)

Figure 13. Frequency Distribution of Widths for "Amphibole" Particles:  
Dimensions Measured by PCM using Walton-Beckett Graticule (400x Magnification)

Figure 14. Frequency Distribution of Aspect Ratios for "Amphibole" Particles:  
Comparison of Dimensions from PCM Measured by Calibrated Visual Estimation and Walton-Beckett Graticule

Figure 15. Frequency Distribution of Lengths for "Amphibole" Particles:  
Comparison of Dimensions from PCM Measured by Calibrated Visual Estimation and Walton-Beckett Graticule

Figure 16. Frequency Distribution of Widths for "Amphibole" Particles:  
Comparison of Dimensions from PCM Measured by Calibrated Visual Estimation and Walton-Beckett Graticule

A primary goal of this research was to develop a procedure for producing fibers similar to airborne fibers found in the work place where massive amphibole minerals are mined or processed. Summary histograms taken from the data in Appendix 3 showing fiber length, width, and aspect ratio for each material as measured by PCM are found in Figures 54 - 59. A cumulative frequency line is shown on each histogram, indicating the percentage of fibers that met the CDC/NIOSH criteria. The approximate percentages are of fibers meeting the CDC/NIOSH target values for aspect ratio, length, and width is shown in Table 13. Cumulative frequency data for each amphibole are taken from Tables A2 - A4 for PCM and Tables B2 - B4 for TEM PCME in Appendix 3.

These data suggest the proposed procedures for processing the amphibole minerals meet the CDC/NIOSH requirements for aspect ratio, length, and width as measured by PCM and by TEM - PCME. There are some notable differences in the percentages in each of the above categories. These differences are possibly due to differences in resolution of fibers in the PCM measurement at a magnification of 400x and the PCME measurement by TEM at a magnification of 10,000x. The differences may also be due in part to the fact that all elongated fibrous particles were counted by TEM and the population of PCME fibers was extracted from this data set. The histogram in Figure 9 (Appendix 3) for the anthophyllite show that many fibers with lengths less than 5  $\mu\text{m}$  were counted by TEM. Other differences in this comparative data may be similarly explained.

For the PCM analysis, three hundred fibers were sized by visual estimation and 100 fibers were measured using the Walton-Beckett graticule. Figures 14, 15, and 16 (Appendix 3) in all data sets suggest that the measurements are equivalent with the exception that the height of the peaks are lower for the Walton-Beckett data due to the difference in the number of fibers counted.

Each analyst analyzed three of the six filters prepared for PCM analysis. Analyst 1 analyzed filters 1, 2, and 3, and Analyst 2 analyzed filters 4, 5, and 6 prepared from suspensions of each amphibole mineral. Data for these counts are given in Appendix 4 and the data are summarized in Table 14.



Although no statistical analysis of these data was made, the counts appear to be well within the variability expected when comparing NIOSH 7400 PCM results of two analysts.

A secondary goal of this research was to develop a means of producing 2 Kg of the characterized fibers of each material for use in future studies. Steps 9 – 13 of the procedure in Appendix 2 for preparing the filters for characterization by PCM and TEM could also be used to collect and harvest fibers on an MCE filter. Following this procedure, fibers were collected on a 5.0  $\mu\text{m}$  pore size MCE filter, dried, and weighed. A 5.0  $\mu\text{m}$  filter was chosen for the filtration rather than a 0.45  $\mu\text{m}$  pore size MCE filter because the suspension rapidly “clogs” when filtered through the 0.45  $\mu\text{m}$  pore size. The 5.0  $\mu\text{m}$  filter also eventually clogged but allowed filtration of significantly more material. Table 15 shows the amounts of fibers harvested from each suspension following these procedures.

The actinolite produced 0.276 grams of material from the suspension of 1.983 grams of processed material, for a recovery of 13.9%. At this rate of recovery, about 7,250 filtrations would be required to collect the 2 Kg of actinolite material requested by CDC/NIOSH. Similar efforts would be required for the other amphibole minerals. A more practical means of collecting the 2 Kg of each amphibole needs to be investigated. The use of a cyclone separator to separate the “fine” fraction of the crushed-sieved material may be more practical. However, the fiber sizes produced by a cyclonic separation are likely to be different from the sizes separated by the aqueous suspension techniques used in this study. Additional characterization of the fibers will be required to assure the fiber sizes generated by an alternate technique meet the CDC/NIOSH target values.

## **5. Summary and Conclusions**

Procedures for processing nonasbestiform amphiboles in the laboratory to produce fibers similar to those found in the workplace have been developed and tested. Target values for workplace fibers are length  $> 5 \mu\text{m}$ , width  $< 3 \mu\text{m}$ , and aspect ratios  $\geq 3:1$ . CDC/NIOSH provided eleven amphibole minerals for testing. Samples of actinolite, cummingtonite, riebeckite, grunerite, and anthophyllite were chosen for processing. An NIEHS nonasbestiform tremolite sample was supplied by RTI because the CDC/NIOSH specimen was determined to be unsuitable. The procedures include crushing massive mineral samples using a hydraulic press, sieving crushed minerals to harvest fine fractions, and hand-grinding using a mortar and pestle to obtain the desired size fibers. The fine minerals are assessed by PLM to determine a stopping point for the grinding process. Fine minerals are then suspended in an aqueous mixture and stirred. The stirring process is stopped and aliquots are withdrawn at prescribed intervals and used to prepare filters for analysis by PCM.

The filters are analyzed using NIOSH 7400 and the aliquot taken from a given sampling time that gives optimum loading and fiber size is chosen. Additional preparations are made using these conditions and filters are prepared for analysis by PCM and TEM. Three hundred particles were measured by PCM and by TEM-PCME for each of six amphibole minerals. Data from the PCM analyses suggest that the protocol is capable of producing fibers where 77 – 97% of the lengths are  $> 5 \mu\text{m}$ , 61 – 83% of the widths are  $< 3 \mu\text{m}$ , and 71 – 94% of the aspect ratios are  $\geq 3:1$ .

An attempt was made to harvest fibers from the filter preparations for use in further studies. A goal was to produce 2 Kg of material for each amphibole. The most productive harvest of fibers gave only 13.9% recovery. At this rate, nearly 7,250 filtrations would be needed to produce the 2 Kg. An alternate means of collecting the minerals needs investigation.

It was found by XRD analysis that several of the mineral samples were not the mineral represented by the supplier to CDC/NIOSH. It is recommended that each material to be used should be verified by XRD analysis before any processing.

## References

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# Tables

Table 1. XRD Matching Phases Report - Actinolite

Peak ID Extended Report (43 Peaks, Max P/N = 125.1)  
 [NIOSHACTN.RAW] NIOSH Actinolite  
 PEAK: 99-pts/Parabolic Filter, Threshold=3.0, Cutoff=0.1%, BG=3/1.0, Peak-Top=Summit

2-Theta d(Å)	Height	Height%	Phase ID	d(Å)	I%	(h k l)	2-Theta Delta
6.240	14.1516	2854	4.5				
8.721	10.1309	3137	5.0				
9.783	9.0340	2380	3.8	Actinolite	9.0400	20.0	(0 2 0) 9.776 -0.006
10.521	8.4017	63164	100.0	Actinolite	8.4200	75.0	(-1 1 0) 10.498 -0.023
12.479	7.0872	10933	17.3				
17.419	5.0869	1770	2.8	Actinolite	5.1020	14.0	(0 0 1) 17.367 -0.052
18.163	4.8803	609	1.0	Actinolite	4.8820	16.0	(-1 1 1) 18.156 -0.006
18.703	4.7404	4619	7.3	Tremolite	4.7375	7.0	(2 0 0) 18.715 0.012
19.642	4.5161	2909	4.6	Actinolite	4.5200	20.0	(0 4 0) 19.624 -0.017
21.118	4.2035	11668	18.5	Actinolite	4.2100	16.0	(-2 2 0) 21.085 -0.033
22.920	3.8770	656	1.0	Actinolite	3.8800	16.0	(-1 3 1) 22.902 -0.018
25.101	3.5448	8402	13.3				
26.340	3.3809	3552	5.6	Actinolite	3.3850	30.0	(0 4 1) 26.307 -0.033
27.220	3.2735	9442	14.9	Actinolite	3.2760	45.0	(-2 4 0) 27.199 -0.022
28.580	3.1207	49052	77.7	Tremolite	3.1189	69.0	(3 1 0) 28.597 0.017
30.378	2.9400	2477	3.9	Actinolite	2.9420	35.0	(2 2 1) 30.357 -0.021
31.885	2.8044	13100	20.7	Actinolite	2.8060	16.0	(-3 3 0) 31.866 -0.018
32.782	2.7297	1675	2.7	Actinolite	2.7300	16.0	(-3 3 1) 32.778 -0.003
33.060	2.7074	4084	6.5	Actinolite	2.7090	55.0	(1 5 1) 33.040 -0.020
34.560	2.5932	1494	2.4	Actinolite	2.5950	18.0	(0 6 1) 34.536 -0.024
35.402	2.5335	1717	2.7	Actinolite	2.5340	25.0	(-2 0 2) 35.394 -0.008
37.279	2.4101	307	0.5	Actinolite	2.4110	3.0	(-2 6 1) 37.264 -0.015
38.519	2.3353	2019	3.2	Actinolite	2.3370	20.0	(-3 5 1) 38.490 -0.029
38.801	2.3190	1438	2.3	Actinolite	2.3200	12.0	(-4 2 1) 38.783 -0.018
39.159	2.2986	827	1.3	Actinolite	2.3000	9.0	(-4 2 0) 39.134 -0.025
39.619	2.2730	589	0.9	Actinolite	2.2750	9.0	(-3 1 2) 39.582 -0.037
40.805	2.2096	169	0.3	Actinolite	2.2090	5.0	(-2 4 2) 40.817 0.012
41.339	2.1823	333	0.5	Actinolite	2.1840	5.0	(1 7 1) 41.305 -0.034
41.721	2.1632	2249	3.6	Actinolite	2.1630	18.0	(2 6 1) 41.725 0.004
44.276	2.0441	506	0.8	Actinolite	2.0460	8.0	(2 0 2) 44.233 -0.043
44.882	2.0179	2031	3.2	Actinolite	2.0180	12.0	(3 5 1) 44.880 -0.002
45.022	2.0120	2396	3.8	Tremolite	2.0128	15.0	(4 0 2) 45.003 -0.019
45.281	2.0010	1604	2.5	Actinolite	2.0010	6.0	(-3 7 0) 45.282 0.001
48.114	1.8896	3421	5.4	Tremolite	1.8887	8.0	(5 1 0) 48.140 0.026
48.780	1.8654	706	1.1	Actinolite	1.8660	7.0	(-1 9 1) 48.762 -0.018
50.298	1.8126	2690	4.3	Actinolite	1.8140	6.0	(-5 3 0) 50.256 -0.042
52.438	1.7435	305	0.5	Actinolite	1.7440	2.0	(-5 1 2) 52.423 -0.015
54.459	1.6835	441	0.7	Actinolite	1.6830	5.0	(-5 3 2) 54.477 0.017
55.660	1.6500	2594	4.1	Actinolite	1.6500	12.0	(-2,10,1)55.659 -0.001
56.142	1.6370	1335	2.1	Actinolite	1.6365	7.0	(-6 0 1) 56.159 0.017
56.878	1.6175	1299	2.1	Actinolite	1.6182	7.0	(-1,11,0)56.852 -0.026
58.196	1.5840	2049	3.2	Tremolite	1.5841	4.0	(6 0 0) 58.190 -0.006
58.359	1.5799	1232	2.0	Actinolite	1.5795	8.0	(-1 5 3) 58.377 0.018

Table 2. XRD Peak Search Report - Actinolite

Peak ID Extended Report (43 Peaks, Max P/N = 125.1)  
 [NIOSHA CTN.RAW] NIOSH Actinolite

PEAK: 99-pts/Parabolic Filter, Threshold=3.0, Cutoff=0.1%, BG=3/1.0, Peak-Top=Summit

2-Theta	d(Å)	Height	Height%	Phase ID	d(Å)	I%	(h k l)	2-Theta	Delta
6.240	14.1516	2854	4.5						
8.721	10.1309	3137	5.0						
9.783	9.0340	2380	3.8	Actinolite	9.0400	20.0	(0 2 0)	9.776	-0.006
10.521	8.4017	63164	100.0	Actinolite	8.4200	75.0	(-1 1 0)	10.498	-0.023
12.479	7.0872	10933	17.3						
17.419	5.0869	1770	2.8	Actinolite	5.1020	14.0	(0 0 1)	17.367	-0.052
18.163	4.8803	609	1.0	Actinolite	4.8820	16.0	(-1 1 1)	18.156	-0.006
18.703	4.7404	4619	7.3	Tremolite	4.7375	7.0	(2 0 0)	18.715	0.012
19.642	4.5161	2909	4.6	Actinolite	4.5200	20.0	(0 4 0)	19.624	-0.017
21.118	4.2035	11668	18.5	Actinolite	4.2100	16.0	(-2 2 0)	21.085	-0.033
22.920	3.8770	656	1.0	Actinolite	3.8800	16.0	(-1 3 1)	22.902	-0.018
25.101	3.5448	8402	13.3						
26.340	3.3809	3552	5.6	Actinolite	3.3850	30.0	(0 4 1)	26.307	-0.033
27.220	3.2735	9442	14.9	Actinolite	3.2760	45.0	(-2 4 0)	27.199	-0.022
28.580	3.1207	49052	77.7	Tremolite	3.1189	69.0	(3 1 0)	28.597	0.017
30.378	2.9400	2477	3.9	Actinolite	2.9420	35.0	(2 2 1)	30.357	-0.021
31.885	2.8044	13100	20.7	Actinolite	2.8060	16.0	(-3 3 0)	31.866	-0.018
32.782	2.7297	1675	2.7	Actinolite	2.7300	16.0	(-3 3 1)	32.778	-0.003
33.060	2.7074	4084	6.5	Actinolite	2.7090	55.0	(1 5 1)	33.040	-0.020
34.560	2.5932	1494	2.4	Actinolite	2.5950	18.0	(0 6 1)	34.536	-0.024
35.402	2.5335	1717	2.7	Actinolite	2.5340	25.0	(-2 0 2)	35.394	-0.008
37.279	2.4101	307	0.5	Actinolite	2.4110	3.0	(-2 6 1)	37.264	-0.015
38.519	2.3353	2019	3.2	Actinolite	2.3370	20.0	(-3 5 1)	38.490	-0.029
38.801	2.3190	1438	2.3	Actinolite	2.3200	12.0	(-4 2 1)	38.783	-0.018
39.159	2.2986	827	1.3	Actinolite	2.3000	9.0	(-4 2 0)	39.134	-0.025
39.619	2.2730	589	0.9	Actinolite	2.2750	9.0	(-3 1 2)	39.582	-0.037
40.805	2.2096	169	0.3	Actinolite	2.2090	5.0	(-2 4 2)	40.817	0.012
41.339	2.1823	333	0.5	Actinolite	2.1840	5.0	(1 7 1)	41.305	-0.034
41.721	2.1632	2249	3.6	Actinolite	2.1630	18.0	(2 6 1)	41.725	0.004
44.276	2.0441	506	0.8	Actinolite	2.0460	8.0	(2 0 2)	44.233	-0.043
44.882	2.0179	2031	3.2	Actinolite	2.0180	12.0	(3 5 1)	44.880	-0.002
45.022	2.0120	2396	3.8	Tremolite	2.0128	15.0	(4 0 2)	45.003	-0.019
45.281	2.0010	1604	2.5	Actinolite	2.0010	6.0	(-3 7 0)	45.282	0.001
48.114	1.8896	3421	5.4	Tremolite	1.8887	8.0	(5 1 0)	48.140	0.026
48.780	1.8654	706	1.1	Actinolite	1.8660	7.0	(-1 9 1)	48.762	-0.018
50.298	1.8126	2690	4.3	Actinolite	1.8140	6.0	(-5 3 0)	50.256	-0.042
52.438	1.7435	305	0.5	Actinolite	1.7440	2.0	(-5 1 2)	52.423	-0.015
54.459	1.6835	441	0.7	Actinolite	1.6830	5.0	(-5 3 2)	54.477	0.017
55.660	1.6500	2594	4.1	Actinolite	1.6500	12.0	(-2,10,1)	55.659	-0.001
56.142	1.6370	1335	2.1	Actinolite	1.6365	7.0	(-6 0 1)	56.159	0.017
56.878	1.6175	1299	2.1	Actinolite	1.6182	7.0	(-1,11,0)	56.852	-0.026
58.196	1.5840	2049	3.2	Tremolite	1.5841	4.0	(6 0 0)	58.190	-0.006
58.359	1.5799	1232	2.0	Actinolite	1.5795	8.0	(-1 5 3)	58.377	0.018

Table 3. XRD Matching Phases Report - Cummingtonite

Peak ID Extended Report (33 Peaks, Max P/N = 90.8)  
 [NIOSHCUMM.RAW] NIOSH Cummingtonite  
 PEAK: 91-pts/Parabolic Filter, Threshold=3.0, Cutoff=0.1%, BG=3/1.0, Peak-Top=Summit

2-Theta d(Å)	Height	Height%	Phase ID	d(Å)	I%	(h k l)	2-Theta Delta
8.741	10.1079	33835	100.0	Biotite-1M	10.1654	100.0	(0 0 1) 8.692 -0.050
9.676	9.1333	1805	5.3	Cummingtonite	9.2149	50.0	(0 2 0) 9.590 -0.086
10.638	8.3095	19928	58.9	Cummingtonite	8.3784	100.0	(1 1 0) 10.550 -0.088
12.519	7.0647	6250	18.5				
17.524	5.0568	1132	3.3	Biotite-1M	5.0383	1.0	(0 0 2) 17.589 0.065
19.001	4.6668	2381	7.0	Biotite-1M	4.6440	3.0	(0 2 0) 19.096 0.094
19.407	4.5702	1195	3.5	Cummingtonite	4.5732	40.0	(0 4 0) 19.394 -0.013
20.858	4.2554	1199	3.5				
21.330	4.1623	2051	6.1	Cummingtonite	4.1592	40.0	(2 2 0) 21.346 0.016
22.941	3.8735	299	0.9	Cummingtonite	3.8867	30.0	(-1 3 1) 22.862 -0.079
25.201	3.5310	4936	14.6				
26.441	3.3681	21995	65.0	Biotite-1M	3.3564	32.0	(0 0 3) 26.536 0.094
27.300	3.2641	4478	13.2	Cummingtonite	3.2717	80.0	(2 4 0) 27.235 -0.065
27.838	3.2022	106	0.3				
29.100	3.0661	19149	56.6	Cummingtonite	3.0703	90.0	(3 1 0) 29.060 -0.041
30.782	2.9024	3279	9.7	Biotite-1M	2.9263	7.0	(1 1 -3) 30.524 -0.258
32.300	2.7693	2527	7.5				
32.379	2.7628	1892	5.6	Cummingtonite	2.7623	70.0	(1 5 1) 32.385 0.006
33.942	2.6390	714	2.1	Biotite-1M	2.6385	22.0	(2 0 0) 33.949 0.006
34.043	2.6314	1123	3.3	Cummingtonite	2.6305	50.0	(0 6 1) 34.056 0.013
35.521	2.5253	3594	10.6	Biotite-1M	2.5118	3.0	(0 0 4) 35.718 0.197
36.710	2.4461	274	0.8	Biotite-1M	2.4424	14.0	(2 0 1) 36.768 0.058
39.201	2.2962	476	1.4	Cummingtonite	2.2986	30.0	(-3 5 1) 39.159 -0.043
40.181	2.2425	140	0.4	Cummingtonite	2.2464	15.0	(-4 2 1) 40.108 -0.073
40.658	2.2172	282	0.8	Cummingtonite	2.2182	15.0	(1 7 1) 40.640 -0.019
41.080	2.1954	1205	3.6	Cummingtonite	2.1951	50.0	(2 6 1) 41.087 0.007
44.840	2.0197	2294	6.8	Biotite-1M	2.0072	7.0	(0 0 5) 45.134 0.294
49.059	1.8554	439	1.3	Cummingtonite	1.8555	10.0	(4 6 0) 49.055 -0.003
54.903	1.6709	462	1.4	Cummingtonite	1.6758	5.0	(-5 5 1) 54.729 -0.173
55.261	1.6610	1193	3.5	Cummingtonite	1.6618	50.0	(4 6 1) 55.232 -0.029
56.361	1.6311	750	2.2	Cummingtonite	1.6337	40.0	(1,11,0) 56.265 -0.096
59.404	1.5546	2115	6.3	Cummingtonite	1.5564	25.0	(6 0 0) 59.330 -0.074
59.980	1.5411	433	1.3	Biotite-1M	1.5433	11.0	(3 3 -1) 59.882 -0.097

Table 4. XRD Peak Search Report - Cummingtonite

Peak Search Report (33 Peaks, Max P/N = 90.8)  
 [NIOSHCUMM.RAW] NIOSH Cummingtonite

PEAK: 91-pts/Parabolic Filter, Threshold=3.0, Cutoff=0.1%, BG=3/1.0, Peak-Top=Summit

2-Theta d(Å)	BG	Height	H%	Area	A%	FWHM XS(Å)		
8.741	10.1079	899	33835	100.0	5636.5	100.0	0.142	795
9.676	9.1333	827	1805	5.3	231.8	4.1	0.103	3396
10.638	8.3095	682	19928	58.9	3102.4	55.0	0.125	1075
12.519	7.0647	520	6250	18.5	1148.2	20.4	0.156	666
17.524	5.0568	362	1132	3.3	260.7	4.6	0.196	478
19.001	4.6668	339	2381	7.0	614.4	10.9	0.219	413
19.407	4.5702	377	1195	3.5	176.8	3.1	0.118	1272
20.858	4.2554	325	1199	3.5	214.1	3.8	0.143	792
21.330	4.1623	303	2051	6.1	1545.1	27.4	0.640	128
22.941	3.8735	309	299	0.9	64.3	1.1	0.172	578
25.201	3.5310	504	4936	14.6	807.3	14.3	0.139	843
26.441	3.3681	723	21995	65.0	5243.6	93.0	0.203	463
27.300	3.2641	626	4478	13.2	648.6	11.5	0.116	1397
27.838	3.2022	430	106	0.3	84.1	1.5	0.674	123
29.100	3.0661	391	19149	56.6	3463.1	61.4	0.154	703
30.782	2.9024	377	3279	9.7	603.3	10.7	0.156	685
32.300	2.7693	325	2527	7.5	755.3	13.4	0.254	354
32.379	2.7628	332	1892	5.6	540.7	9.6	0.229	402
33.942	2.6390	304	714	2.1	360.6	6.4	0.404	212
34.043	2.6314	305	1123	3.3	349.5	6.2	0.265	339
35.521	2.5253	314	3594	10.6	970.2	17.2	0.229	404
36.710	2.4461	290	274	0.8	84.9	1.5	0.263	343
39.201	2.2962	272	476	1.4	189.4	3.4	0.339	261
40.181	2.2425	298	140	0.4	39.7	0.7	0.227	416
40.658	2.2172	278	282	0.8	91.3	1.6	0.259	355
41.080	2.1954	245	1205	3.6	409.6	7.3	0.289	313
44.840	2.0197	258	2294	6.8	696.3	12.4	0.258	361
49.059	1.8554	239	439	1.3	108.4	1.9	0.197	513
54.903	1.6709	236	462	1.4	221.9	3.9	0.408	226
55.261	1.6610	215	1193	3.5	304.3	5.4	0.204	504
56.361	1.6311	208	750	2.2	167.4	3.0	0.190	559
59.404	1.5546	287	2115	6.3	446.6	7.9	0.179	614
59.980	1.5411	331	433	1.3	147.5	2.6	0.272	362



Table 5. XRD Matching Phases Report - Riebeckite

Peak ID Extended Report (36 Peaks, Max P/N = 121.1)  
 [NIOSHRIEB.RAW] NIOSH Riebeckite  
 PEAK: 29-pts/Parabolic Filter, Threshold=3.0, Cutoff=0.1%, BG=3/1.0, Peak-Top=Summit

2-Theta	d(Å)	Height	Height %	Phase ID	d(Å)	I%	(h k l)	2-Theta	Delta
9.839	8.9824	488	0.8	Riebeckite	8.9471	4.0	(0 2 0)	9.878	0.039
10.482	8.4328	59311	100.0	Manganocummingtonite	8.4521	100.0	(1 1 0)	10.458	-0.024
17.461	5.0749	1242	2.1						
18.580	4.7717	1404	2.4	Manganocummingtonite	4.7601	6.0	(2 0 0)	18.625	0.046
19.758	4.4897	4200	7.1	Riebeckite	4.4919	16.0	(0 4 0)	19.748	-0.010
20.839	4.2593	381	0.6	Quartz	4.2550	16.0	(1 0 0)	20.860	0.021
22.979	3.8672	68	0.1	Riebeckite	3.8667	10.0	(-1 3 1)	22.982	0.003
24.293	3.6609	203	0.3	Riebeckite	3.6482	10.0	(-2 2 1)	24.379	0.086
26.157	3.4041	1600	2.7	Manganocummingtonite	3.4051	12.0	(1 3 1)	26.149	-0.008
26.620	3.3459	1465	2.5	Quartz	3.3435	100.0	(1 0 1)	26.640	0.020
27.242	3.2709	2829	4.8	Manganocummingtonite	3.2747	30.0	(2 4 0)	27.210	-0.032
28.480	3.1315	32297	54.5	Manganocummingtonite	3.1343	90.0	(2 0 1)	28.454	-0.026
30.080	2.9685	385	0.6	Riebeckite	2.9683	10.0	(2 2 1)	30.082	0.002
31.840	2.8083	18246	30.8	Manganocummingtonite	2.8084	25.0	(3 3 0)	31.838	-0.002
32.980	2.7138	3870	6.5	Manganocummingtonite	2.7152	25.0	(1 5 1)	32.962	-0.018
34.621	2.5888	1106	1.9	Manganocummingtonite	2.5929	8.0	(0 6 1)	34.564	-0.057
35.360	2.5363	1184	2.0	Riebeckite	2.5354	12.0	(2 6 0)	35.373	0.013
36.555	2.4562	116	0.2	Quartz	2.4569	9.0	(1 1 0)	36.544	-0.011
37.738	2.3818	2324	3.9	Manganocummingtonite	2.3804	4.0	(4 0 0)	37.761	0.023
38.678	2.3260	1132	1.9	Manganocummingtonite	2.3273	6.0	(-3 5 1)	38.657	-0.022
39.323	2.2894	248	0.4	Manganocummingtonite	2.2902	4.0	(-1 7 1)	39.308	-0.015
39.461	2.2817	217	0.4	Quartz	2.2815	8.0	(1 0 2)	39.465	0.003
39.660	2.2707	463	0.8	Manganocummingtonite	2.2672	4.0	(3 3 1)	39.724	0.065
41.620	2.1682	1698	2.9	Manganocummingtonite	2.1700	10.0	(2 6 1)	41.584	-0.036
43.703	2.0696	474	0.8	Riebeckite	2.0754	6.0	(2 0 2)	43.574	-0.129
44.661	2.0273	1000	1.7	Riebeckite	2.0275	8.0	(3 5 1)	44.657	-0.005
47.000	1.9318	1820	3.1						
47.919	1.8968	1125	1.9						
50.124	1.8184	488	0.8	Quartz	1.8180	13.0	(1 1 2)	50.139	0.014
50.800	1.7958	1101	1.9	Quartz	1.8017	1.0	(0 0 3)	50.622	-0.179
55.402	1.6571	1508	2.5	Riebeckite	1.6568	10.0	(4 6 1)	55.412	0.010
56.225	1.6347	1314	2.2	Riebeckite	1.6329	6.0	(4 8 0)	56.295	0.070
57.221	1.6086	1001	1.7	Quartz	1.6083	1.0	(2 1 0)	57.235	0.014
57.980	1.5894	2278	3.8	Riebeckite	1.5910	10.0	(-1 5 3)	57.915	-0.065
59.940	1.5420	99	0.2	Quartz	1.5415	9.0	(2 1 1)	59.960	0.020
61.376	1.5093	612	1.0	Riebeckite	1.5072	4.0	(5 5 1)	61.470	0.094

Table 6. XRD Peak Search Report - Riebeckite

Peak Search Report (36 Peaks, Max P/N = 121.1)  
 [NIOSHRIEB.RAW] NIOSH Riebeckite  
 PEAK: 29-pts/Parabolic Filter, Threshold=3.0, Cutoff=0.1%, BG=3/1.0, Peak-Top=Summit

2-Theta d(Å)	BG	Height	H%	Area	A%	FWHM XS(Å)		
9.839	8.9824	810	488	0.8	152.0	1.7	0.249	349
10.482	8.4328	675	59311	100.0	8742.6	100.0	0.125	1057
17.461	5.0749	364	1242	2.1	198.7	2.3	0.136	871
18.580	4.7717	336	1404	2.4	224.6	2.6	0.136	874
19.758	4.4897	336	4200	7.1	753.4	8.6	0.152	701
20.839	4.2593	331	381	0.6	100.4	1.1	0.211	436
22.979	3.8672	276	68	0.1	14.2	0.2	0.167	604
24.293	3.6609	281	203	0.3	72.3	0.8	0.284	305
26.157	3.4041	366	1600	2.7	311.0	3.6	0.165	620
26.620	3.3459	345	1465	2.5	323.0	3.7	0.176	561
27.242	3.2709	395	2829	4.8	461.5	5.3	0.139	851
28.480	3.1315	317	32297	54.5	6285.9	71.9	0.165	622
30.080	2.9685	263	385	0.6	92.9	1.1	0.205	459
31.840	2.8083	272	18246	30.8	3152.1	36.1	0.147	768
32.980	2.7138	268	3870	6.5	818.2	9.4	0.180	555
34.621	2.5888	274	1106	1.9	254.1	2.9	0.195	496
35.360	2.5363	272	1184	2.0	206.7	2.4	0.148	761
36.555	2.4562	234	116	0.2	37.7	0.4	0.261	347
37.738	2.3818	236	2324	3.9	488.4	5.6	0.179	567
38.678	2.3260	244	1132	1.9	250.9	2.9	0.188	527
39.323	2.2894	242	248	0.4	68.3	0.8	0.220	430
39.461	2.2817	237	217	0.4	75.5	0.9	0.278	325
39.660	2.2707	233	463	0.8	93.2	1.1	0.171	609
41.620	2.1682	218	1698	2.9	358.7	4.1	0.180	570
43.703	2.0696	194	474	0.8	76.2	0.9	0.137	919
44.661	2.0273	200	1000	1.7	185.7	2.1	0.158	703
47.000	1.9318	214	1820	3.1	471.6	5.4	0.220	441
47.919	1.8968	233	1125	1.9	213.0	2.4	0.161	689
50.124	1.8184	184	488	0.8	114.8	1.3	0.188	550
50.800	1.7958	191	1101	1.9	220.9	2.5	0.170	637
55.402	1.6571	336	1508	2.5	318.8	3.6	0.180	601
56.225	1.6347	248	1314	2.2	302.7	3.5	0.196	535
57.221	1.6086	249	1001	1.7	210.3	2.4	0.179	612
57.980	1.5894	256	2278	3.8	497.1	5.7	0.186	581
59.940	1.5420	221	99	0.2	11.8	0.1	0.096	>5000
61.376	1.5093	288	612	1.0	137.6	1.6	0.191	568

Table 7. XRD Matching Phases Report - Grunerite

Peak ID Extended Report (41 Peaks, Max P/N = 61.6)  
 [NIOSPORTGRUN.RAW] NIOSHPortugalGrunerite  
 PEAK: 99-pts/Parabolic Filter, Threshold=3.0, Cutoff=0.1 %, BG=3/1.0, Peak-Top=Summit

2-Theta d(Å)	Height	Height %	Phase ID	d(Å)	I%	(h k l)	2-Theta Delta
6.265	14.0973	409	2.6	Clinoclore	14.1451	80.0	(0 0 1) 6.243 -0.021
8.701	10.1546	4121	25.7	Biotite-1M	10.1654	100.0	(0 0 1) 8.692 -0.009
9.599	9.2060	920	5.7	Grunerite	9.2648	20.0	(0 2 0) 9.538 -0.061
10.600	8.3390	16020	100.0	Grunerite	8.2969	100.0	(1 1 0) 10.654 0.054
12.539	7.0536	4185	26.1	Clinoclore	7.0813	100.0	(0 0 2) 12.490 -0.049
17.556	5.0475	293	1.8	Biotite-1M	5.0383	1.0	(0 0 2) 17.589 0.032
18.282	4.8489	109	0.7	Grunerite	4.8716	5.0	(-1 1 1) 18.195 -0.086
18.788	4.7193	647	4.0	Clinoclore	4.7290	30.0	(0 0 3) 18.749 -0.039
18.940	4.6818	2690	16.8	Grunerite	4.6541	10.0	(2 0 0) 19.054 0.114
19.278	4.6005	942	5.9	Biotite-1M	4.5934	4.0	(1 1 0) 19.308 0.030
21.298	4.1685	2029	12.7	Grunerite	4.1529	40.0	(2 2 0) 21.379 0.081
22.860	3.8871	309	1.9	Grunerite	3.8800	30.0	(-1 3 1) 22.902 0.043
25.239	3.5257	2661	16.6	Clinoclore	3.5398	50.0	(0 0 4) 25.138 -0.102
26.338	3.3811	2451	15.3	Biotite-1M	3.3564	32.0	(0 0 3) 26.536 0.198
27.159	3.2807	2945	18.4	Grunerite	3.2741	40.0	(2 4 0) 27.215 0.056
29.019	3.0746	12965	80.9	Grunerite	3.0724	70.0	(3 1 0) 29.040 0.021
29.723	3.0033	299	1.9	Grunerite	3.0018	10.0	(2 2 1) 29.738 0.015
32.181	2.7793	2896	18.1	Grunerite	2.7660	70.0	(1 5 1) 32.340 0.159
33.822	2.6481	1530	9.5	Biotite-1M	2.6385	22.0	(2 0 0) 33.949 0.126
35.702	2.5128	717	4.5	Biotite-1M	2.5118	3.0	(0 0 4) 35.718 0.015
36.520	2.4584	438	2.7	Clinoclore	2.4513	30.0	(1 3 2) 36.630 0.110
37.220	2.4137	228	1.4	Grunerite	2.4024	5.0	(-2 6 1) 37.403 0.182
37.760	2.3805	101	0.6	Grunerite	2.3762	5.0	(3 5 0) 37.830 0.071
39.020	2.3065	537	3.3	Biotite-1M	2.3137	2.0	(0 4 0) 38.893 -0.127
40.423	2.2296	332	2.1	Grunerite	2.2213	30.0	(1 7 1) 40.581 0.158
40.861	2.2067	1106	6.9	Grunerite	2.1951	50.0	(2 6 1) 41.086 0.225
42.927	2.1051	312	1.9	Grunerite	2.1016	20.0	(2 0 2) 43.004 0.077
44.181	2.0483	484	3.0				
44.982	2.0136	367	2.3	Clinoclore	2.0098	20.0	(2 0 4) 45.072 0.089
48.022	1.8930	150	0.9				
48.119	1.8894	155	1.0	Clinoclore	1.8887	10.0	(-2 2 5) 48.138 0.019
48.882	1.8617	210	1.3	Grunerite	1.8563	5.0	(4 6 0) 49.035 0.153
49.502	1.8398	166	1.0	Grunerite	1.8301	5.0	(1 9 1) 49.783 0.281
50.722	1.7984	122	0.8	Grunerite	1.7939	10.0	(5 3 0) 50.857 0.135
54.338	1.6869	460	2.9	Grunerite	1.6884	5.0	(-2 8 2) 54.286 -0.052
54.539	1.6812	452	2.8	Biotite-1M	1.6768	9.0	(0 0 6) 54.694 0.155
54.982	1.6687	790	4.9	Clinoclore	1.6656	5.0	(2 4 2) 55.095 0.113
55.726	1.6482	596	3.7	Biotite-1M	1.6547	2.0	(3 1 1) 55.486 -0.240
57.481	1.6020	297	1.9	Grunerite	1.5990	20.0	(5 3 1) 57.596 0.115
59.219	1.5590	1212	7.6	Grunerite	1.5584	5.0	(4 2 2) 59.246 0.027
60.280	1.5341	683	4.3				

Table 8. XRD Peak Search Report - Grunerite

Peak Search Report (41 Peaks, Max P/N = 61.6)  
 [NIOSPORTGRUN.RAW] NIOSHPortugalGrunerite

PEAK: 99-pts/Parabolic Filter, Threshold=3.0, Cutoff=0.1%, BG=3/1.0, Peak-Top=Summit

2-Theta d(Å)	BG	Height	H%	Area	A %	FWHM XS(Å)		
6.265	14.0973	1049	409	2.6	50.0	1.9	0.098	>5000
8.701	10.1546	1093	4121	25.7	1798.3	69.3	0.371	223
9.599	9.2060	1182	920	5.7	81.5	3.1	0.071	>5000
10.600	8.3390	898	16020	100.0	2594.6	100.0	0.130	968
12.539	7.0536	583	4185	26.1	860.4	33.2	0.175	558
17.556	5.0475	347	293	1.8	94.5	3.6	0.258	338
18.282	4.8489	371	109	0.7	14.3	0.6	0.105	2614
18.788	4.7193	333	647	4.0	501.9	19.3	0.621	131
18.940	4.6818	326	2690	16.8	678.7	26.2	0.214	425
19.278	4.6005	350	942	5.9	191.2	7.4	0.162	630
21.298	4.1685	299	2029	12.7	379.6	14.6	0.159	654
22.860	3.8871	295	309	1.9	63.2	2.4	0.164	625
25.239	3.5257	335	2661	16.6	548.8	21.2	0.165	620
26.338	3.3811	583	2451	15.3	1211.4	46.7	0.420	200
27.159	3.2807	487	2945	18.4	440.9	17.0	0.120	1239
29.019	3.0746	357	12965	80.9	2322.7	89.5	0.152	715
29.723	3.0033	359	299	1.9	53.1	2.0	0.142	815
32.181	2.7793	284	2896	18.1	860.8	33.2	0.253	356
33.822	2.6481	312	1530	9.5	510.7	19.7	0.284	313
35.702	2.5128	409	717	4.5	257.9	9.9	0.288	309
36.520	2.4584	352	438	2.7	128.2	4.9	0.234	395
37.220	2.4137	284	228	1.4	51.7	2.0	0.182	552
37.760	2.3805	251	101	0.6	18.3	0.7	0.145	802
39.020	2.3065	301	537	3.3	188.4	7.3	0.298	300
40.423	2.2296	334	332	2.1	127.9	4.9	0.308	291
40.861	2.2067	284	1106	6.9	393.2	15.2	0.302	297
42.927	2.1051	208	312	1.9	99.5	3.8	0.271	339
44.181	2.0483	260	484	3.0	85.2	3.3	0.141	864
44.982	2.0136	259	367	2.3	231.4	8.9	0.536	163
48.022	1.8930	206	150	0.9	40.6	1.6	0.216	453
48.119	1.8894	205	155	1.0	40.6	1.6	0.209	473
48.882	1.8617	200	210	1.3	70.4	2.7	0.269	350
49.502	1.8398	194	166	1.0	91.3	3.5	0.467	192
50.722	1.7984	190	122	0.8	42.8	1.6	0.281	335
54.338	1.6869	294	460	2.9	256.7	9.9	0.447	205
54.539	1.6812	298	452	2.8	268.6	10.4	0.505	181
54.982	1.6687	314	790	4.9	204.6	7.9	0.207	494
55.726	1.6482	276	596	3.7	187.0	7.2	0.267	363
57.481	1.6020	203	297	1.9	111.3	4.3	0.318	300
59.219	1.5590	322	1212	7.6	283.1	10.9	0.199	533
60.280	1.5341	379	683	4.3	146.7	5.7	0.172	658

Table 9. XRD Matching Phases Report - Anthophyllite

Peak ID Extended Report (34 Peaks, Max P/N = 93.8)

[NIOHSHWEDANTH.RAW] SwedenAnthophyllite

PEAK: 99-pts/Parabolic Filter, Threshold=3.0, Cutoff=0.1%, BG=3/1.0, Peak-Top=Summit

2-Theta d(Å)	Height	Height%	Phase ID	d(Å)	I%	(h k l)	2-Theta	Delta	
8.820	10.0178	11841	31.7	Muscovite-3T	10.0378	100.0	(0 0 3)	8.802	-0.018
9.422	9.3790	37348	100.0	Willemseite	9.3801	100.0	(0 0 2)	9.421	-0.001
9.856	8.9671	3952	10.6	Anthophyllite	9.1909	5.0	(2 0 0)	9.615	-0.241
10.756	8.2189	8113	21.7	Anthophyllite	8.3144	70.0	(2 1 0)	10.632	-0.124
12.481	7.0862	1969	5.3	Nimite-1MIIB	7.0887	100.0	(0 0 2)	12.477	-0.004
17.662	5.0175	1709	4.6	Anthophyllite	5.0243	5.0	(0 1 1)	17.638	-0.024
18.801	4.7162	3350	9.0	Nimite-1MIIB	4.7350	16.0	(0 0 3)	18.725	-0.075
18.917	4.6874	3950	10.6	Willemseite	4.6751	2.0	(0 0 4)	18.967	0.050
19.396	4.5726	1143	3.1	Willemseite	4.5653	16.0	(0 2 0)	19.428	0.031
19.720	4.4983	5871	15.7	Muscovite-3T	4.5035	20.0	(1 0 0)	19.697	-0.023
21.562	4.1181	3138	8.4	Anthophyllite	4.1362	5.0	(4 2 0)	21.466	-0.096
22.922	3.8767	203	0.5	Muscovite-3T	3.8830	10.0	(1 0 4)	22.884	-0.038
24.419	3.6423	572	1.5	Anthophyllite	3.6570	15.0	(3 2 1)	24.319	-0.100
25.112	3.5433	1778	4.8	Nimite-1MIIB	3.5472	45.0	(0 0 4)	25.084	-0.028
26.585	3.3502	10565	28.3	Muscovite-3T	3.3384	100.0	(0 0 9)	26.681	0.096
27.620	3.2270	8432	22.6	Anthophyllite	3.2277	50.0	(4 4 0)	27.614	-0.006
28.540	3.1250	21007	56.2	Willemseite	3.1179	30.0	(0 0 6)	28.607	0.067
28.709	3.1071	3799	10.2	Muscovite-3T	3.1164	10.0	(1 0 7)	28.621	-0.088
29.321	3.0435	24563	65.8	Anthophyllite	3.0579	100.0	(6 1 0)	29.180	-0.141
31.154	2.8685	463	1.2	Anthophyllite	2.8702	15.0	(5 2 1)	31.135	-0.019
31.571	2.8316	1265	3.4	Anthophyllite	2.8293	20.0	(4 5 0)	31.598	0.027
32.592	2.7452	1947	5.2	Anthophyllite	2.7484	10.0	(4 4 1)	32.553	-0.038
34.717	2.5818	921	2.5	Nimite-1MIIB	2.5806	4.0	(1 3 1)	34.735	0.018
35.762	2.5088	1522	4.1	Muscovite-3T	2.5030	12.0	(0,0,12)	35.847	0.085
38.398	2.3424	539	1.4	Willemseite	2.3368	2.0	(0 0 8)	38.493	0.095
40.160	2.2436	571	1.5	Willemseite	2.2439	8.0	(-2 2 3)	40.154	-0.006
42.306	2.1346	769	2.1	Muscovite-3T	2.1389	12.0	(1 1 8)	42.217	-0.088
45.140	2.0070	3800	10.2	Nimite-1MIIB	2.0022	4.0	(2 0 4)	45.254	0.115
48.540	1.8740	805	2.2	Willemseite	1.8723	2.0	(0,0,10)	48.588	0.048
49.538	1.8386	833	2.2	Anthophyllite	1.8403	10.0	(5 5 2)	49.489	-0.049
52.802	1.7324	514	1.4	Willemseite	1.7284	2.0	(-1 5 1)	52.933	0.131
56.922	1.6164	959	2.6	Muscovite-3T	1.6156	4.0	(2 1 6)	56.953	0.031
57.140	1.6107	1147	3.1	Willemseite	1.6085	2.0	(2 0 8)	57.226	0.087
61.819	1.4995	2312	6.2	Anthophyllite	1.4996	25.0	(6 2 3)	61.818	-0.001

Table 10. XRD Peak Search Report - Anthophyllite

Peak Search Report (34 Peaks, Max P/N = 93.8)  
 [NIOHSHWEDANTH.RAW] SwedenAnthophyllite  
 PEAK: 99-pts/Parabolic Filter, Threshold=3.0, Cutoff=0.1%, BG=3/1.0, Peak-Top=Summit

2-Theta d(Å)	BG	Height	H%	Area	A%	FWHM XS(Å)		
8.820	10.0178	1287	11841	31.7	3915.3	46.4	0.265	325
9.422	9.3790	2296	37348	100.0	8433.7	100.0	0.192	487
9.856	8.9671	2026	3952	10.6	819.4	9.7	0.166	603
10.756	8.2189	801	8113	21.7	2248.9	26.7	0.236	374
12.481	7.0862	711	1969	5.3	408.8	4.8	0.176	550
17.662	5.0175	653	1709	4.6	397.8	4.7	0.198	471
18.801	4.7162	1104	3350	9.0	784.1	9.3	0.199	468
18.917	4.6874	940	3950	10.6	1242.5	14.7	0.252	349
19.396	4.5726	779	1143	3.1	904.9	10.7	0.673	121
19.720	4.4983	653	5871	15.7	1410.5	16.7	0.192	491
21.562	4.1181	612	3138	8.4	709.9	8.4	0.192	492
22.922	3.8767	551	203	0.5	58.8	0.7	0.232	388
24.419	3.6423	650	572	1.5	145.9	1.7	0.204	457
25.112	3.5433	778	1778	4.8	328.4	3.9	0.148	748
26.585	3.3502	993	10565	28.3	3233.8	38.3	0.260	340
27.620	3.2270	1332	8432	22.6	1579.7	18.7	0.150	733
28.540	3.1250	1777	21007	56.2	6469.6	76.7	0.246	364
28.709	3.1071	1403	3799	10.2	3118.2	37.0	0.698	119
29.321	3.0435	635	24563	65.8	6176.0	73.2	0.201	471
31.154	2.8685	613	463	1.2	235.6	2.8	0.433	196
31.571	2.8316	627	1265	3.4	333.8	4.0	0.211	444
32.592	2.7452	615	1947	5.2	577.9	6.9	0.252	357
34.717	2.5818	849	921	2.5	226.4	2.7	0.197	492
35.762	2.5088	804	1522	4.1	585.4	6.9	0.327	268
38.398	2.3424	573	539	1.4	116.2	1.4	0.173	598
40.160	2.2436	595	571	1.5	120.3	1.4	0.168	624
42.306	2.1346	419	769	2.1	414.4	4.9	0.458	190
45.140	2.0070	472	3800	10.2	1260.3	14.9	0.282	326
48.540	1.8740	517	805	2.2	314.6	3.7	0.313	294
49.538	1.8386	463	833	2.2	340.7	4.0	0.348	263
52.802	1.7324	368	514	1.4	197.3	2.3	0.326	286
56.922	1.6164	445	959	2.6	415.7	4.9	0.347	272
57.140	1.6107	461	1147	3.1	589.1	7.0	0.437	213
61.819	1.4995	760	2312	6.2	648.7	7.7	0.224	461

Table 11. XRD Matching Phases Report – NIEHS Tremolite

Peak ID Extended Report (38 Peaks, Max P/N = 168.0)

[U59UN001.RAW] NIEHS Tremolite

PEAK: 91-pts/Parabolic Filter, Threshold=3.0, Cutoff=0.1%, BG=3/1.0, Peak-Top=Summit

2-Theta	d(Å)	Height	Height%	Phase ID	d(Å)	I%	(h k l)	2-Theta	Delta
9.816	9.0035	1641	1.4	Tremolite	8.9977	56.0	(0 2 0)	9.822	0.006
10.541	8.3859	114051	100.0	Tremolite	8.3772	100.0	(1 1 0)	10.552	-0.011
12.121	7.2960	6165	5.4	Chrysotile-2Mcl	7.3100	100.0	(0 0 2)	12.098	-0.023
17.440	5.0810	1722	1.5	Tremolite	5.0705	18.0	(1 3 0)	17.476	0.036
18.206	4.8689	582	0.5	Tremolite	4.8636	23.0	(1 1 -1)	18.226	0.020
18.660	4.7514	6212	5.4	Tremolite	4.7375	7.0	(2 0 0)	18.715	0.055
19.679	4.5076	1785	1.6	Tremolite	4.5018	22.0	(0 4 0)	19.704	0.025
21.137	4.1998	23394	20.5	Tremolite	4.1927	10.0	(2 2 0)	21.173	0.036
22.959	3.8705	550	0.5	Tremolite	3.8634	18.0	(1 3 -1)	23.002	0.043
24.361	3.6508	3976	3.5	Chrysotile-2Mcl	3.6500	70.0	(0 0 4)	24.367	0.005
26.362	3.3781	1963	1.7	Tremolite	3.3734	44.0	(1 3 1)	26.399	0.037
27.241	3.2710	8918	7.8	Tremolite	3.2678	41.0	(2 4 0)	27.268	0.027
28.581	3.1207	71316	62.5	Tremolite	3.1189	69.0	(2 0 1)	28.597	0.017
29.440	3.0315	2004	1.8	Tremolite	3.0099	2.0	(0 6 0)	29.656	0.216
30.402	2.9378	3573	3.1	Tremolite	2.9327	34.0	(1 5 -1)	30.455	0.054
31.903	2.8029	26420	23.2	Tremolite	2.8010	10.0	(3 3 0)	31.924	0.021
32.782	2.7297	2185	1.9	Tremolite	2.7272	20.0	(3 3 -1)	32.813	0.032
33.118	2.7027	4077	3.6	Tremolite	2.7000	71.0	(1 5 1)	33.153	0.035
34.601	2.5902	970	0.9	Tremolite	2.5880	21.0	(0 6 1)	34.632	0.031
35.458	2.5296	954	0.8	Tremolite	2.5280	27.0	(2 0 -2)	35.481	0.024
37.339	2.4064	329	0.3	Tremolite	2.4051	5.0	(3 1 1)	37.360	0.021
37.760	2.3805	2419	2.1	Tremolite	2.3787	7.0	(4 0 0)	37.789	0.030
38.522	2.3351	2488	2.2	Tremolite	2.3324	21.0	(3 5 -1)	38.568	0.046
38.781	2.3201	2733	2.4	Tremolite	2.3157	12.0	(4 2 -1)	38.858	0.077
39.181	2.2974	1015	0.9	Tremolite	2.2925	10.0	(1 7 -1)	39.268	0.087
41.780	2.1603	2083	1.8	Tremolite	2.1570	21.0	(2 6 1)	41.846	0.066
44.340	2.0413	474	0.4	Tremolite	2.0394	8.0	(2 8 0)	44.383	0.043
44.958	2.0147	2124	1.9	Tremolite	2.0128	15.0	(3 5 1)	45.003	0.045
45.320	1.9994	1192	1.0	Tremolite	1.9968	6.0	(2 2 2)	45.382	0.062
46.261	1.9609	399	0.3	Tremolite	1.9601	6.0	(1 9 0)	46.282	0.021
48.063	1.8915	8097	7.1	Tremolite	1.8887	8.0	(5 1 0)	48.140	0.077
50.281	1.8132	4489	3.9	Tremolite	1.8106	4.0	(5 3 0)	50.358	0.077
55.717	1.6484	3796	3.3	Tremolite	1.6469	18.0	(4 6 1)	55.772	0.055
56.180	1.6359	1339	1.2	Tremolite	1.6353	6.0	(4 8 0)	56.202	0.022
58.160	1.5849	3639	3.2	Tremolite	1.5841	4.0	(6 0 0)	58.190	0.029
59.156	1.5605	864	0.8	Tremolite	1.5600	2.0	(2,10,1)	59.179	0.023
60.401	1.5313	1102	1.0	Tremolite	1.5316	4.0	(6 0 -2)	60.387	-0.014
61.778	1.5004	1611	1.4	Tremolite	1.5022	6.0	(0,12,0)	61.696	-0.082

Table 12. XRD Peak Search Report - NIEHS Tremolite

Peak Search Report (38 Peaks, Max P/N = 168.0)  
 [U59UN001.RAW] NIEHS Tremolite

PEAK: 91-pts/Parabolic Filter, Threshold=3.0, Cutoff=0.1%, BG=3/1.0, Peak-Top=Summit

2-Theta d(Å)	BG	Height	H%	Area	A%	FWHM	XS(Å)
9.816	9.0035	1377	1641	1.4	215.3	1.5	0.105 2500
10.541	8.3859	1113	114051	100.0	14767.9	100.0	0.104 2952
12.121	7.2960	633	6165	5.4	1899.6	12.9	0.262 330
17.440	5.0810	382	1722	1.5	324.2	2.2	0.151 713
18.206	4.8689	438	582	0.5	121.9	0.8	0.168 598
18.660	4.7514	502	6212	5.4	1035.7	7.0	0.142 802
19.679	4.5076	533	1785	1.6	427.6	2.9	0.204 455
21.137	4.1998	448	23394	20.5	3465.6	23.5	0.119 1271
22.959	3.8705	396	550	0.5	115.8	0.8	0.168 598
24.361	3.6508	396	3976	3.5	1390.6	9.4	0.297 290
26.362	3.3781	455	1963	1.7	417.0	2.8	0.170 594
27.241	3.2710	474	8918	7.8	1648.8	11.2	0.148 750
28.581	3.1207	552	71316	62.5	12822.2	86.8	0.153 709
29.440	3.0315	546	2004	1.8	363.1	2.5	0.145 783
30.402	2.9378	383	3573	3.1	670.0	4.5	0.159 663
31.903	2.8029	360	26420	23.2	4330.8	29.3	0.139 852
32.782	2.7297	361	2185	1.9	566.2	3.8	0.207 456
33.118	2.7027	337	4077	3.6	835.4	5.7	0.174 581
34.601	2.5902	464	970	0.9	180.7	1.2	0.149 753
35.458	2.5296	538	954	0.8	245.8	1.7	0.206 463
37.339	2.4064	509	329	0.3	104.9	0.7	0.271 333
37.760	2.3805	469	2419	2.1	400.2	2.7	0.132 969
38.522	2.3351	450	2488	2.2	792.1	5.4	0.255 359
38.781	2.3201	425	2733	2.4	882.3	6.0	0.274 330
39.181	2.2974	379	1015	0.9	266.6	1.8	0.210 456
41.780	2.1603	311	2083	1.8	565.5	3.8	0.231 409
44.340	2.0413	306	474	0.4	90.4	0.6	0.153 744
44.958	2.0147	254	2124	1.9	543.4	3.7	0.217 445
45.320	1.9994	282	1192	1.0	281.4	1.9	0.189 537
46.261	1.9609	261	399	0.3	102.9	0.7	0.206 479
48.063	1.8915	347	8097	7.1	1755.9	11.9	0.184 562
50.281	1.8132	255	4489	3.9	1059.4	7.2	0.201 505
55.717	1.6484	308	3796	3.3	975.0	6.6	0.218 463
56.180	1.6359	323	1339	1.2	312.1	2.1	0.186 572
58.160	1.5849	303	3639	3.2	684.3	4.6	0.160 729
59.156	1.5605	360	864	0.8	222.6	1.5	0.206 507
60.401	1.5313	454	1102	1.0	363.3	2.5	0.280 351
61.778	1.5004	495	1611	1.4	460.9	3.1	0.229 450



Table 13. Percentage of fibers meeting CDC/NIOSH criteria for each amphibole measured by PCM and by TEM – PCME.

Amphibole	Approximate Percentage of fibers meeting CDC/NIOSH Criteria by PCM Analysis			Approximate Percentage of fibers meeting CDC/NIOSH Criteria by TEM - PCME Analysis		
	Aspect Ratio >3:1	Length ≥ 5 μm	Width < 3 μm	Aspect Ratio >3:1	Length ≥ 5 μm	Width < 3 μm
Actinolite	71	78	79	87	86	96
Cummingtonite	76	92	66	70	73	93
Riebeckite	75	77	80	67	70	90
Grunerite	73	88	71	70	84	97
Anthophyllite	94	97	83	92	49	95
Tremolite	70	85	61	78	81	94

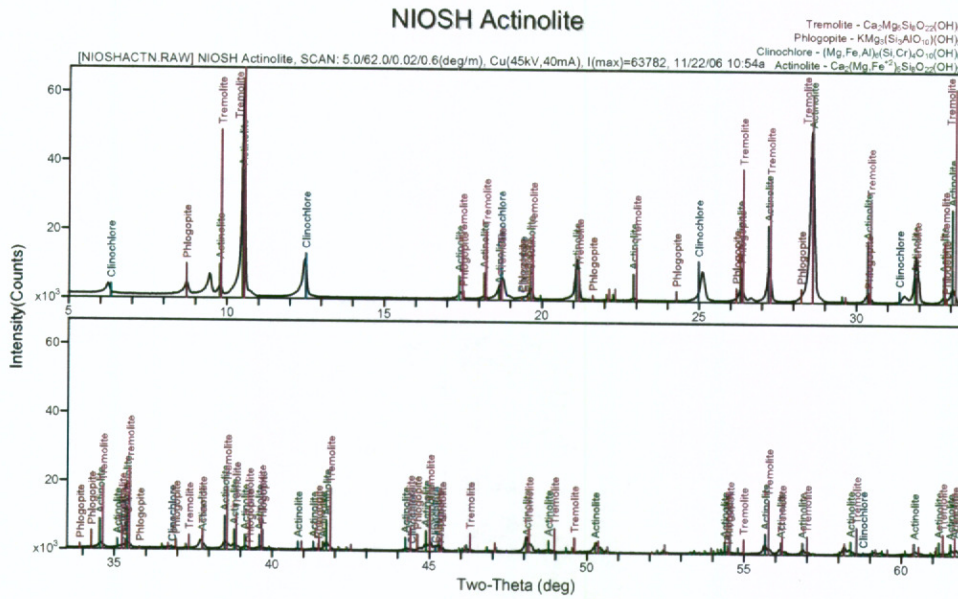
Table 14. NIOSH 7400 Fiber Density Data (f/mm<sup>2</sup>) for each filter preparation measured by Analyst 1 and 2. Nominal graticule area 0.00785 mm<sup>2</sup>.

Amphibole: Actinolite						
Analyst	Filter 1	Filter 2	Filter 3	Filter 4	Filter 5	Filter 6
1	616.7	656.1	675.2	-	-	-
2	-	-	-	1045 (926.8) recount	697.5	767.5
Amphibole: Cummingtonite						
Analyst	Filter 1	Filter 2	Filter 3	Filter 4	Filter 5	Filter 6
1	406.1	341.9	402.1	-	-	-
2	-	-	-	599.3	457.2	413.0
Amphibole: Riebeckite						
Analyst	Filter 1	Filter 2	Filter 3	Filter 4	Filter 5	Filter 6
1	437.4	395.7	465.0	-	-	-
2	-	-	-	697.5	590.6	859.9
Amphibole: Grunerite						
Analyst	Filter 1	Filter 2	Filter 3	Filter 4	Filter 5	Filter 6
1	208.8	183.9	195.9	-	-	-
2	-	-	-	326.4	497.8	514.6
Amphibole: Anthophyllite						
Analyst	Filter 1	Filter 2	Filter 3	Filter 4	Filter 5	Filter 6
1	947.8	1041.4	1009.6	-	-	-
2	-	-	-	1929.9	949.0	1515.9
Amphibole: NIEHS Tremolite						
Analyst	Filter 1	Filter 2	Filter 3	Filter 4	Filter 5	Filter 6
1	386.9	379.0	409.2	-	-	-
2	-	-	-	586	369	484

**Table 15. Weight recovered from filtration of suspended amphibole**

<b>Amphibole</b>	<b>Weight Suspended</b>	<b>Weight Filtered</b>	<b>Percent Recovery</b>
Actinolite	1.983	0.276	13.9
Cummingtonite	2.44	0.31	12.7
Riebeckite	2.02	0.26	12.9
Grunerite	6.00	0.26	4.3
Anthophyllite	3.03	0.41	13.5
Tremolite	6.00	Deposit too thin	-

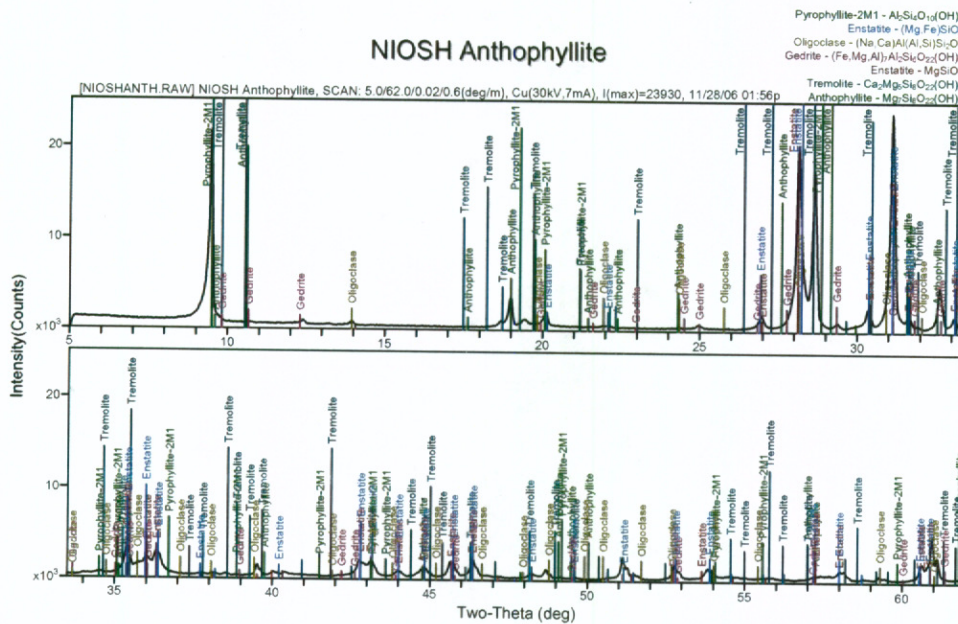
# Figures



RTI International

[Shimadzu XRD-6000] Monday, June 11, 2007 02:32p (MDI/JADE7)

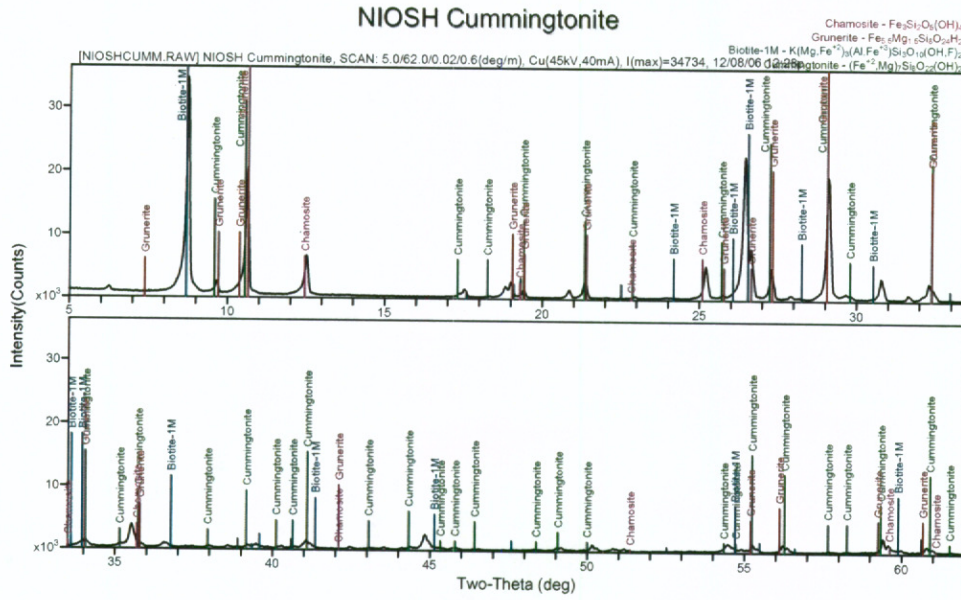
**Figure 1. XRD Spectrum for Actinolite -- (Near Wrightwood, CA)**



RTI International

[Shimadzu XRD-6000] Tuesday, June 12, 2007 08:41a (MDI/JADE7)

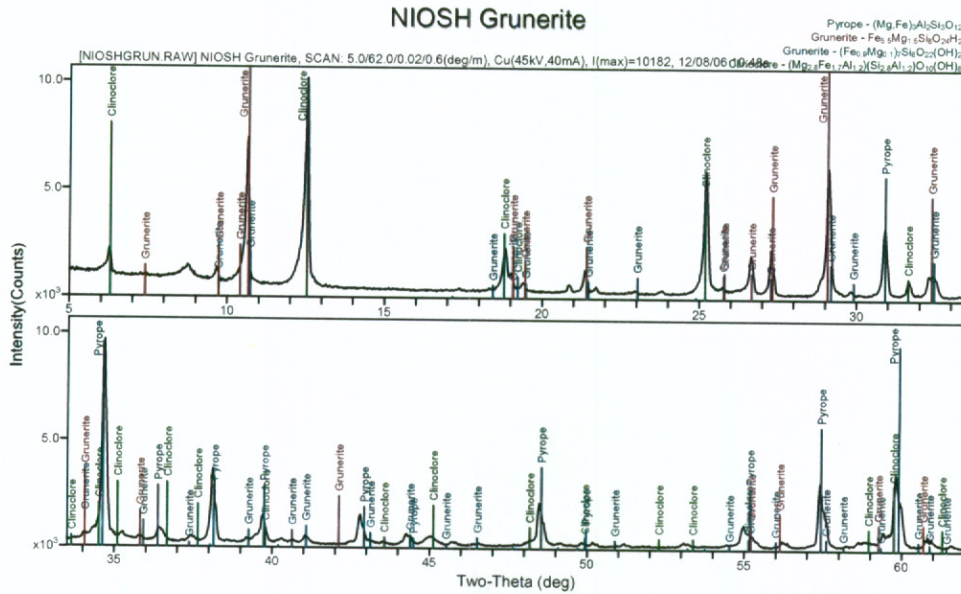
**Figure 2. XRD Spectrum for Anthophyllite (Winchester, CA)**



RTI International

[Shimadzu XRD-6000] Monday, June 11, 2007 02:43p (MDI/JADE7)

**Figure 3. XRD Spectrum for Cummingtonite with biotite (Homestake Mine, SD)**

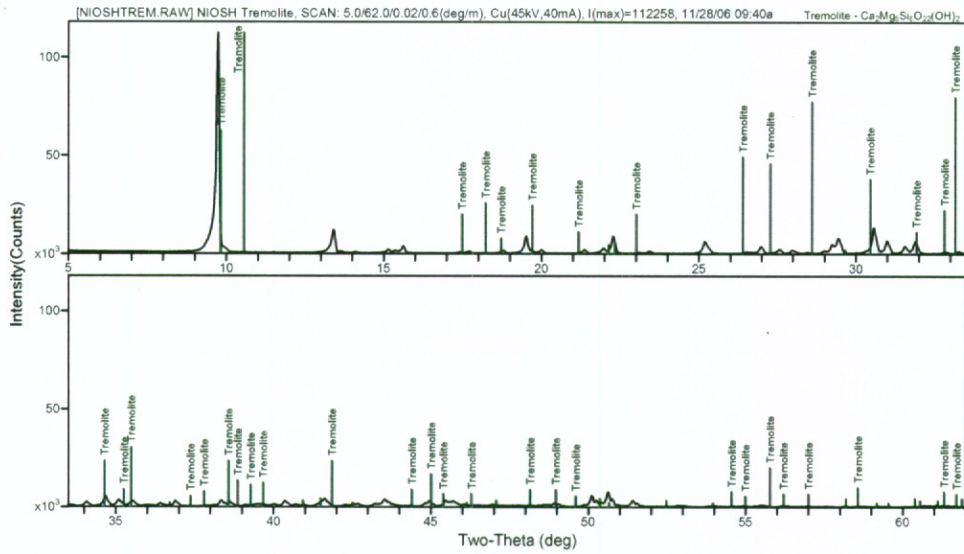


RTI International

[Shimadzu XRD-6000] Tuesday, June 12, 2007 08:29a (MDI/JADE7)

**Figure 4. XRD Spectrum for Grunerite with magnetite (Michigamme, MI)**

### NIOSH Tremolite

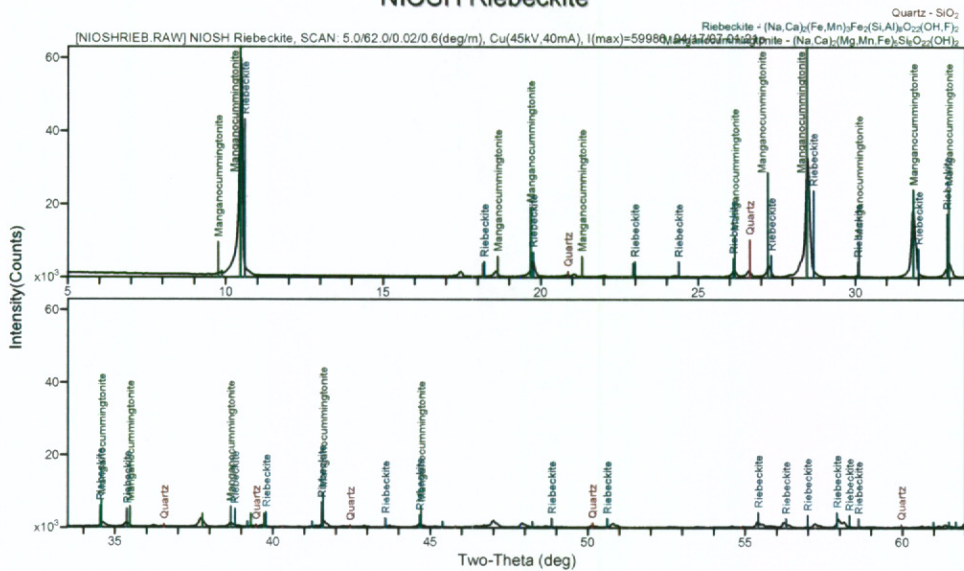


RTI International

[Shimadzu XRD-6000] Tuesday, June 12, 2007 08:34a (MDI/JADE7)

Figure 5. XRD Spectrum for Tremolite (Near Baker, CA)

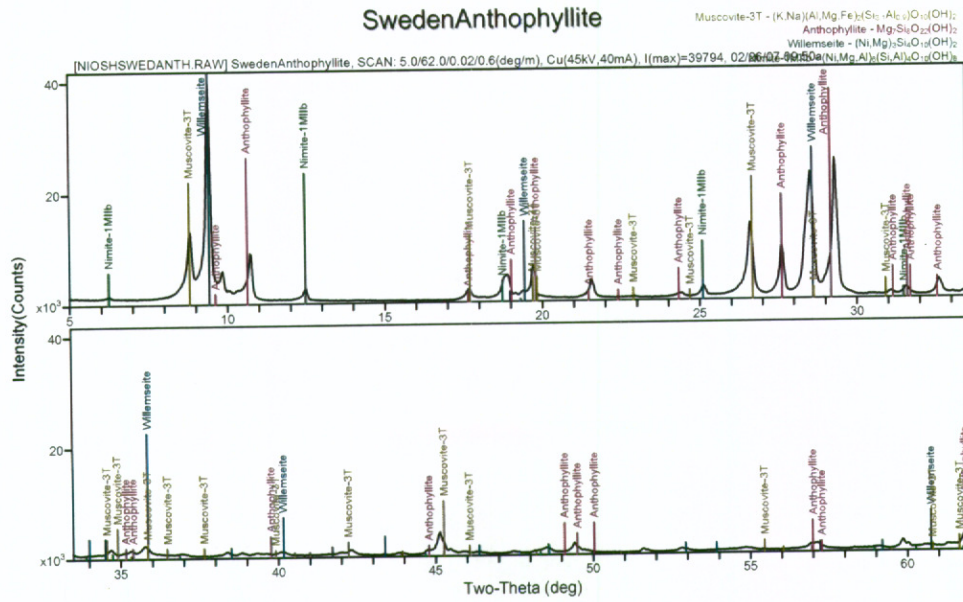
### NIOSH Riebeckite



RTI International

[Shimadzu XRD-6000] Monday, June 11, 2007 02:50p (MDI/JADE7)

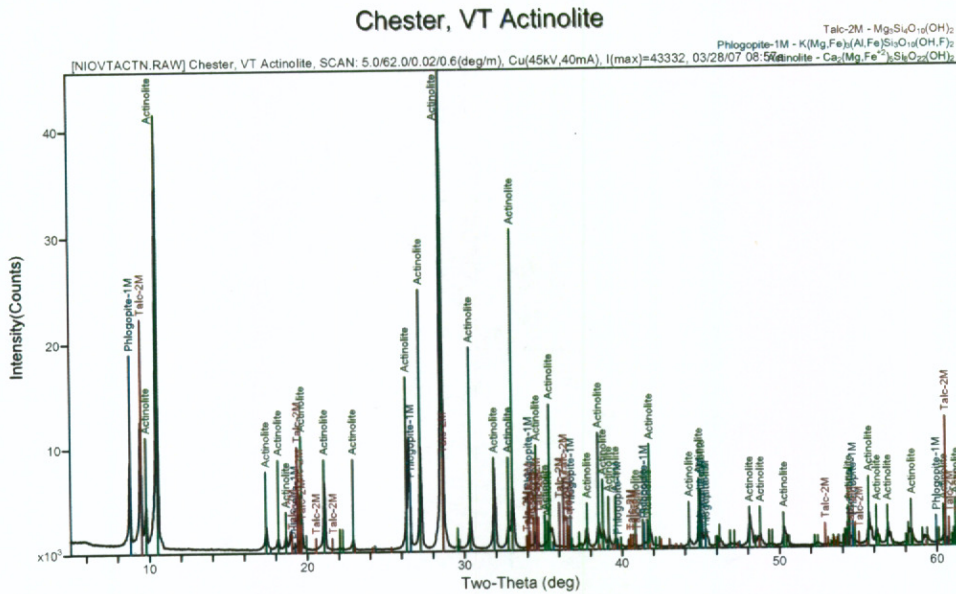
Figure 6. XRD Spectrum for Riebeckite (Colorado Springs, CO)



RTI International

[Shimadzu XRD-6000] Monday, June 11, 2007 02:51p (MDI/JADE7)

**Figure 9. XRD Spectrum for Anthophyllite (Sweden)**

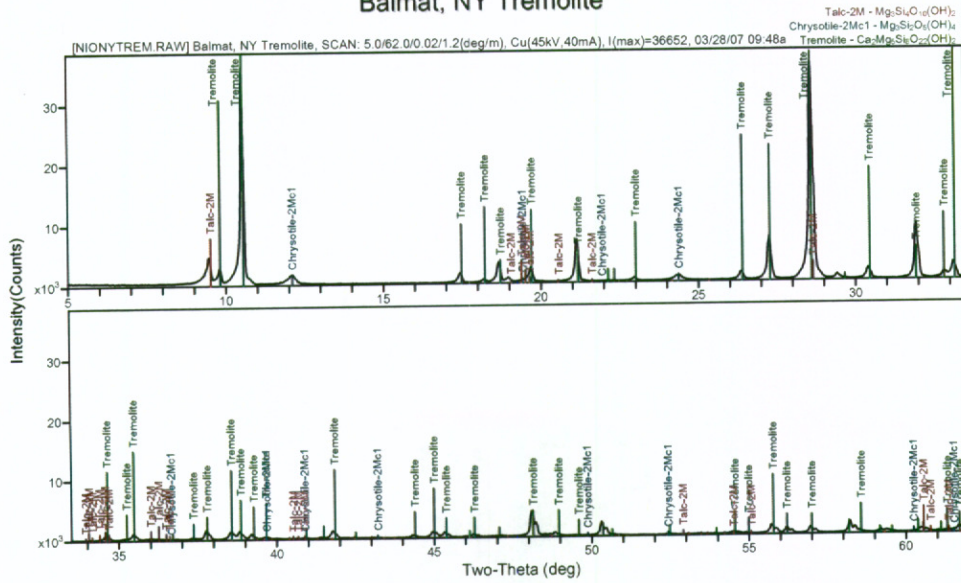


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[Shimadzu XRD-6000] Tuesday, June 12, 2007 08:26a (MDI/JADE7)

**Figure 10. XRD Spectrum for Actinolite (Chester, VT)**

Balmat, NY Tremolite

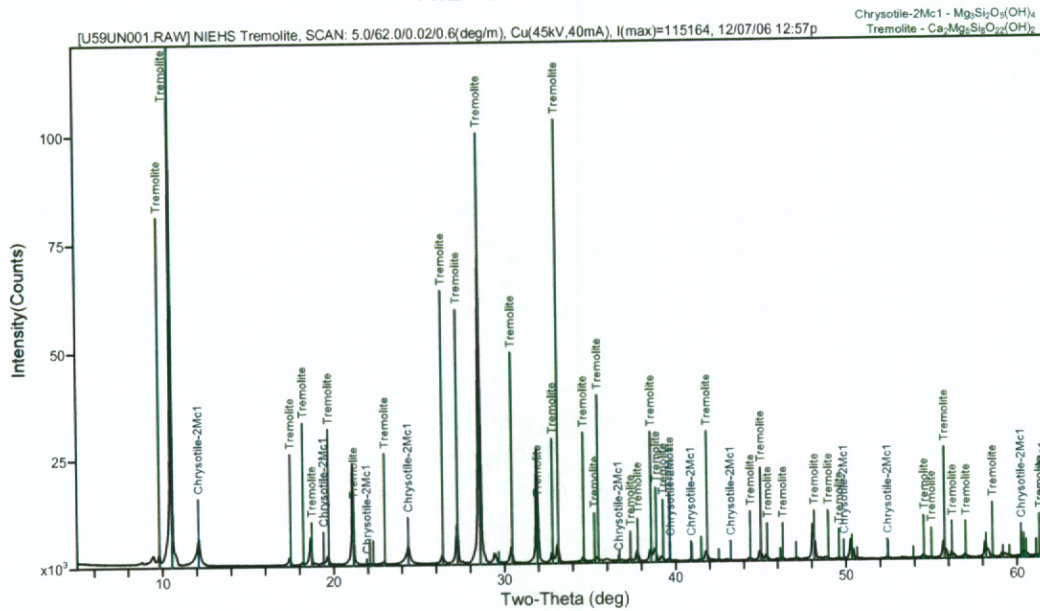


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[Shimadzu XRD-6000] Tuesday, June 12, 2007 08:27a (MDI/JADE7)

Figure 11. XRD Spectrum for Tremolite (Balmat, NY)

NIEHS Tremolite

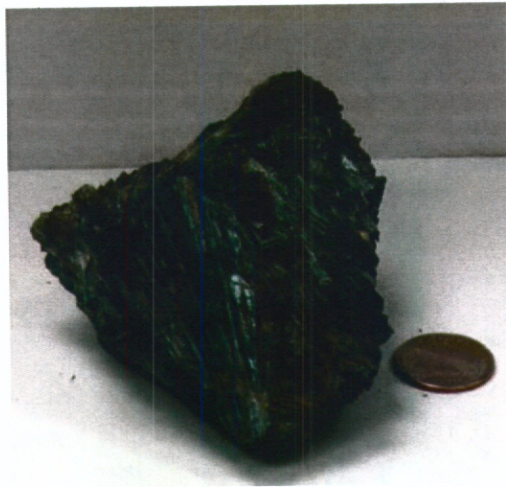


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[Shimadzu XRD-6000] Tuesday, June 12, 2007 02:59p (MDI/JADE7)

Figure 12. XRD Spectrum for NIEHS Tremolite





**Figure 13. Actinolite (Near Wrightwood, CA) weight 99.451 grams**



**Figure 14. Anthophyllite (Sweden) weight 23.0 grams**



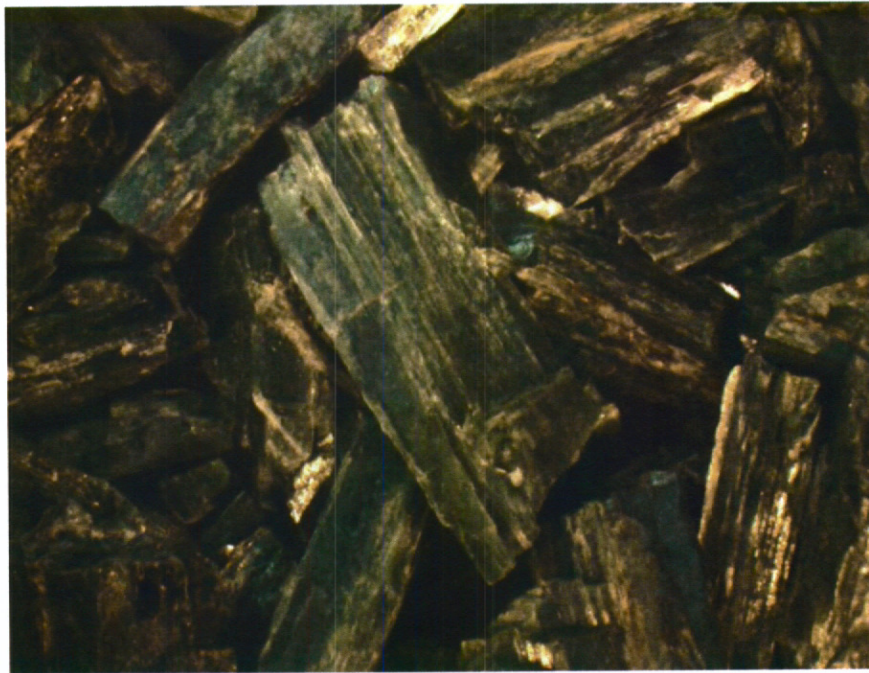
**Figure 15. Grunerite (Portugal) weight 146.45 grams**



**Figure 16. Riebeckite (Colorado Springs, CO) weight 12.0 grams**



**Figure 17. RTI Fabricated Hydraulic Press**



**Figure 18. Actinolite sample following hydraulic crushing.  
Stereomicroscope, 3.5X**



**Figure 19. Cummingtonite sample following hydraulic crushing.**



**Figure 20. Riebekite sample following hydraulic crushing.**



**Figure 21. Grunerite sample following hydraulic crushing.**



**Figure 22. Anthophyllite sample following hydraulic crushing.**



**Figure 23. NIEHS nonasbestiform tremolite sample.**

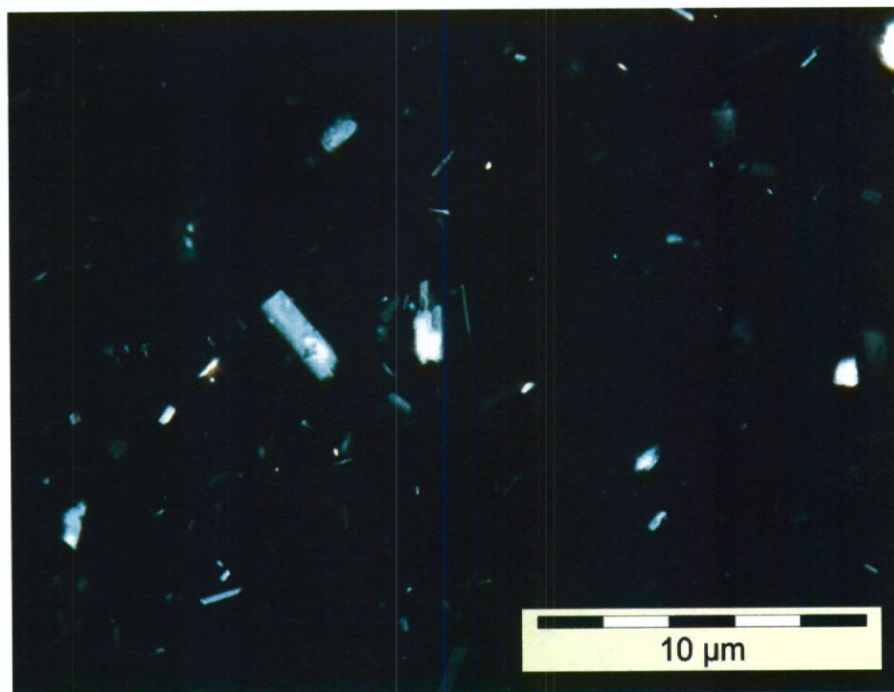


Figure 24. PLM photograph of Actinolite sample following treatment with mortar and pestle.

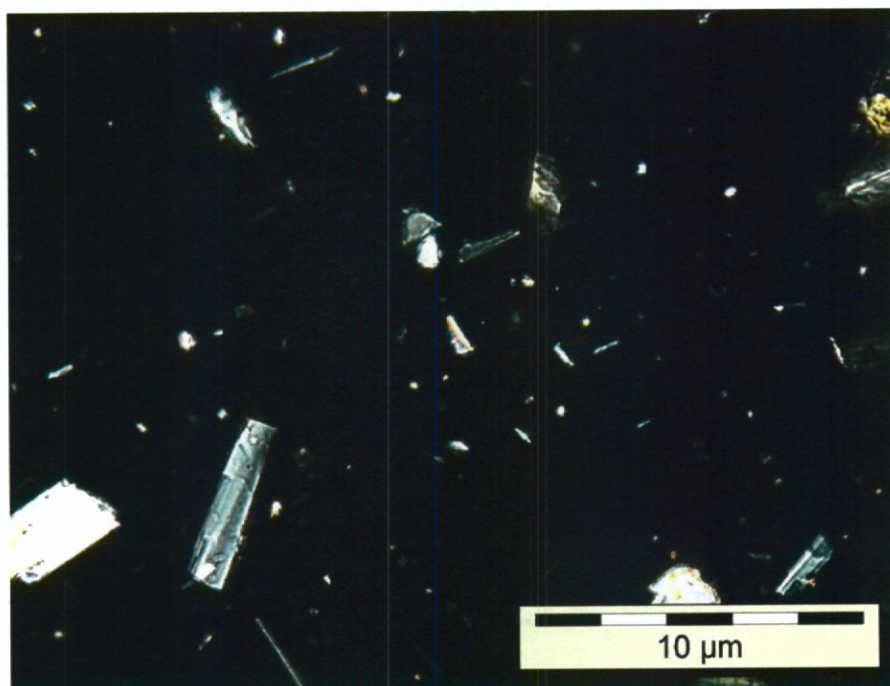


Figure 25. PLM photograph of Cummingtonite sample following treatment with mortar and pestle.

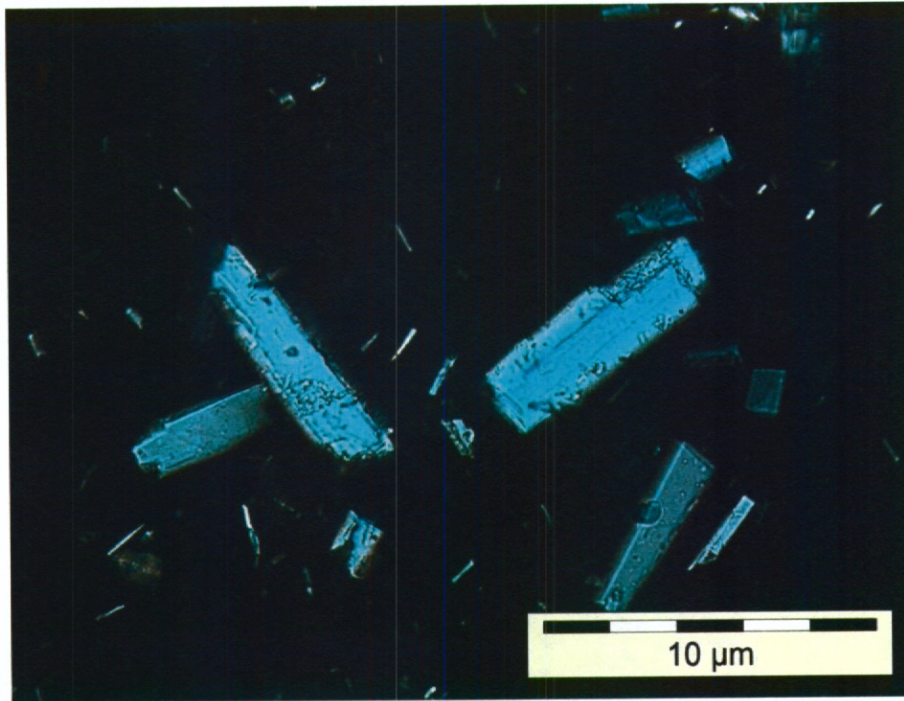


Figure 26. PLM photograph of Riebeckite sample following treatment with mortar and pestle.

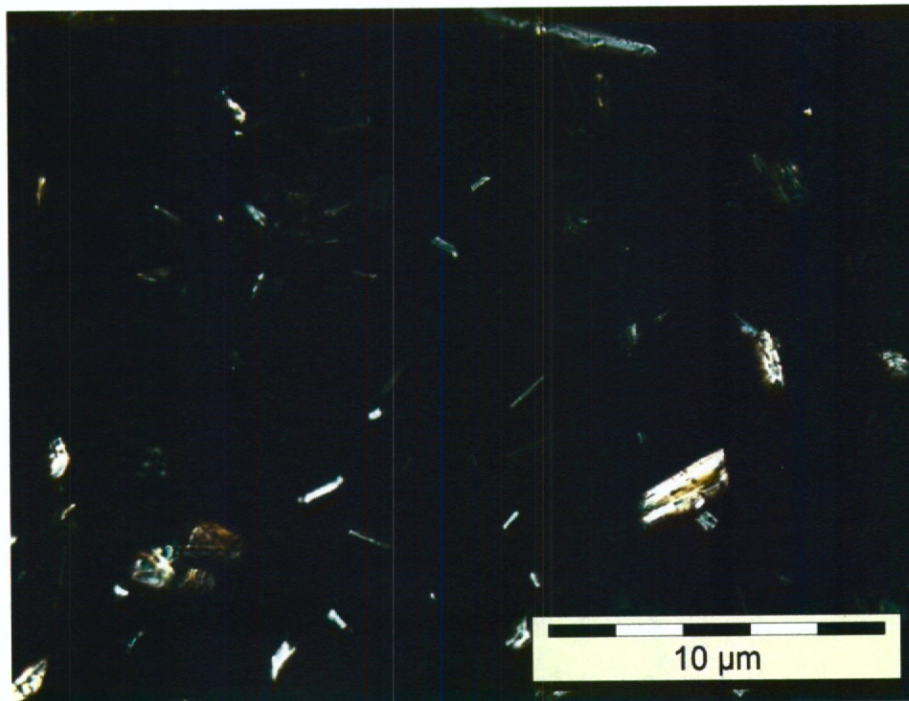


Figure 27. PLM photograph of Grunerite sample following treatment with mortar and pestle.



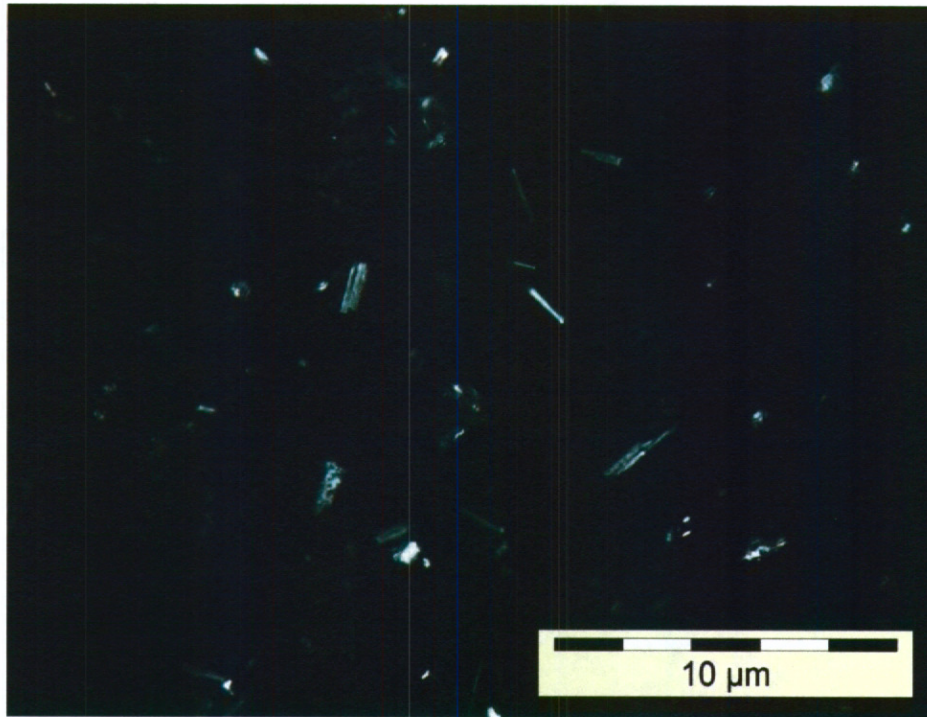


Figure 28. PLM photograph of Anthophyllite sample following treatment with mortar and pestle.

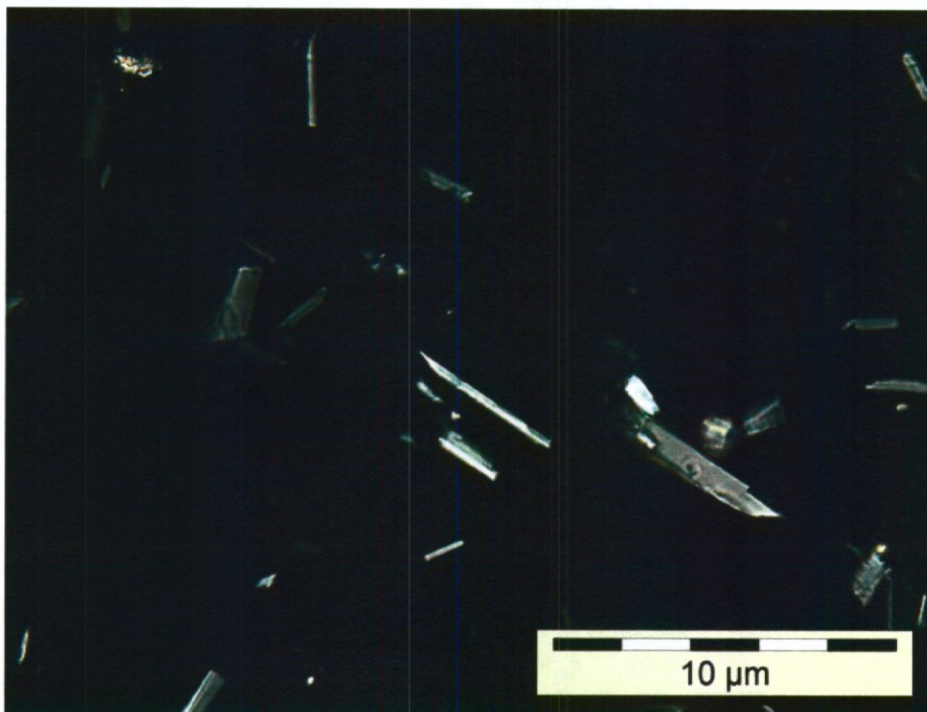


Figure 29. PLM photograph of NIEHS Tremolite sample following treatment with mortar and pestle

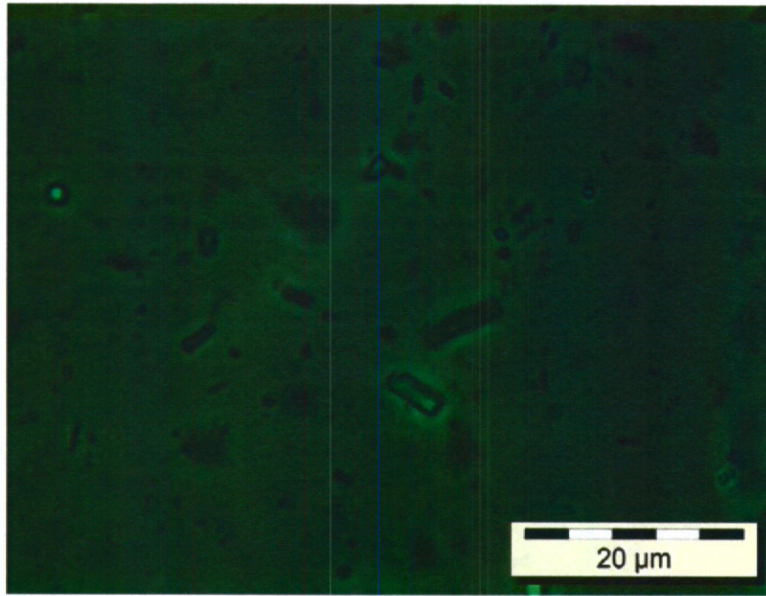


Figure 30. PCM photograph of Actinolite preparation.

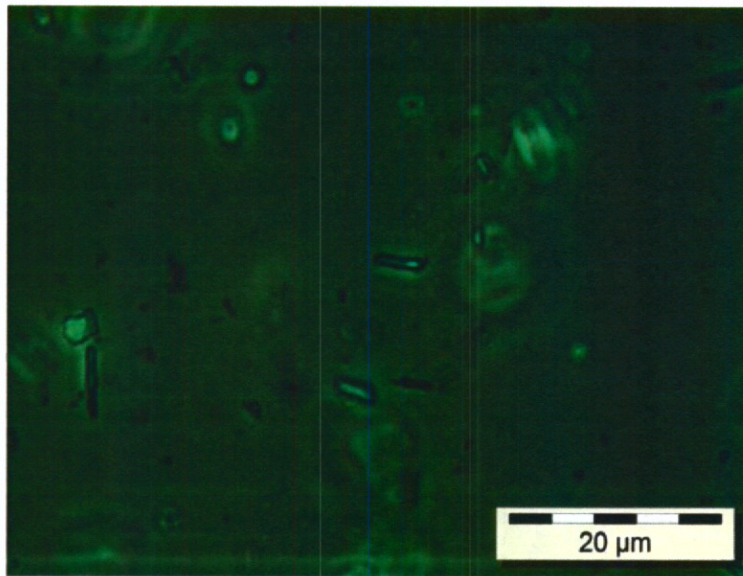


Figure 31. PCM photograph of Cummingtonite preparation.

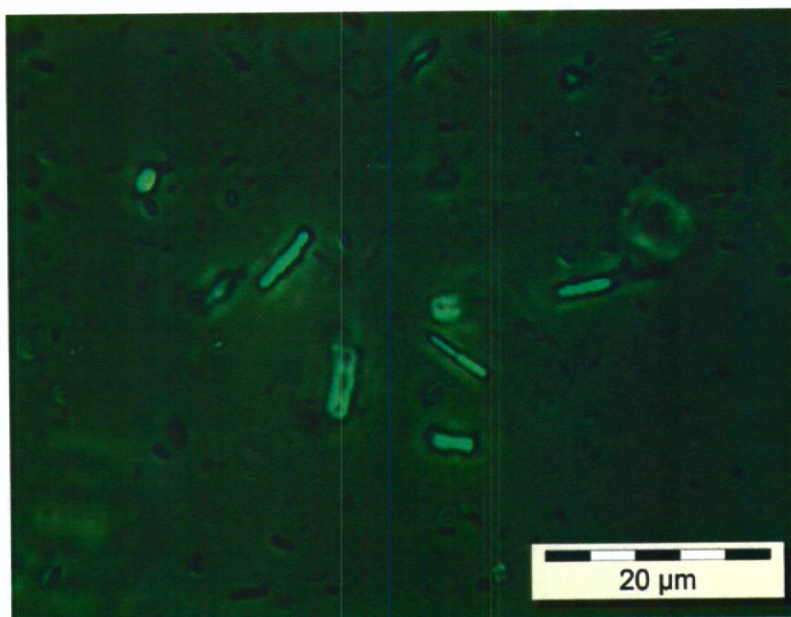


Figure 32. PCM photograph of Riebeckite preparation.

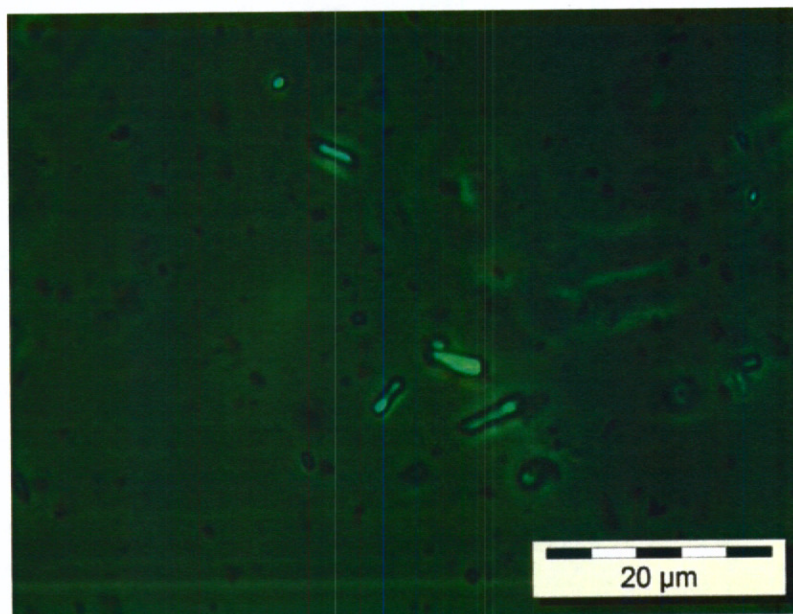


Figure 33. PCM photograph of Grunerite preparation.

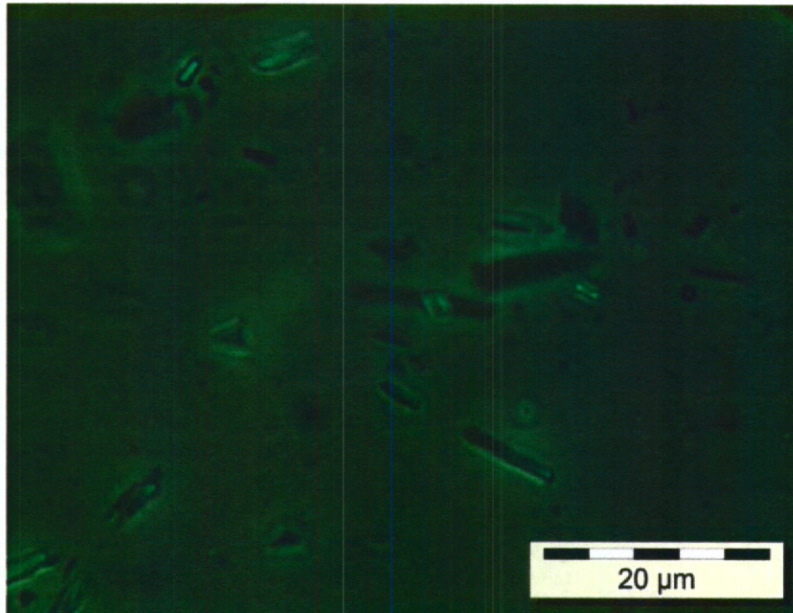


Figure 34. PCM photograph of Anthophyllite preparation.

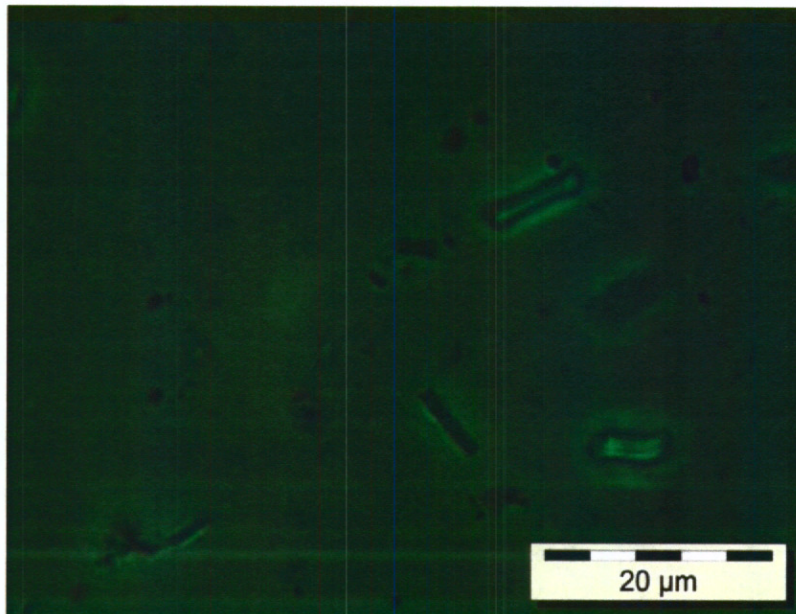
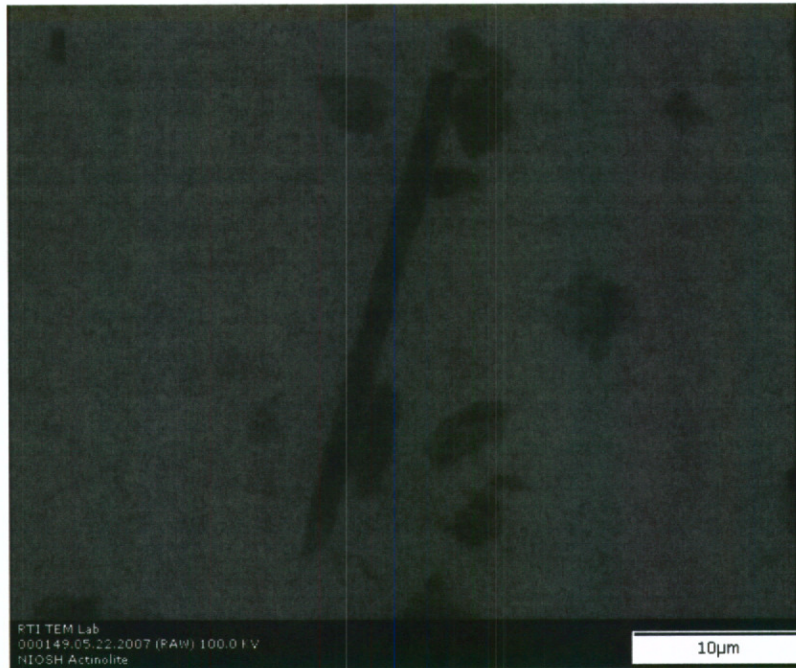


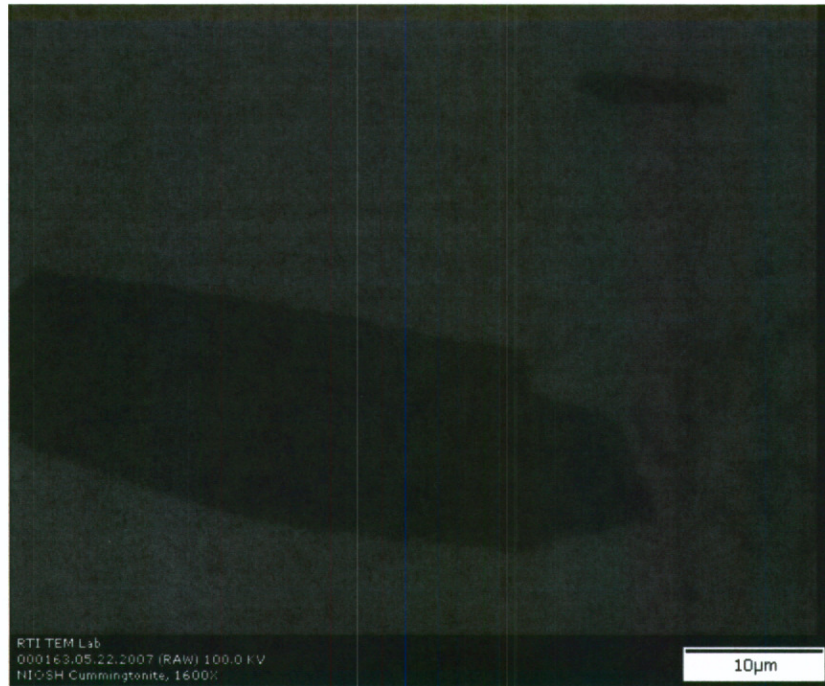
Figure 35. PCM photograph of NIEHS Tremolite preparation.



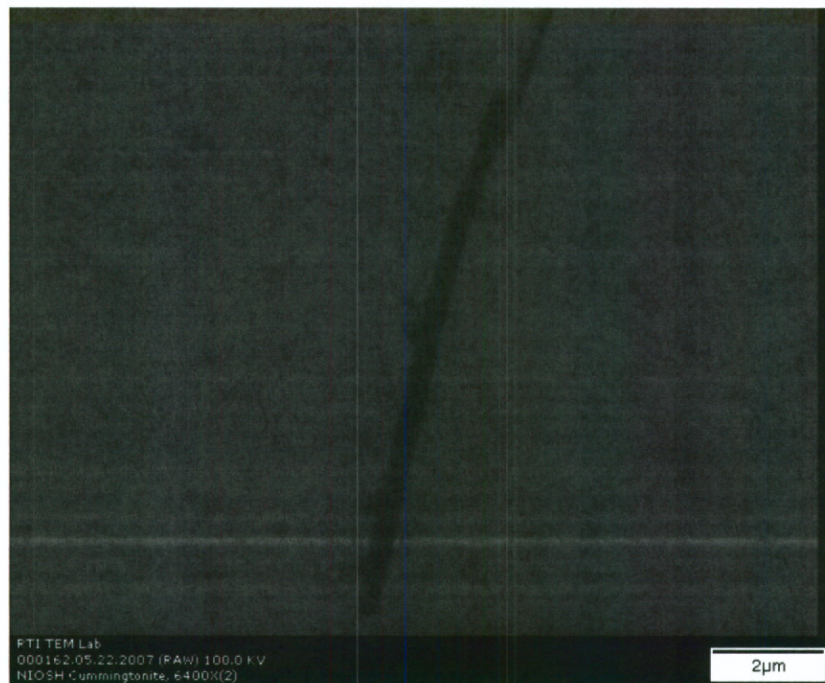
**Figure 36. TEM photograph of Actinolite preparation. 2000X**



**Figure 37. TEM photograph of Actinolite preparation. 8000X**



**Figure 38. TEM photograph of Cummingtonite preparation. 1600X**



**Figure 39. TEM photograph of Cummingtonite preparation. 6400X**



Figure 40. TEM photograph of Riebeckite preparation. 1600X

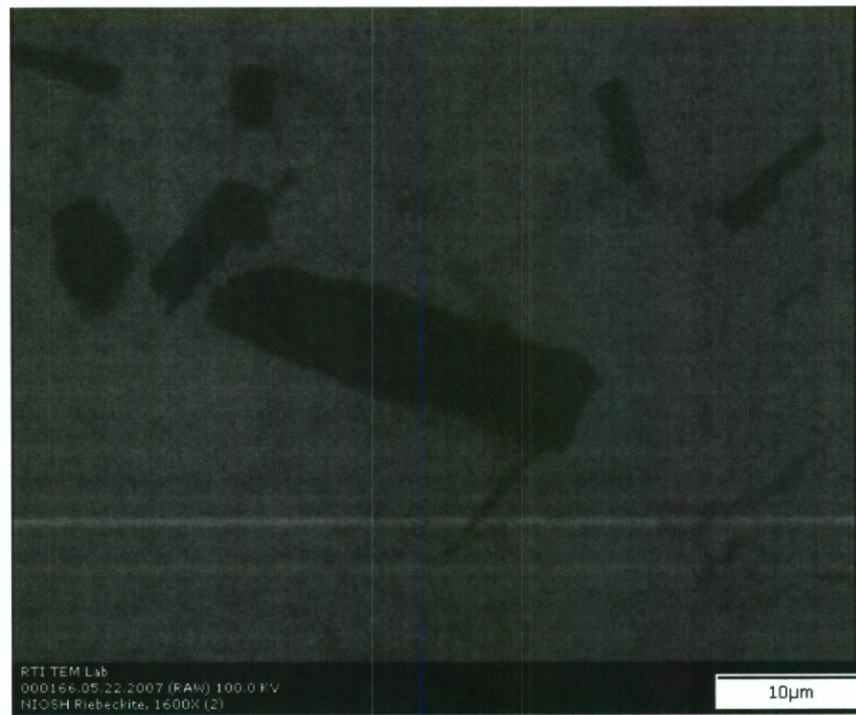
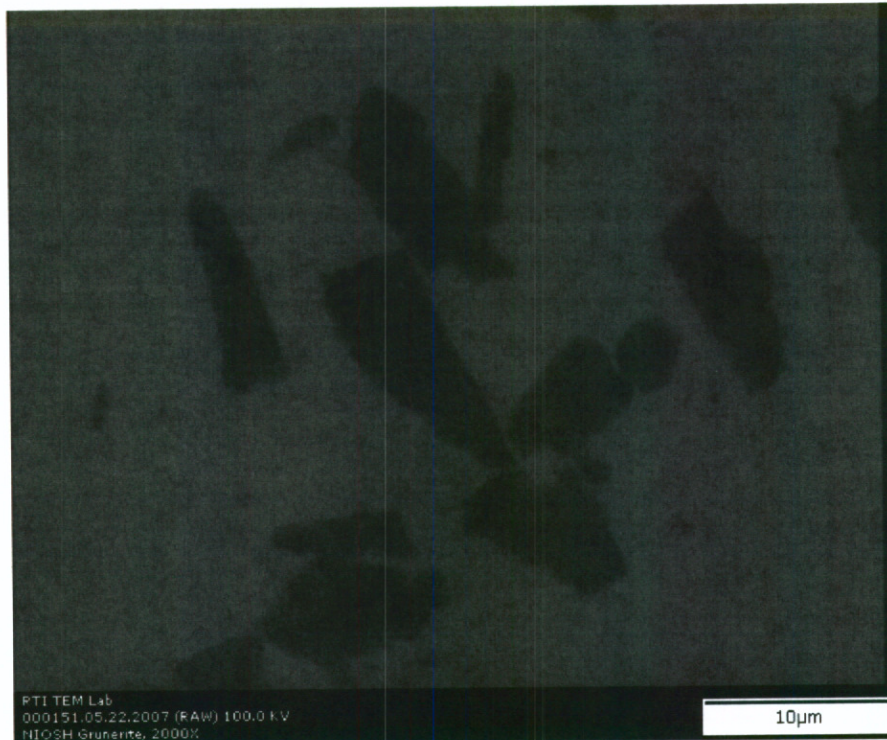
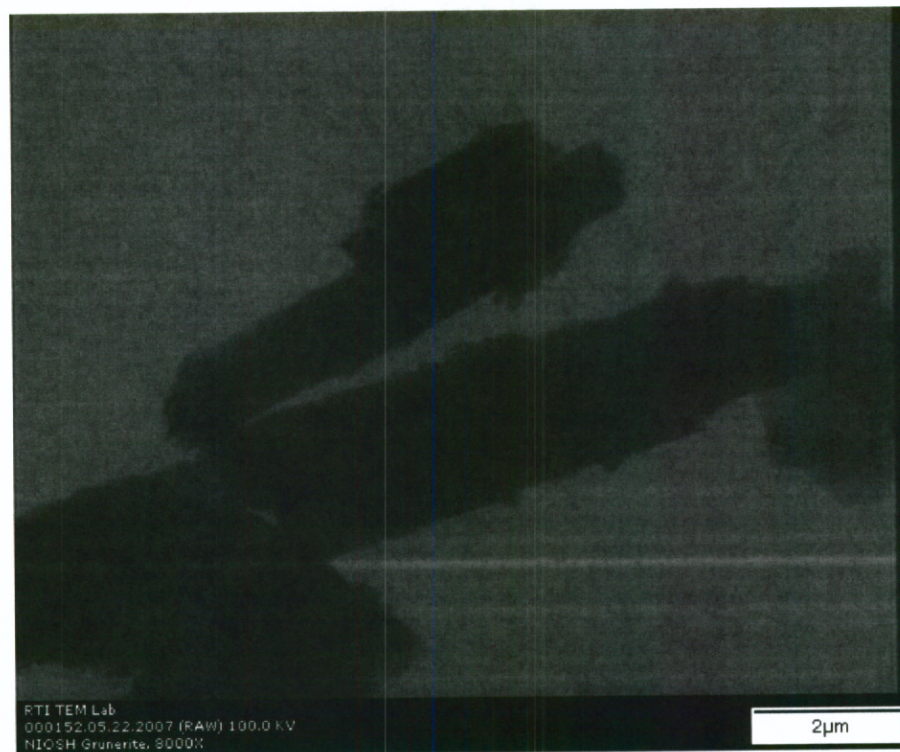


Figure 41. TEM photograph of Riebeckite preparation. 1600X

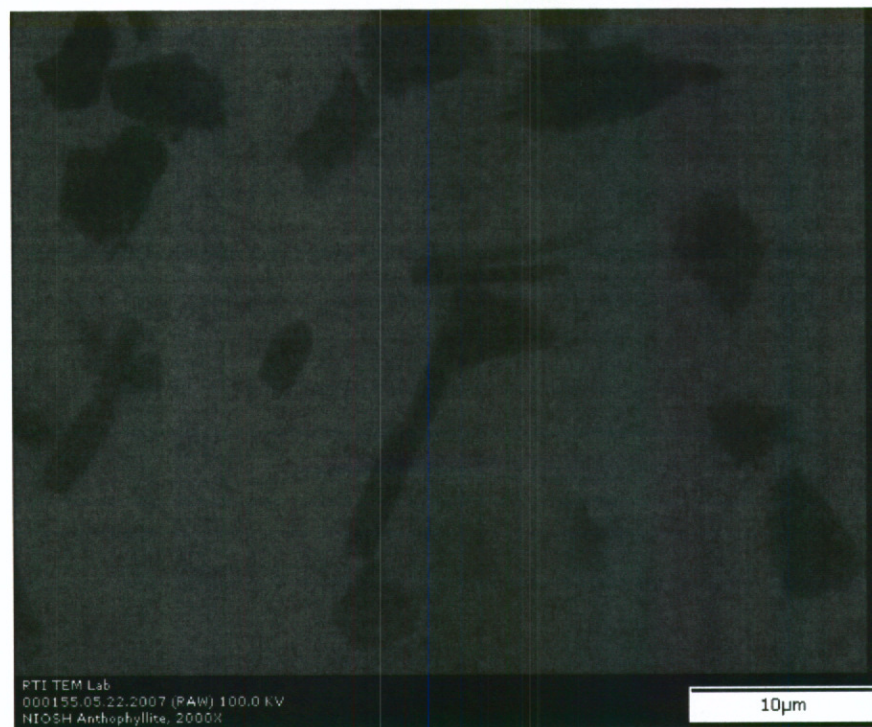


**Figure 42. TEM photograph of Grunerite preparation. 2000X**

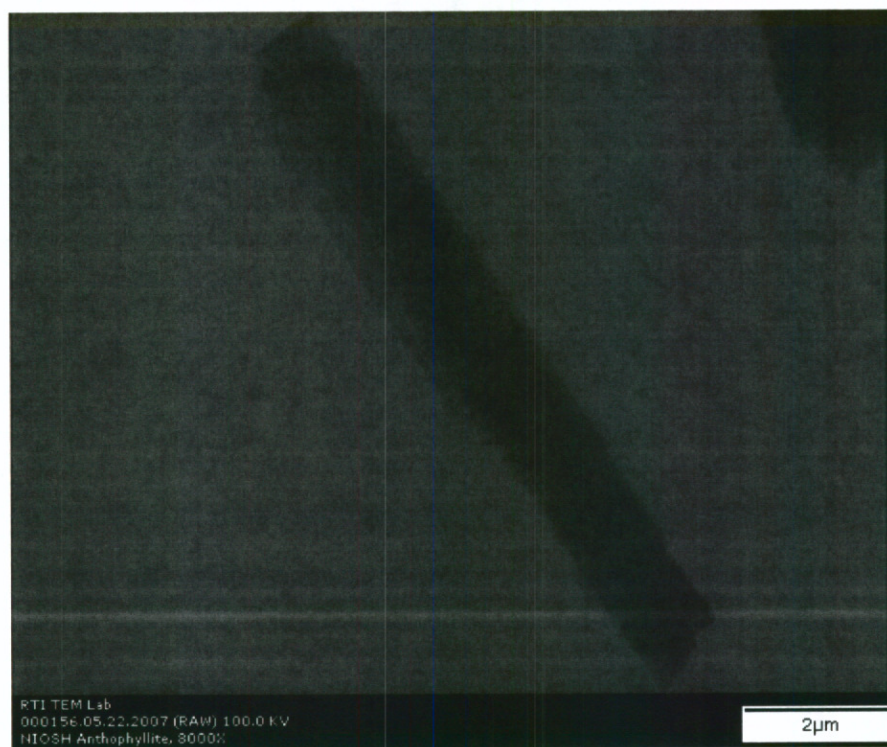


**Figure 43. TEM photograph of Grunerite preparation. 8000X**

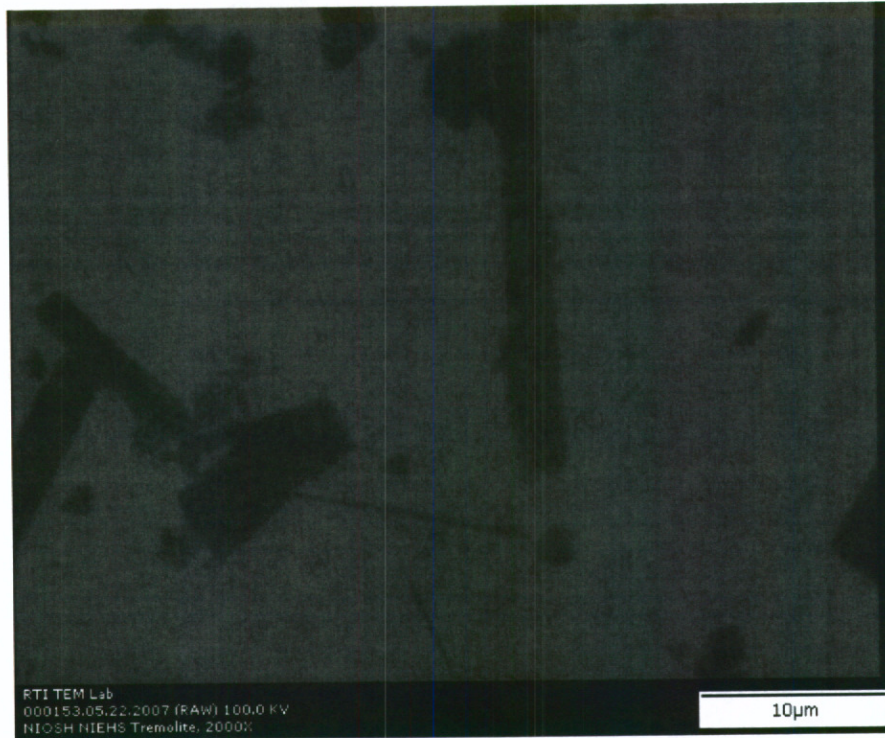




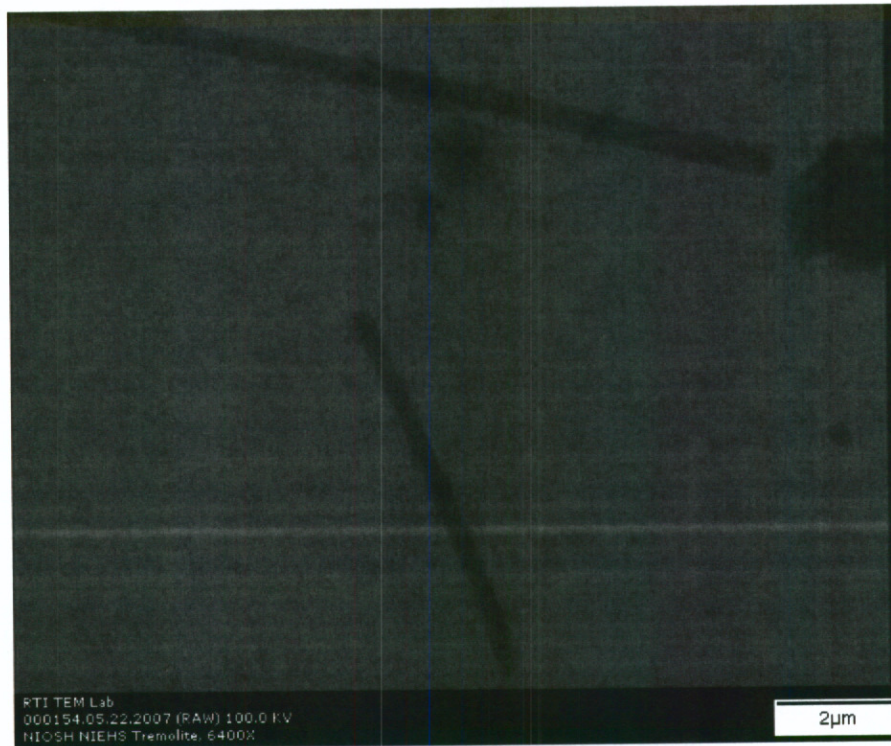
**Figure 44. TEM photograph of Anthophyllite preparation. 2000X**



**Figure 45. TEM photograph of Anthophyllite preparation. 8000X**



**Figure 46. TEM photograph of NIEHS Tremolite preparation. 2000X**



**Figure 47. TEM photograph of NIEHS Tremolite preparation. 6400X**

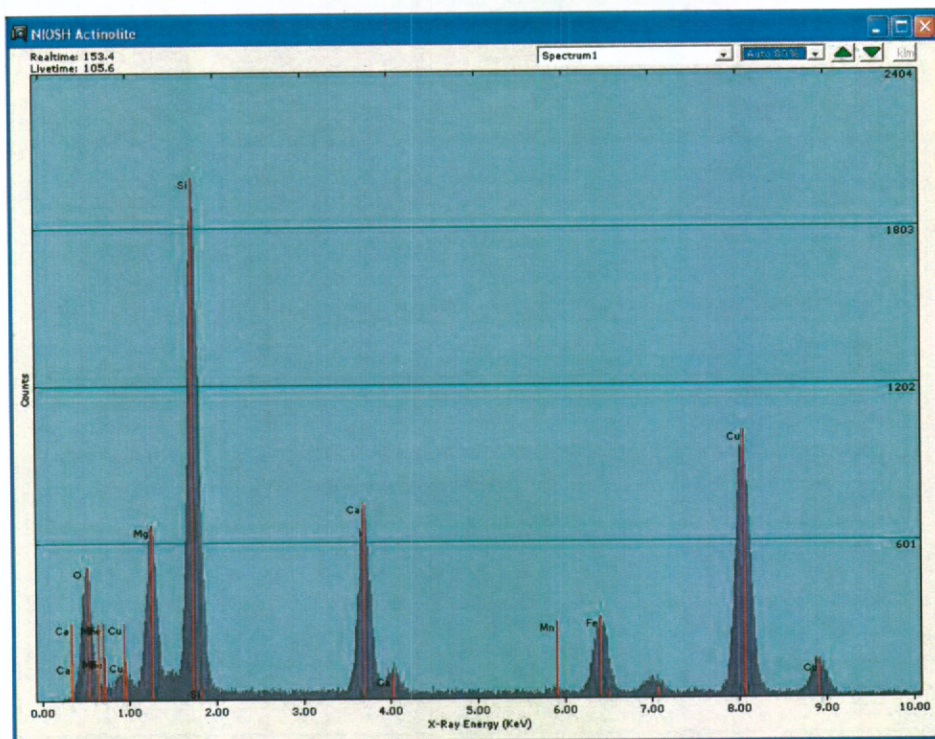


Figure 48. EDS Spectra for Actinolite.

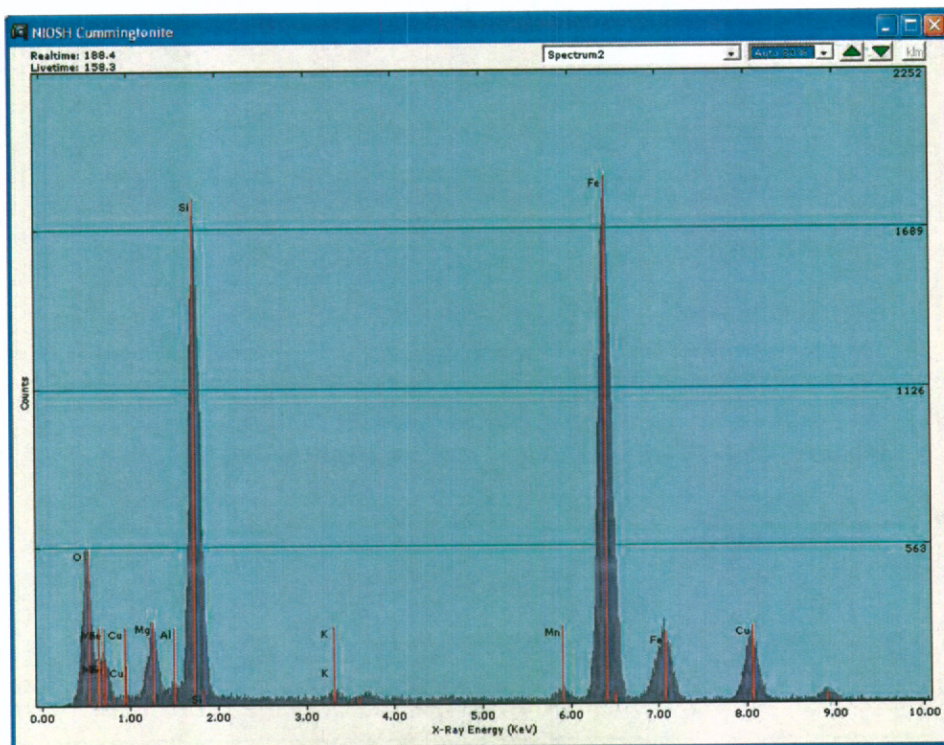


Figure 49. EDS Spectra for Cummingtonite.

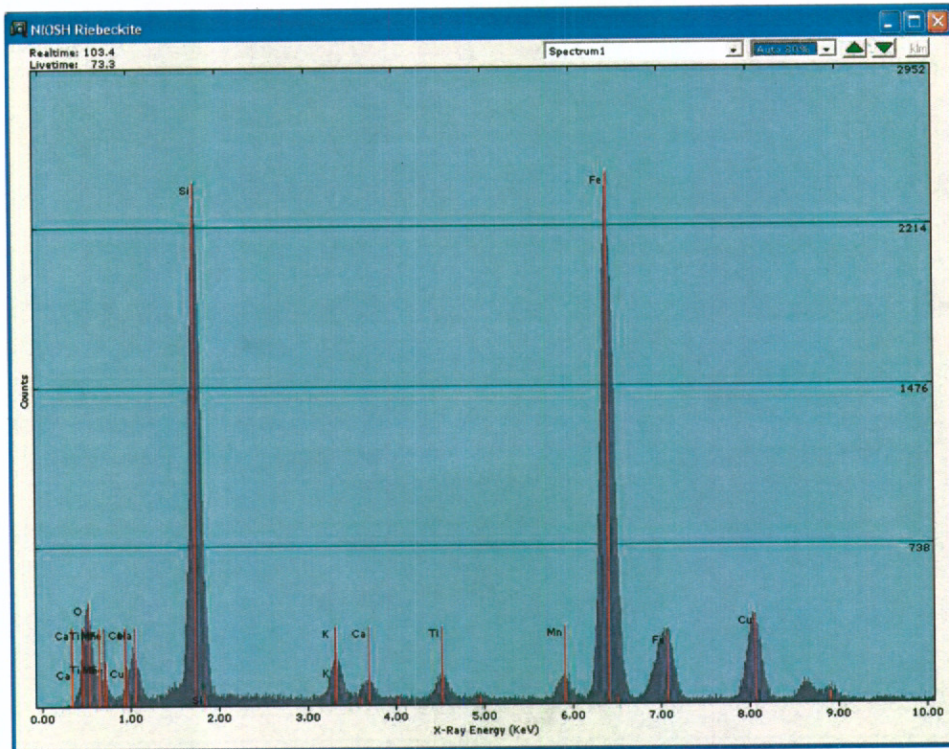


Figure 50. EDS Spectra for Riebeckite preparation.

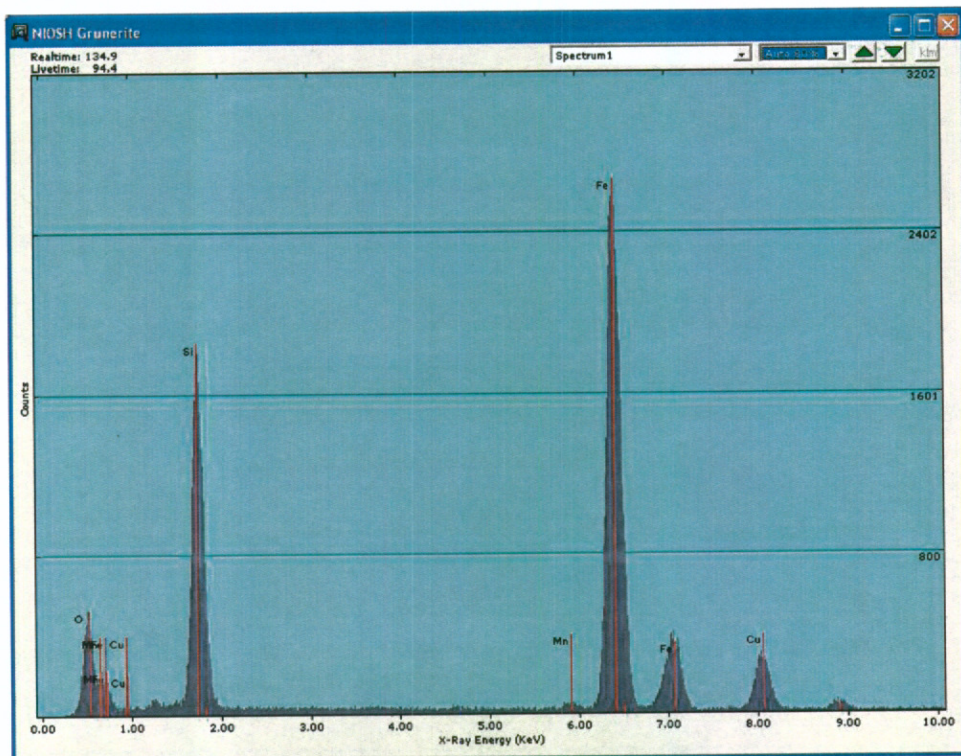


Figure 51. EDS Spectra for Grunerite preparation.

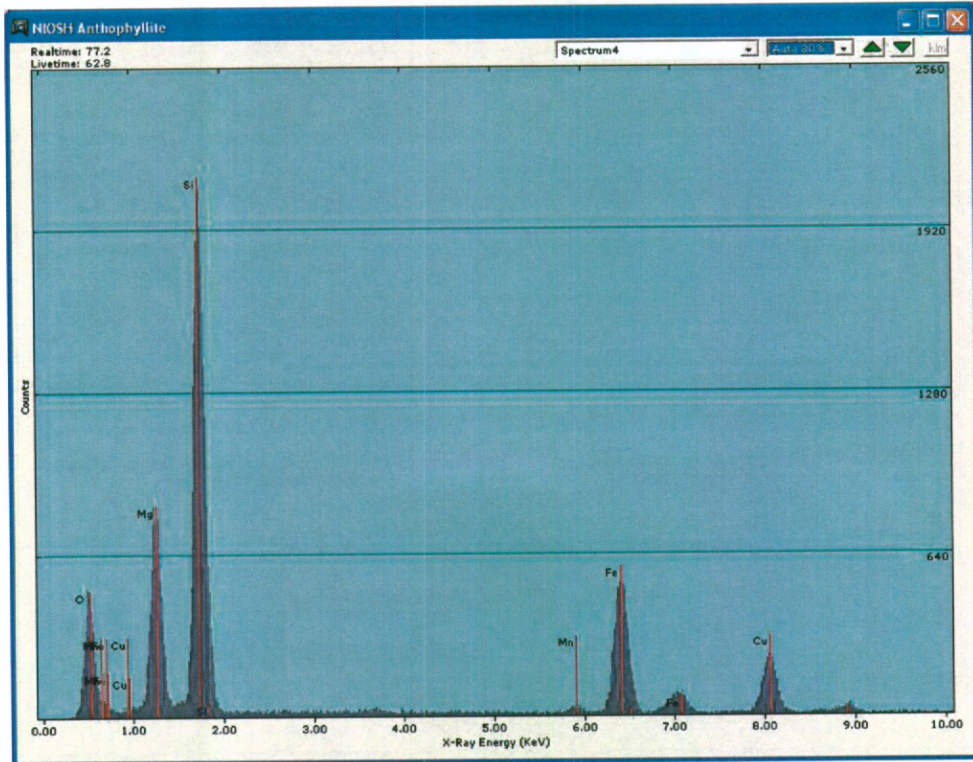


Figure 52. EDS Spectra for Anthophyllite preparation.

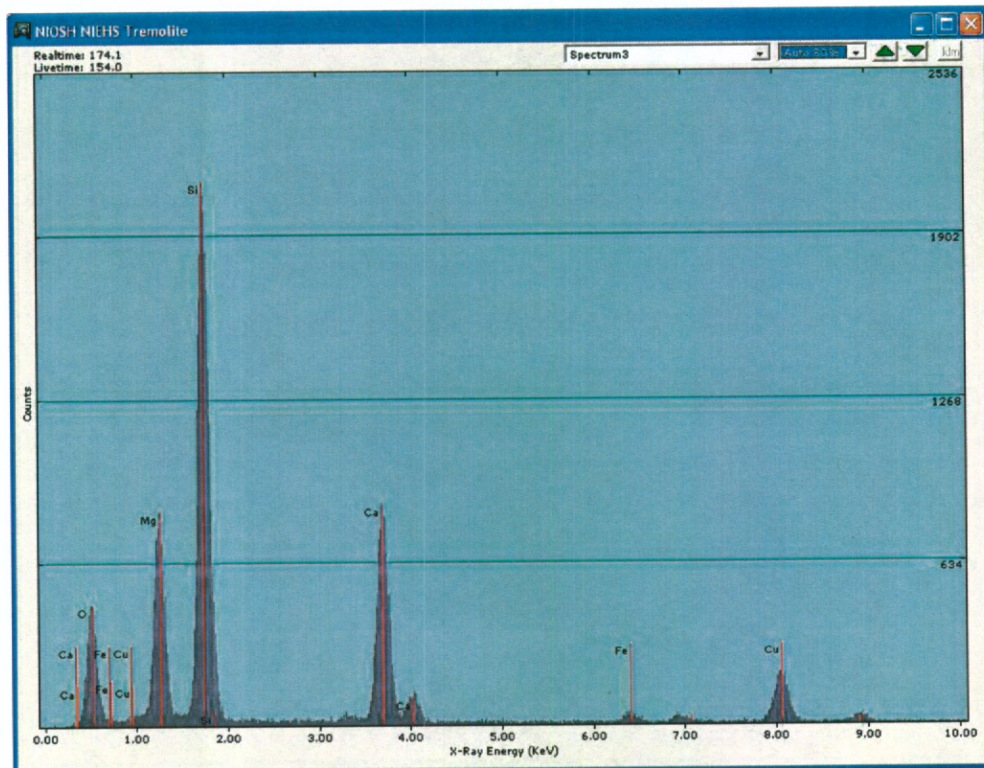


Figure 53. EDS Spectra for NIEHS Tremolite preparation.

Frequency Distribution for 300 Actinolite Particles:  
 Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

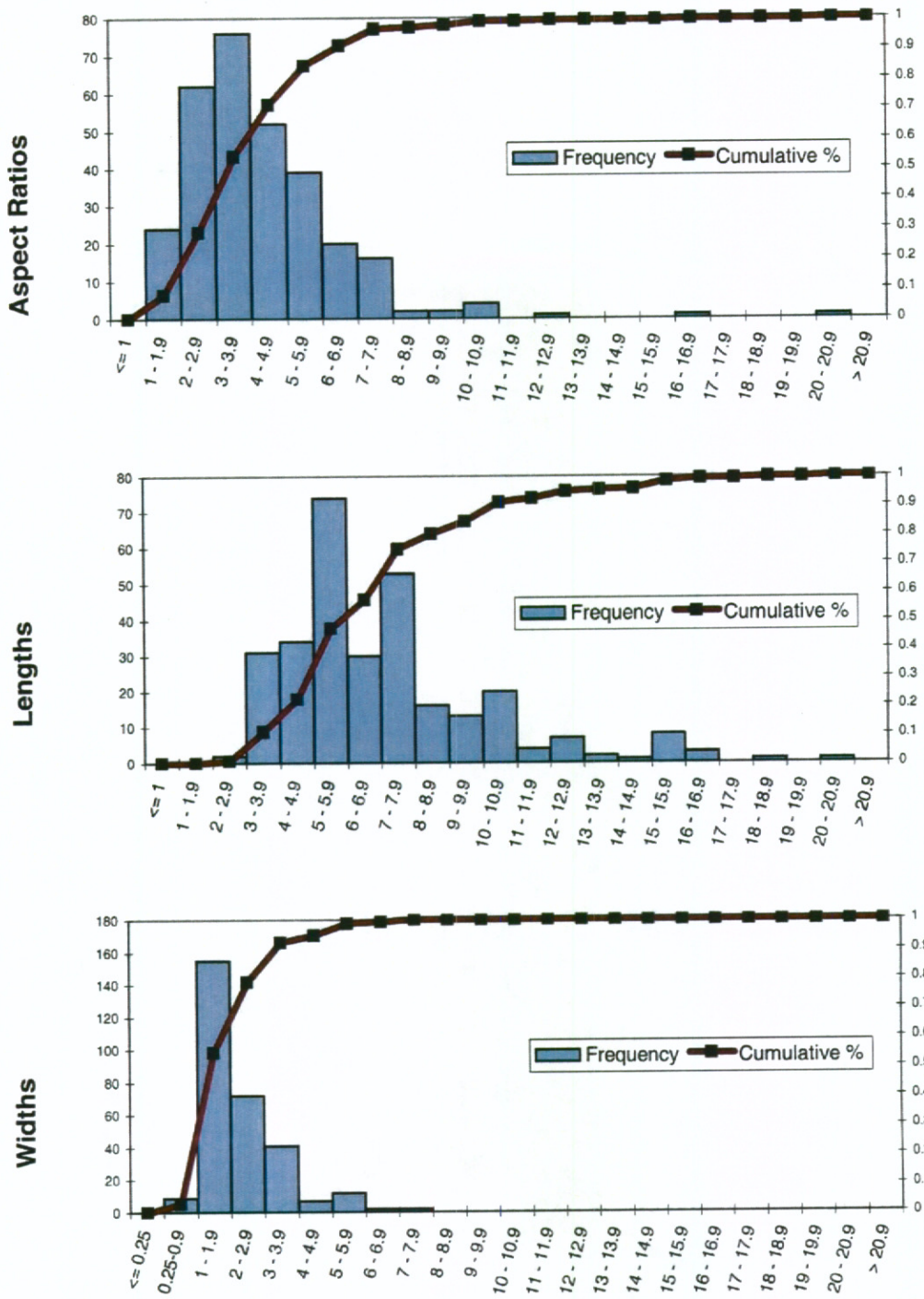


Figure 54. Summary Histograms and Cumulative Frequencies for Actinolite.

Frequency Distribution for 300 Cummingtonite Particles:  
Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

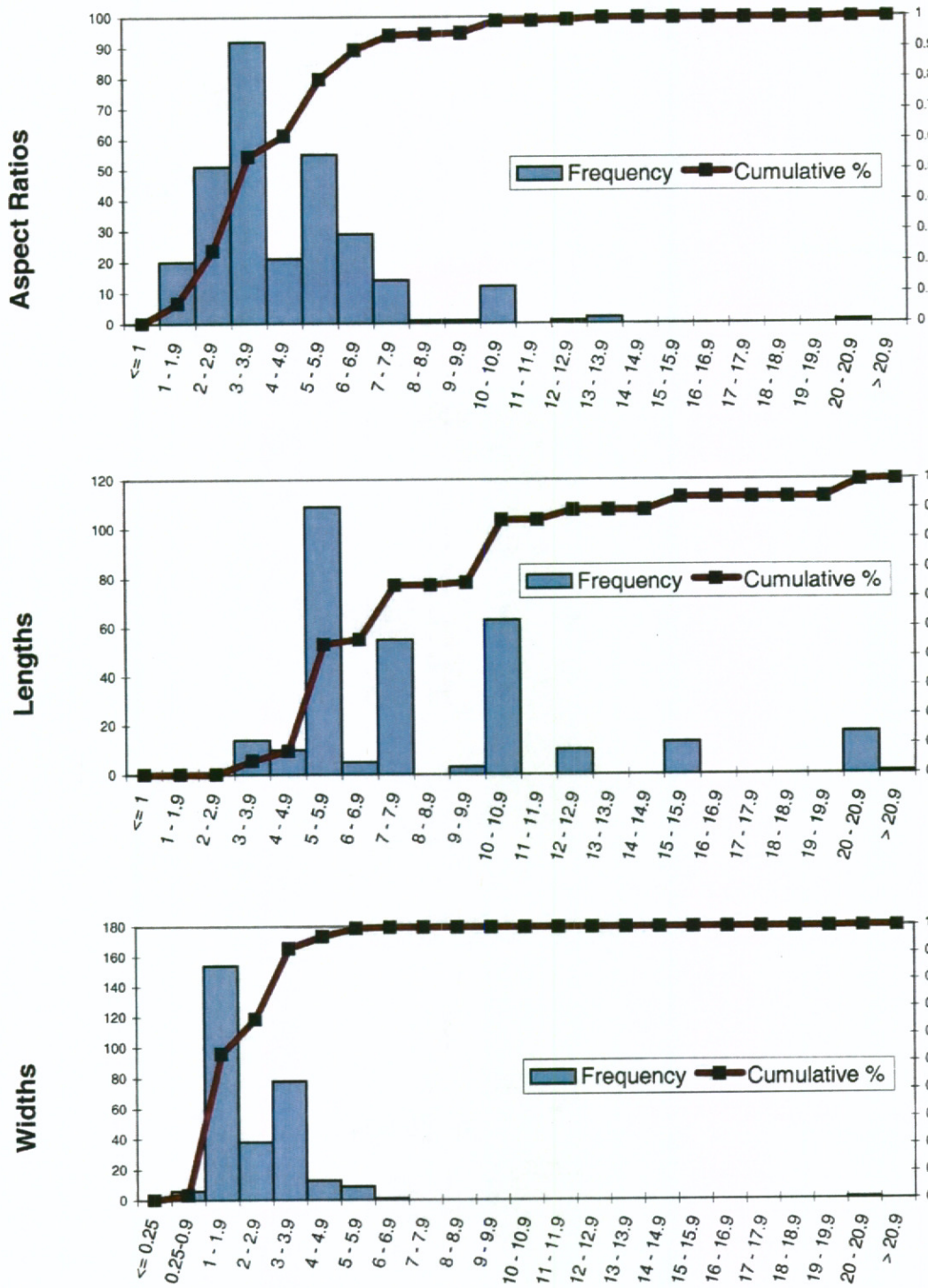
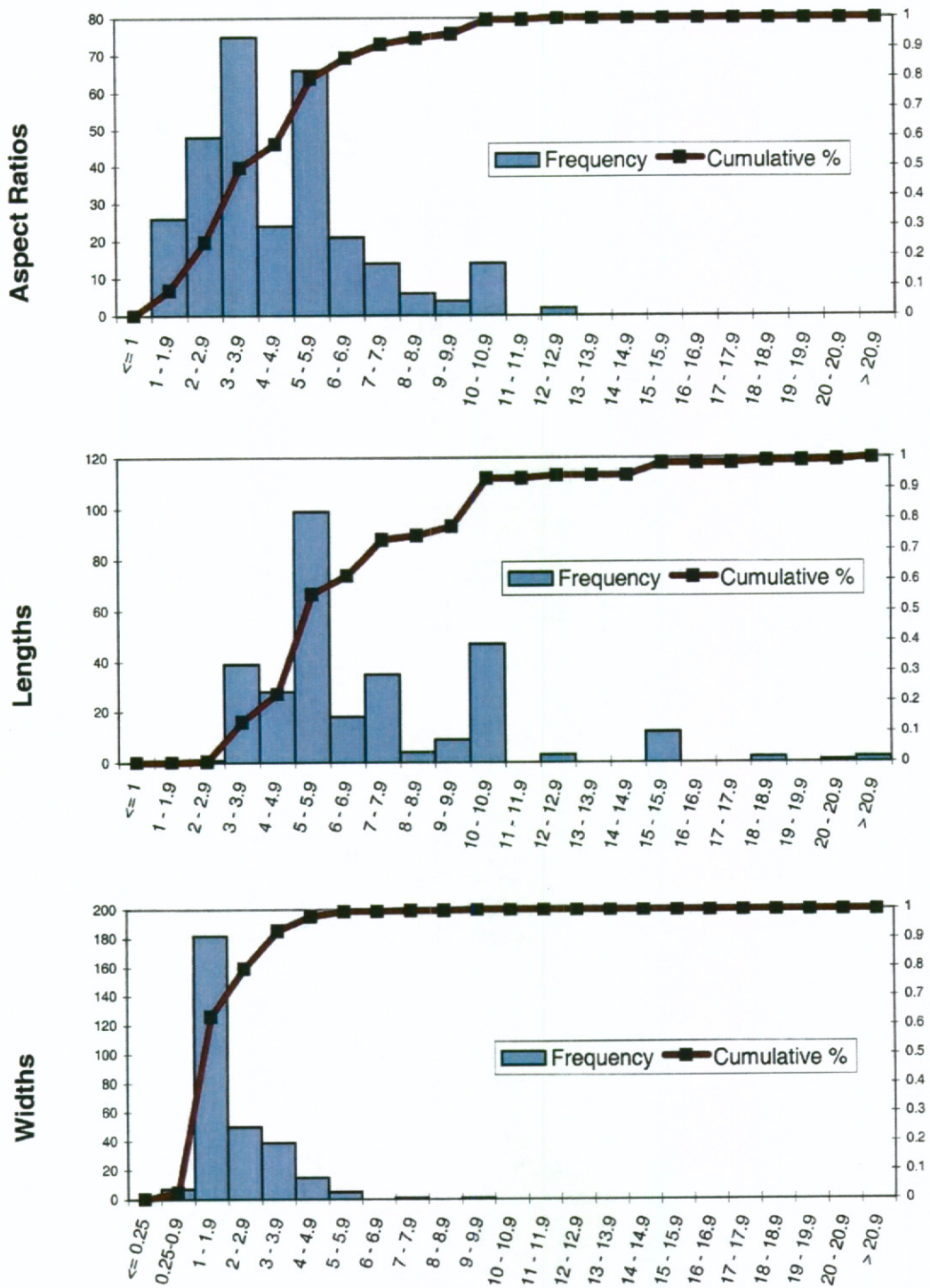


Figure 55. Summary Histograms and Cumulative Frequencies for Cummingtonite.

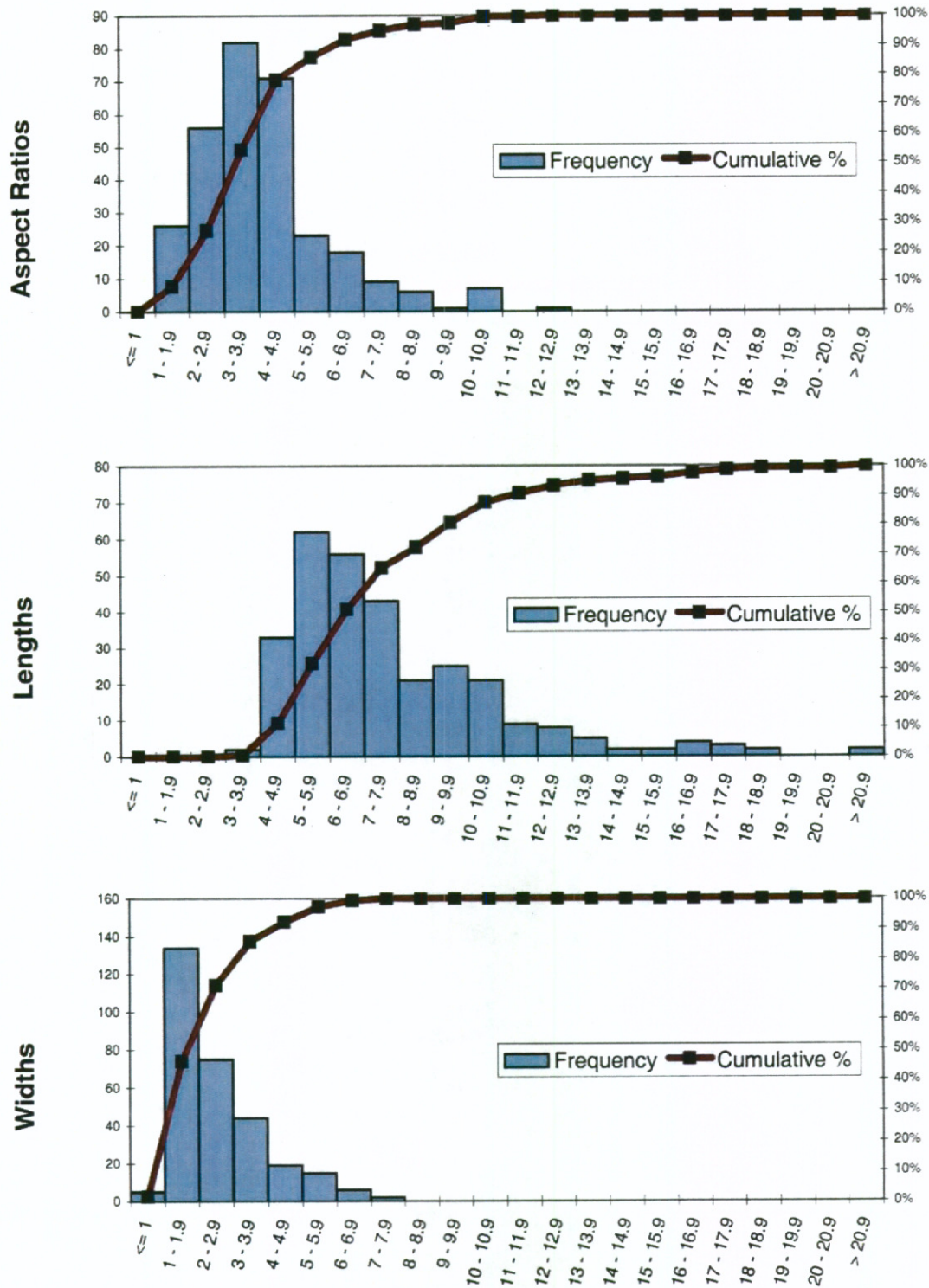
**Frequency Distribution for 300 Riebeckite Particles:  
Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**



**Figure 56. Summary Histograms and Cumulative Frequencies for Riebeckite.**

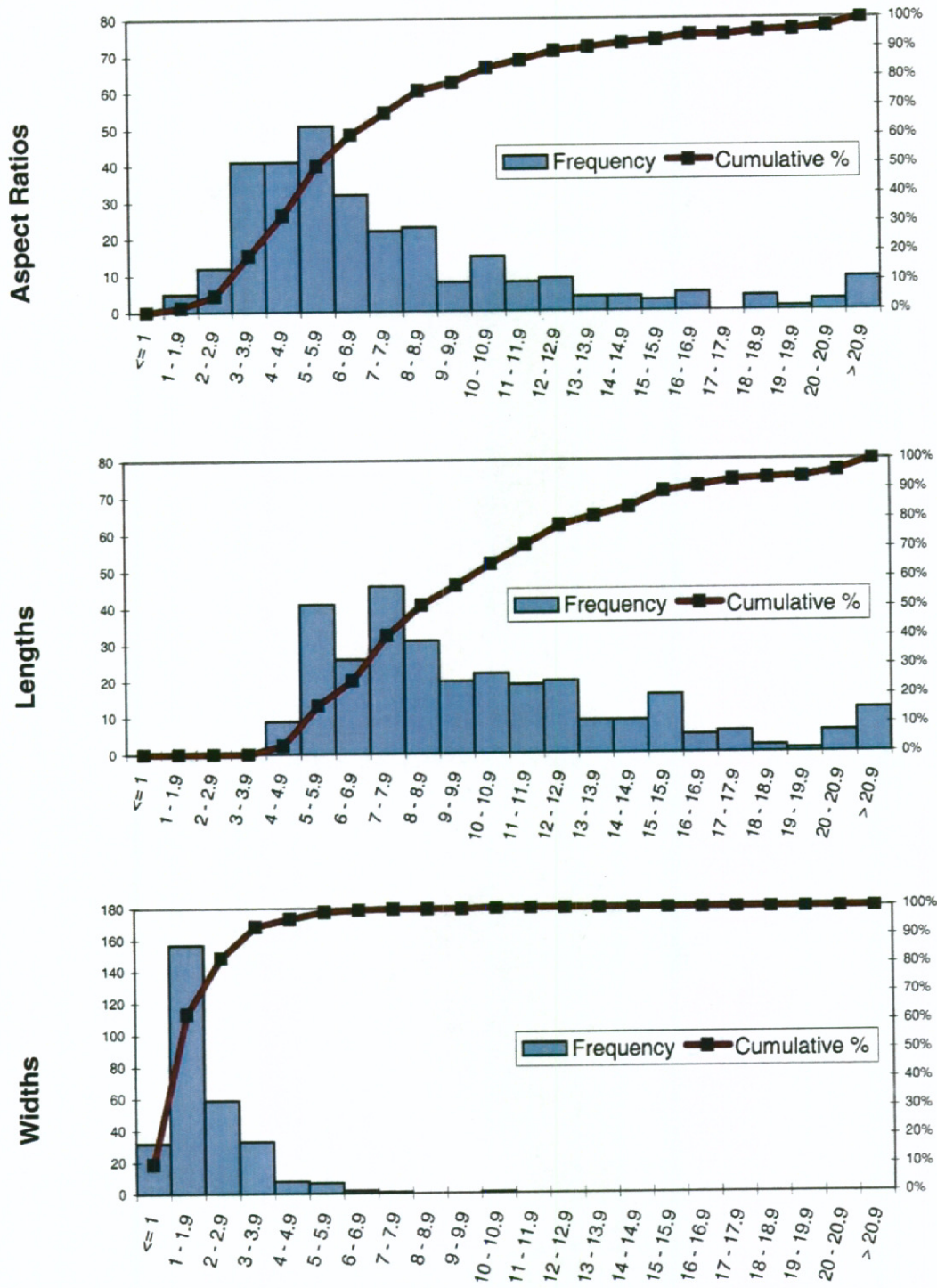


**Frequency Distribution for 300 Grunerite Particles:  
Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**



**Figure 57. Summary Histograms and Cumulative Frequencies for Grunerite.**

**Frequency Distribution for 300 Anthophyllite Particles:  
Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**



**Figure 58. Summary Histograms and Cumulative Frequencies for Anthophyllite.**

Frequency Distribution for 300 Tremolite Particles:  
Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

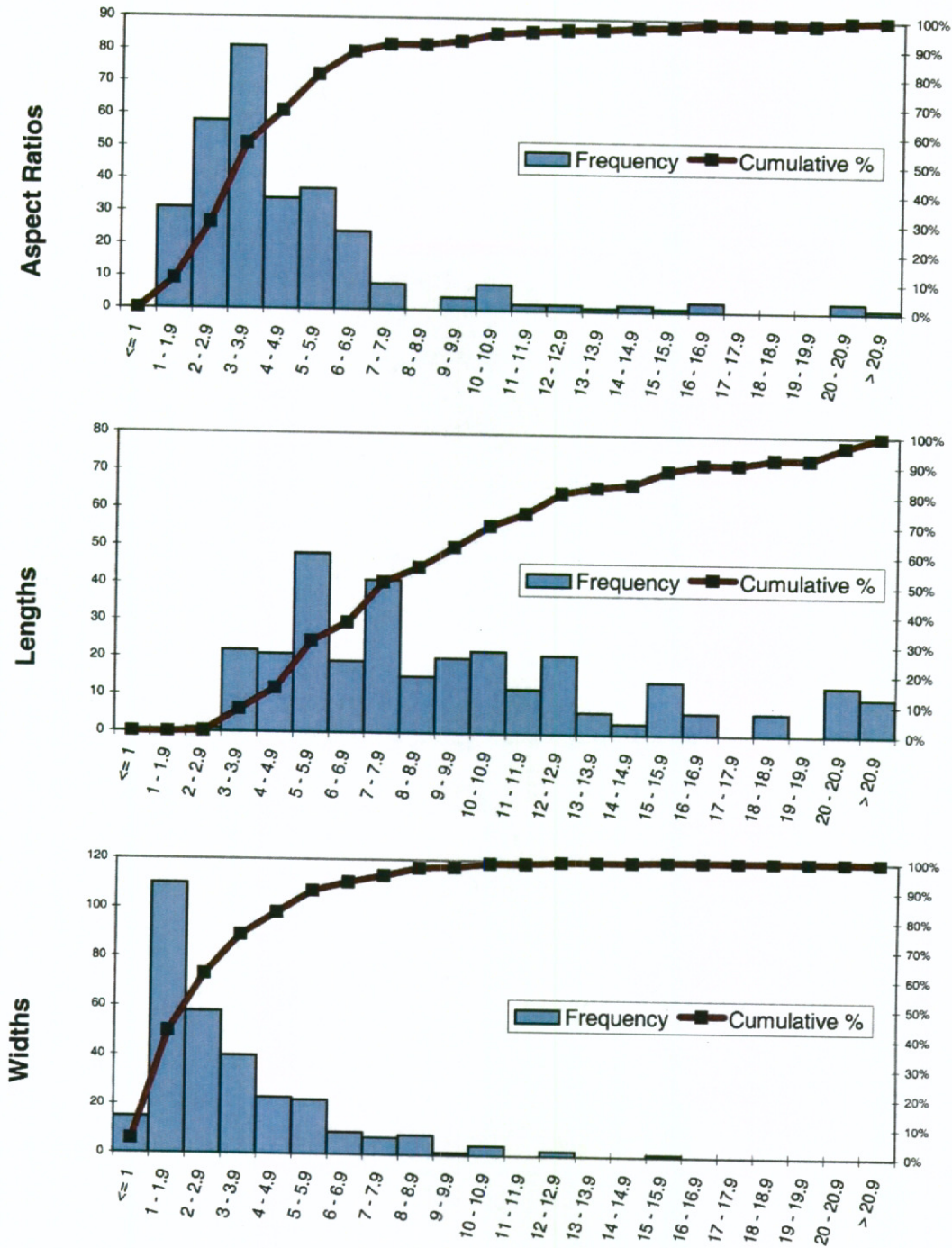


Figure 59. Summary Histograms and Cumulative Frequencies for NIEHS Tremolite.

## **Appendices**

Appendix 1. Procedure for Preparation of Massive Amphibole Samples for NIOSH Amphibole Cleavage Fragment Study

Appendix 2. Procedure for Preparation of Filters for Characterization of Amphibole Samples by PCM and TEM for NIOSH Amphibole Cleavage Fragment Study

Appendix 3. Analytical Data Summaries

Appendix 4. NIOSH 7400 Count Sheets for Each Analyst

## **Appendix 1.**

### **Procedure for Preparation of Massive Amphibole Samples for NIOSH Amphibole Cleavage Fragment Study**

#### **A. Grinding of Minerals**

- 1) Materials were inspected upon receipt for sample integrity and form, checking for any suspect/secondary mineral inclusions, and/or foreign materials.
- 2) Each mineral sample was weighed on a balance to determine starting weight and each weight was recorded in lab notebook.
- 3) Amphibole minerals were prepared for hydraulic crushing, and the press base was cleaned with soap and water and dried between each mineral species.
- 4) Each mineral was crushed to centimeter-sized fragments. The accompanying dust from the crushing processes was recovered to be used in the grinding phase for each mineral. Each crushed mineral was placed in a large glass petri dish and labeled for grinding.
- 5) After all minerals were crushed each entire aliquot of mineral was photographed using the digital camera and the research stereomicroscope at 3.5X magnification to record the appearance and size ranges present in the crushed material.
- 6) Each crushed mineral was then sieved through a 1mm opening-size pan (No.18). The mineral fragments which passed through the 1mm sieve were then separated from the main mineral aliquot and placed in a small glass petri dish and labeled with mineral name and the term "fine fraction" for further sieving and grinding.
- 7) After each mineral was sieved through the 1 mm sieve pan, each mineral was placed in a small glass petri dish for storage until such time that the hand-grinding would ensue.
- 8) Each mineral was then sieved through a 364 micron opening-size pan (No. 45) and also a 250 micron opening-size pan (No. 60). In each case the finer fraction was placed in a labeled glass petri dish and the larger particles were separated, labeled, and stored for eventual grinding.

#### **B. Hand Grinding and PLM Examination**

- 1) The material was ground by hand in a mortar and pestle using very little to no hand pressure for 1 minute intervals. After each minute interval a glass slide mount was prepared with the mineral and a 1.550 refractive index liquid to provide maximum contrast. The slide was then inspected by PLM to observe the range of particle sizes present.

2) Once mineral fragments which measured a minimum of 5 microns long and a maximum of 3 microns wide were observed (but also including a smaller fraction of larger and equant particles) the grinding was ceased.

3) The resultant material was weighed and delivered to the TEM laboratory for suspension, filtration and characterization by PCM and TEM.

6/6/2007

## Appendix 2.

### Procedure for Preparation of Filters for Characterization of Amphibole Samples by PCM and TEM for NIOSH Amphibole Cleavage Fragment Study

#### A. Preparation of Filters

- 1) A measured mass of ground amphibole mineral powder was received from the bulk sample preparation laboratory and placed in a 500 ml beaker with 100 ml of distilled water and 100 ml of isopropyl alcohol. The suspension was sonicated using a Fisher Scientific Model E60 Sonic Dismembrator on a setting of "7" for fifteen minutes.
- 2) The suspension was poured into a 2L graduated cylinder with a stir bar, topped off to 2L (with two drops of Liquinox<sup>®</sup> detergent/surfactant), and stirred for 5 minutes.
- 3) The stir plate was stopped, and once swirling of particles ceased, a timer was started.
- 4) A 0.5 ml aliquot of the suspension was withdrawn from one-third of the way down the graduated cylinder at increments of 5 minutes, 10 minutes, 30 minutes, and 1 hour.
- 5) Aliquots were deposited on 25 mm diameter 0.45 um MCE filters using a 6-station filtration manifold.
- 6) Filters were placed in a labeled petrislide and dried on a slide warmer with a UV warming lamp overhead.
- 7) A quarter of each filter was placed on a labeled slide and collapsed using an acetone vaporizer. A drop of triacetin and a cover slip was placed on the filter.
- 8) Slides were examined to note the characteristics of the particle population, the presence of elongate particles and cleavage fragments, and the density of the particle population.
- 9) Following the exploratory phase of the work, the sample was restirred for five minutes, and the clock was restarted. The sample was allowed to settle for 30 minutes, at which time six 0.5 ml aliquots were filtered for analysis by PCM and TEM.
- 10) A siphon tube was placed in the graduated cylinder and 1500 ml was withdrawn to a large vessel.

11) The suspension was then filtered on the filter manifold using six 25 mm diameter 5.0 um pore size filters, which took generally 10 - 20 minutes.

12) The filters were removed and placed in a petri dish, which was placed on a slide warmer under a UV warming lamp.

13) Once the filters were completely dry, the filtered material was peeled off of the six filters, combined, and placed on a balance. The final mass collected from 1500 ml of suspension after 30 minutes of settling was typically about 10% of the original mass of material.

Other notable aspects of the preparatory work:

- The suspension can be restarted at the zero time period by simply restirring for five minutes and allowing to resettle.
- The early preps had large amounts of large blocky material that had largely dropped out by 30 minutes.
- At one point (the one hour period) aliquots were pulled from the 600 ml. level, the 1200 ml. level, and the top of the suspension to determine if there was a notable difference in the suspension at various levels. There was very little difference in the particle population. Most large particles seem to sink to the bottom of the graduated cylinder in the first 30 minutes.
- During examination, it was noted that particles reside on the filters at several focal planes. To attempt to reduce this factor, a 0.1 um pore size filter was utilized for one aliquot from the two hour suspension. Upon microscopic examination there was no notable improvement in concentrating particles at one focal plane.
- If any less than 0.3 ml of suspension is to be filtered, a serial dilution must be performed (0.3 ml is the minimum volume which will completely wet the filter).
- The amount of the thirty-minute suspension filtered on the 5.0 um filters was approximately 250 ml. This clogs the filters gradually, so it is not likely that much more could be filtered on each filter.

6/5/2007



## **Appendix 3. Analytical Data Summaries**

## **Analytical Data Summaries**

### **3A. Actinolite**

Actinolite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

**Table A: Actinolite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

\* Note: data in red does not meet criteria for counting; ie.  $\geq 5$   $\mu\text{m}$  in length or  $\geq 3:1$  aspect ratio.

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
Structure	1	10.0	1.5	6.7
numbers	2	5.0	3.0	1.7
1-150	3	9.0	5.0	1.8
LCG	4	6.0	2.0	3.0
on	5	5.0	2.0	2.5
Filters 4-6	6	9.0	3.0	3.0
	7	5.0	1.0	5.0
	8	3.0	1.0	3.0
	9	9.0	2.5	3.6
	10	4.0	1.0	4.0
	11	3.0	3.0	1.0
	12	8.0	2.0	4.0
	13	5.0	1.5	3.3
	14	7.0	2.0	3.5
	15	4.0	0.5	8.0
	16	3.0	1.0	3.0
	17	3.0	1.0	3.0
	18	7.0	2.0	3.5
	19	9.0	3.0	3.0
	20	3.0	0.5	6.0
	21	5.0	1.0	5.0
	22	4.0	1.5	2.7
	23	7.0	1.0	7.0
	24	4.0	1.0	4.0
	25	7.0	2.0	3.5
	26	10.0	0.5	20.0
	27	3.0	0.5	6.0

Count of fibers	Count of non-fibers	Total Structures Counted
175	125	300

Percent Fibers	Percent non-fibers
58.3%	41.7%

Meet Fiber Criteria

Fiber

Fiber

Fiber

Fiber

Fiber

Bin

0.9 <= 1

1.9 1 - 1.9

2.9 2 - 2.9

3.9 3 - 3.9

4.9 4 - 4.9

5.9 5 - 5.9

6.9 6 - 6.9

7.9 7 - 7.9

8.9 8 - 8.9

9.9 9 - 9.9

10.9 10 - 10.9

11.9 11 - 11.9

12.9 12 - 12.9

13.9 13 - 13.9

14.9 14 - 14.9

15.9 15 - 15.9

16.9 16 - 16.9

17.9 17 - 17.9

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Actinolite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	28	15.0	4.0	3.8
	29	5.0	2.0	2.5
	30	5.0	2.0	2.5
	31	4.0	1.0	4.0
	32	5.0	2.0	2.5
	33	4.0	1.5	2.7
	34	5.0	1.5	3.3
	35	5.0	2.0	2.5
	36	5.0	1.0	5.0
	37	3.0	1.5	2.0
	38	3.0	1.0	3.0
	39	5.0	1.5	3.3
	40	3.0	1.0	3.0
	41	7.0	2.5	2.8
	42	5.0	2.0	2.5
	43	5.0	2.0	2.5
	44	4.0	2.0	2.0
	45	4.0	1.0	4.0
	46	5.0	1.0	5.0
	47	3.0	1.0	3.0
	48	5.0	2.0	2.5
	49	5.0	1.0	5.0
	50	5.0	1.0	5.0
	51	2.0	0.5	4.0
	52	5.0	1.5	3.3
	53	3.0	1.5	2.0
	54	3.0	1.0	3.0
	55	4.0	2.0	2.0
	56	4.0	1.5	2.7
	57	4.0	1.0	4.0
	58	3.0	2.0	1.5
	59	15.0	6.0	2.5
	60	5.0	5.0	1.0
	61	3.0	2.0	1.5

Bin	Meet Fiber Criteria	58.3%	41.7%
18.9	18 - 18.9	Fiber	
19.9	19 - 19.9		
20.9	20 - 20.9		
More	> 20.9		
0.24	<= 0.25	Fiber	
0.9	0.25-0.9		
1.9	1 - 1.9		
2.9	2 - 2.9	Fiber	
3.9	3 - 3.9		
4.9	4 - 4.9		
5.9	5 - 5.9		
6.9	6 - 6.9		
7.9	7 - 7.9		
8.9	8 - 8.9		
9.9	9 - 9.9	Fiber	
10.9	10 - 10.9		
11.9	11 - 11.9		
12.9	12 - 12.9	Fiber	
13.9	13 - 13.9	Fiber	
14.9	14 - 14.9		
15.9	15 - 15.9	Fiber	
16.9	16 - 16.9		
17.9	17 - 17.9		
18.9	18 - 18.9		
19.9	19 - 19.9		
20.9	20 - 20.9		
More	> 20.9		

Actinolite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	62	4.0	1.5	2.7
	63	3.0	1.0	3.0
	64	6.0	3.0	2.0
	65	3.0	1.5	2.0
	66	4.0	1.5	2.7
	67	4.0	1.0	4.0
	68	3.0	2.5	1.2
	69	5.0	2.5	2.0
	70	4.0	1.0	4.0
	71	7.5	1.5	5.0
	72	3.0	1.5	2.0
	73	4.0	1.5	2.7
	74	3.0	1.0	3.0
	75	5.0	2.5	2.0
	76	7.0	1.5	4.7
	77	5.0	1.0	5.0
	78	4.0	1.5	2.7
	79	6.0	1.5	4.0
	80	3.0	1.0	3.0
	81	10.0	3.0	3.3
	82	10.0	2.0	5.0
	83	4.0	1.5	2.7
	84	3.0	1.0	3.0
	85	7.0	2.5	2.8
	86	9.0	3.0	3.0
	87	9.0	2.5	3.6
	88	4.0	1.5	2.7
	89	7.0	1.0	7.0
	90	3.0	1.0	3.0
	91	5.0	0.5	10.0
	92	3.0	1.0	3.0
	93	3.0	3.0	1.0
	94	5.0	1.0	5.0
	95	10.0	3.0	3.3

Meet Fiber Criteria 58.3% 41.7%

Fiber

Fiber  
Fiber

Fiber

Fiber  
Fiber

Fiber  
Fiber

Fiber

Fiber

Fiber  
Fiber

Actinolite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	96	4.0	1.0	4.0
	97	2.0	1.0	2.0
	98	5.0	0.5	10.0
	99	7.0	2.0	3.5
	100	7.0	1.5	4.7
	101	5.0	3.0	1.7
	102	5.0	1.5	3.3
	103	3.0	1.0	3.0
	104	3.0	1.0	3.0
	105	7.0	1.5	4.7
	106	7.0	1.5	4.7
	107	4.0	1.5	2.7
	108	7.0	1.5	4.7
	109	5.0	1.0	5.0
	110	7.0	1.0	7.0
	111	7.0	1.0	7.0
	112	7.0	1.0	7.0
	113	7.0	1.0	7.0
	114	7.0	1.0	7.0
	115	5.0	1.0	5.0
	116	3.0	1.5	2.0
	117	5.0	1.0	5.0
	118	3.0	1.0	3.0
	119	7.5	1.0	7.5
	120	10.0	3.0	3.3
	121	7.5	1.5	5.0
	122	8.0	0.5	16.0
	123	7.0	1.5	4.7
	124	5.0	2.0	2.5
	125	7.0	1.0	7.0
	126	15.0	2.5	6.0
	127	10.0	2.0	5.0
	128	5.0	1.0	5.0
	129	5.0	1.5	3.3

Meet  
Fiber  
Criteria 58.3% 41.7%

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Actinolite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	130	10.0	3.0	3.3
	131	10.0	1.5	6.7
	132	7.0	5.0	1.4
	133	5.0	2.5	2.0
	134	5.0	2.0	2.5
	135	6.0	1.5	4.0
	136	7.0	1.5	4.7
	137	4.0	1.0	4.0
	138	6.0	1.5	4.0
	139	8.0	1.5	5.3
	140	7.0	1.5	4.7
	141	8.0	2.0	4.0
	142	3.0	2.0	1.5
	143	5.0	1.0	5.0
	144	7.0	2.0	3.5
	145	4.0	1.0	4.0
	146	5.0	1.5	3.3
	147	9.0	1.0	9.0
	148	4.0	2.0	2.0
	149	5.0	3.0	1.7
	150	5.0	3.0	1.7
Structure numbers	151	8.0	3.0	2.7
151-300	152	10.0	5.0	2.0
BWH	153	6.0	0.5	12.0
on	154	7.0	1.0	7.0
Filters 1-3	155	8.0	3.0	2.7
	156	6.0	1.0	6.0
	157	7.0	2.0	3.5
	158	5.0	2.0	2.5
	159	5.0	3.0	1.7
	160	5.0	1.0	5.0
	161	6.0	1.0	6.0
	162	6.0	1.0	6.0
	163	8.0	1.5	5.3

Meet Fiber Criteria 58.3% 41.7%

Fiber  
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Actinolite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	164	12.0	4.0	3.0
	165	7.0	1.5	4.7
	166	5.0	1.0	5.0
	167	5.0	2.0	2.5
	168	10.0	2.0	5.0
	169	10.0	3.0	3.3
	170	7.0	1.5	4.7
	171	5.0	2.0	2.5
	172	5.0	1.0	5.0
	173	5.0	1.5	3.3
	174	6.0	2.0	3.0
	175	8.0	4.0	2.0
	176	9.0	3.0	3.0
	177	9.0	1.0	9.0
	178	7.0	1.5	4.7
	179	7.0	3.0	2.3
	180	15.0	5.0	3.0
	181	10.0	1.0	10.0
	182	7.0	4.0	1.8
	183	6.0	1.5	4.0
	184	15.0	3.0	5.0
	185	5.0	2.0	2.5
	186	8.0	1.5	5.3
	187	12.0	3.0	4.0
	188	12.0	3.0	4.0
	189	6.0	1.5	4.0
	190	5.0	2.0	2.5
	191	9.0	4.0	2.3
	192	15.0	3.0	5.0
	193	18.0	5.0	3.6
	194	8.0	1.5	5.3
	195	6.0	5.0	1.2
	196	10.0	5.0	2.0
	197	7.0	2.0	3.5

Meet  
Fiber  
Criteria 58.3% 41.7%

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Actinolite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	232	3.0	2.0	1.5
	233	5.0	2.0	2.5
	234	6.0	2.0	3.0
	235	6.0	1.5	4.0
	236	7.0	1.0	7.0
	237	7.0	5.0	1.4
	238	5.0	1.5	3.3
	239	10.0	1.5	6.7
	240	5.0	1.0	5.0
	241	7.0	2.0	3.5
	242	4.0	1.0	4.0
	243	16.0	2.0	8.0
	244	5.0	1.5	3.3
	245	7.0	2.0	3.5
	246	6.0	2.0	3.0
	247	7.0	1.0	7.0
	248	4.0	1.0	4.0
	249	7.0	1.5	4.7
	250	7.0	2.5	2.8
	251	6.0	1.0	6.0
	252	16.0	5.0	3.2
	253	11.0	5.0	2.2
	254	4.0	1.0	4.0
	255	11.0	3.0	3.7
	256	10.0	2.0	5.0
	257	20.0	6.0	3.3
	258	7.0	4.0	1.8
	259	5.0	1.0	5.0
	260	6.0	1.0	6.0
	261	5.0	3.0	1.7
	262	7.0	2.0	3.5
	263	8.0	1.5	5.3
	264	15.0	3.0	5.0
	265	6.0	1.0	6.0

Meet  
Fiber  
Criteria 58.3% 41.7%

Fiber  
Fiber  
Fiber

Fiber  
Fiber  
Fiber

Fiber  
Fiber  
Fiber  
Fiber

Fiber

Fiber  
Fiber

Fiber  
Fiber  
Fiber

Fiber  
Fiber

Fiber  
Fiber  
Fiber  
Fiber

Actinolite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	266	16.0	3.0	5.3
	267	12.0	5.0	2.4
	268	10.0	1.5	6.7
	269	5.0	1.5	3.3
	270	5.0	1.0	5.0
	271	10.0	1.0	10.0
	272	4.0	1.0	4.0
	273	5.0	3.0	1.7
	274	10.0	7.0	1.4
	275	7.0	2.0	3.5
	276	11.0	1.5	7.3
	277	5.0	1.5	3.3
	278	7.0	2.0	3.5
	279	6.0	1.0	6.0
	280	5.0	3.0	1.7
	281	6.0	1.5	4.0
	282	5.0	1.5	3.3
	283	4.0	1.0	4.0
	284	3.0	1.0	3.0
	285	5.0	2.5	2.5
	286	15.0	7.0	2.1
	287	5.0	2.0	2.5
	288	7.0	2.0	3.5
	289	8.0	3.0	2.7
	290	5.0	1.5	3.3
	291	7.0	3.0	2.3
	292	4.0	1.0	4.0
	293	4.0	3.0	1.3
	294	5.0	1.5	3.3
	295	7.0	1.0	7.0
	296	5.0	2.0	2.5
	297	12.0	3.0	4.0
	298	14.0	2.0	7.0
	299	6.0	1.0	6.0

Meet  
Fiber  
Criteria 58.3% 41.7%

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Actinolite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	300	12.0	4.0	3.0

Meet  
Fiber  
Criteria 58.3% 41.7%  
Fiber

**Table A1: Summary Statistics for Actinolite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

<i>Length (microns)</i>		<i>Width (microns)</i>		<i>Aspect Ratio</i>	
<b>Mean</b>	6.58	<b>Mean</b>	1.93	<b>Mean</b>	4.01
<b>Standard Error</b>	0.18	<b>Standard Error</b>	0.07	<b>Standard Error</b>	0.12
<b>Median</b>	6.00	<b>Median</b>	1.50	<b>Median</b>	3.50
<b>Mode</b>	5.00	<b>Mode</b>	1.00	<b>Mode</b>	4.00
<b>Standard Deviation</b>	3.05	<b>Standard Deviation</b>	1.14	<b>Standard Deviation</b>	2.12
<b>Sample Variance</b>	9.30	<b>Sample Variance</b>	1.29	<b>Sample Variance</b>	4.51
<b>Kurtosis</b>	2.44	<b>Kurtosis</b>	3.55	<b>Kurtosis</b>	13.85
<b>Skewness</b>	1.44	<b>Skewness</b>	1.72	<b>Skewness</b>	2.65
<b>Range</b>	18.00	<b>Range</b>	6.50	<b>Range</b>	19.00
<b>Minimum</b>	2.00	<b>Minimum</b>	0.50	<b>Minimum</b>	1.00
<b>Maximum</b>	20.00	<b>Maximum</b>	7.00	<b>Maximum</b>	20.00
<b>Sum</b>	1974.50	<b>Sum</b>	579.50	<b>Sum</b>	1202.27
<b>Count</b>	300	<b>Count</b>	300	<b>Count</b>	300

**Table A2. Aspect Ratios for Actinolite Particles: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Aspect Ratio</i>
0.9	0	0.0%	0.0%	<= 1
1.9	24	8.0%	8.0%	1 - 1.9
2.9	62	20.7%	28.7%	2 - 2.9
3.9	76	25.3%	54.0%	3 - 3.9
4.9	52	17.3%	71.3%	4 - 4.9
5.9	39	13.0%	84.3%	5 - 5.9
6.9	20	6.7%	91.0%	6 - 6.9
7.9	16	5.3%	96.3%	7 - 7.9
8.9	2	0.7%	97.0%	8 - 8.9
9.9	2	0.7%	97.7%	9 - 9.9
10.9	4	1.3%	99.0%	10 - 10.9
11.9	0	0.0%	99.0%	11 - 11.9
12.9	1	0.3%	99.3%	12 - 12.9
13.9	0	0.0%	99.3%	13 - 13.9
14.9	0	0.0%	99.3%	14 - 14.9
15.9	0	0.0%	99.3%	15 - 15.9
16.9	1	0.3%	99.7%	16 - 16.9
17.9	0	0.0%	99.7%	17 - 17.9
18.9	0	0.0%	99.7%	18 - 18.9
19.9	0	0.0%	99.7%	19 - 19.9
20.9	1	0.3%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9

Sum 300

**Table A3. Lengths for Actinolite Particles: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

<i>Length (microns)</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Length (microns)</i>
0.9	0	0.0%	0.0%	<= 1
1.9	0	0.0%	0.0%	1 - 1.9
2.9	2	0.7%	0.7%	2 - 2.9
3.9	31	10.3%	11.0%	3 - 3.9
4.9	34	11.3%	22.3%	4 - 4.9
5.9	74	24.7%	47.0%	5 - 5.9
6.9	30	10.0%	57.0%	6 - 6.9
7.9	53	17.7%	74.7%	7 - 7.9
8.9	16	5.3%	80.0%	8 - 8.9
9.9	13	4.3%	84.3%	9 - 9.9
10.9	20	6.7%	91.0%	10 - 10.9
11.9	4	1.3%	92.3%	11 - 11.9
12.9	7	2.3%	94.7%	12 - 12.9
13.9	2	0.7%	95.3%	13 - 13.9
14.9	1	0.3%	95.7%	14 - 14.9
15.9	8	2.7%	98.3%	15 - 15.9
16.9	3	1.0%	99.3%	16 - 16.9
17.9	0	0.0%	99.3%	17 - 17.9
18.9	1	0.3%	99.7%	18 - 18.9
19.9	0	0.0%	99.7%	19 - 19.9
20.9	1	0.3%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9
Sum	300			

**Table A4. Widths for Actinolite Particles: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>
0.24	0	0.0%	0.0%	<= 0.25
0.9	9	3.0%	3.0%	0.25-0.9
1.9	155	51.7%	54.7%	1 - 1.9
2.9	72	24.0%	78.7%	2 - 2.9
3.9	41	13.7%	92.3%	3 - 3.9
4.9	7	2.3%	94.7%	4 - 4.9
5.9	12	4.0%	98.7%	5 - 5.9
6.9	2	0.7%	99.3%	6 - 6.9
7.9	2	0.7%	100.0%	7 - 7.9
8.9	0	0.0%	100.0%	8 - 8.9
9.9	0	0.0%	100.0%	9 - 9.9
10.9	0	0.0%	100.0%	10 - 10.9
11.9	0	0.0%	100.0%	11 - 11.9
12.9	0	0.0%	100.0%	12 - 12.9
13.9	0	0.0%	100.0%	13 - 13.9
14.9	0	0.0%	100.0%	14 - 14.9
15.9	0	0.0%	100.0%	15 - 15.9
16.9	0	0.0%	100.0%	16 - 16.9
17.9	0	0.0%	100.0%	17 - 17.9
18.9	0	0.0%	100.0%	18 - 18.9
19.9	0	0.0%	100.0%	19 - 19.9
20.9	0	0.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9
Sum	300			



Actinolite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

**Table B. Actinolite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)**

\* Note: data in red does not meet criteria for counting; ie.  $\geq 5 \mu\text{m}$  in length or  $\geq 3:1$  aspect ratio.

Filter	Grid	Grid Opening	Struct. Number	Length (microns)	Width (microns)	Aspect Ratio
1	A1	D23	1	4.8	0.6	8.0
1	A1	D23	2	3.6	0.5	7.5
1	A1	D23	3	3.6	0.8	4.3
1	A1	D23	4	2.7	0.8	3.2
1	A1	D23	5	4.8	1.5	3.2
1	A1	D23	6	2.4	0.7	3.3
1	A1	D23	7	6.4	1.5	4.2
1	A1	D23	8	2.4	0.4	6.7
1	A1	D23	9	9.1	3.6	2.5
1	A1	D23	10	2.7	1.2	2.3
1	A1	D23	11	4.0	0.4	11.0
1	A1	D23	12	1.5	0.2	6.0
1	A1	D23	13	1.8	0.6	3.0
1	A1	D23	14	3.9	0.8	4.6
1	A1	D23	15	2.1	0.3	6.8
1	A1	D23	16	3.0	0.3	10.0
1	A1	D23	17	5.4	1.2	4.5
1	A1	D23	18	1.5	0.3	4.8
1	A1	D23	19	2.8	0.7	3.8
1	A1	D23	20	2.4	0.8	2.9
1	A1	D23	21	3.6	0.7	5.0
1	A1	D23	22	2.7	1.2	2.3
1	A1	D23	23	2.7	0.4	7.3
1	A1	D23	24	15.7	3.6	4.3
1	A1	D23	25	12.7	4.2	3.0
1	A1	D23	26	4.5	1.2	3.8
1	A1	D23	27	3.3	1.2	2.8

Bin	PCM Fiber	PCM Equivalent Fiber	TEM only fiber	Length <5 or A.R. <3	Percent PCM-Equivalent Fibers	Percent TEM-only Fibers	Percent non-Fibers
0.9							
1.9	<= 1	Fiber	PEF				
2.9	1 - 1.9			Yes			
3.9	2 - 2.9			Yes			
4.9	3 - 3.9			Yes			
5.9	4 - 4.9			Yes			
6.9	5 - 5.9			Yes			
7.9	6 - 6.9			Yes			
8.9	7 - 7.9			Yes			
9.9	8 - 8.9			Yes			
10.9	9 - 9.9			Yes			
11.9	10 - 10.9	Fiber	PEF				
12.9	11 - 11.9			Yes			
13.9	12 - 12.9			Yes			
14.9	13 - 13.9			Yes			
15.9	14 - 14.9			Yes			
16.9	15 - 15.9			Yes			
17.9	16 - 16.9			Yes			
18.9	17 - 17.9	Fiber	PEF				
19.9	18 - 18.9	Fiber	PEF				
20.9	19 - 19.9			Yes			
	20 - 20.9			Yes			

Count of Struct.	PCM-Equivalent Fiber	TEM-only fiber	Length <5 $\mu\text{m}$ or Width < 3 $\mu\text{m}$
300	34	0	266
	Percent PCM-Equivalent Fibers	Percent TEM-only Fibers	Percent non-Fibers
	11.3%	0.0%	88.7%

Actinolite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

1	A1	D23	1	4.8	0.6	8.0					
1	A1	D23	28	3.3	0.2	13.8					
1	A1	D23	29	2.4	0.1	40.0					
1	A1	D23	30	3.0	1.2	2.5					
1	A1	D23	31	3.3	0.4	9.2					
1	A1	D23	32	2.5	0.4	7.0					
1	A1	D23	33	3.0	0.4	8.3	Bin				
1	A1	D23	34	2.1	0.2	8.5	0.09	<= 0.1			
1	A1	D23	35	4.8	1.8	2.7	0.19	0.10 - 0.19			
1	A1	D23	36	2.7	0.9	2.9	0.24	0.20 - 0.24			
1	A1	D23	37	1.8	0.1	30.0	0.29	0.25 - 0.29			
1	A1	D23	38	4.8	0.9	5.3	0.39	0.30 - 0.39			
1	A1	D23	39	4.4	0.7	6.0	0.49	0.40 - 0.49			
1	A1	D23	40	4.5	1.2	3.8	0.59	0.50 - 0.59			
1	A1	E7	41	2.4	0.9	2.7	0.69	0.60 - 0.69			
1	A1	E7	42	2.7	0.9	3.0	0.79	0.70 - 0.79			
1	A1	E7	43	2.5	0.6	4.2	0.89	0.80 - 0.89			
1	A1	E7	44	1.2	0.2	5.0	0.99	0.90 - 0.99			
1	A1	E7	45	2.7	0.6	4.5	1.09	1 - 1.09			
1	A1	E7	46	5.2	1.2	4.3	1.19	1.1 - 1.19			
1	A1	E7	47	2.1	0.9	2.3	1.29	1.2 - 1.29	Fiber PEF		
1	A1	E7	48	12.4	0.6	20.5	1.39	1.3 - 1.39			
1	A1	E7	49	3.0	1.2	2.5	1.49	1.4 - 1.49	Fiber PEF		
1	A1	E7	50	3.3	0.4	9.2	1.59	1.5 - 1.59			
2	B1	E7	51	12.1	3.6	3.3	1.69	1.6 - 1.69			
2	B1	E7	52	7.6	2.1	3.6	1.79	1.7 - 1.79	Fiber PEF		
2	B1	E7	53	3.1	1.2	2.6	1.89	1.8 - 1.89	Fiber PEF		
2	B1	E7	54	5.4	2.1	2.6	1.99	1.9 - 1.99			
2	B1	E7	55	4.8	0.6	8.0	2.09	2.0 - 2.09			
2	B1	E7	56	2.7	0.5	5.5	2.19	2.1 - 2.19			
2	B1	E7	57	2.7	0.7	3.7	2.29	2.2 - 2.29			
2	B1	E7	58	1.9	0.4	5.3	2.39	2.3 - 2.39			
2	B1	E7	59	0.3	0.1	5.0	2.49	2.4 - 2.49			
2	B1	E7	60	3.6	1.0	3.8	2.59	2.5 - 2.59			
2	B1	E7	61	5.1	0.9	5.6	2.69	2.6 - 2.69			
2	B1	E7	62	3.1	0.6	5.2	2.79	2.7 - 2.79	Fiber PEF		
2	B1	E7	63	3.0	0.6	5.0	2.89	2.8 - 2.89			
2	B1	E7	64	6.3	1.2	5.2	2.99	2.9 - 2.99			
2	B1	E7	65	3.3	0.9	3.7	3.09	3.0 - 3.09	Fiber PEF		
2	B1	E7	66	4.2	1.8	2.3	3.19	3.1 - 3.19			
							3.29	3.2 - 3.29			

> 20.9

11.3% 0.0% 88.7%

Actinolite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

1	A1	D23	1	4.8	0.6	8.0			Yes	11.3%	0.0%	88.7%
2	B1	E7	67	4.8	1.2	4.0	3.39 3.3 - 3.39		Yes			
2	B1	E7	68	5.4	1.8	3.0	3.49 3.4 - 3.49	Fiber PEF	Yes			
2	B1	E7	69	3.3	0.1	27.5	3.59 3.5 - 3.59		Yes			
2	B1	E7	70	3.1	1.2	2.6	3.69 3.6 - 3.69		Yes			
2	B1	E7	71	6.1	1.5	4.0	3.79 3.7 - 3.79	Fiber PEF	Yes			
2	B1	E7	72	1.2	0.2	5.0	3.89 3.8 - 3.89		Yes			
2	B1	E7	73	2.7	1.2	2.3	3.99 3.9 - 3.99		Yes			
2	B1	E7	74	5.1	1.2	4.3	4.09 4.0 - 4.09	Fiber PEF	Yes			
2	B1	E7	75	3.3	0.9	3.7	4.19 4.1 - 4.19		Yes			
2	B1	D4	76	1.5	1.8	0.8	4.29 4.2 - 4.29		Yes			
2	B1	D4	77	3.9	0.7	5.3	4.39 4.3 - 4.39		Yes			
2	B1	D4	78	7.5	1.0	7.8	4.49 4.4 - 4.49	Fiber PEF	Yes			
2	B1	D4	79	2.4	1.0	2.5	4.59 4.5 - 4.59		Yes			
2	B1	D4	80	4.4	1.8	2.4	4.69 4.6 - 4.69		Yes			
2	B1	D4	81	3.6	0.6	6.0	4.79 4.7 - 4.79		Yes			
2	B1	D4	82	3.9	0.2	16.0	4.89 4.8 - 4.89		Yes			
2	B1	D4	83	9.7	4.2	2.3	More > 4.89		Yes			
2	B1	D4	84	11.5	3.6	3.2		Fiber PEF	Yes			
2	B1	D4	85	4.2	0.9	4.7			Yes			
2	B1	D4	86	3.0	0.6	5.0			Yes			
2	B1	D4	87	2.4	0.9	2.7			Yes			
2	B1	D4	88	1.8	0.4	5.0			Yes			
2	B1	D4	89	7.9	2.1	3.7		Fiber PEF	Yes			
2	B1	D4	90	3.6	1.2	3.0			Yes			
2	B1	D4	91	3.3	2.1	1.6			Yes			
2	B1	D4	92	1.1	0.1	9.0			Yes			
2	B1	D4	93	4.4	0.8	5.1			Yes			
2	B1	D4	94	3.6	0.9	4.0			Yes			
2	B1	D4	95	1.5	0.1	25.0			Yes			
2	B1	D4	96	4.5	0.9	5.0			Yes			
2	B1	D4	97	1.5	0.1	12.0			Yes			
2	B1	D4	98	1.8	0.5	3.8			Yes			
2	B1	D4	99	1.2	0.2	5.0			Yes			
2	B1	D4	100	3.6	1.2	3.0			Yes			
3	C2	I1	101	8.5	4.2	2.0			Yes			
3	C2	I1	102	2.4	0.3	8.0			Yes			
3	C2	I1	103	4.5	0.6	7.4			Yes			
3	C2	I1	104	2.7	1.8	1.5			Yes			
3	C2	I1	105	3.0	0.9	3.3			Yes			

Actinolite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

1	A1	D23	1	4.8	0.6	8.0
3	C2	I1	106	2.4	0.3	8.0
3	C2	I1	107	4.5	1.2	3.8
3	C2	I1	108	2.4	1.2	2.0
3	C2	I1	109	6.1	1.8	3.3
3	C2	I1	110	3.6	0.6	6.0
3	C2	I1	111	2.4	0.8	2.9
3	C2	I1	112	3.9	1.0	4.1
3	C2	I1	113	2.1	0.6	3.5
3	C2	I1	114	2.4	1.2	2.0
3	C2	I1	115	7.3	3.3	2.2
3	C2	I1	116	6.1	3.6	1.7
3	C2	I1	117	2.4	0.3	8.0
3	C2	I1	118	1.5	0.2	6.0
3	C2	I1	119	2.4	0.9	2.7
3	C2	I1	120	9.7	2.7	3.6
3	C2	I1	121	6.1	1.2	5.0
3	C2	I1	122	3.6	0.4	10.0
3	C2	I1	123	3.3	0.9	3.7
3	C2	I1	124	1.5	0.2	6.0
3	C2	I1	125	4.2	0.9	4.7
3	C2	H5	126	2.1	1.0	2.1
3	C2	H5	127	3.6	0.6	6.0
3	C2	H5	128	1.5	0.1	12.0
3	C2	H5	129	5.7	1.5	3.8
3	C2	H5	130	3.6	2.4	1.5
3	C2	H5	131	1.8	0.6	3.0
3	C2	H5	132	4.2	0.9	4.7
3	C2	H5	133	2.4	0.6	4.0
3	C2	H5	134	8.5	4.8	1.8
3	C2	H5	135	2.2	0.6	3.6
3	C2	H5	136	1.0	0.1	16.0
3	C2	H5	137	3.8	0.7	5.2
3	C2	H5	138	4.8	0.7	6.7
3	C2	H5	139	10.9	1.2	9.0
3	C2	H5	140	5.4	1.2	4.5
3	C2	H5	141	2.4	0.9	2.7
3	C2	H5	142	2.7	0.2	11.0
3	C2	H5	143	4.2	1.5	2.8
3	C2	H5	144	4.2	1.0	4.4

	Yes	11.3%	0.0%	88.7%
	Yes			
	Yes			
	Yes			
Fiber PEF				
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
Fiber PEF				
Fiber PEF				
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
Fiber PEF				
Fiber PEF				
	Yes			
	Yes			
	Yes			
	Yes			



Actinolite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

1	A1	D23	1	4.8	0.6	8.0
4	C3	E3	184	2.5	0.2	10.5
4	C3	E3	185	1.5	0.5	3.0
4	C3	E3	186	1.8	0.6	3.0
4	C3	E3	187	3.1	0.9	3.5
4	C3	E3	188	2.1	0.4	5.7
4	C3	E3	189	1.9	0.8	2.3
4	C3	E3	190	3.6	1.5	2.4
4	C3	E3	191	2.4	0.1	20.0
4	C3	E3	192	1.5	0.4	4.2
4	C3	E3	193	7.3	0.9	8.0
4	C3	E3	194	2.4	0.6	4.0
4	C3	E3	195	2.4	0.6	4.0
4	C3	E3	196	2.7	0.4	7.5
4	C3	E3	197	4.2	0.6	7.0
4	C3	E3	198	0.9	0.1	7.5
4	C3	E3	199	1.8	0.4	5.0
4	C3	E3	200	2.7	0.9	3.0
5	D1	H10	201	3.0	0.9	3.3
5	D1	H10	202	10.3	1.8	5.7
5	D1	H10	203	1.8	0.7	2.5
5	D1	H10	204	3.0	0.1	25.0
5	D1	H10	205	2.7	1.8	1.5
5	D1	H10	206	3.6	0.4	10.0
5	D1	H10	207	2.7	1.8	1.5
5	D1	H10	208	7.3	1.8	4.0
5	D1	H10	209	1.8	0.8	2.1
5	D1	H10	210	2.1	1.2	1.7
5	D1	H10	211	2.1	0.6	3.5
5	D1	H10	212	1.8	0.2	7.5
5	D1	H10	213	2.4	0.2	10.0
5	D1	H10	214	4.2	0.6	7.0
5	D1	H10	215	2.1	0.4	5.8
5	D1	H10	216	0.7	0.1	6.0
5	D1	H10	217	3.3	0.7	4.6
5	D1	H10	218	2.1	0.6	3.5
5	D1	H10	219	3.3	0.9	3.7
5	D1	H10	220	3.6	1.2	3.0
5	D1	H10	221	6.7	1.2	5.5
5	D1	H10	222	1.8	0.6	3.0

		Yes	11.3%	0.0%	88.7%
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
	Fiber PEF	Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
	Fiber PEF	Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
		Yes			
	Fiber PEF	Yes			
		Yes			







**Table B1: Summary Statistics for Actinolite Particle Size Data: TEM PCME (10,000X Magnification)**

<i>Length (microns)</i>		<i>Width (microns)</i>		<i>Aspect Ratio</i>	
<b>Mean</b>	3.55	<b>Mean</b>	0.93	<b>Mean</b>	5.76
<b>Standard Error</b>	0.13	<b>Standard Error</b>	0.05	<b>Standard Error</b>	0.31
<b>Median</b>	3.03	<b>Median</b>	0.85	<b>Median</b>	4.00
<b>Mode</b>	2.42	<b>Mode</b>	0.61	<b>Mode</b>	4.00
<b>Standard Deviation</b>	2.23	<b>Standard Deviation</b>	0.78	<b>Standard Deviation</b>	5.33
<b>Sample Variance</b>	4.98	<b>Sample Variance</b>	0.61	<b>Sample Variance</b>	28.45
<b>Kurtosis</b>	6.07	<b>Kurtosis</b>	6.13	<b>Kurtosis</b>	13.52
<b>Skewness</b>	2.13	<b>Skewness</b>	2.16	<b>Skewness</b>	3.34
<b>Range</b>	15.43	<b>Range</b>	4.78	<b>Range</b>	39.17
<b>Minimum</b>	0.30	<b>Minimum</b>	0.06	<b>Minimum</b>	0.83
<b>Maximum</b>	15.73	<b>Maximum</b>	4.84	<b>Maximum</b>	40.00
<b>Sum</b>	1063.52	<b>Sum</b>	279.37	<b>Sum</b>	1729.06
<b>Count</b>	300	<b>Count</b>	300	<b>Count</b>	300

**Table B2. Aspect Ratios for 300 Actinolite Particles: TEM  
PCME (10,000X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Aspect Ratio</i>
0.9	1	0.3%	0.3%	<= 1
1.9	12	4.0%	4.3%	1 - 1.9
2.9	57	19.0%	23.3%	2 - 2.9
3.9	63	21.0%	44.3%	3 - 3.9
4.9	46	15.3%	59.7%	4 - 4.9
5.9	37	12.3%	72.0%	5 - 5.9
6.9	17	5.7%	77.7%	6 - 6.9
7.9	13	4.3%	82.0%	7 - 7.9
8.9	13	4.3%	86.3%	8 - 8.9
9.9	5	1.7%	88.0%	9 - 9.9
10.9	11	3.7%	91.7%	10 - 10.9
11.9	2	0.7%	92.3%	11 - 11.9
12.9	3	1.0%	93.3%	12 - 12.9
13.9	1	0.3%	93.7%	13 - 13.9
14.9	1	0.3%	94.0%	14 - 14.9
15.9	3	1.0%	95.0%	15 - 15.9
16.9	3	1.0%	96.0%	16 - 16.9
17.9	0	0.0%	96.0%	17 - 17.9
18.9	0	0.0%	96.0%	18 - 18.9
19.9	0	0.0%	96.0%	19 - 19.9
20.9	3	1.0%	97.0%	20 - 20.9
More	9	3.0%	100.0%	> 20.9
Sum	300			

**Table B3. Lengths for 300 Actinolite Particles: TEM PCME (10,000X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Length (microns)</i>
0.9	6	2.0%	2.0%	<= 1
1.9	50	16.7%	18.7%	1 - 1.9
2.9	87	29.0%	47.7%	2 - 2.9
3.9	70	23.3%	71.0%	3 - 3.9
4.9	44	14.7%	85.7%	4 - 4.9
5.9	10	3.3%	89.0%	5 - 5.9
6.9	10	3.3%	92.3%	6 - 6.9
7.9	8	2.7%	95.0%	7 - 7.9
8.9	3	1.0%	96.0%	8 - 8.9
9.9	4	1.3%	97.3%	9 - 9.9
10.9	2	0.7%	98.0%	10 - 10.9
11.9	1	0.3%	98.3%	11 - 11.9
12.9	4	1.3%	99.7%	12 - 12.9
13.9	0	0.0%	99.7%	13 - 13.9
14.9	0	0.0%	99.7%	14 - 14.9
15.9	1	0.3%	100.0%	15 - 15.9
16.9	0	0.0%	100.0%	16 - 16.9
17.9	0	0.0%	100.0%	17 - 17.9
18.9	0	0.0%	100.0%	18 - 18.9
19.9	0	0.0%	100.0%	19 - 19.9
20.9	0	0.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9
Sum	300			

**Table B4. Widths for 300 Actinolite Particles: TEM PCME (10,000X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>
0.9	160	53.3%	53.3%	<= 1
1.9	118	39.3%	92.7%	1 - 1.9
2.9	10	3.3%	96.0%	2 - 2.9
3.9	8	2.7%	98.7%	3 - 3.9
4.9	4	1.3%	100.0%	4 - 4.9
5.9	0	0.0%	100.0%	5 - 5.9
6.9	0	0.0%	100.0%	6 - 6.9
7.9	0	0.0%	100.0%	7 - 7.9
8.9	0	0.0%	100.0%	8 - 8.9
9.9	0	0.0%	100.0%	9 - 9.9
10.9	0	0.0%	100.0%	10 - 10.9
11.9	0	0.0%	100.0%	11 - 11.9
12.9	0	0.0%	100.0%	12 - 12.9
13.9	0	0.0%	100.0%	13 - 13.9
14.9	0	0.0%	100.0%	14 - 14.9
15.9	0	0.0%	100.0%	15 - 15.9
16.9	0	0.0%	100.0%	16 - 16.9
17.9	0	0.0%	100.0%	17 - 17.9
18.9	0	0.0%	100.0%	18 - 18.9
19.9	0	0.0%	100.0%	19 - 19.9
20.9	0	0.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9
Sum	300			

**Table B5. Widths for 300 Actinolite Particles: TEM  
PCME (10,000X Magnification) Finer Detail**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>
0.09	9	3.0%	3.0%	<= 0.1
0.19	20	6.7%	9.7%	0.10 - 0.19
0.24	0	0.0%	9.7%	0.20 - 0.24
0.29	17	5.7%	15.3%	0.25 - 0.29
0.39	36	12.0%	27.3%	0.30 - 0.39
0.49	5	1.7%	29.0%	0.40 - 0.49
0.59	0	0.0%	29.0%	0.50 - 0.59
0.69	42	14.0%	43.0%	0.60 - 0.69
0.79	17	5.7%	48.7%	0.70 - 0.79
0.89	14	4.7%	53.3%	0.80 - 0.89
0.99	53	17.7%	71.0%	0.90 - 0.99
1.09	0	0.0%	71.0%	1 - 1.09
1.19	0	0.0%	71.0%	1.1 - 1.19
1.29	38	12.7%	83.7%	1.2 - 1.29
1.39	0	0.0%	83.7%	1.3 - 1.39
1.49	2	0.7%	84.3%	1.4 - 1.49
1.59	9	3.0%	87.3%	1.5 - 1.59
1.69	0	0.0%	87.3%	1.6 - 1.69
1.79	0	0.0%	87.3%	1.7 - 1.79
1.89	16	5.3%	92.7%	1.8 - 1.89
1.99	0	0.0%	92.7%	1.9 - 1.99
2.09	0	0.0%	92.7%	2.0 - 2.09
2.19	7	2.3%	95.0%	2.1 - 2.19
2.29	0	0.0%	95.0%	2.2 - 2.29
2.39	0	0.0%	95.0%	2.3 - 2.39
2.49	2	0.7%	95.7%	2.4 - 2.49
2.59	0	0.0%	95.7%	2.5 - 2.59
2.69	1	0.3%	96.0%	2.6 - 2.69
2.79	0	0.0%	96.0%	2.7 - 2.79
2.89	0	0.0%	96.0%	2.8 - 2.89
2.99	0	0.0%	96.0%	2.9 - 2.99
3.09	2	0.7%	96.7%	3.0 - 3.09
3.19	0	0.0%	96.7%	3.1 - 3.19
3.29	0	0.0%	96.7%	3.2 - 3.29
3.39	1	0.3%	97.0%	3.3 - 3.39
3.49	0	0.0%	97.0%	3.4 - 3.49
3.59	0	0.0%	97.0%	3.5 - 3.59
3.69	5	1.7%	98.7%	3.6 - 3.69
3.79	0	0.0%	98.7%	3.7 - 3.79
3.89	0	0.0%	98.7%	3.8 - 3.89
3.99	0	0.0%	98.7%	3.9 - 3.99
4.09	0	0.0%	98.7%	4.0 - 4.09
4.19	0	0.0%	98.7%	4.1 - 4.19
4.29	3	1.0%	99.7%	4.2 - 4.29
4.39	0	0.0%	99.7%	4.3 - 4.39
4.49	0	0.0%	99.7%	4.4 - 4.49
4.59	0	0.0%	99.7%	4.5 - 4.59
4.69	0	0.0%	99.7%	4.6 - 4.69
4.79	0	0.0%	99.7%	4.7 - 4.79
4.89	1	0.3%	100.0%	4.8 - 4.89
More	0	0.0%	100.0%	> 4.89
Sum	300			



Particle Size Data for Actinolite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

Filter	Particle	Length (microns)	Width (microns)	Aspect Ratio			Meet Fiber Criteria	Percent Fibers	Percent non-fibers
	27	4.5	2.0	2.3	17.9	17 - 17.9			
	28	3.0	1.0	3.0	18.9	18 - 18.9			
	29	10.0	2.0	5.0	19.9	19 - 19.9	Fiber		
	30	6.0	2.0	3.0	20.9	20 - 20.9	Fiber		
	31	4.0	3.0	1.3	More	> 20.9			
	32	6.0	1.5	4.0			Fiber		
	33	10.0	1.5	6.7			Fiber		
	34	12.0	3.0	4.0	Bin		Fiber		
	35	9.0	2.0	4.5	0.24	<= 0.25	Fiber		
	36	12.0	1.5	8.0	0.9	0.25-0.9	Fiber		
	37	12.0	4.0	3.0	1.9	1 - 1.9	Fiber		
	38	10.0	2.5	4.0	2.9	2 - 2.9	Fiber		
	39	15.0	2.0	7.5	3.9	3 - 3.9	Fiber		
	40	6.0	5.0	1.2	4.9	4 - 4.9			
	41	6.0	2.5	2.4	5.9	5 - 5.9			
	42	5.0	2.0	2.5	6.9	6 - 6.9			
	43	6.0	2.5	2.4	7.9	7 - 7.9			
	44	4.5	2.0	2.3	8.9	8 - 8.9			
	45	12.5	1.5	8.3	9.9	9 - 9.9	Fiber		
	46	5.0	3.0	1.7	10.9	10 - 10.9			
	47	10.0	3.0	3.3	11.9	11 - 11.9	Fiber		
	48	10.0	2.0	5.0	12.9	12 - 12.9	Fiber		
	49	7.0	2.5	2.8	13.9	13 - 13.9			
	50	9.0	2.0	4.5	14.9	14 - 14.9	Fiber		
Structure	51	5.0	3.0	1.7	15.9	15 - 15.9			
numbers	52	12.0	3.0	4.0	16.9	16 - 16.9	Fiber		
51-100	53	4.0	0.5	8.0	17.9	17 - 17.9			
BWH	54	15.0	2.5	6.0	18.9	18 - 18.9	Fiber		
on	55	6.0	1.0	6.0	19.9	19 - 19.9	Fiber		
Filter 1	56	5.0	2.0	2.5	20.9	20 - 20.9			
	57	14.0	3.0	4.7	More	> 20.9	Fiber		
	58	5.0	0.5	10.0			Fiber		
	59	4.0	1.0	4.0					
	60	4.0	1.5	2.7					





Particle Size Data for Actinolite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

Filter	Particle	Length (microns)	Width (microns)	Aspect Ratio
	95	4.0	1.5	2.7
	96	7.0	1.5	4.7
	97	3.0	0.5	6.0
	98	6.0	1.5	4.0
	99	6.0	1.6	3.8
	100	4.0	1.0	4.0

Meet Fiber Criteria	Percent Fibers	Percent non-fibers
Fiber		
Fiber		
Fiber		

**Table C1. Summary Statistics: Particle Size Data for Actinolite Particles:  
Dimensions Measured by PCM using Walton-Beckett Graticule (400X  
Magnification)**

<i>Length (microns)</i>		<i>Width (microns)</i>		<i>Aspect Ratio</i>	
<b>Mean</b>	7.38	<b>Mean</b>	1.95	<b>Mean</b>	4.16
<b>Standard Error</b>	0.37	<b>Standard Error</b>	0.08	<b>Standard Error</b>	0.20
<b>Median</b>	6.00	<b>Median</b>	2.00	<b>Median</b>	4.00
<b>Mode</b>	6.00	<b>Mode</b>	2.00	<b>Mode</b>	4.00
<b>Standard Deviation</b>	3.68	<b>Standard Deviation</b>	0.82	<b>Standard Deviation</b>	1.99
<b>Sample Variance</b>	13.54	<b>Sample Variance</b>	0.67	<b>Sample Variance</b>	3.95
<b>Kurtosis</b>	2.10	<b>Kurtosis</b>	0.67	<b>Kurtosis</b>	1.98
<b>Skewness</b>	1.48	<b>Skewness</b>	0.64	<b>Skewness</b>	1.26
<b>Range</b>	17.00	<b>Range</b>	4.50	<b>Range</b>	10.47
<b>Minimum</b>	3.00	<b>Minimum</b>	0.50	<b>Minimum</b>	1.20
<b>Maximum</b>	20.00	<b>Maximum</b>	5.00	<b>Maximum</b>	11.67
<b>Sum</b>	737.50	<b>Sum</b>	195.10	<b>Sum</b>	415.93
<b>Count</b>	100	<b>Count</b>	100	<b>Count</b>	100

**Table C2. Aspect Ratios for Actinolite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)**

<i>Bin</i>	<i>Frequency (Number of Counts)</i>	<i>Relative</i>	<i>Cumulative %</i>	<i>Aspect Ratio</i>
0.9	0	0.0%	0.0%	<= 1
1.9	6	6.0%	6.0%	1 - 1.9
2.9	23	23.0%	29.0%	2 - 2.9
3.9	19	19.0%	48.0%	3 - 3.9
4.9	23	23.0%	71.0%	4 - 4.9
5.9	10	10.0%	81.0%	5 - 5.9
6.9	8	8.0%	89.0%	6 - 6.9
7.9	5	5.0%	94.0%	7 - 7.9
8.9	3	3.0%	97.0%	8 - 8.9
9.9	0	0.0%	97.0%	9 - 9.9
10.9	2	2.0%	99.0%	10 - 10.9
11.9	1	1.0%	100.0%	11 - 11.9
12.9	0	0.0%	100.0%	12 - 12.9
13.9	0	0.0%	100.0%	13 - 13.9
14.9	0	0.0%	100.0%	14 - 14.9
15.9	0	0.0%	100.0%	15 - 15.9
16.9	0	0.0%	100.0%	16 - 16.9
17.9	0	0.0%	100.0%	17 - 17.9
18.9	0	0.0%	100.0%	18 - 18.9
19.9	0	0.0%	100.0%	19 - 19.9
20.9	0	0.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9

Sum 100

**Table C3. Lengths for Actinolite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Length (microns)</i>
0.9	0	0.0%	0.0%	<= 1
1.9	0	0.0%	0.0%	1 - 1.9
2.9	0	0.0%	0.0%	2 - 2.9
3.9	4	4.0%	4.0%	3 - 3.9
4.9	17	17.0%	21.0%	4 - 4.9
5.9	16	16.0%	37.0%	5 - 5.9
6.9	18	18.0%	55.0%	6 - 6.9
7.9	14	14.0%	69.0%	7 - 7.9
8.9	2	2.0%	71.0%	8 - 8.9
9.9	5	5.0%	76.0%	9 - 9.9
10.9	8	8.0%	84.0%	10 - 10.9
11.9	3	3.0%	87.0%	11 - 11.9
12.9	5	5.0%	92.0%	12 - 12.9
13.9	0	0.0%	92.0%	13 - 13.9
14.9	1	1.0%	93.0%	14 - 14.9
15.9	2	2.0%	95.0%	15 - 15.9
16.9	2	2.0%	97.0%	16 - 16.9
17.9	1	1.0%	98.0%	17 - 17.9
18.9	0	0.0%	98.0%	18 - 18.9
19.9	0	0.0%	98.0%	19 - 19.9
20.9	2	2.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9
Sum	100			

**Table C4. Widths for Actinolite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>
0.24	0	0.0%	0.0%	<= 0.25
0.9	3	3.0%	3.0%	0.25-0.9
1.9	42	42.0%	45.0%	1 - 1.9
2.9	33	33.0%	78.0%	2 - 2.9
3.9	20	20.0%	98.0%	3 - 3.9
4.9	1	1.0%	99.0%	4 - 4.9
5.9	1	1.0%	100.0%	5 - 5.9
6.9	0	0.0%	100.0%	6 - 6.9
7.9	0	0.0%	100.0%	7 - 7.9
8.9	0	0.0%	100.0%	8 - 8.9
9.9	0	0.0%	100.0%	9 - 9.9
10.9	0	0.0%	100.0%	10 - 10.9
11.9	0	0.0%	100.0%	11 - 11.9
12.9	0	0.0%	100.0%	12 - 12.9
13.9	0	0.0%	100.0%	13 - 13.9
14.9	0	0.0%	100.0%	14 - 14.9
15.9	0	0.0%	100.0%	15 - 15.9
16.9	0	0.0%	100.0%	16 - 16.9
17.9	0	0.0%	100.0%	17 - 17.9
18.9	0	0.0%	100.0%	18 - 18.9
19.9	0	0.0%	100.0%	19 - 19.9
20.9	0	0.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9

Sum 100

Figure 1. Frequency Distribution of Aspect Ratios for 300 Actinolite Particles:  
 Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

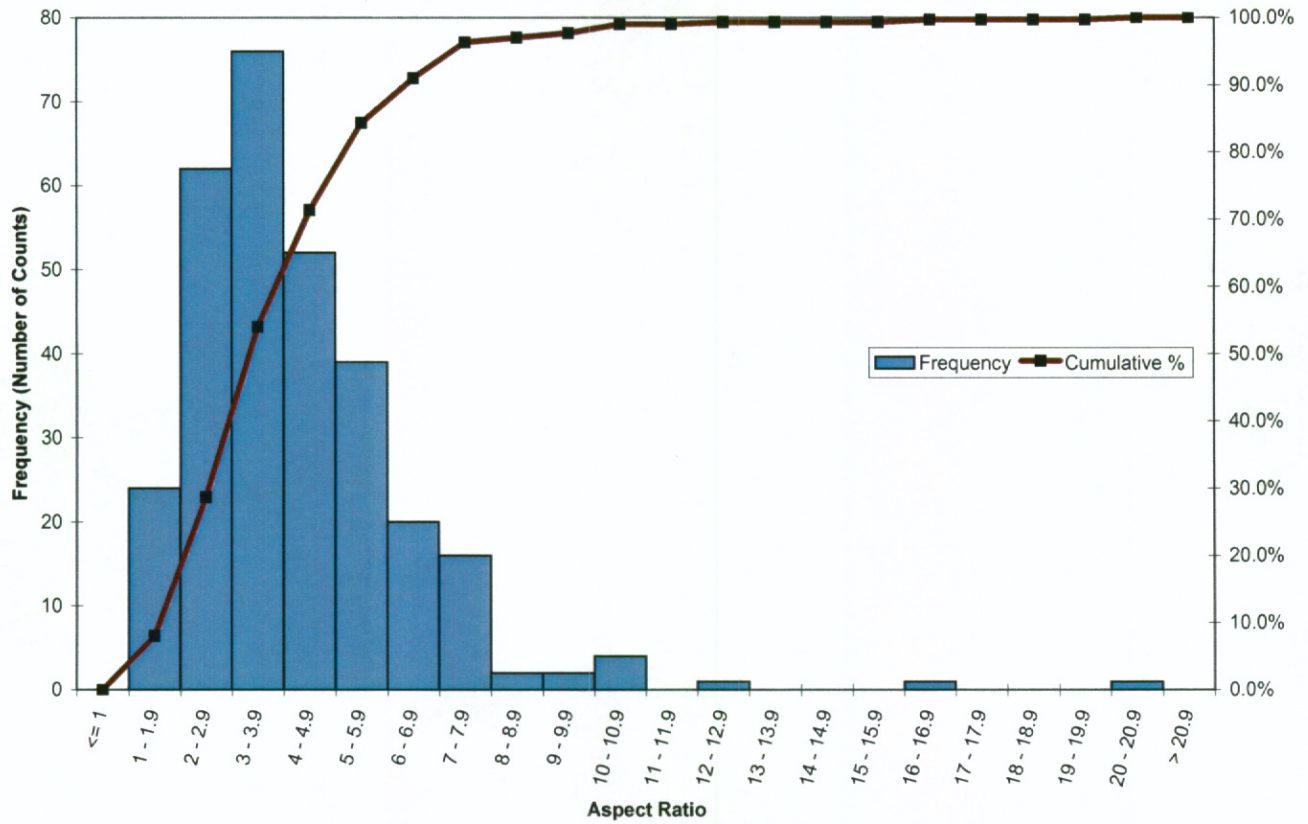


Figure 2. Frequency Distribution of Lengths for 300 Actinolite Particles:  
 Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

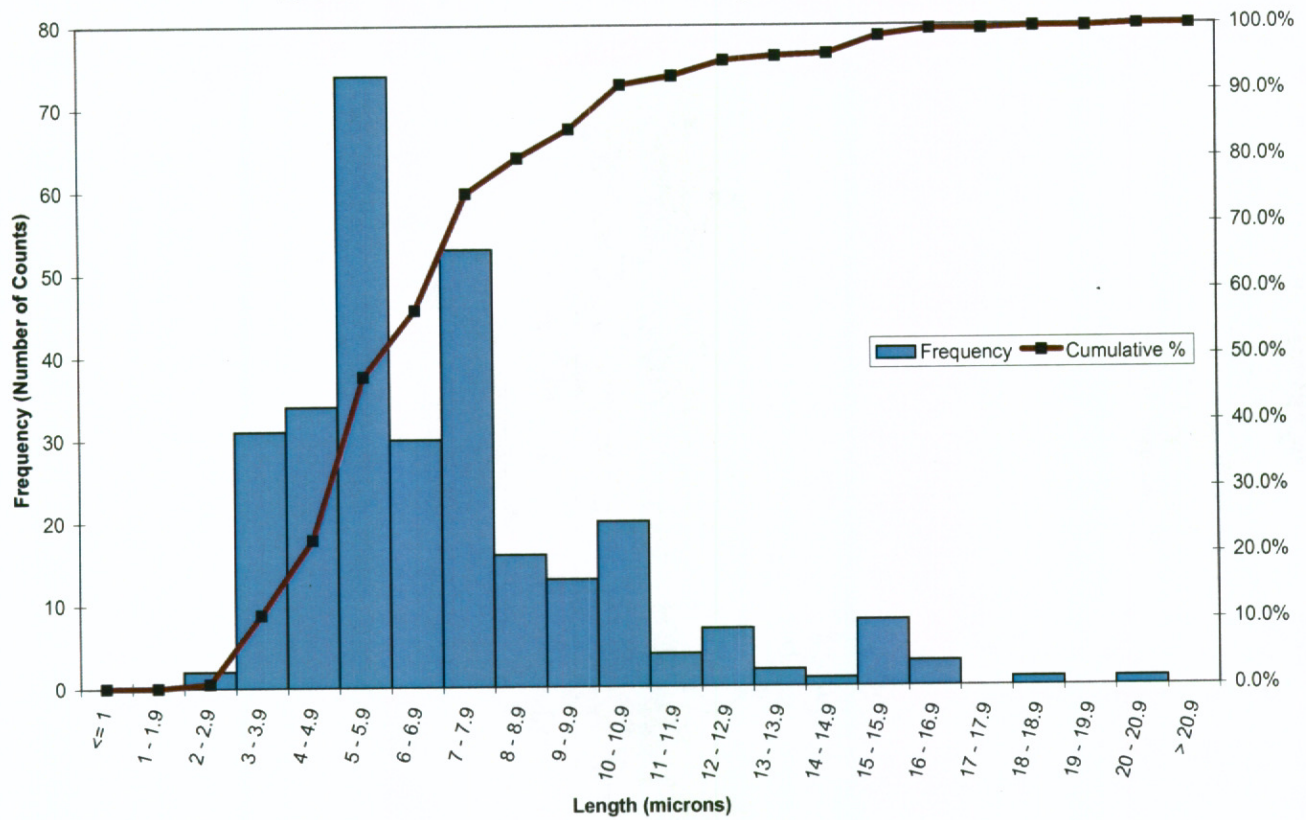


Figure 3. Frequency Distribution of Widths for 300 Actinolite Particles:  
 Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

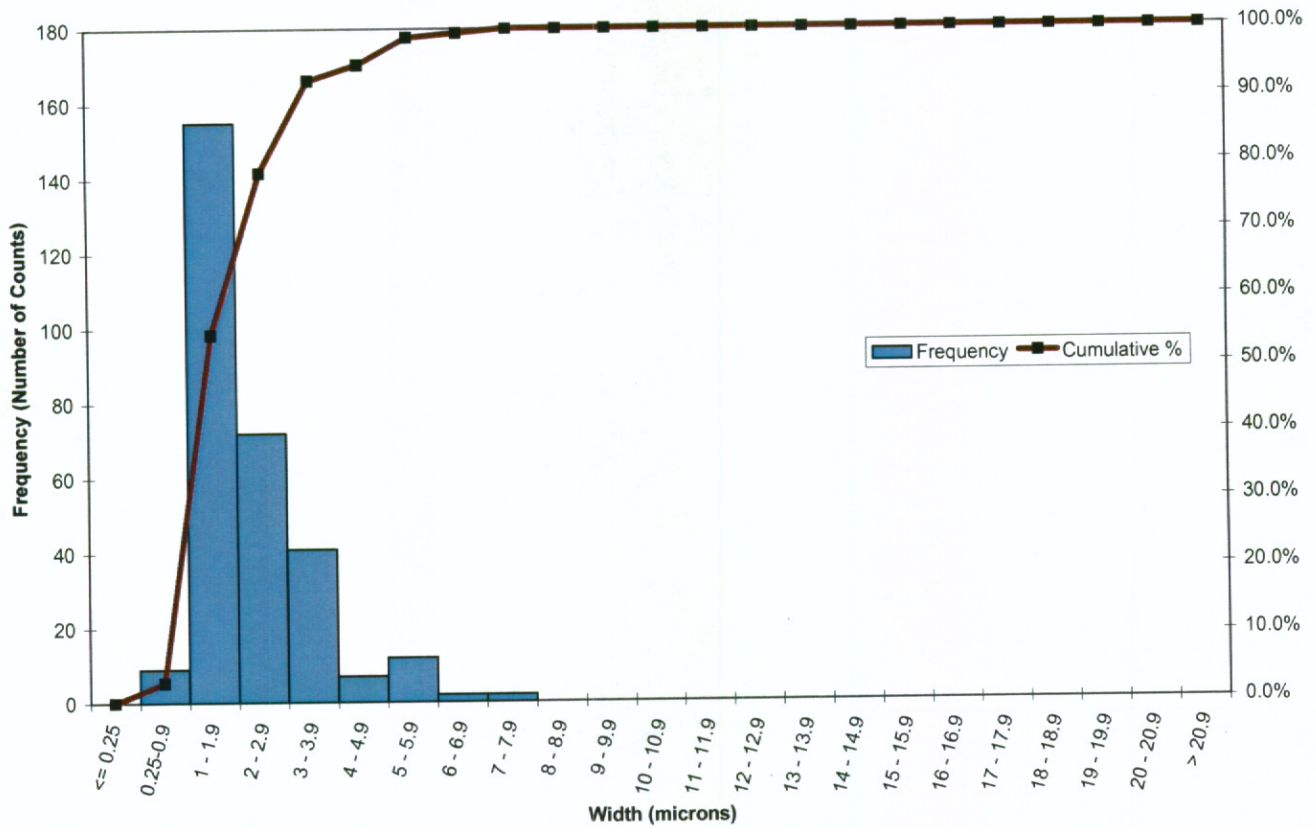




Figure 4. Frequency Distribution of Aspect Ratios for 300 Actinolite Particles:  
Dimensions Measured by TEM PCME (10,000X Magnification)

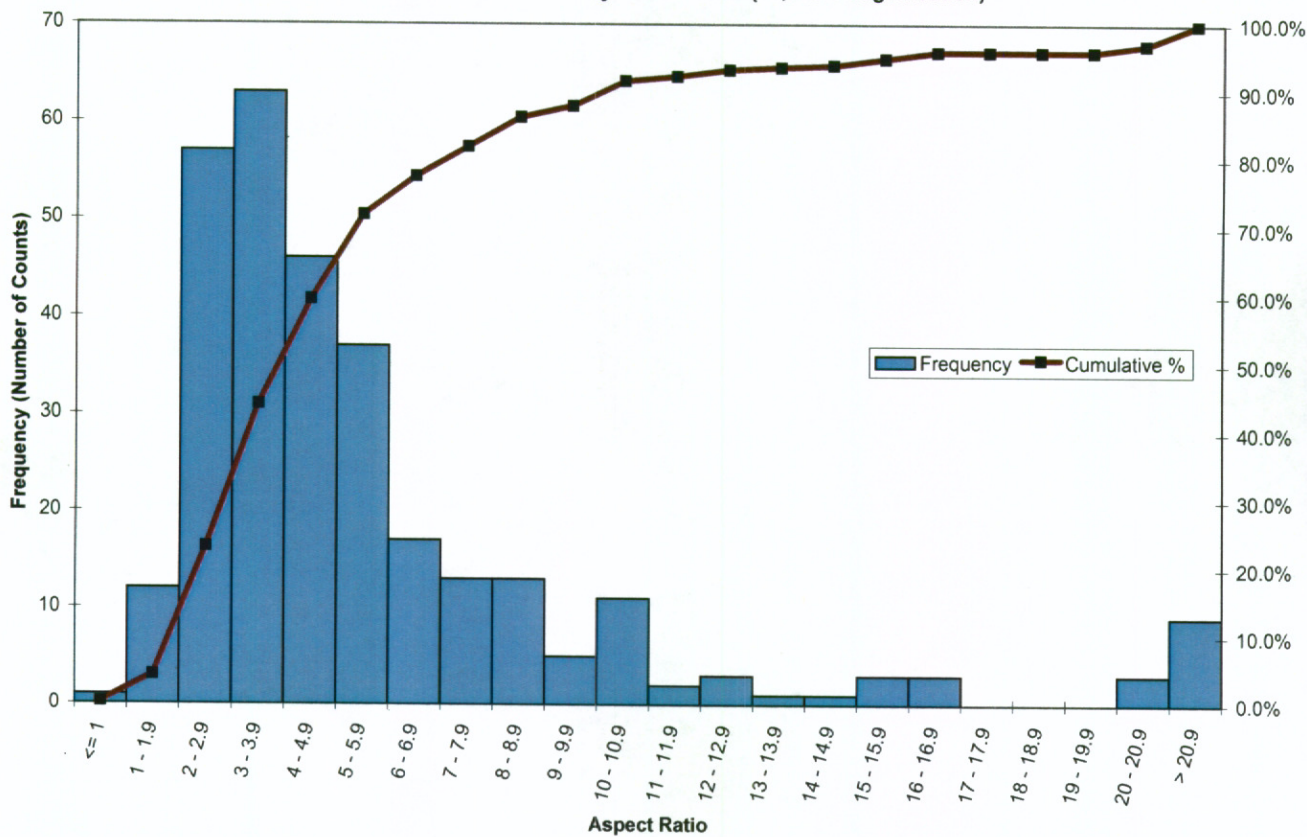


Figure 5. Frequency Distribution of Lengths for 300 Actinolite Particles:  
Dimensions Measured by TEM PCME (10,000X Magnification)

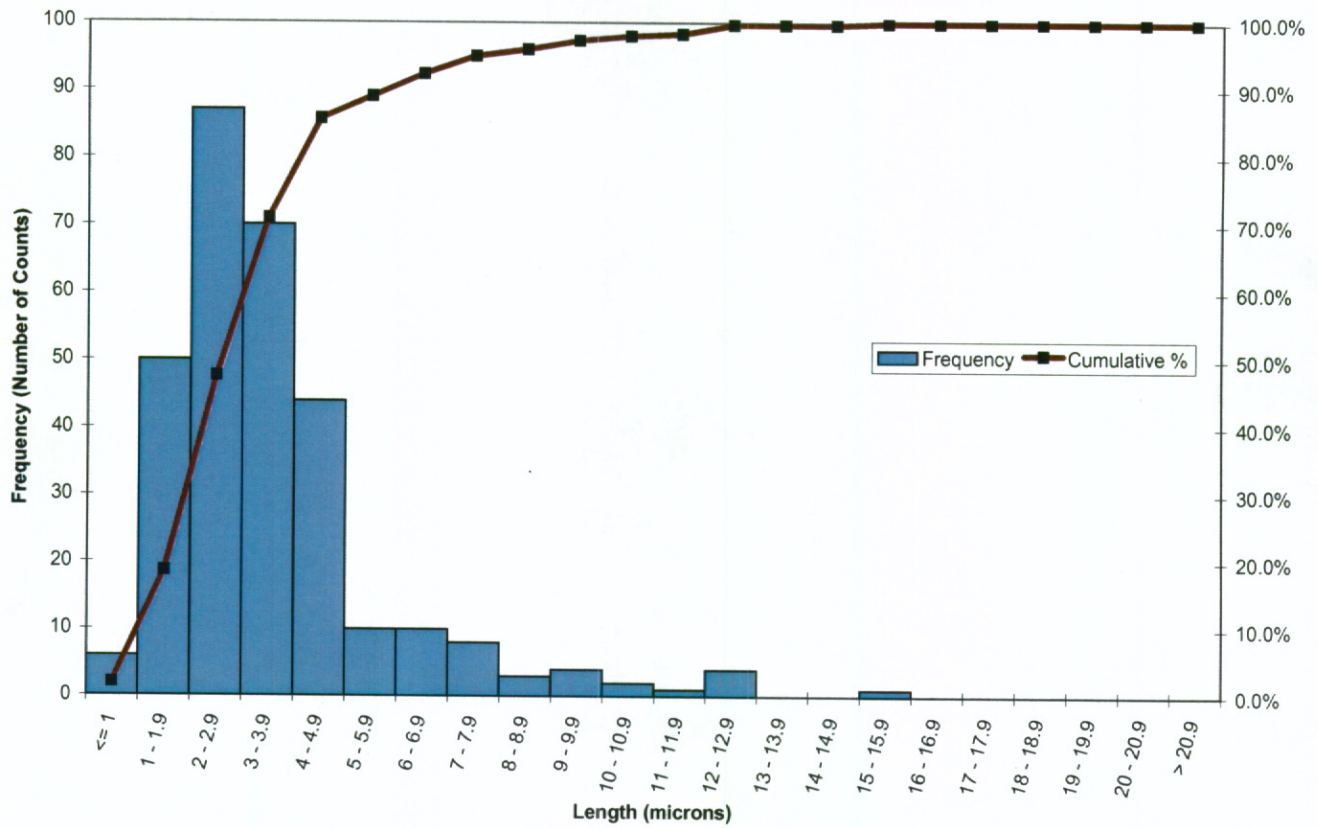


Figure 6. Frequency Distribution of Widths for 300 Actinolite Particles:  
Dimensions Measured by TEM PCME (10,000X Magnification)

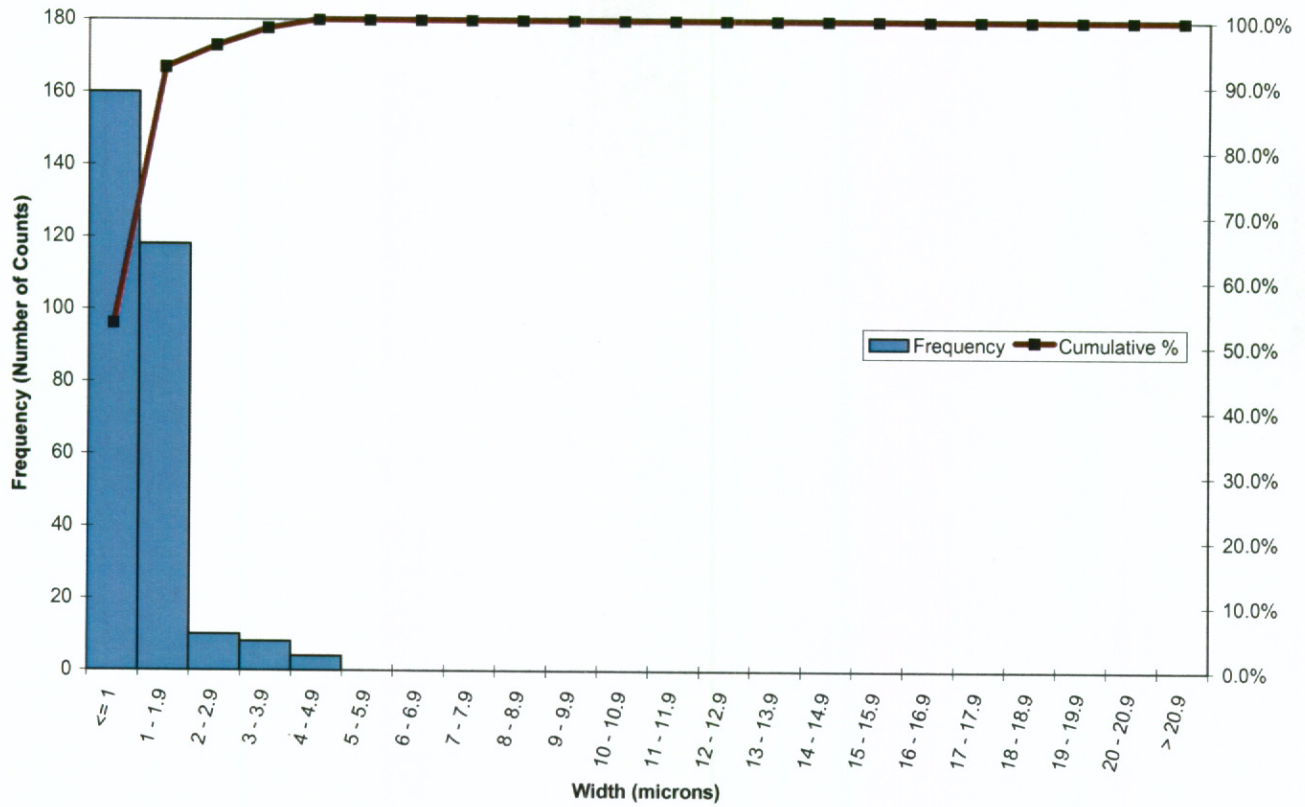


Figure 7. Frequency Distribution of Widths for 300 Actinolite Particles:  
Dimensions Measured by TEM PCME (10,000X Magnification) Finer Detail

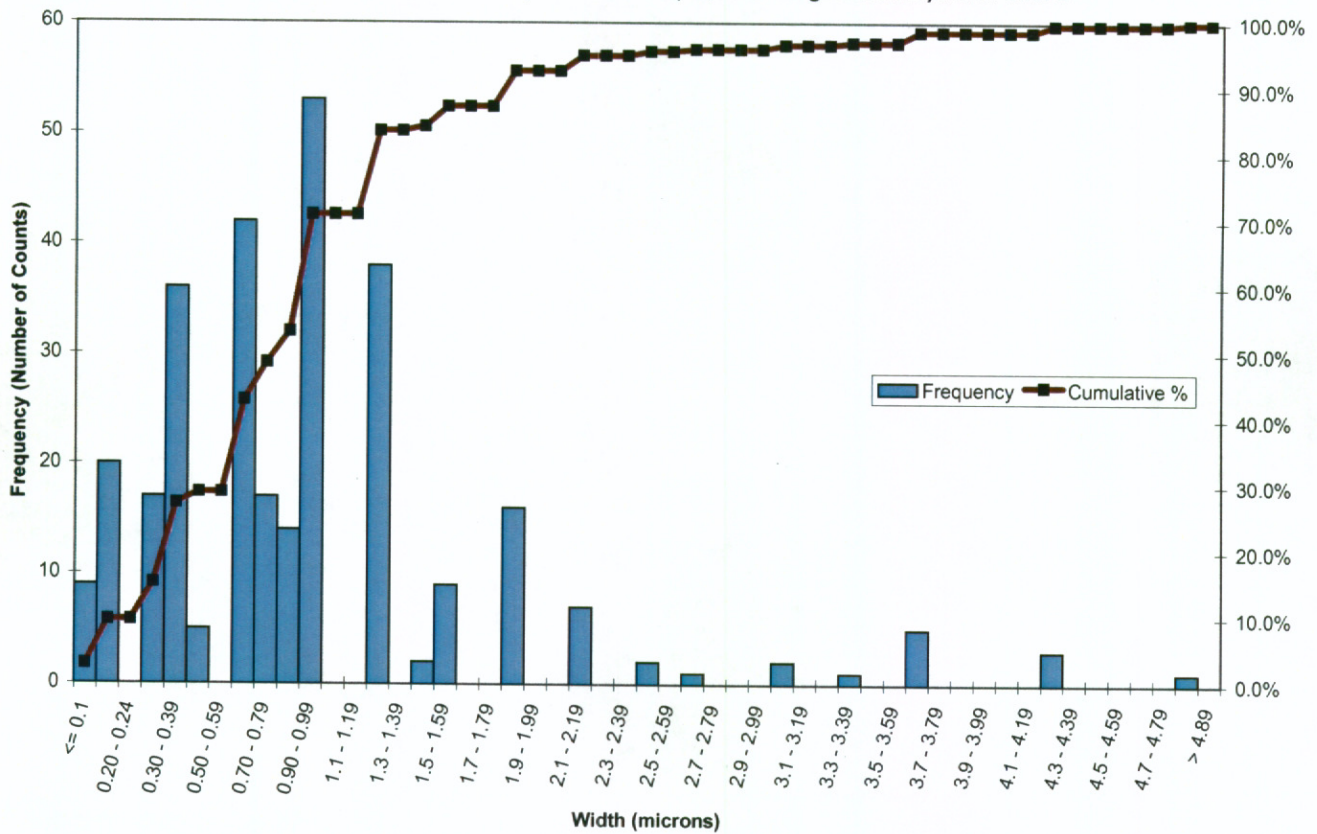


Figure 8. Frequency Distribution of Aspect Ratios for Actinolite Particles:  
Comparison of TEM PCME and PCM Data

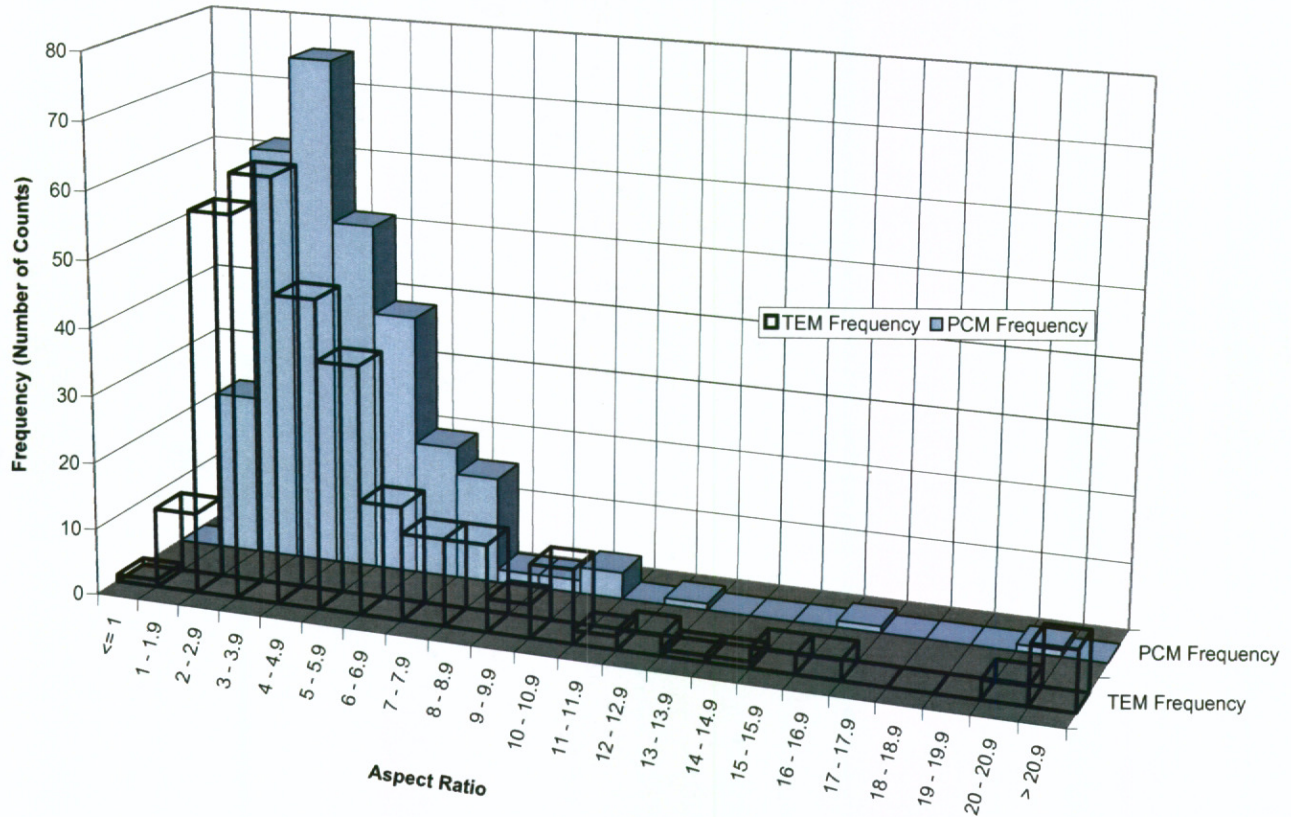


Figure 10. Frequency Distribution of Widths for Actinolite Particles:  
Comparison of TEM PCME and PCM Data

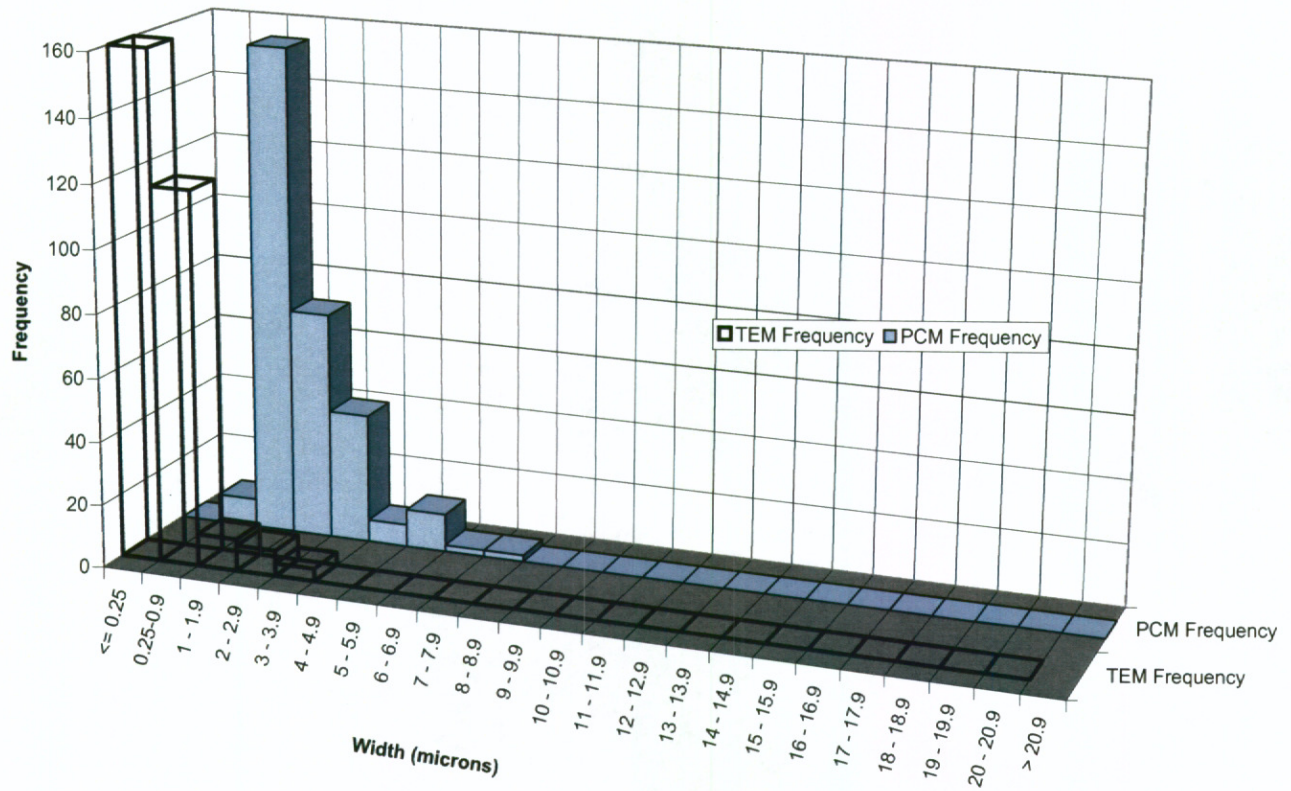


Figure 11. Frequency Distribution of Aspect Ratios for Actinolite Particles:  
Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

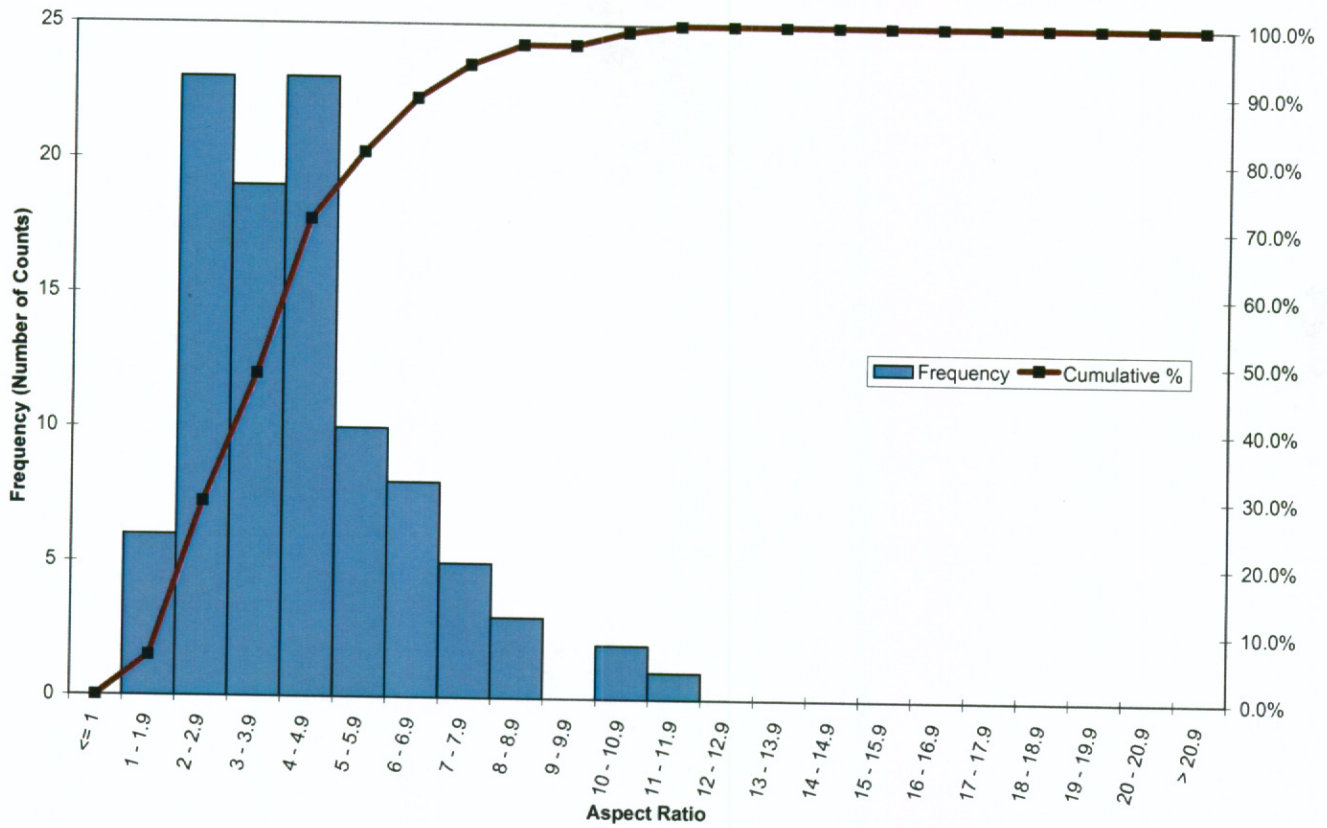


Figure 12. Frequency Distribution of Lengths for Actinolite Particles:  
Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

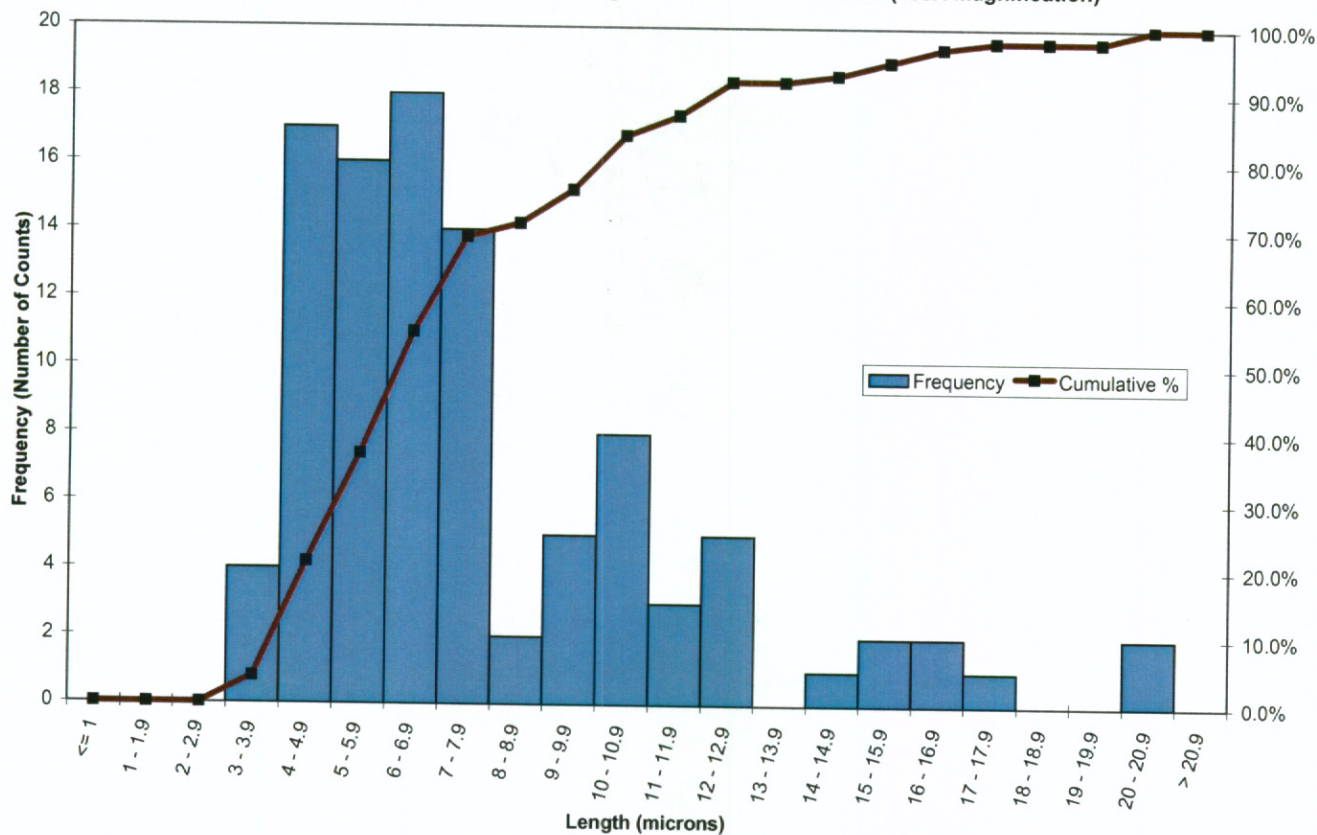
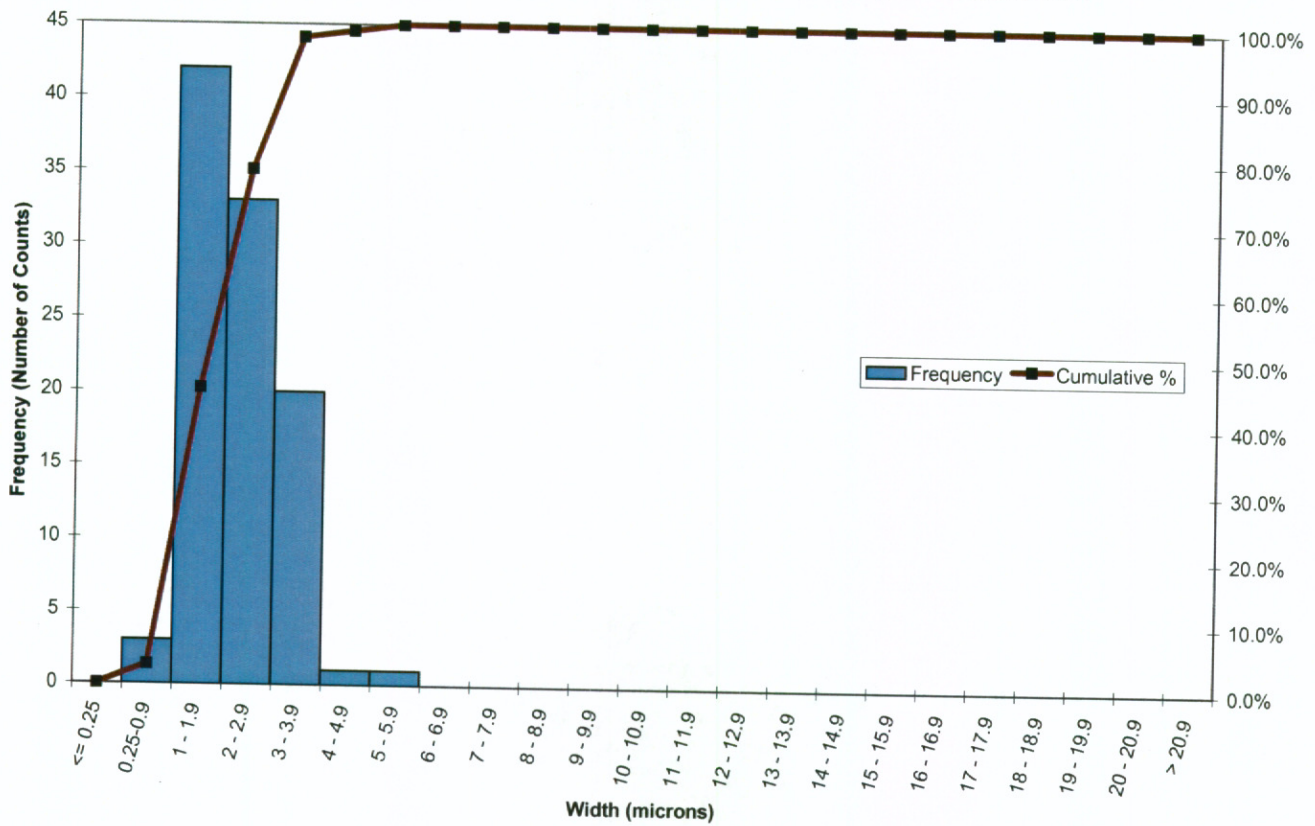




Figure 13. Frequency Distribution of Widths for Actinolite Particles:  
 Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)



**Figure 14. Frequency Distribution of Aspect Ratios for Actinolite Particles:  
Comparison of Dimensions from PCM Measured by Calibrated Visual Estimation and Walton-Beckett  
Graticule**

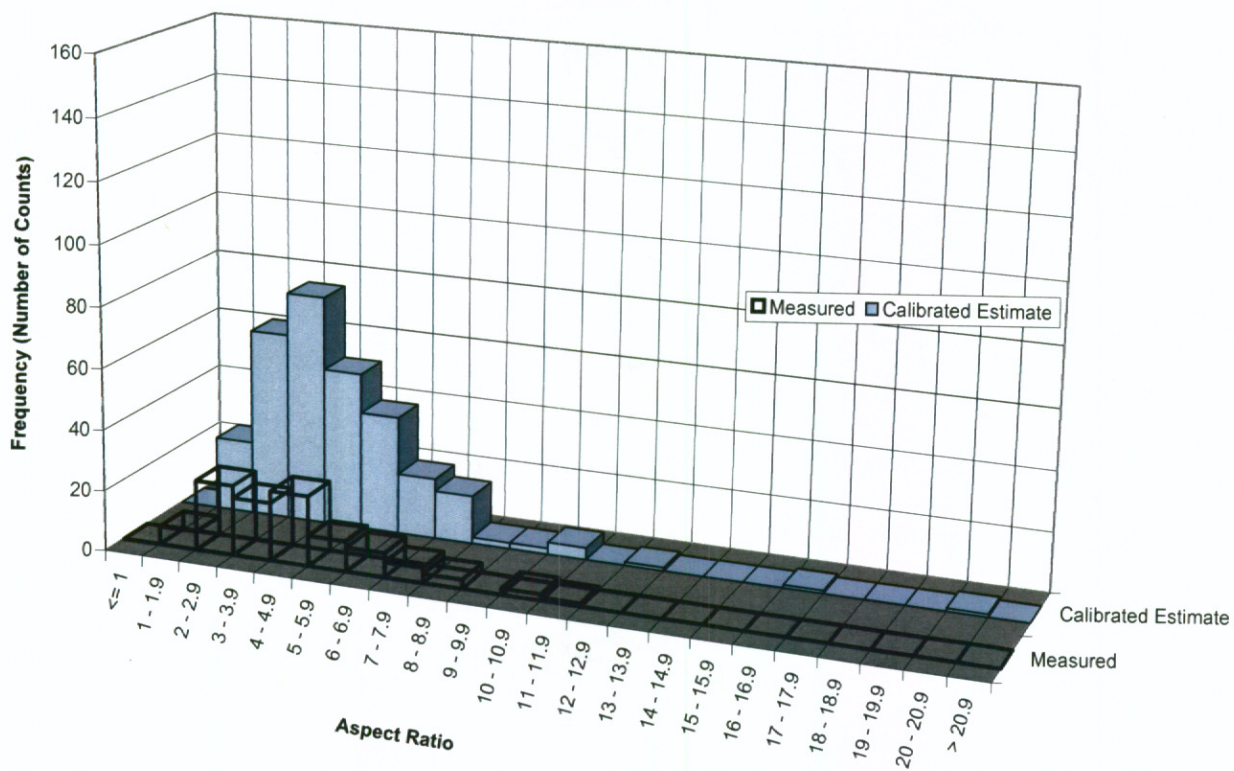


Figure 15. Frequency Distribution of Lengths for Actinolite Particles:  
Comparison of Dimensions from PCM Measured by Calibrated Visual Estimation and Walton-Beckett  
Graticule

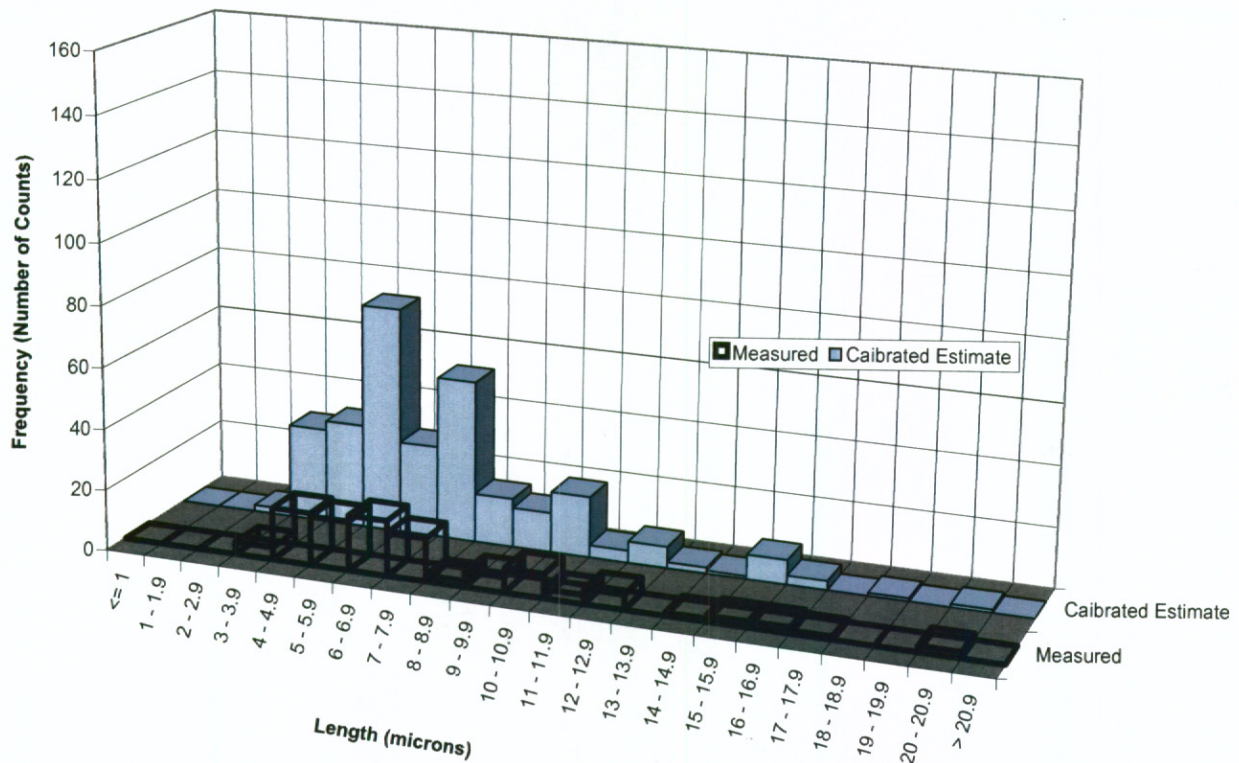
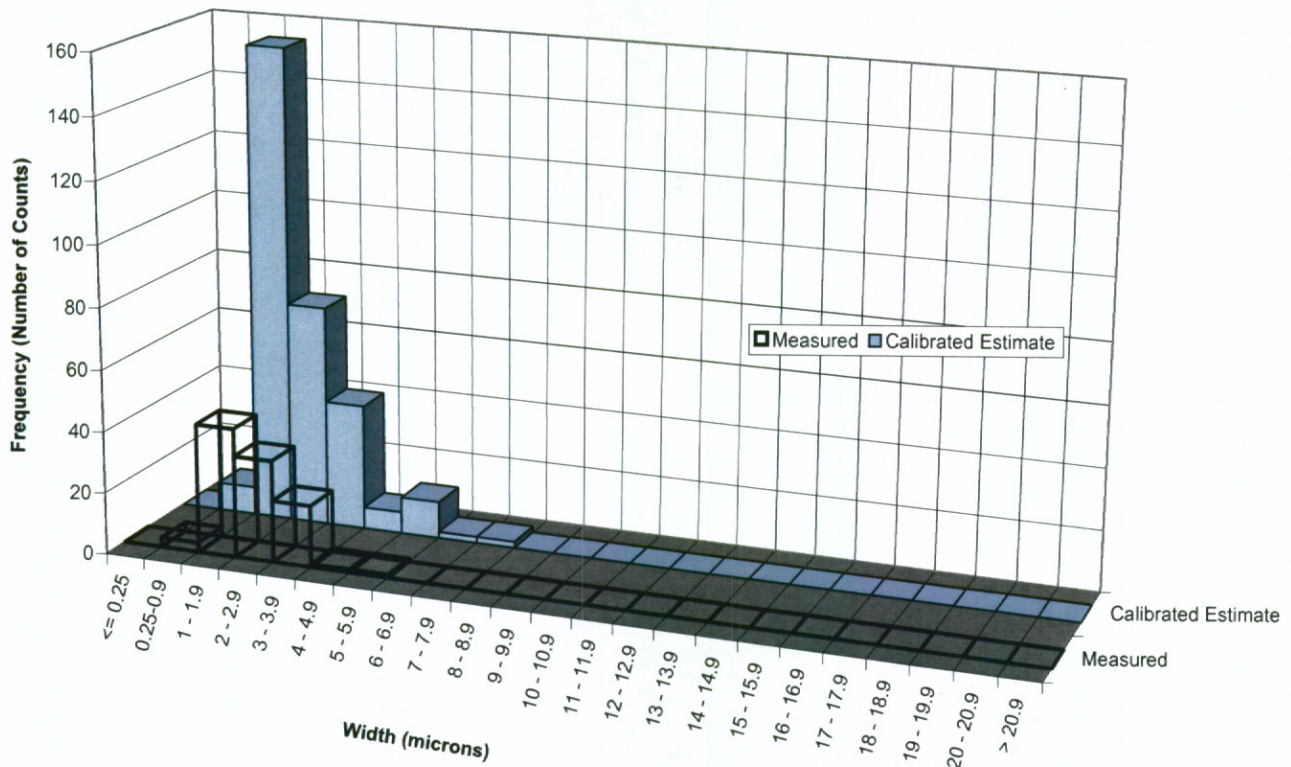


Figure 16. Frequency Distribution of Widths for Actinolite Particles:  
Comparison of Dimensions from PCM Measured by Calibrated Visual Estimation and Walton-Beckett Graticule



## **Analytical Data Summaries**

### **3B. Cummingtonite with biotite**

Cummingtonite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

**Table A: Cummingtonite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

\* Note: data in red does not meet criteria for counting; ie.  $\geq 5$   $\mu\text{m}$  in length or  $\geq 3:1$  aspect ratio.

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
1 Structures Measured by LCG (50 Structures per filter on each of 6 filters)	1	15.0	2.0	7.5
	2	7.5	2.0	3.8
	3	10.0	3.0	3.3
	4	10.0	1.5	6.7
	5	10.0	3.0	3.3
	6	4.0	1.0	4.0
	7	5.0	3.0	1.7
	8	4.0	2.5	1.6
	9	5.0	1.5	3.3
	10	5.0	1.5	3.3
	11	5.0	1.0	5.0
	12	9.0	1.5	6.0
	13	5.0	1.0	5.0
	14	5.0	1.0	5.0
	15	7.5	3.0	2.5
	16	7.0	1.0	7.0
	17	10.0	3.0	3.3
	18	5.0	1.5	3.3
	19	7.5	3.0	2.5
	20	15.0	3.0	5.0
	21	5.0	1.5	3.3
	22	5.0	1.0	5.0
	23	5.0	2.0	2.5
	24	10.0	1.0	10.0
	25	10.0	1.5	6.7
	26	5.0	4.0	1.3
	27	5.0	1.0	5.0

Count of fibers	Count of non-fibers	Total Structures Counted
214	86	300

Percent Fibers	Percent non-fibers
71.3%	28.7%

Meet Fiber Criteria

Bin		
0.9	<= 1	Fiber
1.9	1 - 1.9	Fiber
2.9	2 - 2.9	Fiber
3.9	3 - 3.9	Fiber
4.9	4 - 4.9	Fiber
5.9	5 - 5.9	
6.9	6 - 6.9	Fiber
7.9	7 - 7.9	Fiber
8.9	8 - 8.9	Fiber
9.9	9 - 9.9	
10.9	10 - 10.9	Fiber
11.9	11 - 11.9	Fiber
12.9	12 - 12.9	Fiber
13.9	13 - 13.9	
14.9	14 - 14.9	Fiber
15.9	15 - 15.9	Fiber
16.9	16 - 16.9	
17.9	17 - 17.9	Fiber

Cumingtonite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	28	10.0	2.0	5.0
	29	7.5	2.0	3.8
	30	20.0	3.0	6.7
	31	10.0	3.0	3.3
	32	10.0	3.0	3.3
	33	7.0	1.5	4.7
	34	20.0	3.0	6.7
	35	5.0	1.0	5.0
	36	5.0	1.3	4.0
	37	10.0	1.0	10.0
	38	10.0	1.5	6.7
	39	5.0	1.5	3.3
	40	5.0	3.0	1.7
	41	7.5	1.5	5.0
	42	10.0	3.0	3.3
	43	7.5	3.0	2.5
	44	15.0	2.0	7.5
	45	5.0	1.0	5.0
	46	5.0	1.0	5.0
	47	7.5	2.0	3.8
	48	10.0	1.0	10.0
	49	5.0	1.0	5.0
	50	10.0	1.0	10.0
2	51	5.0	3.0	1.7
	52	5.0	1.0	5.0
	53	5.0	3.0	1.7
	54	5.0	1.0	5.0
	55	7.5	3.0	2.5
	56	20.0	3.0	6.7
	57	10.0	1.5	6.7
	58	5.0	1.5	3.3
	59	5.0	1.5	3.3
	60	20.0	1.5	13.3
	61	5.0	1.5	3.3

Meet Fiber Criteria	71.3%	28.7%
18.9	18 - 18.9	Fiber
19.9	19 - 19.9	Fiber
20.9	20 - 20.9	Fiber
More	> 20.9	Fiber
		Fiber
		Fiber
		Fiber
		Fiber
Bin		Fiber
0.24	<= 0.25	Fiber
0.9	0.25-0.9	Fiber
1.9	1 - 1.9	Fiber
2.9	2 - 2.9	Fiber
3.9	3 - 3.9	
4.9	4 - 4.9	Fiber
5.9	5 - 5.9	Fiber
6.9	6 - 6.9	
7.9	7 - 7.9	Fiber
8.9	8 - 8.9	Fiber
9.9	9 - 9.9	Fiber
10.9	10 - 10.9	Fiber
11.9	11 - 11.9	Fiber
12.9	12 - 12.9	Fiber
13.9	13 - 13.9	Fiber
14.9	14 - 14.9	
15.9	15 - 15.9	Fiber
16.9	16 - 16.9	
17.9	17 - 17.9	Fiber
18.9	18 - 18.9	
19.9	19 - 19.9	Fiber
20.9	20 - 20.9	Fiber
More	> 20.9	Fiber
		Fiber
		Fiber

Cummingtonite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	62	4.0	1.5	2.7
	63	5.0	1.0	5.0
	64	5.0	1.0	5.0
	65	5.0	1.0	5.0
	66	3.0	1.0	3.0
	67	5.0	2.0	2.5
	68	10.0	3.0	3.3
	69	5.0	3.0	1.7
	70	12.0	3.0	4.0
	71	5.0	3.0	1.7
	72	20.0	3.0	6.7
	73	12.0	3.0	4.0
	74	12.0	3.5	3.4
	75	7.0	2.0	3.5
	76	5.0	2.0	2.5
	77	5.0	1.5	3.3
	78	10.0	6.0	1.7
	79	15.0	4.0	3.8
	80	10.0	3.0	3.3
	81	7.0	1.0	7.0
	82	7.0	1.0	7.0
	83	10.0	1.0	10.0
	84	7.0	3.0	2.3
	85	10.0	3.0	3.3
	86	7.0	2.0	3.5
	87	10.0	5.0	2.0
	88	20.0	3.0	6.7
	89	7.0	3.0	2.3
	90	7.0	3.0	2.3
	91	10.0	3.0	3.3
	92	5.0	3.0	1.7
	93	5.0	3.0	1.7
	94	7.0	4.0	1.8
	95	10.0	2.0	5.0

Meet  
Fiber  
Criteria 71.3% 28.7%

Fiber  
Fiber  
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Fiber  
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Fiber

Fiber



Cumingtonite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	96	5.0	1.5	3.3
	97	10.0	2.5	4.0
	98	10.0	3.5	2.9
	99	5.0	3.0	1.7
	100	9.0	1.0	9.0
3	101	10.0	1.0	10.0
	102	12.0	2.0	6.0
	103	5.0	1.0	5.0
	104	5.0	3.0	1.7
	105	7.0	3.0	2.3
	106	5.0	2.0	2.5
	107	25.0	2.0	12.5
	108	10.0	3.0	3.3
	109	5.0	1.0	5.0
	110	10.0	1.5	6.7
	111	7.0	1.5	4.7
	112	3.0	0.5	6.0
	113	3.0	0.5	6.0
	114	5.0	1.5	3.3
	115	5.0	1.5	3.3
	116	5.0	1.0	5.0
	117	7.5	1.0	7.5
	118	3.0	1.0	3.0
	119	5.0	1.0	5.0
	120	20.0	4.0	5.0
	121	10.0	2.0	5.0
	122	5.0	1.5	3.3
	123	5.0	1.5	3.3
	124	5.0	1.0	5.0
	125	3.0	1.0	3.0
	126	20.0	5.0	4.0
	127	15.0	4.0	3.8
	128	5.0	3.0	1.7
	129	7.5	3.0	2.5

Meet Fiber Criteria 71.3% 28.7%

Fiber  
Fiber

Fiber  
Fiber  
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Fiber

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Fiber

Fiber  
Fiber

Cumingtonite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	130	10.0	2.0	5.0
	131	7.5	3.0	2.5
	132	5.0	1.5	3.3
	133	5.0	1.5	3.3
	134	5.0	1.5	3.3
	135	10.0	1.5	6.7
	136	5.0	1.5	3.3
	137	5.0	1.5	3.3
	138	5.0	2.0	2.5
	139	10.0	1.0	10.0
	140	5.0	1.5	3.3
	141	5.0	1.5	3.3
	142	7.0	1.5	4.7
	143	5.0	1.5	3.3
	144	3.0	1.5	2.0
	145	5.0	1.0	5.0
	146	5.0	1.5	3.3
	147	5.0	1.5	3.3
	148	20.0	3.0	6.7
	149	10.0	1.5	6.7
	150	7.0	2.0	3.5
4	151	5.0	2.5	2.0
	152	10.0	3.0	3.3
	153	7.0	3.0	2.3
	154	5.0	1.5	3.3
	155	7.5	2.0	3.8
	156	20.0	3.0	6.7
	157	20.0	5.0	4.0
	158	7.5	3.0	2.5
	159	5.0	1.0	5.0
	160	3.0	1.0	3.0
	161	7.5	1.0	7.5
	162	5.0	1.5	3.3
	163	5.0	1.0	5.0

Meet  
Fiber  
Criteria

71.3%

28.7%

Fiber

Fiber

Fiber

Fiber

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Fiber



Cummingonite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	198	3.0	1.5	2.0
	199	15.0	3.0	5.0
	200	5.0	3.0	1.7
5	201	10.0	1.5	6.7
	202	10.0	2.0	5.0
	203	12.0	2.0	6.0
	204	7.0	1.5	4.7
	205	12.0	3.0	4.0
	206	5.0	3.0	1.7
	207	5.0	1.5	3.3
	208	6.0	2.0	3.0
	209	5.0	1.5	3.3
	210	12.0	2.0	6.0
	211	7.0	3.0	2.3
	212	5.0	2.0	2.5
	213	5.0	1.5	3.3
	214	10.0	3.0	3.3
	215	12.0	4.0	3.0
	216	5.0	1.5	3.3
	217	5.0	1.0	5.0
	218	4.0	1.5	2.7
	219	3.0	1.5	2.0
	220	7.0	1.0	7.0
	221	5.0	1.0	5.0
	222	10.0	1.0	10.0
	223	10.0	4.0	2.5
	224	12.0	4.0	3.0
	225	7.0	1.0	7.0
	226	5.0	1.0	5.0
	227	4.0	0.5	8.0
	228	5.0	0.5	10.0
	229	6.0	1.5	4.0
	230	5.0	2.0	2.5
	231	10.0	3.0	3.3

Meet Fiber Criteria 71.3% 28.7%

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Fiber

Cummingtonite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	232	5.0	1.5	3.3
	233	6.0	1.5	4.0
	234	15.0	4.0	3.8
	235	9.0	4.0	2.3
	236	15.0	4.0	3.8
	237	5.0	1.0	5.0
	238	5.0	2.0	2.5
	239	5.0	1.0	5.0
	240	10.0	3.0	3.3
	241	10.0	3.0	3.3
	242	7.0	1.5	4.7
	243	15.0	4.0	3.8
	244	10.0	5.0	2.0
	245	7.5	1.5	5.0
	246	10.0	1.5	6.7
	247	7.5	1.0	7.5
	248	7.5	1.0	7.5
	249	20.0	4.0	5.0
	250	20.0	20.0	1.0
6	251	20.0	1.5	13.3
	252	4.0	1.0	4.0
	253	7.5	2.5	3.0
	254	10.0	1.0	10.0
	255	5.0	1.0	5.0
	256	5.0	1.0	5.0
	257	7.0	1.5	4.7
	258	10.0	5.0	2.0
	259	10.0	3.0	3.3
	260	7.0	3.0	2.3
	261	7.0	3.0	2.3
	262	10.0	3.0	3.3
	263	10.0	3.0	3.3
	264	15.0	2.0	7.5
	265	10.0	3.0	3.3

Meet Fiber Criteria 71.3% 28.7%

Fiber  
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Cummingtonite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	266	3.0	1.0	3.0
	267	3.0	1.0	3.0
	268	20.0	3.0	6.7
	269	10.0	2.0	5.0
	270	15.0	3.0	5.0
	271	7.0	2.0	3.5
	272	15.0	3.0	5.0
	273	5.0	2.0	2.5
	274	10.0	0.5	20.0
	275	5.0	1.5	3.3
	276	10.0	3.0	3.3
	277	7.0	3.0	2.3
	278	10.0	1.5	6.7
	279	5.0	1.5	3.3
	280	7.0	3.0	2.3
	281	7.0	3.0	2.3
	282	5.0	1.0	5.0
	283	5.0	1.5	3.3
	284	5.0	1.5	3.3
	285	7.5	1.5	5.0
	286	7.5	1.5	5.0
	287	20.0	3.0	6.7
	288	15.0	3.0	5.0
	289	7.5	3.0	2.5
	290	5.0	1.0	5.0
	291	5.0	0.5	10.0
	292	5.0	1.5	3.3
	293	6.0	1.0	6.0
	294	6.0	1.0	6.0
	295	10.0	1.5	6.7
	296	10.0	3.0	3.3
	297	7.5	3.0	2.5
	298	5.0	1.0	5.0
	299	5.0	1.0	5.0

Meet  
Fiber  
Criteria 71.3% 28.7%

Fiber  
Fiber  
Fiber  
Fiber  
Fiber

Fiber  
Fiber  
Fiber

Fiber  
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Fiber  
Fiber  
Fiber  
Fiber

Fiber  
Fiber

Cumingtonite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	300	4.0	1.0	4.0

Meet  
Fiber  
Criteria 71.3% 28.7%

**Table A1: Summary Statistics for Cummingtonite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

<i>Length (microns)</i>		<i>Width (microns)</i>		<i>Aspect Ratio</i>
<b>Mean</b>	7.97	<b>Mean</b>	2.11	<b>Mean</b> 4.37
<b>Standard Error</b>	0.24	<b>Standard Error</b>	0.09	<b>Standard Error</b> 0.13
<b>Median</b>	7.00	<b>Median</b>	1.50	<b>Median</b> 3.46
<b>Mode</b>	5.00	<b>Mode</b>	1.50	<b>Mode</b> 3.33
<b>Standard Deviation</b>	4.23	<b>Standard Deviation</b>	1.48	<b>Standard Deviation</b> 2.33
<b>Sample Variance</b>	17.85	<b>Sample Variance</b>	2.20	<b>Sample Variance</b> 5.42
<b>Kurtosis</b>	2.28	<b>Kurtosis</b>	70.19	<b>Kurtosis</b> 7.85
<b>Skewness</b>	1.56	<b>Skewness</b>	6.20	<b>Skewness</b> 2.08
<b>Range</b>	22.00	<b>Range</b>	19.50	<b>Range</b> 19.00
<b>Minimum</b>	3.00	<b>Minimum</b>	0.50	<b>Minimum</b> 1.00
<b>Maximum</b>	25.00	<b>Maximum</b>	20.00	<b>Maximum</b> 20.00
<b>Sum</b>	2390.50	<b>Sum</b>	633.75	<b>Sum</b> 1310.12
<b>Count</b>	300	<b>Count</b>	300	<b>Count</b> 300



**Table A2. Aspect Ratios for Cummingtonite Particles: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Aspect Ratio</i>
0.9	0	0.0%	0.0%	<= 1
1.9	20	6.7%	6.7%	1 - 1.9
2.9	51	17.0%	23.7%	2 - 2.9
3.9	92	30.7%	54.3%	3 - 3.9
4.9	21	7.0%	61.3%	4 - 4.9
5.9	55	18.3%	79.7%	5 - 5.9
6.9	29	9.7%	89.3%	6 - 6.9
7.9	14	4.7%	94.0%	7 - 7.9
8.9	1	0.3%	94.3%	8 - 8.9
9.9	1	0.3%	94.7%	9 - 9.9
10.9	12	4.0%	98.7%	10 - 10.9
11.9	0	0.0%	98.7%	11 - 11.9
12.9	1	0.3%	99.0%	12 - 12.9
13.9	2	0.7%	99.7%	13 - 13.9
14.9	0	0.0%	99.7%	14 - 14.9
15.9	0	0.0%	99.7%	15 - 15.9
16.9	0	0.0%	99.7%	16 - 16.9
17.9	0	0.0%	99.7%	17 - 17.9
18.9	0	0.0%	99.7%	18 - 18.9
19.9	0	0.0%	99.7%	19 - 19.9
20.9	1	0.3%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9
Sum	300			

**Table A3. Lengths for Cummingtonite Particles: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

<i>Length (microns)</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Length (microns)</i>
0.9	0	0.0%	0.0%	<= 1
1.9	0	0.0%	0.0%	1 - 1.9
2.9	0	0.0%	0.0%	2 - 2.9
3.9	14	4.7%	4.7%	3 - 3.9
4.9	10	3.3%	8.0%	4 - 4.9
5.9	109	36.3%	44.3%	5 - 5.9
6.9	5	1.7%	46.0%	6 - 6.9
7.9	55	18.3%	64.3%	7 - 7.9
8.9	0	0.0%	64.3%	8 - 8.9
9.9	3	1.0%	65.3%	9 - 9.9
10.9	63	21.0%	86.3%	10 - 10.9
11.9	0	0.0%	86.3%	11 - 11.9
12.9	10	3.3%	89.7%	12 - 12.9
13.9	0	0.0%	89.7%	13 - 13.9
14.9	0	0.0%	89.7%	14 - 14.9
15.9	13	4.3%	94.0%	15 - 15.9
16.9	0	0.0%	94.0%	16 - 16.9
17.9	0	0.0%	94.0%	17 - 17.9
18.9	0	0.0%	94.0%	18 - 18.9
19.9	0	0.0%	94.0%	19 - 19.9
20.9	17	5.7%	99.7%	20 - 20.9
More	1	0.3%	100.0%	> 20.9
Sum	300			

**Table A4. Widths for Cummingtonite Particles: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>
0.24	0	0.0%	0.0%	<= 0.25
0.9	6	2.0%	2.0%	0.25-0.9
1.9	154	51.3%	53.3%	1 - 1.9
2.9	38	12.7%	66.0%	2 - 2.9
3.9	78	26.0%	92.0%	3 - 3.9
4.9	13	4.3%	96.3%	4 - 4.9
5.9	9	3.0%	99.3%	5 - 5.9
6.9	1	0.3%	99.7%	6 - 6.9
7.9	0	0.0%	99.7%	7 - 7.9
8.9	0	0.0%	99.7%	8 - 8.9
9.9	0	0.0%	99.7%	9 - 9.9
10.9	0	0.0%	99.7%	10 - 10.9
11.9	0	0.0%	99.7%	11 - 11.9
12.9	0	0.0%	99.7%	12 - 12.9
13.9	0	0.0%	99.7%	13 - 13.9
14.9	0	0.0%	99.7%	14 - 14.9
15.9	0	0.0%	99.7%	15 - 15.9
16.9	0	0.0%	99.7%	16 - 16.9
17.9	0	0.0%	99.7%	17 - 17.9
18.9	0	0.0%	99.7%	18 - 18.9
19.9	0	0.0%	99.7%	19 - 19.9
20.9	1	0.3%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9
Sum	300			



Cummingtonite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

1	A1	E5	1	4.13	1.91	2.17							
1	A1	D12	28	7.75	0.95	8.13							
1	A1	D17	29	2.54	0.38	6.67	> 20.9	Fiber PEF	Yes	19.0%	0.0%	81.0%	
1	A1	D17	30	3.81	1.27	3.00			Yes				
1	A1	D17	31	2.54	0.76	3.33			Yes				
1	A1	D17	32	4.45	2.16	2.06			Yes				
1	A1	D17	33	10.67	2.92	3.65	Bin						
1	A1	D17	34	5.72	1.02	5.63	0.09	<= 0.1	Fiber PEF				
1	A1	D17	35	4.83	2.54	1.90	0.19	0.10 - 0.19	Fiber PEF				
1	A1	D17	36	2.03	0.64	3.20	0.24	0.20 - 0.24		Yes			
1	A1	G3	37	2.67	0.95	2.80	0.29	0.25 - 0.29		Yes			
1	A1	G3	38	7.24	3.18	2.28	0.39	0.30 - 0.39		Yes			
1	A1	G3	39	2.03	0.64	3.20	0.49	0.40 - 0.49		Yes			
1	A1	G3	40	2.54	0.51	5.00	0.59	0.50 - 0.59		Yes			
1	A1	G3	41	1.27	0.38	3.33	0.69	0.60 - 0.69		Yes			
1	A1	G3	42	0.76	0.13	6.00	0.79	0.70 - 0.79		Yes			
1	A1	G3	43	1.27	0.13	10.00	0.89	0.80 - 0.89		Yes			
1	A1	G2	44	5.72	2.54	2.25	0.99	0.90 - 0.99		Yes			
1	A1	G2	45	8.89	2.79	3.18	1.09	1 - 1.09		Yes			
1	A1	G2	46	2.67	0.89	3.00	1.19	1.1 - 1.19	Fiber PEF				
1	A1	G2	47	0.95	0.06	15.00	1.29	1.2 - 1.29		Yes			
1	A1	G2	48	2.54	1.02	2.50	1.39	1.3 - 1.39		Yes			
1	A1	G2	49	4.45	1.91	2.33	1.49	1.4 - 1.49		Yes			
1	A1	G2	50	1.91	0.32	6.00	1.59	1.5 - 1.59		Yes			
2	B1	D4	51	10.67	4.19	2.55	1.69	1.6 - 1.69		Yes			
2	B1	D4	52	1.91	0.38	5.00	1.79	1.7 - 1.79		Yes			
2	B1	D4	53	2.22	1.52	1.46	1.89	1.8 - 1.89		Yes			
2	B1	D4	54	1.91	0.76	2.50	1.99	1.9 - 1.99		Yes			
2	B1	D4	55	2.67	0.32	8.40	2.09	2.0 - 2.09		Yes			
2	B1	D4	56	5.33	3.18	1.68	2.19	2.1 - 2.19		Yes			
2	B1	D4	57	2.29	0.51	4.50	2.29	2.2 - 2.29		Yes			
2	B1	D4	58	6.60	2.54	2.60	2.39	2.3 - 2.39		Yes			
2	B1	D4	59	3.30	1.27	2.60	2.49	2.4 - 2.49		Yes			
2	B1	D4	60	2.54	0.38	6.67	2.59	2.5 - 2.59		Yes			
2	B1	D4	61	8.89	2.54	3.50	2.69	2.6 - 2.69		Yes			
2	B1	D4	62	1.52	0.64	2.40	2.79	2.7 - 2.79	Fiber PEF				
2	B1	D4	63	1.40	0.06	22.00	2.89	2.8 - 2.89		Yes			
2	B1	D4	64	4.32	2.29	1.89	2.99	2.9 - 2.99		Yes			
2	B1	D4	65	3.81	2.54	1.50	3.09	3.0 - 3.09		Yes			
2	B1	D4	66	3.81	1.27	3.00	3.19	3.1 - 3.19		Yes			
							3.29	3.2 - 3.29		Yes			

Cumingtonite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

1	A1	E5	1	4.13	1.91	2.17							
2	B1	D4	67	4.19	2.86	1.47	3.39	3.3 - 3.39	Yes	19.0%	0.0%	81.0%	
2	B1	D4	68	2.29	0.64	3.60	3.49	3.4 - 3.49	Yes				
2	B1	D4	69	1.91	0.89	2.14	3.59	3.5 - 3.59	Yes				
2	B1	D4	70	1.91	0.38	5.00	3.69	3.6 - 3.69	Yes				
2	B1	D4	71	1.27	0.25	5.00	3.79	3.7 - 3.79	Yes				
2	B1	D4	72	8.64	2.79	3.09	3.89	3.8 - 3.89	Yes				
2	B1	D4	73	6.73	1.02	6.63	3.99	3.9 - 3.99	Fiber PEF				
2	B1	D4	74	0.89	0.13	7.00	4.09	4.0 - 4.09	Fiber PEF				
2	B1	D4	75	2.29	0.64	3.60	4.19	4.1 - 4.19	Yes				
2	B1	D4	76	3.56	1.27	2.80	4.29	4.2 - 4.29	Yes				
2	B1	D4	77	3.30	0.25	13.00	4.39	4.3 - 4.39	Yes				
2	B1	D4	78	1.91	1.02	1.88	4.49	4.4 - 4.49	Yes				
2	B1	A24	79	1.78	0.89	2.00	4.59	4.5 - 4.59	Yes				
2	B1	A24	80	2.03	0.64	3.20	4.69	4.6 - 4.69	Yes				
2	B1	A24	81	1.65	0.64	2.60	4.79	4.7 - 4.79	Yes				
2	B1	A24	82	0.89	0.06	14.00	4.89	4.8 - 4.89	Yes				
2	B1	A24	83	0.76	0.32	2.40	More	> 4.89	Yes				
2	B1	A24	84	1.27	0.51	2.50			Yes				
2	B1	A24	85	0.89	0.13	7.00			Yes				
2	B1	A24	86	3.05	0.32	9.60			Yes				
2	B1	A24	87	3.05	0.51	6.00			Yes				
2	B1	A24	88	4.06	1.40	2.91			Yes				
2	B1	A24	89	1.52	0.25	6.00			Yes				
2	B1	A24	90	0.25	0.32	0.79			Yes				
2	B1	A24	91	2.86	0.89	3.21			Yes				
2	B1	A24	92	3.30	1.59	2.08			Yes				
2	B1	A24	93	3.81	1.27	3.00			Yes				
2	B1	A24	94	2.29	0.89	2.57			Yes				
2	B1	A24	95	6.60	3.05	2.17			Yes				
2	B1	A24	96	2.03	0.13	16.00			Yes				
2	B1	A24	97	4.76	0.76	6.25			Yes				
2	B1	A24	98	5.72	0.51	11.25			Yes				
2	B1	A24	99	1.91	0.64	3.00			Fiber PEF				
2	B1	A24	100	5.97	0.51	11.75			Fiber PEF				
3	C3	A24	101	4.06	1.02	4.00			Yes				
3	C3	A24	102	4.83	0.95	5.07			Yes				
3	C3	A24	103	3.49	1.27	2.75			Yes				
3	C3	A24	104	1.91	0.51	3.75			Yes				
3	C3	A24	105	1.59	0.25	6.25			Yes				



Cummingtonite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

1	A1	E5	1	4.13	1.91	2.17					
3	C3	D14	145	2.79	2.29	1.22					
3	C3	D14	146	20.32	3.18	6.40					
3	C3	D14	147	3.18	1.27	2.50					
3	C3	D14	148	2.29	0.38	6.00					
3	C3	D14	149	4.06	0.76	5.33					
3	C3	D14	150	6.99	0.51	13.75					
4	D1	E23	151	6.99	2.41	2.89					
4	D1	E23	152	1.14	0.13	9.00					
4	D1	E23	153	5.08	1.02	5.00					
4	D1	E23	154	3.30	1.65	2.00					
4	D1	E23	155	4.57	1.91	2.40					
4	D1	E23	156	3.81	0.64	6.00					
4	D1	E23	157	1.65	0.51	3.25					
4	D1	E23	158	3.81	1.27	3.00					
4	D1	E23	159	5.72	1.91	3.00					
4	D1	E23	160	5.08	1.02	5.00					
4	D1	E23	161	4.06	0.32	12.80					
4	D1	H1	162	7.94	4.06	1.95					
4	D1	H1	163	1.65	0.51	3.25					
4	D1	H1	164	4.19	1.59	2.64					
4	D1	H1	165	3.30	0.95	3.47					
4	D1	H1	166	3.18	0.64	5.00					
4	D1	H1	167	5.33	0.89	6.00					
4	D1	H1	168	1.78	0.32	5.60					
4	D1	H1	169	2.29	0.25	9.00					
4	D1	H1	170	2.67	0.64	4.20					
4	D1	H1	171	2.54	1.27	2.00					
4	D1	H1	172	2.92	1.52	1.92					
4	D1	H1	173	5.21	0.64	8.20					
4	D1	H1	174	9.53	3.81	2.50					
4	D1	H1	175	12.70	2.22	5.71					
4	D1	H1	176	6.86	0.89	7.71					
4	D1	F15	177	3.56	0.89	4.00					
4	D1	F15	178	3.05	0.38	8.00					
4	D1	F15	179	4.06	1.27	3.20					
4	D1	F15	180	3.56	0.51	7.00					
4	D1	F15	181	9.65	1.91	5.07					
4	D1	F15	182	3.81	1.91	2.00					
4	D1	F15	183	8.26	3.43	2.41					
							Fiber PEF	Yes	19.0%	0.0%	81.0%
								Yes			
							Fiber PEF	Yes			
								Yes			
							Fiber PEF	Yes			
								Yes			
							Fiber PEF	Yes			
								Yes			
							Fiber PEF	Yes			
								Yes			
							Fiber PEF	Yes			
								Yes			
							Fiber PEF	Yes			
								Yes			
							Fiber PEF	Yes			
								Yes			









**Table B1: Summary Statistics for Cummingtonite Particle Size Data: TEM PCME  
(10,000X Magnification)**

<i>Length (microns)</i>	<i>Width (microns)</i>	<i>Aspect Ratio</i>
<b>Mean</b>	4.14	<b>Mean</b> 5.28
<b>Standard Error</b>	0.17	<b>Standard Error</b> 0.41
<b>Median</b>	3.43	<b>Median</b> 4.00
<b>Mode</b>	2.54	<b>Mode</b> 6.00
<b>Standard Deviation</b>	2.98	<b>Standard Deviation</b> 7.08
<b>Sample Variance</b>	8.86	<b>Sample Variance</b> 50.15
<b>Kurtosis</b>	8.41	<b>Kurtosis</b> 161.54
<b>Skewness</b>	2.38	<b>Skewness</b> 11.31
<b>Range</b>	21.34	<b>Range</b> 109.21
<b>Minimum</b>	0.25	<b>Minimum</b> 0.79
<b>Maximum</b>	21.59	<b>Maximum</b> 110.00
<b>Sum</b>	1240.91	<b>Sum</b> 1582.60
<b>Count</b>	300	<b>Count</b> 300

**Table B3. Lengths for 300 Cummingtonite Particles: TEM PCME  
(10,000X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Length (microns)</i>
0.9	9	3.0%	3.0%	<= 1
1.9	36	12.0%	15.0%	1 - 1.9
2.9	81	27.0%	42.0%	2 - 2.9
3.9	57	19.0%	61.0%	3 - 3.9
4.9	37	12.3%	73.3%	4 - 4.9
5.9	26	8.7%	82.0%	5 - 5.9
6.9	14	4.7%	86.7%	6 - 6.9
7.9	11	3.7%	90.3%	7 - 7.9
8.9	12	4.0%	94.3%	8 - 8.9
9.9	4	1.3%	95.7%	9 - 9.9
10.9	3	1.0%	96.7%	10 - 10.9
11.9	3	1.0%	97.7%	11 - 11.9
12.9	1	0.3%	98.0%	12 - 12.9
13.9	1	0.3%	98.3%	13 - 13.9
14.9	1	0.3%	98.7%	14 - 14.9
15.9	1	0.3%	99.0%	15 - 15.9
16.9	0	0.0%	99.0%	16 - 16.9
17.9	1	0.3%	99.3%	17 - 17.9
18.9	0	0.0%	99.3%	18 - 18.9
19.9	0	0.0%	99.3%	19 - 19.9
20.9	1	0.3%	99.7%	20 - 20.9
More	1	0.3%	100.0%	> 20.9

Sum 300

**Table B4. Widths for 300 Cummingtonite Particles: TEM PCME (10,000X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>
0.9	157	52.3%	52.3%	<= 1
1.9	84	28.0%	80.3%	1 - 1.9
2.9	38	12.7%	93.0%	2 - 2.9
3.9	12	4.0%	97.0%	3 - 3.9
4.9	4	1.3%	98.3%	4 - 4.9
5.9	3	1.0%	99.3%	5 - 5.9
6.9	1	0.3%	99.7%	6 - 6.9
7.9	1	0.3%	100.0%	7 - 7.9
8.9	0	0.0%	100.0%	8 - 8.9
9.9	0	0.0%	100.0%	9 - 9.9
10.9	0	0.0%	100.0%	10 - 10.9
11.9	0	0.0%	100.0%	11 - 11.9
12.9	0	0.0%	100.0%	12 - 12.9
13.9	0	0.0%	100.0%	13 - 13.9
14.9	0	0.0%	100.0%	14 - 14.9
15.9	0	0.0%	100.0%	15 - 15.9
16.9	0	0.0%	100.0%	16 - 16.9
17.9	0	0.0%	100.0%	17 - 17.9
18.9	0	0.0%	100.0%	18 - 18.9
19.9	0	0.0%	100.0%	19 - 19.9
20.9	0	0.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9
Sum	300			

**Table B5. Widths for 300 Cummingtonite Particles: TEM  
PCME (10,000X Magnification) Finer Detail**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>
0.09	9	3.0%	3.0%	<= 0.1
0.19	8	2.7%	5.7%	0.10 - 0.19
0.24	1	0.3%	6.0%	0.20 - 0.24
0.29	14	4.7%	10.7%	0.25 - 0.29
0.39	36	12.0%	22.7%	0.30 - 0.39
0.49	0	0.0%	22.7%	0.40 - 0.49
0.59	19	6.3%	29.0%	0.50 - 0.59
0.69	30	10.0%	39.0%	0.60 - 0.69
0.79	14	4.7%	43.7%	0.70 - 0.79
0.89	26	8.7%	52.3%	0.80 - 0.89
0.99	19	6.3%	58.7%	0.90 - 0.99
1.09	22	7.3%	66.0%	1 - 1.09
1.19	3	1.0%	67.0%	1.1 - 1.19
1.29	24	8.0%	75.0%	1.2 - 1.29
1.39	0	0.0%	75.0%	1.3 - 1.39
1.49	1	0.3%	75.3%	1.4 - 1.49
1.59	8	2.7%	78.0%	1.5 - 1.59
1.69	5	1.7%	79.7%	1.6 - 1.69
1.79	2	0.7%	80.3%	1.7 - 1.79
1.89	0	0.0%	80.3%	1.8 - 1.89
1.99	13	4.3%	84.7%	1.9 - 1.99
2.09	1	0.3%	85.0%	2.0 - 2.09
2.19	3	1.0%	86.0%	2.1 - 2.19
2.29	7	2.3%	88.3%	2.2 - 2.29
2.39	0	0.0%	88.3%	2.3 - 2.39
2.49	1	0.3%	88.7%	2.4 - 2.49
2.59	10	3.3%	92.0%	2.5 - 2.59
2.69	0	0.0%	92.0%	2.6 - 2.69
2.79	0	0.0%	92.0%	2.7 - 2.79
2.89	3	1.0%	93.0%	2.8 - 2.89
2.99	1	0.3%	93.3%	2.9 - 2.99
3.09	1	0.3%	93.7%	3.0 - 3.09
3.19	5	1.7%	95.3%	3.1 - 3.19
3.29	0	0.0%	95.3%	3.2 - 3.29
3.39	0	0.0%	95.3%	3.3 - 3.39
3.49	2	0.7%	96.0%	3.4 - 3.49
3.59	0	0.0%	96.0%	3.5 - 3.59
3.69	0	0.0%	96.0%	3.6 - 3.69
3.79	0	0.0%	96.0%	3.7 - 3.79
3.89	3	1.0%	97.0%	3.8 - 3.89
3.99	0	0.0%	97.0%	3.9 - 3.99
4.09	1	0.3%	97.3%	4.0 - 4.09
4.19	0	0.0%	97.3%	4.1 - 4.19
4.29	1	0.3%	97.7%	4.2 - 4.29
4.39	0	0.0%	97.7%	4.3 - 4.39
4.49	1	0.3%	98.0%	4.4 - 4.49
4.59	0	0.0%	98.0%	4.5 - 4.59
4.69	0	0.0%	98.0%	4.6 - 4.69
4.79	0	0.0%	98.0%	4.7 - 4.79
4.89	1	0.3%	98.3%	4.8 - 4.89
More	5	1.7%	100.0%	> 4.89
Sum	300			





Particle Size Data for Cummingtonite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

Filter	Particle	Length (microns)	Width (microns)	Aspect Ratio			Meet Fiber Criteria	Percent Fibers	Percent non-fibers
	27	10.0	2.0	5.0	17.9	17 - 17.9	Fiber		
	28	10.0	2.0	5.0	18.9	18 - 18.9	Fiber		
	29	5.0	2.0	2.5	19.9	19 - 19.9			
	30	5.0	2.0	2.5	20.9	20 - 20.9			
	31	5.0	1.0	5.0	More	> 20.9	Fiber		
	32	3.0	1.0	3.0					
	33	3.0	1.0	3.0					
	34	10.0	5.0	2.0	Bin				
	35	20.0	5.0	4.0	0.24	<= 0.25	Fiber		
	36	20.0	5.0	4.0	0.9	0.25-0.9	Fiber		
	37	24.0	5.0	4.8	1.9	1 - 1.9	Fiber		
	38	12.0	1.5	8.0	2.9	2 - 2.9	Fiber		
	39	12.5	3.0	4.2	3.9	3 - 3.9	Fiber		
	40	10.0	1.5	6.7	4.9	4 - 4.9	Fiber		
	41	3.0	1.0	3.0	5.9	5 - 5.9			
	42	9.0	1.5	6.0	6.9	6 - 6.9	Fiber		
	43	6.0	1.0	6.0	7.9	7 - 7.9	Fiber		
	44	5.0	1.0	5.0	8.9	8 - 8.9	Fiber		
	45	3.0	1.0	3.0	9.9	9 - 9.9			
	46	6.0	1.0	6.0	10.9	10 - 10.9	Fiber		
	47	6.0	1.0	6.0	11.9	11 - 11.9	Fiber		
	48	9.0	1.0	9.0	12.9	12 - 12.9	Fiber		
	49	21.0	12.0	5.0	13.9	13 - 13.9	Fiber		
	50	12.0	3.0	4.0	14.9	14 - 14.9	Fiber		
Structure numbers	51	12.0	5.0	2.4	15.9	15 - 15.9			
51-100	52	12.0	5.0	2.4	16.9	16 - 16.9			
LCG	53	5.0	3.0	1.7	17.9	17 - 17.9			
on	54	14.0	4.0	3.5	18.9	18 - 18.9	Fiber		
Filter 2	55	7.0	3.0	2.3	19.9	19 - 19.9			
	56	5.0	3.0	1.7	20.9	20 - 20.9			
	57	5.0	0.3	20.0	More	> 20.9	Fiber		
	58	5.0	0.5	10.0			Fiber		
	59	5.0	1.0	5.0			Fiber		
	60	15.0	2.5	6.0			Fiber		





**Table C1. Summary Statistics: Particle Size Data for Cummingtonite Particles:  
Dimensions Measured by PCM using Walton-Beckett Graticule (400X  
Magnification)**

<i>Length (microns)</i>		<i>Width (microns)</i>		<i>Aspect Ratio</i>	
<b>Mean</b>	9.28	<b>Mean</b>	2.78	<b>Mean</b>	4.25
<b>Standard Error</b>	0.60	<b>Standard Error</b>	0.21	<b>Standard Error</b>	0.28
<b>Median</b>	7.50	<b>Median</b>	2.00	<b>Median</b>	3.33
<b>Mode</b>	5.00	<b>Mode</b>	1.00	<b>Mode</b>	3.00
<b>Standard Deviation</b>	5.98	<b>Standard Deviation</b>	2.09	<b>Standard Deviation</b>	2.80
<b>Sample Variance</b>	35.79	<b>Sample Variance</b>	4.35	<b>Sample Variance</b>	7.84
<b>Kurtosis</b>	7.21	<b>Kurtosis</b>	4.09	<b>Kurtosis</b>	14.52
<b>Skewness</b>	2.17	<b>Skewness</b>	1.75	<b>Skewness</b>	3.18
<b>Range</b>	37.00	<b>Range</b>	11.75	<b>Range</b>	19.00
<b>Minimum</b>	3.00	<b>Minimum</b>	0.25	<b>Minimum</b>	1.00
<b>Maximum</b>	40.00	<b>Maximum</b>	12.00	<b>Maximum</b>	20.00
<b>Sum</b>	928.00	<b>Sum</b>	278.00	<b>Sum</b>	425.19
<b>Count</b>	100	<b>Count</b>	100	<b>Count</b>	100

**Table C2. Aspect Ratios for Cummingtonite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)**

<i>Bin</i>	<i>Frequency (Number of Counts)</i>	<i>Relative</i>	<i>Cumulative %</i>	<i>Aspect Ratio</i>
0.9	0	0.0%	0.0%	<= 1
1.9	10	10.0%	10.0%	1 - 1.9
2.9	16	16.0%	26.0%	2 - 2.9
3.9	27	27.0%	53.0%	3 - 3.9
4.9	12	12.0%	65.0%	4 - 4.9
5.9	15	15.0%	80.0%	5 - 5.9
6.9	12	12.0%	92.0%	6 - 6.9
7.9	1	1.0%	93.0%	7 - 7.9
8.9	2	2.0%	95.0%	8 - 8.9
9.9	2	2.0%	97.0%	9 - 9.9
10.9	1	1.0%	98.0%	10 - 10.9
11.9	0	0.0%	98.0%	11 - 11.9
12.9	0	0.0%	98.0%	12 - 12.9
13.9	0	0.0%	98.0%	13 - 13.9
14.9	0	0.0%	98.0%	14 - 14.9
15.9	0	0.0%	98.0%	15 - 15.9
16.9	0	0.0%	98.0%	16 - 16.9
17.9	0	0.0%	98.0%	17 - 17.9
18.9	1	1.0%	99.0%	18 - 18.9
19.9	0	0.0%	99.0%	19 - 19.9
20.9	1	1.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9

Sum 100

**Table C3. Lengths for Cummingtonite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Length (microns)</i>
0.9	0	0.0%	0.0%	<= 1
1.9	0	0.0%	0.0%	1 - 1.9
2.9	0	0.0%	0.0%	2 - 2.9
3.9	8	8.0%	8.0%	3 - 3.9
4.9	4	4.0%	12.0%	4 - 4.9
5.9	22	22.0%	34.0%	5 - 5.9
6.9	10	10.0%	44.0%	6 - 6.9
7.9	7	7.0%	51.0%	7 - 7.9
8.9	1	1.0%	52.0%	8 - 8.9
9.9	6	6.0%	58.0%	9 - 9.9
10.9	13	13.0%	71.0%	10 - 10.9
11.9	0	0.0%	71.0%	11 - 11.9
12.9	11	11.0%	82.0%	12 - 12.9
13.9	3	3.0%	85.0%	13 - 13.9
14.9	1	1.0%	86.0%	14 - 14.9
15.9	5	5.0%	91.0%	15 - 15.9
16.9	0	0.0%	91.0%	16 - 16.9
17.9	0	0.0%	91.0%	17 - 17.9
18.9	1	1.0%	92.0%	18 - 18.9
19.9	0	0.0%	92.0%	19 - 19.9
20.9	4	4.0%	96.0%	20 - 20.9
More	4	4.0%	100.0%	> 20.9

Sum 100

**Table C4. Widths for Cummingtonite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>
0.24	0	0.0%	0.0%	<= 0.25
0.9	3	3.0%	3.0%	0.25-0.9
1.9	36	36.0%	39.0%	1 - 1.9
2.9	19	19.0%	58.0%	2 - 2.9
3.9	17	17.0%	75.0%	3 - 3.9
4.9	4	4.0%	79.0%	4 - 4.9
5.9	14	14.0%	93.0%	5 - 5.9
6.9	1	1.0%	94.0%	6 - 6.9
7.9	3	3.0%	97.0%	7 - 7.9
8.9	1	1.0%	98.0%	8 - 8.9
9.9	0	0.0%	98.0%	9 - 9.9
10.9	1	1.0%	99.0%	10 - 10.9
11.9	0	0.0%	99.0%	11 - 11.9
12.9	1	1.0%	100.0%	12 - 12.9
13.9	0	0.0%	100.0%	13 - 13.9
14.9	0	0.0%	100.0%	14 - 14.9
15.9	0	0.0%	100.0%	15 - 15.9
16.9	0	0.0%	100.0%	16 - 16.9
17.9	0	0.0%	100.0%	17 - 17.9
18.9	0	0.0%	100.0%	18 - 18.9
19.9	0	0.0%	100.0%	19 - 19.9
20.9	0	0.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9

Sum 100

Figure 1. Frequency Distribution of Aspect Ratios for 300 Cummingtonite Particles:  
Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

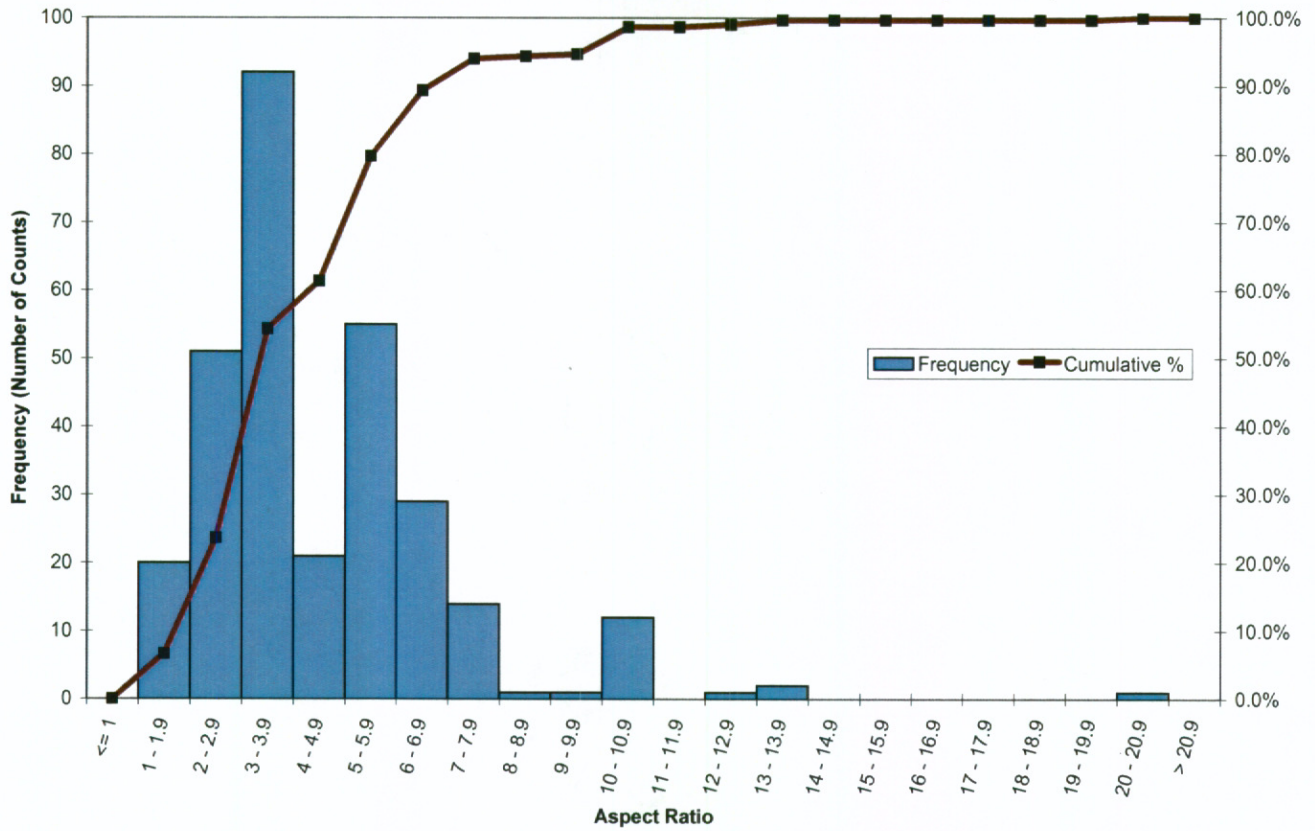




Figure 2. Frequency Distribution of Lengths for 300 Cummingtonite Particles:  
 Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

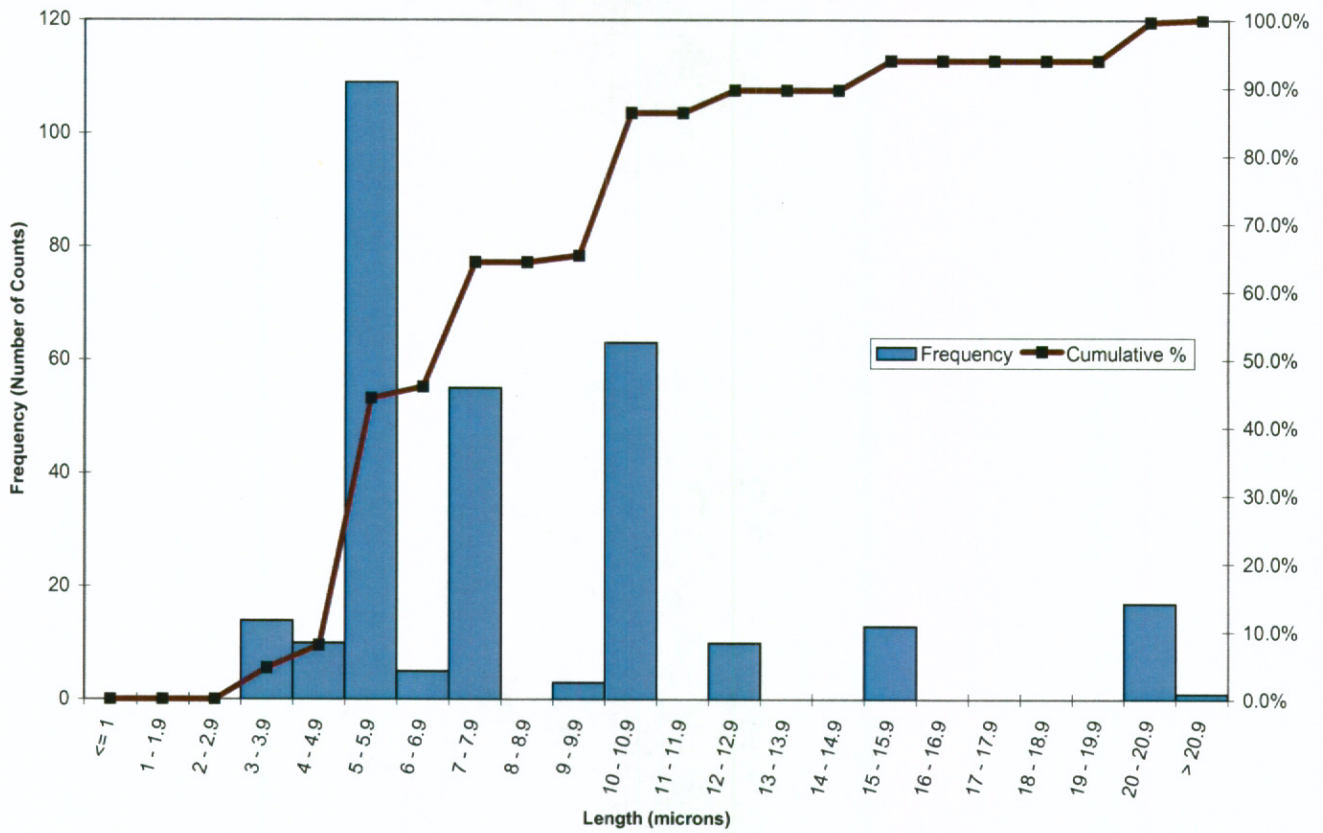


Figure 3. Frequency Distribution of Widths for 300 Cummingtonite Particles:  
 Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

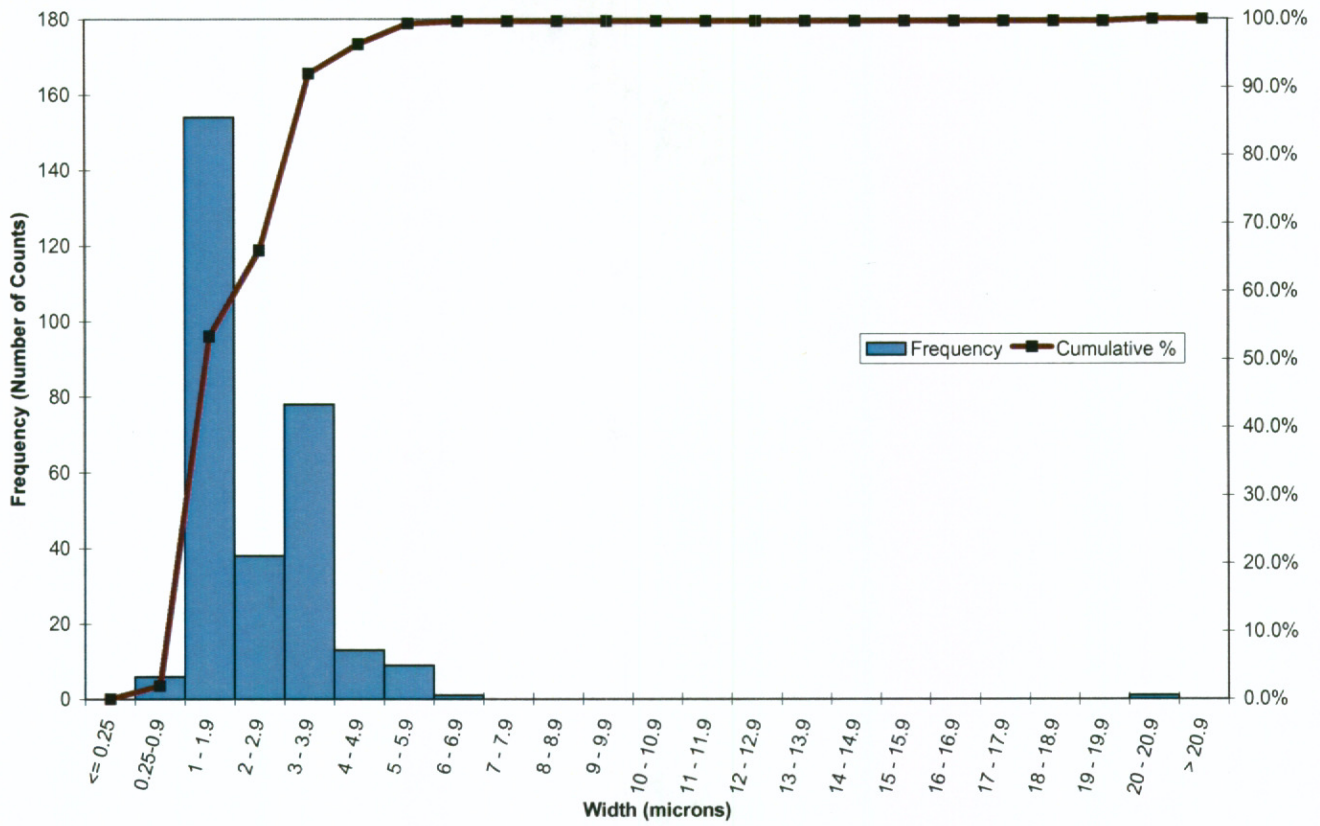


Figure 4. Frequency Distribution of Aspect Ratios for 300 Cummingtonite Particles:  
Dimensions Measured by TEM PCME (10,000X Magnification)

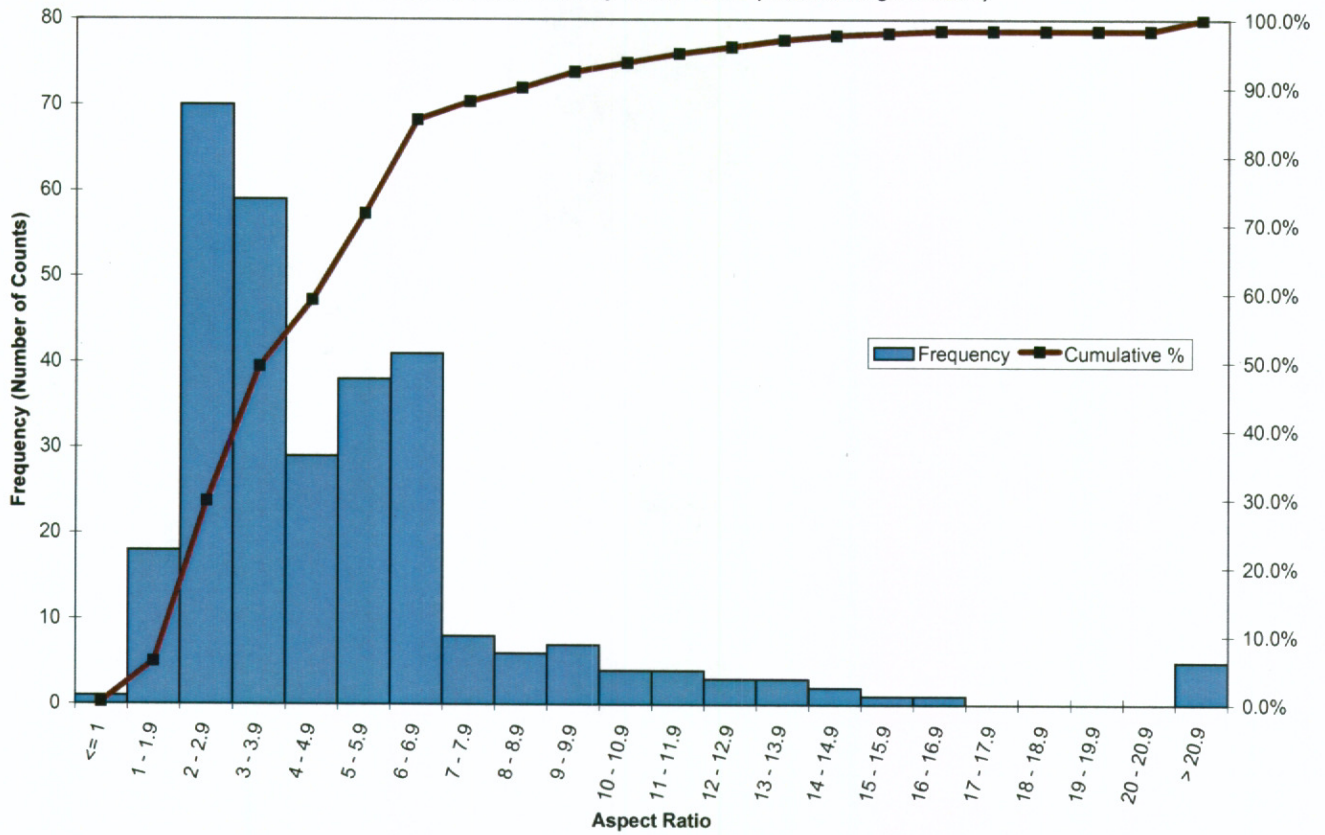


Figure 5. Frequency Distribution of Lengths for 300 Cummingtonite Particles:  
Dimensions Measured by TEM PCME (10,000X Magnification)

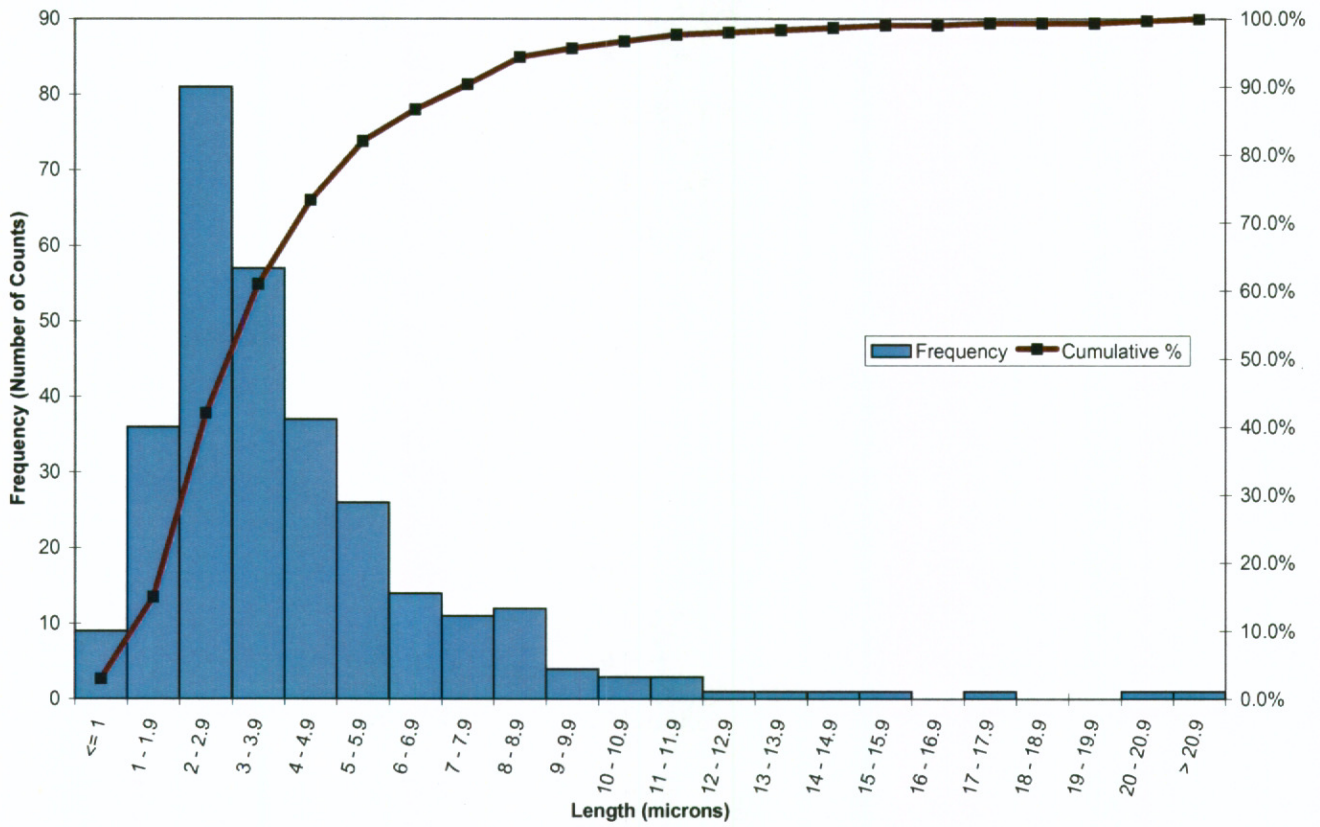


Figure 6. Frequency Distribution of Widths for 300 Cummingtonite Particles:  
Dimensions Measured by TEM PCME (10,000X Magnification)

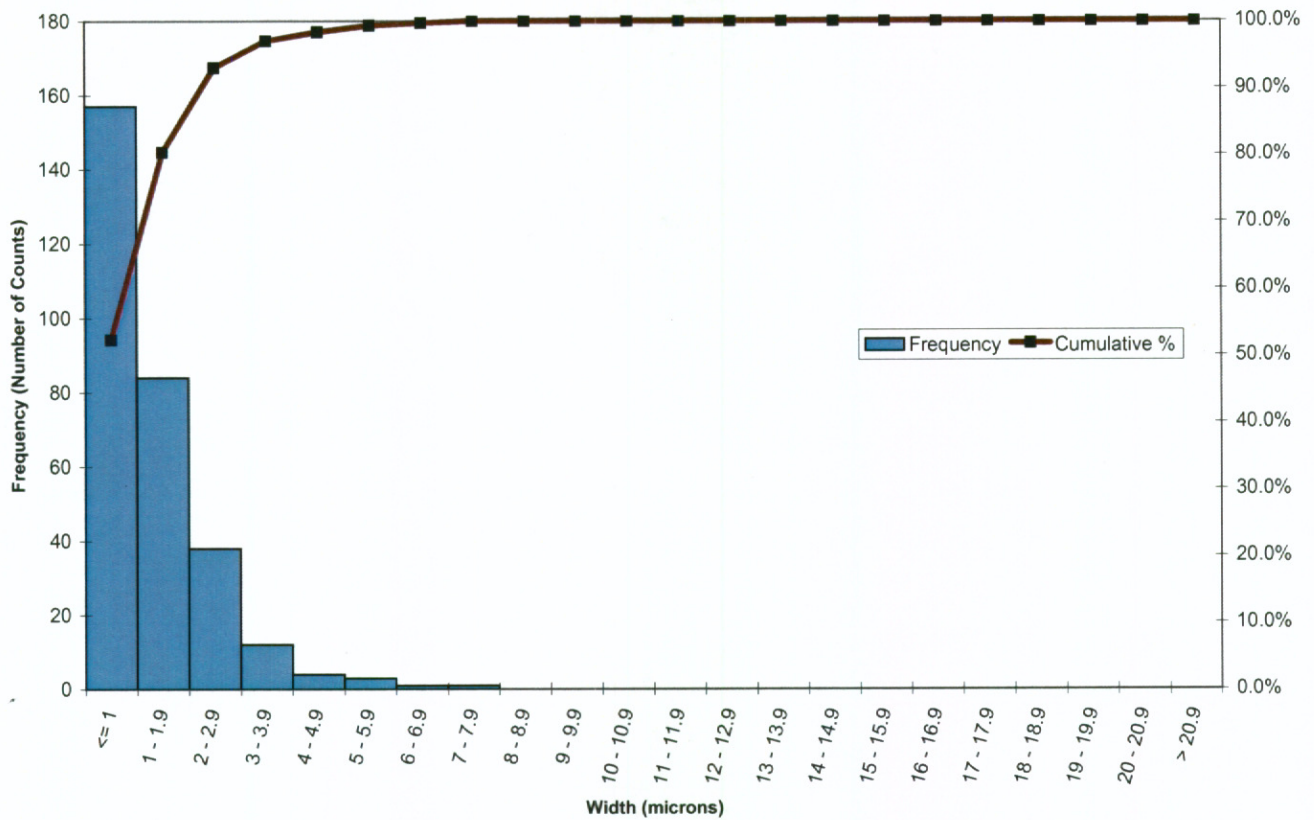


Figure 7. Frequency Distribution of Widths for 300 Cummingtonite Particles:  
Dimensions Measured by TEM PCME (10,000X Magnification) Finer Detail

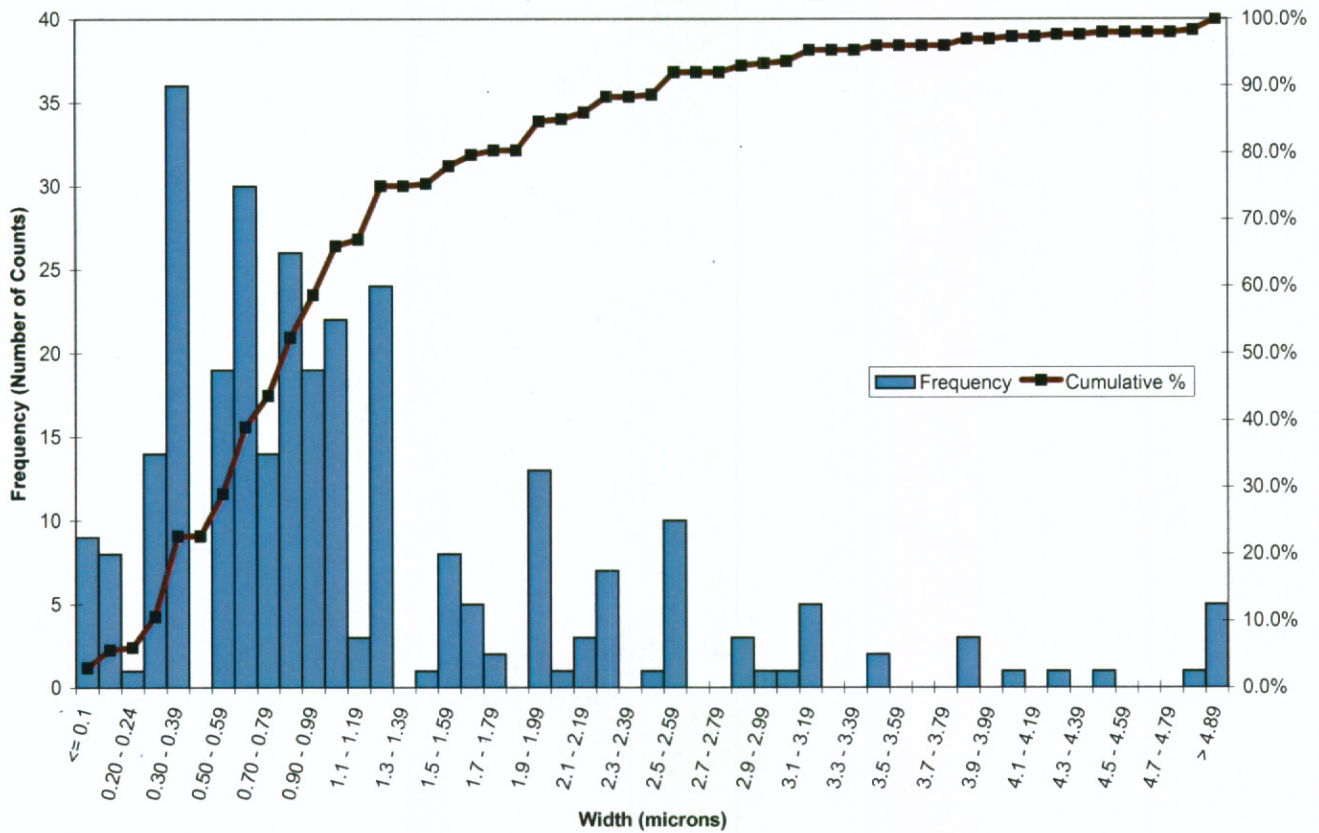


Figure 8. Frequency Distribution of Aspect Ratios for Cummingtonite Particles:  
Comparison of TEM PCME and PCM Data

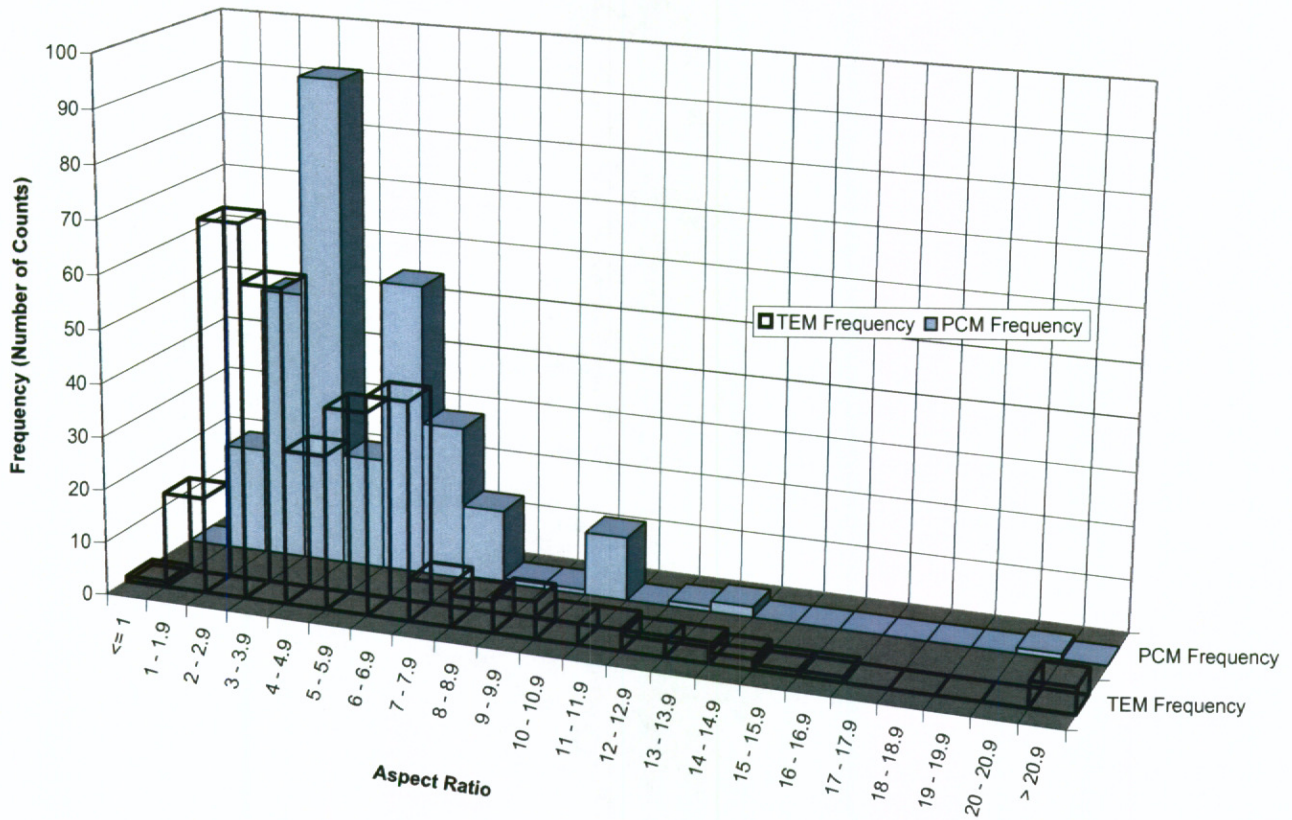


Figure 9. Frequency Distribution of Lengths for Cummingtonite Particles:  
Comparison of TEM PCME and PCM Data

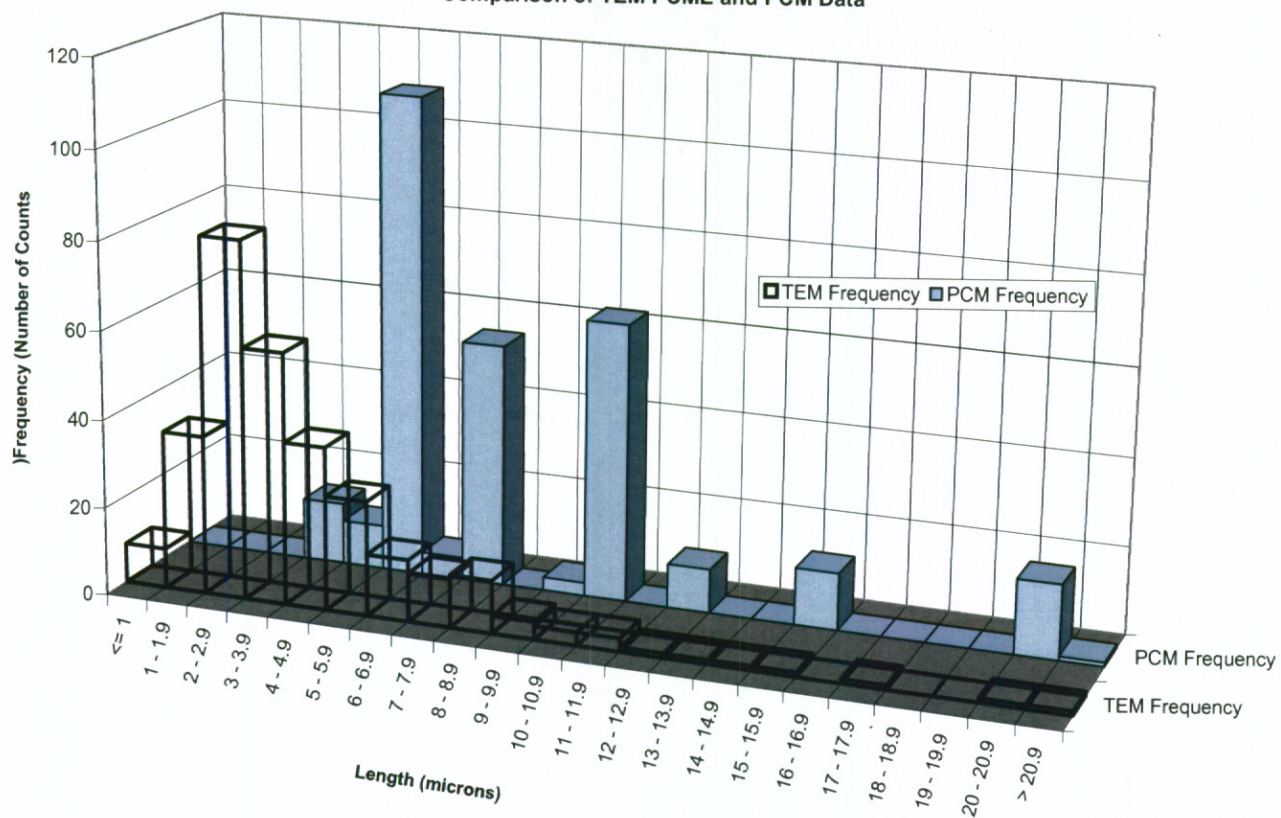




Figure 10. Frequency Distribution of Widths for Cummingtonite Particles:  
Comparison of TEM PCME and PCM Data

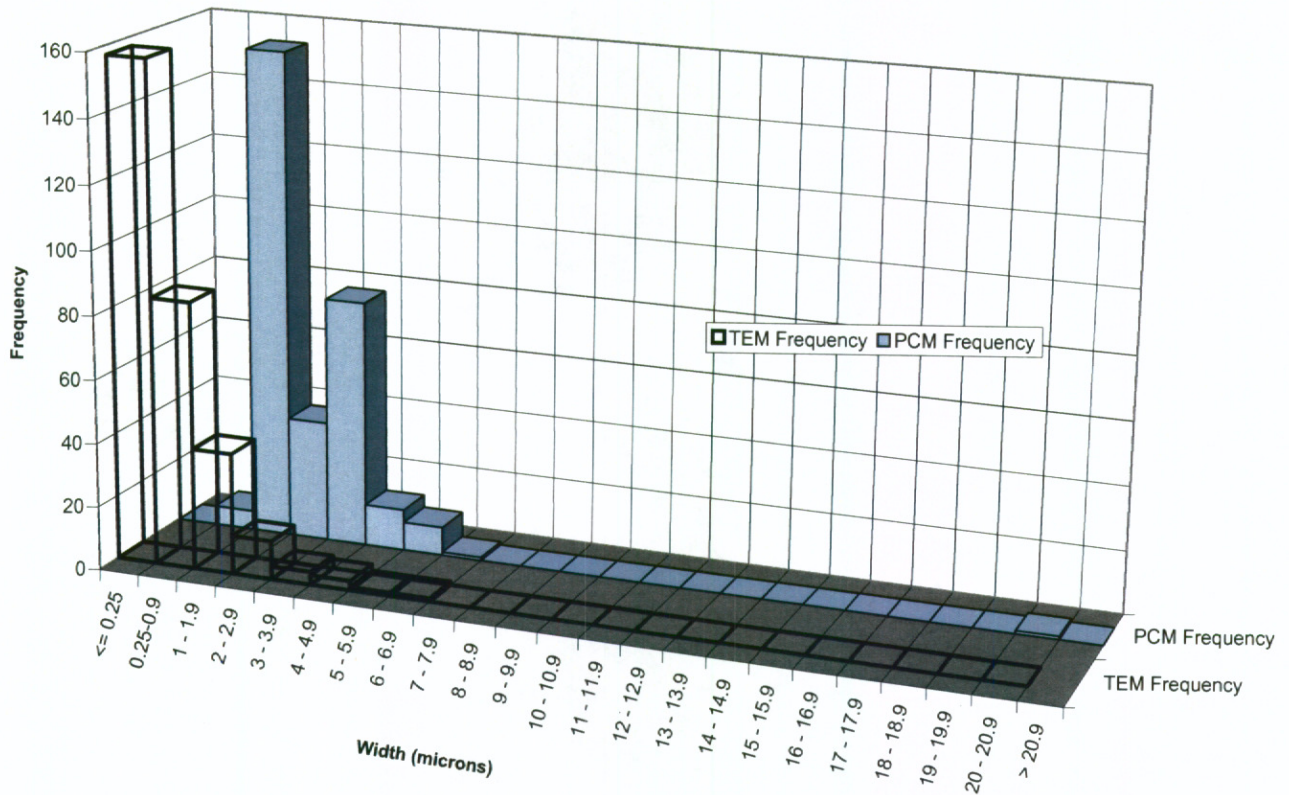


Figure 11. Frequency Distribution of Aspect Ratios for Cummingtonite Particles:  
Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

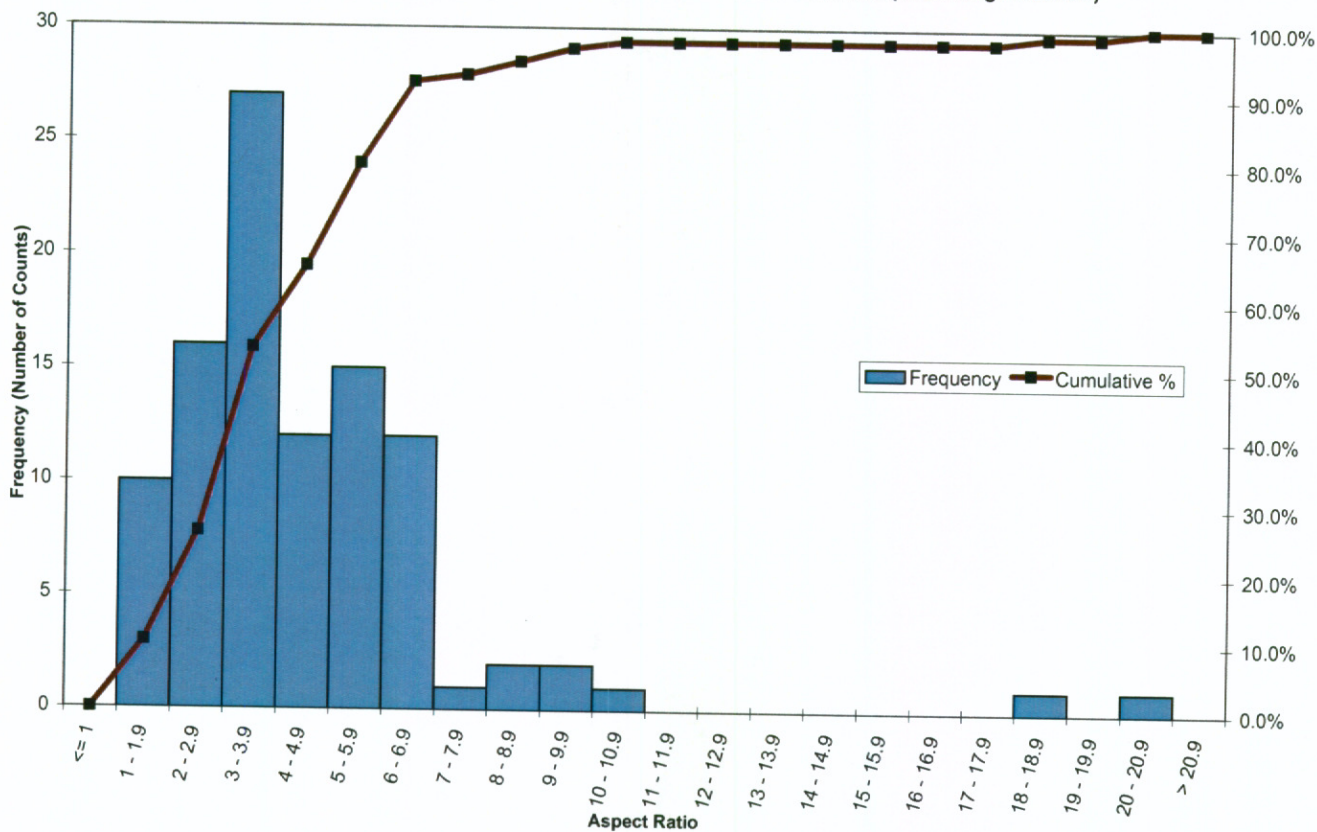


Figure 12. Frequency Distribution of Lengths for Cummingtonite Particles:  
Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

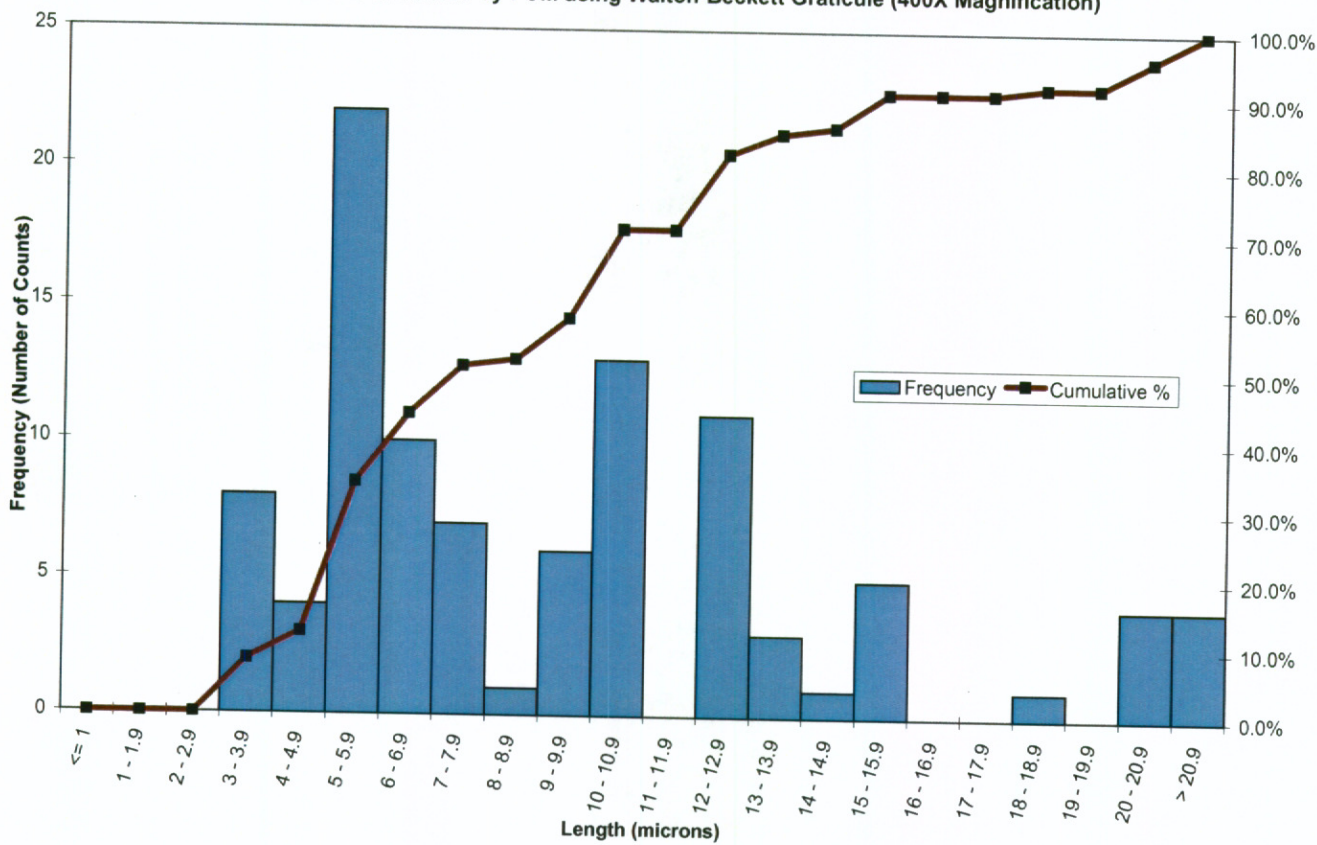
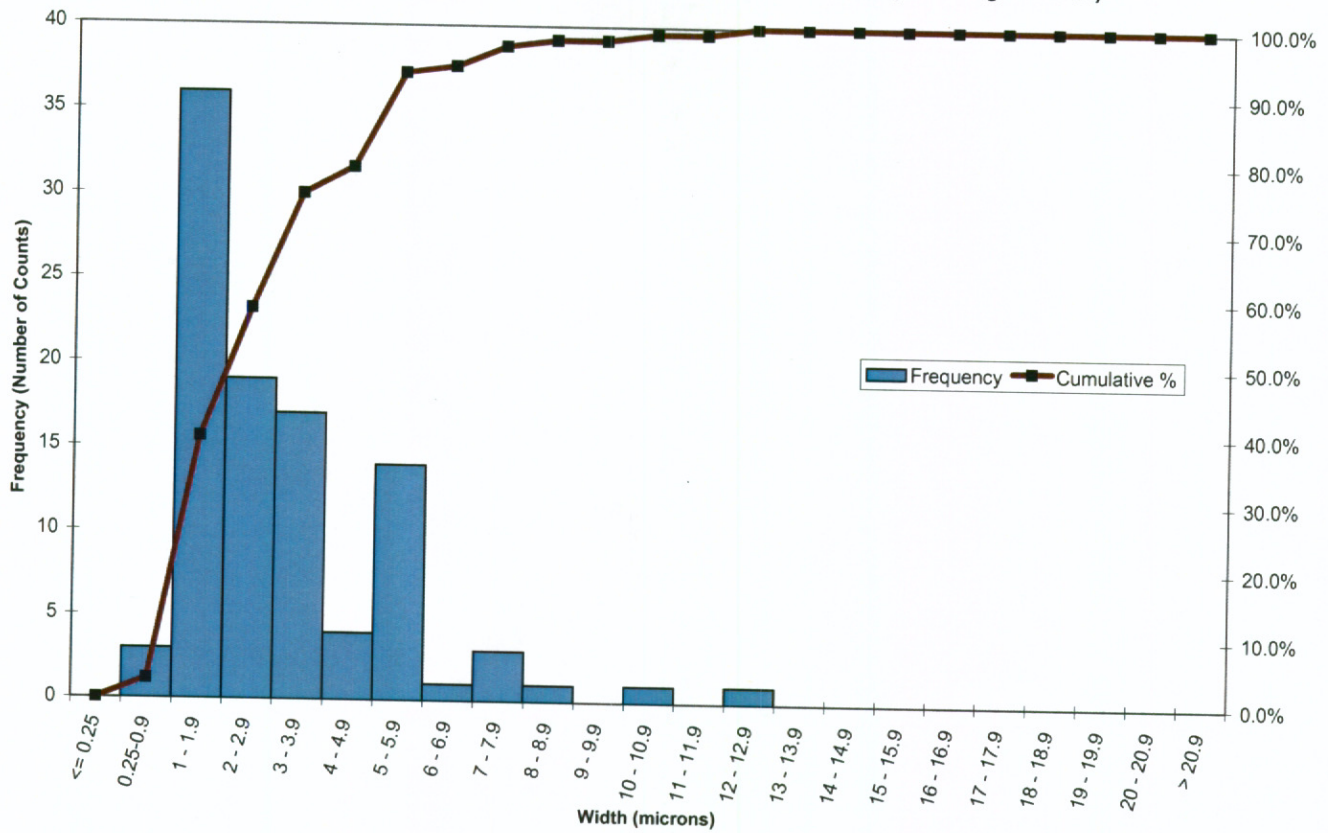
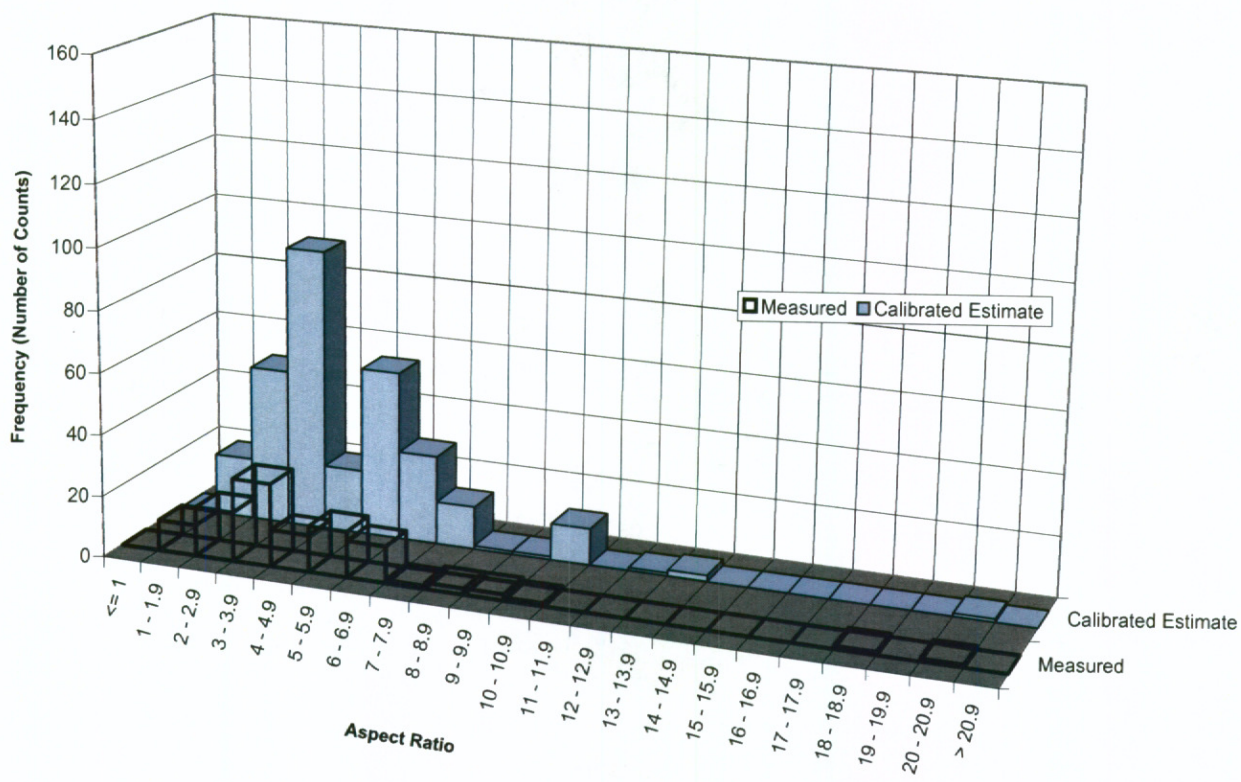


Figure 13. Frequency Distribution of Widths for Cummingtonite Particles:  
Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)



**Figure 14. Frequency Distribution of Aspect Ratios for Cummingtonite Particles:  
Comparison of Dimensions from PCM Measured by Calibrated Visual Estimation and Walton-Beckett  
Graticule**



**Figure 15. Frequency Distribution of Lengths for Cummingtonite Particles:  
Comparison of Dimensions from PCM Measured by Calibrated Visual Estimation and Walton-Beckett  
Graticule**

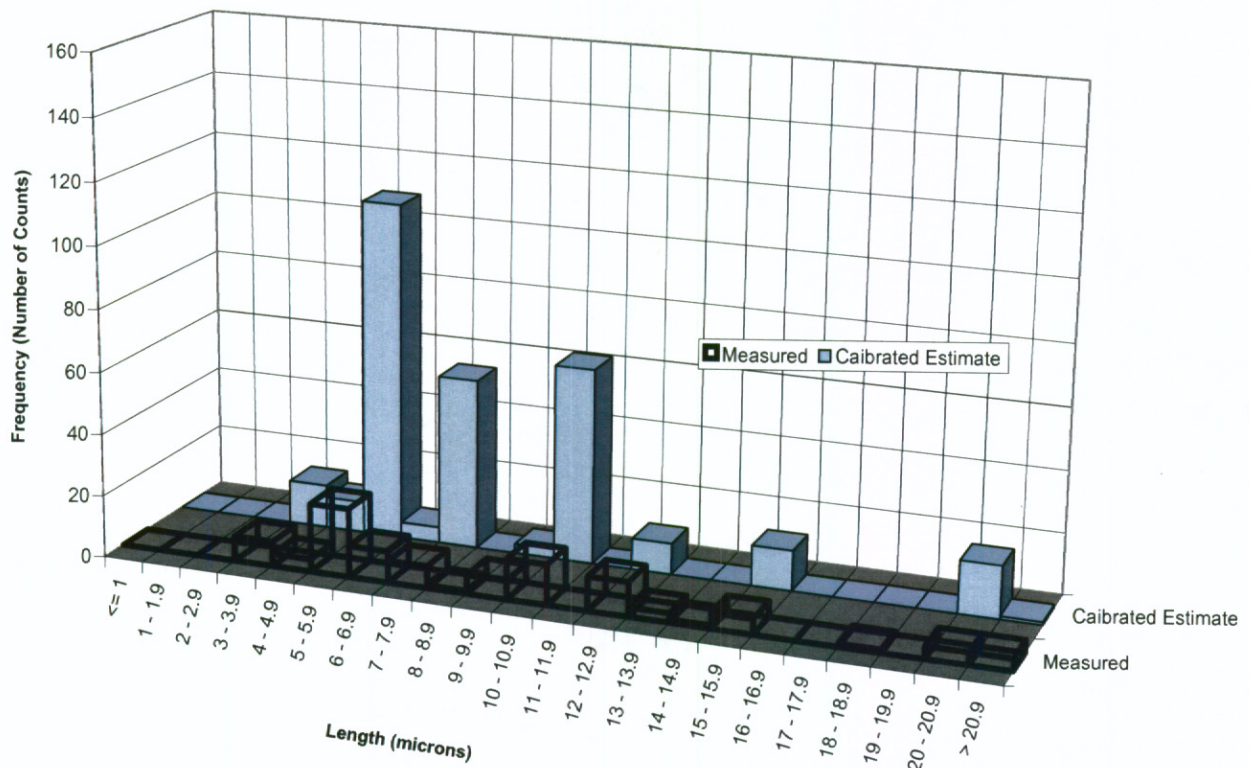
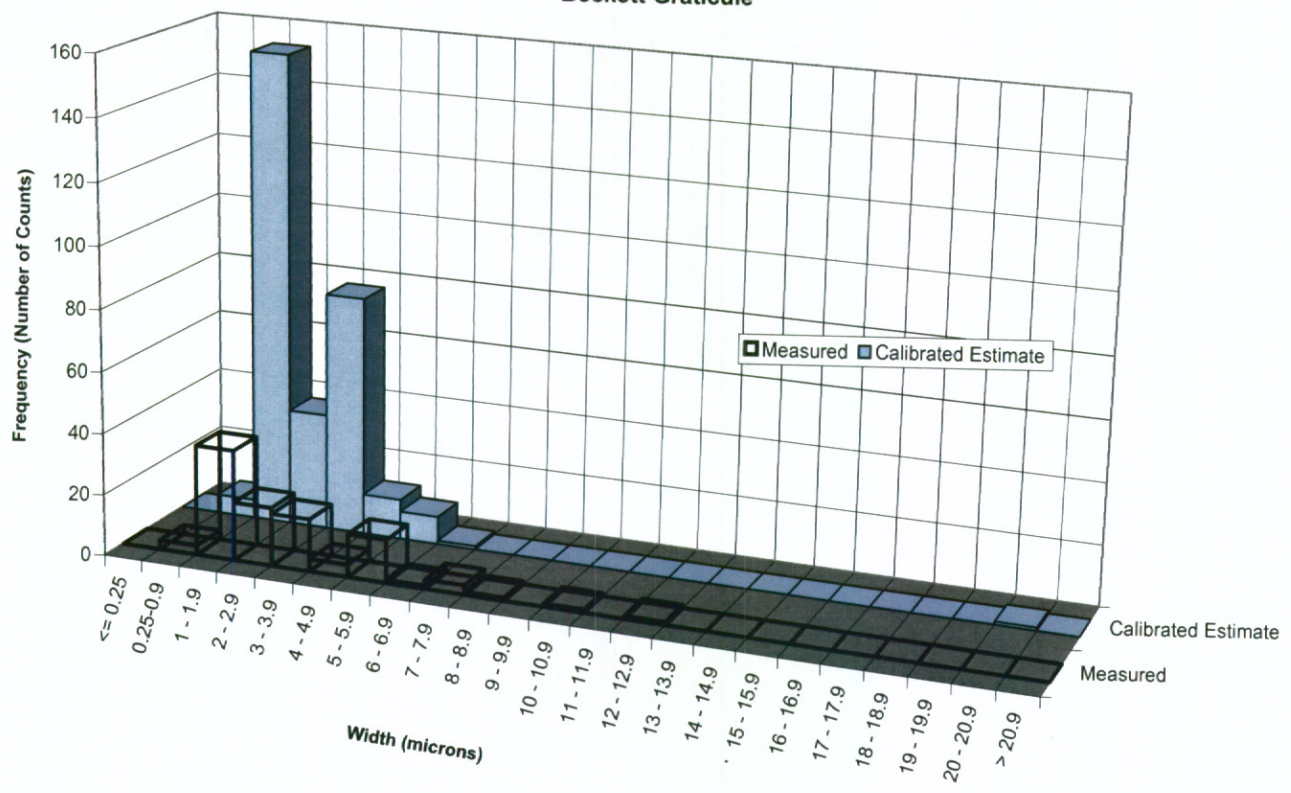


Figure 16. Frequency Distribution of Widths for Cummingtonite Particles:  
 Comparison of Dimensions from PCM Measured by Calibrated Visual Estimation and Walton-  
 Beckett Graticule



## **Analytical Data Summaries**

### **3C. Riebeckite**



Riebeckite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

**Table A: Riebeckite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

\* Note: data in red does not meet criteria for counting; ie.  $\geq 5 \mu\text{m}$  in length or  $\geq 3:1$  aspect ratio.

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
Structure	1	7.0	1.5	4.7
numbers	2	3.0	2.0	1.5
1-300	3	6.0	3.0	2.0
LCG	4	3.0	2.0	1.5
on	5	3.0	1.0	3.0
Filters 1-6	6	4.5	2.0	2.3
	7	10.0	3.0	3.3
	8	15.0	3.0	5.0
	9	15.0	4.0	3.8
	10	18.0	5.0	3.6
	11	5.0	1.0	5.0
	12	5.0	1.0	5.0
	13	9.0	1.0	9.0
	14	5.0	1.5	3.3
	15	10.0	2.0	5.0
	16	4.0	3.0	1.3
	17	18.0	3.0	6.0
	18	5.0	3.0	1.7
	19	7.0	2.0	3.5
	20	7.5	2.0	3.8
	21	8.0	3.0	2.7
	22	10.0	2.0	5.0
	23	7.5	2.0	3.8
	24	5.0	2.0	2.5
	25	3.0	3.0	1.0
	26	10.0	4.0	2.5
	27	7.5	4.0	1.9

Count of fibers	Count of non-fibers	Total Structures Counted
186	114	300

Percent Fibers	Percent non-fibers
62.0%	38.0%

Meet Fiber Criteria

Bin	Structure Number	Meeting Criteria
0.9	<= 1	Fiber
1.9	1 - 1.9	Fiber
2.9	2 - 2.9	Fiber
3.9	3 - 3.9	Fiber
4.9	4 - 4.9	Fiber
5.9	5 - 5.9	Fiber
6.9	6 - 6.9	Fiber
7.9	7 - 7.9	Fiber
8.9	8 - 8.9	Fiber
9.9	9 - 9.9	Fiber
10.9	10 - 10.9	Fiber
11.9	11 - 11.9	Fiber
12.9	12 - 12.9	Fiber
13.9	13 - 13.9	Fiber
14.9	14 - 14.9	Fiber
15.9	15 - 15.9	Fiber
16.9	16 - 16.9	Fiber
17.9	17 - 17.9	Fiber

Riebeckite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	28	5.0	1.0	5.0
	29	10.0	1.0	10.0
	30	10.0	3.0	3.3
	31	5.0	2.0	2.5
	32	7.5	3.0	2.5
	33	5.0	3.0	1.7
	34	5.0	1.0	5.0
	35	15.0	2.0	7.5
	36	20.0	4.0	5.0
	37	5.0	2.0	2.5
	38	10.0	3.0	3.3
	39	10.0	3.0	3.3
	40	8.0	3.0	2.7
	41	5.0	1.0	5.0
	42	5.0	1.0	5.0
	43	10.0	1.0	10.0
	44	7.5	1.0	7.5
	45	15.0	2.5	6.0
	46	10.0	2.5	4.0
	47	3.0	0.5	6.0
	48	4.0	0.5	8.0
	49	4.0	0.5	8.0
	50	10.0	3.0	3.3
	51	5.0	3.0	1.7
	52	5.0	1.0	5.0
	53	6.0	1.0	6.0
	54	5.0	1.0	5.0
	55	3.0	1.0	3.0
	56	2.0	1.0	2.0
	57	7.0	2.0	3.5
	58	3.0	2.0	1.5
	59	3.0	2.0	1.5
	60	7.5	3.0	2.5
	61	9.0	9.0	1.0

		Meet Fiber Criteria	62.0%	38.0%
18.9	18 - 18.9	Fiber		
19.9	19 - 19.9	Fiber		
20.9	20 - 20.9	Fiber		
More	> 20.9			
		Fiber		
		Fiber		
Bin				
0.24	<= 0.25	Fiber		
0.9	0.25-0.9			
1.9	1 - 1.9	Fiber		
2.9	2 - 2.9	Fiber		
3.9	3 - 3.9			
4.9	4 - 4.9	Fiber		
5.9	5 - 5.9	Fiber		
6.9	6 - 6.9	Fiber		
7.9	7 - 7.9	Fiber		
8.9	8 - 8.9	Fiber		
9.9	9 - 9.9	Fiber		
10.9	10 - 10.9			
11.9	11 - 11.9			
12.9	12 - 12.9			
13.9	13 - 13.9	Fiber		
14.9	14 - 14.9			
15.9	15 - 15.9	Fiber		
16.9	16 - 16.9	Fiber		
17.9	17 - 17.9	Fiber		
18.9	18 - 18.9			
19.9	19 - 19.9			
20.9	20 - 20.9	Fiber		
More	> 20.9			

Riebeckite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	62	5.0	3.0	1.7
	63	6.0	1.0	6.0
	64	7.0	1.0	7.0
	65	3.0	2.0	1.5
	66	3.0	2.0	1.5
	67	5.0	1.5	3.3
	68	7.0	2.0	3.5
	69	5.0	4.0	1.3
	70	4.0	1.5	2.7
	71	6.0	1.0	6.0
	72	3.0	1.0	3.0
	73	3.0	1.5	2.0
	74	5.0	1.0	5.0
	75	5.0	1.0	5.0
	76	4.0	1.0	4.0
	77	5.0	1.0	5.0
	78	6.0	3.0	2.0
	79	10.0	4.0	2.5
	80	6.0	2.0	3.0
	81	10.0	3.0	3.3
	82	3.0	1.0	3.0
	83	15.0	2.0	7.5
	84	3.0	1.5	2.0
	85	5.0	1.0	5.0
	86	12.0	1.0	12.0
	87	5.0	1.0	5.0
	88	7.0	1.0	7.0
	89	5.0	1.0	5.0
	90	10.0	2.0	5.0
	91	5.0	2.0	2.5
	92	5.0	1.0	5.0
	93	5.0	1.5	3.3
	94	5.0	1.0	5.0
	95	5.0	1.0	5.0

Meet Fiber Criteria 62.0% 38.0%

Fiber  
Fiber

Fiber  
Fiber

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Fiber  
Fiber

Riebeckite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	96	4.0	1.5	2.7
	97	9.0	1.0	9.0
	98	3.0	1.0	3.0
	99	7.5	2.0	3.8
	100	5.0	4.0	1.3
	101	5.0	3.0	1.7
	102	5.0	1.0	5.0
	103	3.0	1.0	3.0
	104	4.0	1.0	4.0
	105	5.0	2.0	2.5
	106	15.0	2.0	7.5
	107	4.0	1.0	4.0
	108	5.0	1.0	5.0
	109	9.0	1.0	9.0
	110	4.0	1.5	2.7
	111	5.0	1.0	5.0
	112	3.0	1.0	3.0
	113	4.0	1.0	4.0
	114	3.0	1.0	3.0
	115	5.0	1.0	5.0
	116	5.0	1.0	5.0
	117	4.0	1.0	4.0
	118	4.0	1.0	4.0
	119	4.0	0.5	8.0
	120	4.0	1.0	4.0
	121	4.0	1.5	2.7
	122	5.0	1.5	3.3
	123	9.0	1.5	6.0
	124	10.0	1.0	10.0
	125	9.0	1.0	9.0
	126	12.0	1.5	8.0
	127	5.0	1.0	5.0
	128	4.0	1.5	2.7
	129	5.0	1.0	5.0

Meet  
Fiber  
Criteria 62.0% 38.0%

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Riebeckite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	130	8.0	1.0	8.0
	131	10.0	1.0	10.0
	132	4.0	1.0	4.0
	133	3.0	1.5	2.0
	134	5.0	1.0	5.0
	135	4.0	1.5	2.7
	136	3.0	1.0	3.0
	137	12.0	1.0	12.0
	138	10.0	1.0	10.0
	139	5.0	1.0	5.0
	140	5.0	1.0	5.0
	141	5.0	1.0	5.0
	142	5.0	1.0	5.0
	143	3.0	1.0	3.0
	144	6.0	2.0	3.0
	145	4.0	1.0	4.0
	146	5.0	1.0	5.0
	147	5.0	2.0	2.5
	148	3.0	2.0	1.5
	149	4.0	1.0	4.0
	150	6.0	2.0	3.0
	151	23.0	4.0	5.8
	152	7.0	3.0	2.3
	153	5.0	1.0	5.0
	154	4.0	1.0	4.0
	155	6.0	1.0	6.0
	156	10.0	4.0	2.5
	157	10.0	2.0	5.0
	158	7.5	3.0	2.5
	159	6.0	2.0	3.0
	160	6.0	2.0	3.0
	161	7.0	3.0	2.3
	162	7.0	4.0	1.8
	163	5.0	1.0	5.0

Meet  
Fiber  
Criteria 62.0% 38.0%

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Riebeckite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	164	4.0	1.0	4.0
	165	4.0	1.0	4.0
	166	7.5	2.0	3.8
	167	5.0	1.0	5.0
	168	5.0	1.5	3.3
	169	6.0	1.5	4.0
	170	5.0	1.0	5.0
	171	5.0	2.0	2.5
	172	10.0	1.0	10.0
	173	15.0	3.0	5.0
	174	10.0	1.0	10.0
	175	5.0	3.0	1.7
	176	3.0	3.0	1.0
	177	10.0	4.0	2.5
	178	8.0	1.0	8.0
	179	10.0	1.0	10.0
	180	10.0	4.0	2.5
	181	9.0	3.0	3.0
	182	15.0	2.0	7.5
	183	7.0	3.0	2.3
	184	10.0	1.0	10.0
	185	5.0	1.0	5.0
	186	3.0	2.0	1.5
	187	5.0	1.0	5.0
	188	4.0	1.5	2.7
	189	5.0	1.5	3.3
	190	7.0	3.0	2.3
	191	4.0	1.5	2.7
	192	10.0	4.0	2.5
	193	10.0	5.0	2.0
	194	6.0	1.0	6.0
	195	7.0	1.5	4.7
	196	5.0	1.0	5.0
	197	3.0	1.0	3.0

Meet  
Fiber  
Criteria 62.0% 38.0%

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Riebeckite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	232	5.0	1.0	5.0
	233	5.0	1.5	3.3
	234	9.0	3.0	3.0
	235	6.0	1.5	4.0
	236	5.0	2.0	2.5
	237	3.0	2.0	1.5
	238	5.0	2.0	2.5
	239	7.0	2.0	3.5
	240	5.0	0.5	10.0
	241	3.0	0.5	6.0
	242	5.0	2.0	2.5
	243	3.0	1.0	3.0
	244	3.0	2.0	1.5
	245	6.0	1.0	6.0
	246	6.0	1.0	6.0
	247	5.0	1.0	5.0
	248	7.0	1.0	7.0
	249	5.0	1.5	3.3
	250	3.0	1.0	3.0
	251	7.0	1.5	4.7
	252	7.0	1.5	4.7
	253	7.0	1.0	7.0
	254	10.0	3.0	3.3
	255	7.0	1.0	7.0
	256	5.0	1.5	3.3
	257	5.0	1.0	5.0
	258	7.0	1.5	4.7
	259	3.0	1.0	3.0
	260	3.0	1.0	3.0
	261	10.0	1.5	6.7
	262	10.0	2.0	5.0
	263	10.0	1.5	6.7
	264	7.0	1.5	4.7
	265	10.0	1.0	10.0

Meet  
Fiber  
Criteria      62.0%      38.0%

Fiber  
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Fiber  
Fiber

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Fiber  
Fiber





Riebeckite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	300	5.0	3.0	1.7

Meet  
Fiber  
Criteria 62.0% 38.0%

**Table A1: Summary Statistics for Riebeckite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

<i>Length (microns)</i>		<i>Width (microns)</i>		<i>Aspect Ratio</i>	
<b>Mean</b>	6.63	<b>Mean</b>	1.77	<b>Mean</b>	4.37
<b>Standard Error</b>	0.20	<b>Standard Error</b>	0.06	<b>Standard Error</b>	0.13
<b>Median</b>	5.00	<b>Median</b>	1.50	<b>Median</b>	4.00
<b>Mode</b>	5.00	<b>Mode</b>	1.00	<b>Mode</b>	5.00
<b>Standard Deviation</b>	3.46	<b>Standard Deviation</b>	1.10	<b>Standard Deviation</b>	2.20
<b>Sample Variance</b>	11.94	<b>Sample Variance</b>	1.20	<b>Sample Variance</b>	4.85
<b>Kurtosis</b>	4.82	<b>Kurtosis</b>	7.67	<b>Kurtosis</b>	1.00
<b>Skewness</b>	1.83	<b>Skewness</b>	2.18	<b>Skewness</b>	1.09
<b>Range</b>	23.00	<b>Range</b>	8.50	<b>Range</b>	11.00
<b>Minimum</b>	2.00	<b>Minimum</b>	0.50	<b>Minimum</b>	1.00
<b>Maximum</b>	25.00	<b>Maximum</b>	9.00	<b>Maximum</b>	12.00
<b>Sum</b>	1988.50	<b>Sum</b>	532.00	<b>Sum</b>	1311.63
<b>Count</b>	300	<b>Count</b>	300	<b>Count</b>	300

**Table A2. Aspect Ratios for Riebeckite Particles: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Aspect Ratio</i>
0.9	0	0.0%	0.0%	<= 1
1.9	26	8.7%	8.7%	1 - 1.9
2.9	48	16.0%	24.7%	2 - 2.9
3.9	75	25.0%	49.7%	3 - 3.9
4.9	24	8.0%	57.7%	4 - 4.9
5.9	66	22.0%	79.7%	5 - 5.9
6.9	21	7.0%	86.7%	6 - 6.9
7.9	14	4.7%	91.3%	7 - 7.9
8.9	6	2.0%	93.3%	8 - 8.9
9.9	4	1.3%	94.7%	9 - 9.9
10.9	14	4.7%	99.3%	10 - 10.9
11.9	0	0.0%	99.3%	11 - 11.9
12.9	2	0.7%	100.0%	12 - 12.9
13.9	0	0.0%	100.0%	13 - 13.9
14.9	0	0.0%	100.0%	14 - 14.9
15.9	0	0.0%	100.0%	15 - 15.9
16.9	0	0.0%	100.0%	16 - 16.9
17.9	0	0.0%	100.0%	17 - 17.9
18.9	0	0.0%	100.0%	18 - 18.9
19.9	0	0.0%	100.0%	19 - 19.9
20.9	0	0.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9
Sum	300			

**Table A3. Lengths for Riebeckite Particles: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

<i>Length (microns)</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Length (microns)</i>
0.9	0	0.0%	0.0%	<= 1
1.9	0	0.0%	0.0%	1 - 1.9
2.9	1	0.3%	0.3%	2 - 2.9
3.9	39	13.0%	13.3%	3 - 3.9
4.9	28	9.3%	22.7%	4 - 4.9
5.9	99	33.0%	55.7%	5 - 5.9
6.9	18	6.0%	61.7%	6 - 6.9
7.9	35	11.7%	73.3%	7 - 7.9
8.9	4	1.3%	74.7%	8 - 8.9
9.9	9	3.0%	77.7%	9 - 9.9
10.9	47	15.7%	93.3%	10 - 10.9
11.9	0	0.0%	93.3%	11 - 11.9
12.9	3	1.0%	94.3%	12 - 12.9
13.9	0	0.0%	94.3%	13 - 13.9
14.9	0	0.0%	94.3%	14 - 14.9
15.9	12	4.0%	98.3%	15 - 15.9
16.9	0	0.0%	98.3%	16 - 16.9
17.9	0	0.0%	98.3%	17 - 17.9
18.9	2	0.7%	99.0%	18 - 18.9
19.9	0	0.0%	99.0%	19 - 19.9
20.9	1	0.3%	99.3%	20 - 20.9
More	2	0.7%	100.0%	> 20.9
Sum	300			

**Table A4. Widths for Riebeckite Particles: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>
0.24	0	0.0%	0.0%	<= 0.25
0.9	7	2.3%	2.3%	0.25-0.9
1.9	182	60.7%	63.0%	1 - 1.9
2.9	50	16.7%	79.7%	2 - 2.9
3.9	39	13.0%	92.7%	3 - 3.9
4.9	15	5.0%	97.7%	4 - 4.9
5.9	5	1.7%	99.3%	5 - 5.9
6.9	0	0.0%	99.3%	6 - 6.9
7.9	1	0.3%	99.7%	7 - 7.9
8.9	0	0.0%	99.7%	8 - 8.9
9.9	1	0.3%	100.0%	9 - 9.9
10.9	0	0.0%	100.0%	10 - 10.9
11.9	0	0.0%	100.0%	11 - 11.9
12.9	0	0.0%	100.0%	12 - 12.9
13.9	0	0.0%	100.0%	13 - 13.9
14.9	0	0.0%	100.0%	14 - 14.9
15.9	0	0.0%	100.0%	15 - 15.9
16.9	0	0.0%	100.0%	16 - 16.9
17.9	0	0.0%	100.0%	17 - 17.9
18.9	0	0.0%	100.0%	18 - 18.9
19.9	0	0.0%	100.0%	19 - 19.9
20.9	0	0.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9
Sum	300			

Riebeckite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

**Table B. Riebeckite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)**

\* Note: data in red does not meet criteria for counting; ie.  $\geq 5 \mu\text{m}$  in length or  $\geq 3:1$  aspect ratio.

Filter	Grid	Grid Opening	Struct. Number	Length (microns)	Width (microns)	Aspect Ratio
1	A1	E4	1	6.99	2.54	2.75
1	A1	E4	2	5.08	2.54	2.00
1	A1	E4	3	3.56	0.76	4.67
1	A1	E4	4	1.40	0.06	22.00
1	A1	E4	5	2.16	0.89	2.43
1	A1	E4	6	1.52	0.89	1.71
1	A1	E4	7	2.41	0.64	3.80
1	A1	E4	8	3.05	1.91	1.60
1	A1	E4	9	2.54	0.64	4.00
1	A1	E4	10	8.89	3.56	2.50
1	A1	E4	11	8.00	1.40	5.73
1	A1	E4	12	3.81	1.27	3.00
1	A1	E4	13	2.54	0.89	2.86
1	A1	E4	14	2.54	0.64	4.00
1	A1	E4	15	2.92	0.95	3.07
1	A1	E4	16	3.81	1.59	2.40
1	A1	E4	17	4.45	0.95	4.67
1	A1	E4	18	3.56	1.52	2.33
1	A1	F5	19	8.89	2.86	3.11
1	A1	F5	20	11.43	4.45	2.57
1	A1	F5	21	1.91	0.76	2.50
1	A1	F5	22	1.91	0.32	6.00
1	A1	F5	23	2.54	1.02	2.50
1	A1	F5	24	1.27	0.64	2.00
1	A1	F5	25	2.92	1.59	1.84
1	A1	F5	26	3.81	1.91	2.00
1	A1	F5	27	2.54	0.64	4.00

Bin	PCM Equ Fiber	PCM Equ Fiber	TEM only fiber	Count of Struct.	PCM-Equivalent Fiber	TEM-only fiber	Length <5 $\mu\text{m}$ or A.R. <3	Percent PCM-Equivalent Fibers	Percent TEM-only Fibers	Length <5 $\mu\text{m}$ or Width < 3 $\mu\text{m}$
0.9				300	61	0				239
1.9					20.3%	0.0%				79.7%
2.9										
3.9										
4.9										
5.9										
6.9										
7.9										
8.9										
9.9										
10.9										
11.9										
12.9										
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17.9										
18.9										
19.9										
20.9										

Bin  
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 20.9

<= 1  
 1 - 1.9  
 2 - 2.9  
 3 - 3.9  
 4 - 4.9  
 5 - 5.9  
 6 - 6.9  
 7 - 7.9  
 8 - 8.9  
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 16 - 16.9  
 17 - 17.9  
 18 - 18.9  
 19 - 19.9  
 20 - 20.9

Fiber PEF  
 Fiber PEF

Riebeckite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

1	A1	E4	1	6.99	2.54	2.75							
1	A1	F5	28	6.35	4.45	1.43							
1	A1	F5	29	2.54	1.59	1.60	> 20.9	Yes	20.3%	0.0%	79.7%		
1	A1	F5	30	2.54	0.32	8.00		Yes					
1	A1	D2	31	5.72	3.30	1.73		Yes					
1	A1	D2	32	16.26	2.92	5.57		Yes					
1	A1	D2	33	3.18	2.79	1.14	Bin	Fiber PEF					
1	A1	D2	34	3.81	1.65	2.31	0.09	<= 0.1					
1	A1	D2	35	9.53	1.02	9.38	0.19	0.10 - 0.19					
1	A1	D2	36	5.33	1.27	4.20	0.24	0.20 - 0.24	Fiber PEF				
1	A1	D2	37	1.91	0.64	3.00	0.29	0.25 - 0.29	Fiber PEF				
1	A1	D2	38	2.86	0.38	7.50	0.39	0.30 - 0.39					Yes
1	A1	D2	39	6.03	3.49	1.73	0.49	0.40 - 0.49					Yes
1	A1	D2	40	3.81	1.27	3.00	0.59	0.50 - 0.59					Yes
1	A1	D2	41	3.30	1.02	3.25	0.69	0.60 - 0.69					Yes
1	A1	D2	42	1.27	0.06	20.00	0.79	0.70 - 0.79					Yes
1	A1	D2	43	3.81	0.64	6.00	0.89	0.80 - 0.89					Yes
1	A1	D2	44	12.70	2.29	5.56	0.99	0.90 - 0.99					Yes
1	A1	D2	45	3.81	0.89	4.29	1.09	1 - 1.09	Fiber PEF				
1	A1	D2	46	3.30	0.64	5.20	1.19	1.1 - 1.19					Yes
1	A1	D2	47	2.54	0.95	2.67	1.29	1.2 - 1.29					Yes
1	A1	D2	48	2.67	0.76	3.50	1.39	1.3 - 1.39					Yes
1	A1	D2	49	4.76	4.76	1.00	1.49	1.4 - 1.49					Yes
1	A1	D2	50	9.78	1.91	5.13	1.59	1.5 - 1.59					Yes
2	B1	B21	51	1.27	0.32	4.00	1.69	1.6 - 1.69	Fiber PEF				
2	B1	B21	52	3.81	3.30	1.15	1.79	1.7 - 1.79					Yes
2	B1	B21	53	1.91	0.38	5.00	1.89	1.8 - 1.89					Yes
2	B1	B21	54	3.81	1.27	3.00	1.99	1.9 - 1.99					Yes
2	B1	B21	55	3.43	0.76	4.50	2.09	2.0 - 2.09					Yes
2	B1	B21	56	4.57	0.95	4.80	2.19	2.1 - 2.19					Yes
2	B1	B21	57	2.16	0.64	3.40	2.29	2.2 - 2.29					Yes
2	B1	B21	58	1.40	0.25	5.50	2.39	2.3 - 2.39					Yes
2	B1	B21	59	3.18	0.32	10.00	2.49	2.4 - 2.49					Yes
2	B1	B21	60	3.05	1.27	2.40	2.59	2.5 - 2.59					Yes
2	B1	B21	61	6.99	1.91	3.67	2.69	2.6 - 2.69					Yes
2	B1	B21	62	2.54	0.64	4.00	2.79	2.7 - 2.79	Fiber PEF				
2	B1	B21	63	16.51	3.56	4.64	2.89	2.8 - 2.89					Yes
2	B1	B21	64	2.79	0.64	4.40	2.99	2.9 - 2.99	Fiber PEF				
2	B1	B21	65	6.35	2.67	2.38	3.09	3.0 - 3.09					Yes
2	B1	B21	66	4.70	3.49	1.35	3.19	3.1 - 3.19					Yes
							3.29	3.2 - 3.29					Yes



Riebeckite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

1	A1	E4	1	6.99	2.54	2.75							
2	B1	B21	67	3.05	1.65	1.85	3.39	3.3 - 3.39	Yes	20.3%	0.0%	79.7%	
2	B1	B21	68	3.49	1.27	2.75	3.49	3.4 - 3.49	Yes				
2	B1	B21	69	4.45	0.76	5.83	3.59	3.5 - 3.59	Yes				
2	B1	B21	70	3.81	0.51	7.50	3.69	3.6 - 3.69	Yes				
2	B1	B21	71	2.79	0.64	4.40	3.79	3.7 - 3.79	Yes				
2	B1	B21	72	2.22	0.32	7.00	3.89	3.8 - 3.89	Yes				
2	B1	B21	73	2.54	0.38	6.67	3.99	3.9 - 3.99	Yes				
2	B1	B21	74	3.30	1.52	2.17	4.09	4.0 - 4.09	Yes				
2	B1	B21	75	1.91	0.89	2.14	4.19	4.1 - 4.19	Yes				
2	B1	B21	76	3.18	0.89	3.57	4.29	4.2 - 4.29	Yes				
2	B1	B21	77	3.81	1.02	3.75	4.39	4.3 - 4.39	Yes				
2	B1	E1	78	4.06	1.78	2.29	4.49	4.4 - 4.49	Yes				
2	B1	E1	79	2.54	1.02	2.50	4.59	4.5 - 4.59	Yes				
2	B1	E1	80	4.32	0.76	5.67	4.69	4.6 - 4.69	Yes				
2	B1	E1	81	2.29	0.76	3.00	4.79	4.7 - 4.79	Yes				
2	B1	E1	82	5.40	0.64	8.50	4.89	4.8 - 4.89	Yes				
2	B1	E1	83	25.40	7.62	3.33	4.89	4.8 - 4.89	Fiber PEF				
2	B1	E1	84	3.18	0.64	5.00	More	> 4.89	Fiber PEF				
2	B1	E1	85	7.87	0.76	10.33			Yes				
2	B1	E1	86	2.79	0.13	22.00			Fiber PEF				
2	B1	E1	87	8.89	2.92	3.04			Yes				
2	B1	E1	88	4.57	0.89	5.14			Fiber PEF				
2	B1	E1	89	2.29	0.76	3.00			Yes				
2	B1	E1	90	3.81	0.89	4.29			Yes				
2	B1	E1	91	12.70	1.52	8.33			Yes				
2	B1	E1	92	12.70	4.57	2.78			Fiber PEF				
2	B1	E1	93	3.49	3.49	1.00			Yes				
2	B1	E1	94	3.18	0.32	10.00			Yes				
2	B1	E20	95	5.72	1.65	3.46			Yes				
2	B1	E20	96	4.45	1.27	3.50			Fiber PEF				
2	B1	E20	97	9.53	2.54	3.75			Yes				
2	B1	E20	98	4.70	0.76	6.17			Fiber PEF				
2	B1	E20	99	6.99	0.51	13.75			Yes				
2	B1	E20	100	10.16	1.65	6.15			Fiber PEF				
3	C1	E1	101	2.29	1.91	1.20			Fiber PEF				
3	C1	E1	102	8.89	2.54	3.50			Yes				
3	C1	E1	103	16.13	5.72	2.82			Fiber PEF				
3	C1	E1	104	1.02	0.19	5.33			Yes				
3	C1	E1	105	0.95	0.76	1.25			Yes				



Riebeckite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

1	A1	E4	1	6.99	2.54	2.75
3	C1	D2	145	3.94	0.13	31.00
3	C1	D2	146	9.53	2.54	3.75
3	C1	D2	147	5.33	0.89	6.00
3	C1	D2	148	19.05	9.53	2.00
3	C1	D2	149	1.91	0.64	3.00
3	C1	D2	150	3.81	0.64	6.00
4	D1	B11	151	3.43	1.27	2.70
4	D1	B11	152	2.03	1.02	2.00
4	D1	B11	153	1.14	0.06	18.00
4	D1	B11	154	3.18	0.51	6.25
4	D1	B11	155	2.92	1.27	2.30
4	D1	B11	156	2.16	0.38	5.67
4	D1	B11	157	0.64	0.06	10.00
4	D1	B11	158	4.19	1.27	3.30
4	D1	B11	159	2.54	0.51	5.00
4	D1	B11	160	6.03	1.27	4.75
4	D1	B11	161	1.91	0.51	3.75
4	D1	B11	162	2.22	0.76	2.92
4	D1	B11	163	1.91	0.64	3.00
4	D1	B11	164	8.57	2.29	3.75
4	D1	B11	165	12.32	1.91	6.47
4	D1	B11	166	3.56	1.02	3.50
4	D1	B11	167	0.95	0.38	2.50
4	D1	B11	168	8.26	2.79	2.95
4	D1	B11	169	2.92	0.51	5.75
4	D1	B11	170	2.54	0.89	2.86
4	D1	B11	171	2.54	0.95	2.67
4	D1	B11	172	2.29	0.89	2.57
4	D1	B18	173	2.16	1.65	1.31
4	D1	B18	174	1.91	0.89	2.14
4	D1	B18	175	2.29	0.25	9.00
4	D1	B18	176	1.52	0.25	6.00
4	D1	B18	177	2.54	0.64	4.00
4	D1	B18	178	2.16	1.02	2.13
4	D1	B18	179	6.03	1.27	4.75
4	D1	B18	180	2.16	0.25	8.50
4	D1	B18	181	10.41	2.29	4.56
4	D1	B18	182	2.54	0.38	6.67
4	D1	B18	183	9.91	2.54	3.90

	Yes			
	Yes	20.3%	0.0%	79.7%
Fiber PEF				
Fiber PEF				
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
Fiber PEF				
	Yes			
	Yes			
	Yes			
Fiber PEF				
Fiber PEF				
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
Fiber PEF				
	Yes			
Fiber PEF				
	Yes			
Fiber PEF				



Riebeckite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

1	A1	E4	1	6.99	2.54	2.75
5	E4	B21	223	2.16	0.95	2.27
5	E4	B21	224	6.86	2.54	2.70
5	E4	B21	225	11.68	5.08	2.30
5	E4	B21	226	4.45	2.29	1.94
5	E4	B21	227	4.19	1.91	2.20
5	E4	E23	228	8.51	4.19	2.03
5	E4	E23	229	8.57	3.30	2.60
5	E4	E23	230	3.43	0.51	6.75
5	E4	E23	231	12.32	6.10	2.02
5	E4	E23	232	6.99	2.92	2.39
5	E4	E23	233	7.62	2.54	3.00
5	E4	E23	234	6.35	1.27	5.00
5	E4	E23	235	5.33	1.65	3.23
5	E4	E23	236	3.05	0.95	3.20
5	E4	E23	237	11.68	2.92	4.00
5	E4	E23	238	7.62	4.57	1.67
5	E4	E23	239	1.40	0.13	11.00
5	E4	E23	240	1.27	0.06	20.00
5	E4	E23	241	6.35	1.59	4.00
5	E4	E23	242	2.86	1.27	2.25
5	E4	E23	243	4.19	1.02	4.13
5	E4	E23	244	6.99	1.78	3.93
5	E4	E23	245	6.73	1.91	3.53
5	E4	E23	246	4.06	0.89	4.57
5	E4	E23	247	4.45	0.95	4.67
5	E4	E23	248	3.30	0.51	6.50
5	E4	E23	249	1.78	0.64	2.80
5	E4	E23	250	3.43	0.76	4.50
6	A6	E17	251	3.30	0.76	4.33
6	A6	E17	252	2.79	0.95	2.93
6	A6	E17	253	3.81	0.64	6.00
6	A6	E17	254	2.29	1.02	2.25
6	A6	E17	255	3.81	1.91	2.00
6	A6	E17	256	8.64	1.65	5.23
6	A6	E17	257	2.41	0.76	3.17
6	A6	E17	258	4.13	0.89	4.64
6	A6	E17	259	3.43	1.91	1.80
6	A6	E17	260	4.06	0.89	4.57
6	A6	E17	261	2.67	0.95	2.80

	Yes	20.3%	0.0%	79.7%
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
Fiber PEF				
Fiber PEF				
Fiber PEF				
	Yes			
Fiber PEF				
	Yes			
	Yes			
	Yes			
Fiber PEF				
Fiber PEF				
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
Fiber PEF				
	Yes			
	Yes			
	Yes			
	Yes			

Riebeckite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

1	A1	E4	1	6.99	2.54	2.75
6	A6	E17	262	5.33	1.27	4.20
6	A6	E17	263	2.22	0.76	2.92
6	A6	E17	264	2.22	0.32	7.00
6	A6	E17	265	3.43	0.38	9.00
6	A6	E17	266	5.08	0.64	8.00
6	A6	E17	267	2.16	0.38	5.67
6	A6	E17	268	2.03	0.64	3.20
6	A6	E17	269	3.05	2.22	1.37
6	A6	E17	270	5.46	1.52	3.58
6	A6	E17	271	2.54	0.38	6.67
6	A6	E17	272	8.89	3.43	2.59
6	A6	E17	273	5.33	1.65	3.23
6	A6	E17	274	6.60	2.22	2.97
6	A6	E17	275	3.30	0.25	13.00
6	A6	E17	276	0.95	0.38	2.50
6	A6	E17	277	2.29	0.38	6.00
6	A6	H2	278	4.45	1.27	3.50
6	A6	H2	279	2.54	0.38	6.67
6	A6	H2	280	5.08	1.65	3.08
6	A6	H2	281	3.94	1.02	3.88
6	A6	H2	282	4.70	0.95	4.93
6	A6	H2	283	5.33	1.27	4.20
6	A6	H2	284	5.59	0.64	8.80
6	A6	H2	285	2.29	0.64	3.60
6	A6	H2	286	13.59	4.45	3.06
6	A6	H2	287	2.03	0.13	16.00
6	A6	H2	288	1.65	0.38	4.33
6	A6	H2	289	3.30	0.38	8.67
6	A6	H2	290	4.45	0.89	5.00
6	A6	H2	291	2.92	0.51	5.75
6	A6	H2	292	3.81	0.89	4.29
6	A6	H2	293	3.30	0.51	6.50
6	A6	H2	294	2.86	0.76	3.75
6	A6	H2	295	4.13	1.27	3.25
6	A6	H2	296	2.16	0.38	5.67
6	A6	H2	297	5.33	2.54	2.10
6	A6	H2	298	3.05	0.64	4.80
6	A6	H2	299	4.45	1.65	2.69
6	A6	H2	300	7.62	1.02	7.50

Fiber PEF	Yes	20.3%	0.0%	79.7%
	Yes			
	Yes			
Fiber PEF	Yes			
	Yes			
	Yes			
Fiber PEF	Yes			
	Yes			
	Yes			
Fiber PEF	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
Fiber PEF	Yes			
	Yes			
Fiber PEF	Yes			
Fiber PEF	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
	Yes			
Fiber PEF	Yes			

**Table B1: Summary Statistics for Riebeckite Particle Size Data: TEM PCME  
(10,000X Magnification)**

<i>Length (microns)</i>	<i>Width (microns)</i>	<i>Aspect Ratio</i>
<b>Mean</b>	4.48	<b>Mean</b> 1.36
<b>Standard Error</b>	0.20	<b>Standard Error</b> 0.07
<b>Median</b>	3.43	<b>Median</b> 0.95
<b>Mode</b>	2.54	<b>Mode</b> 0.64
<b>Standard Deviation</b>	3.42	<b>Standard Deviation</b> 1.28
<b>Sample Variance</b>	11.71	<b>Sample Variance</b> 1.63
<b>Kurtosis</b>	7.09	<b>Kurtosis</b> 8.58
<b>Skewness</b>	2.25	<b>Skewness</b> 2.42
<b>Range</b>	24.77	<b>Range</b> 9.46
<b>Minimum</b>	0.64	<b>Minimum</b> 0.06
<b>Maximum</b>	25.40	<b>Maximum</b> 9.53
<b>Sum</b>	1344.17	<b>Sum</b> 409.38
<b>Count</b>	300	<b>Count</b> 300

**Table B2. Aspect Ratios for 300 Riebeckite Particles: TEM  
PCME (10,000X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Aspect Ratio</i>
0.9	0	0.0%	0.0%	<= 1
1.9	31	10.3%	10.3%	1 - 1.9
2.9	68	22.7%	33.0%	2 - 2.9
3.9	63	21.0%	54.0%	3 - 3.9
4.9	45	15.0%	69.0%	4 - 4.9
5.9	30	10.0%	79.0%	5 - 5.9
6.9	22	7.3%	86.3%	6 - 6.9
7.9	8	2.7%	89.0%	7 - 7.9
8.9	10	3.3%	92.3%	8 - 8.9
9.9	3	1.0%	93.3%	9 - 9.9
10.9	6	2.0%	95.3%	10 - 10.9
11.9	1	0.3%	95.7%	11 - 11.9
12.9	0	0.0%	95.7%	12 - 12.9
13.9	2	0.7%	96.3%	13 - 13.9
14.9	0	0.0%	96.3%	14 - 14.9
15.9	1	0.3%	96.7%	15 - 15.9
16.9	1	0.3%	97.0%	16 - 16.9
17.9	0	0.0%	97.0%	17 - 17.9
18.9	1	0.3%	97.3%	18 - 18.9
19.9	0	0.0%	97.3%	19 - 19.9
20.9	2	0.7%	98.0%	20 - 20.9
More	6	2.0%	100.0%	> 20.9

Sum 300



**Table B3. Lengths for 300 Riebeckite Particles: TEM PCME (10,000X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Length (microns)</i>
0.9	5	1.7%	1.7%	<= 1
1.9	31	10.3%	12.0%	1 - 1.9
2.9	80	26.7%	38.7%	2 - 2.9
3.9	61	20.3%	59.0%	3 - 3.9
4.9	34	11.3%	70.3%	4 - 4.9
5.9	21	7.0%	77.3%	5 - 5.9
6.9	16	5.3%	82.7%	6 - 6.9
7.9	13	4.3%	87.0%	7 - 7.9
8.9	15	5.0%	92.0%	8 - 8.9
9.9	4	1.3%	93.3%	9 - 9.9
10.9	3	1.0%	94.3%	10 - 10.9
11.9	3	1.0%	95.3%	11 - 11.9
12.9	5	1.7%	97.0%	12 - 12.9
13.9	2	0.7%	97.7%	13 - 13.9
14.9	0	0.0%	97.7%	14 - 14.9
15.9	1	0.3%	98.0%	15 - 15.9
16.9	3	1.0%	99.0%	16 - 16.9
17.9	0	0.0%	99.0%	17 - 17.9
18.9	1	0.3%	99.3%	18 - 18.9
19.9	1	0.3%	99.7%	19 - 19.9
20.9	0	0.0%	99.7%	20 - 20.9
More	1	0.3%	100.0%	> 20.9
Sum	300			

**Table B4. Widths for 300 Riebeckite Particles: TEM PCME (10,000X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>
0.9	148	49.3%	49.3%	<= 1
1.9	82	27.3%	76.7%	1 - 1.9
2.9	39	13.0%	89.7%	2 - 2.9
3.9	17	5.7%	95.3%	3 - 3.9
4.9	8	2.7%	98.0%	4 - 4.9
5.9	2	0.7%	98.7%	5 - 5.9
6.9	2	0.7%	99.3%	6 - 6.9
7.9	1	0.3%	99.7%	7 - 7.9
8.9	0	0.0%	99.7%	8 - 8.9
9.9	1	0.3%	100.0%	9 - 9.9
10.9	0	0.0%	100.0%	10 - 10.9
11.9	0	0.0%	100.0%	11 - 11.9
12.9	0	0.0%	100.0%	12 - 12.9
13.9	0	0.0%	100.0%	13 - 13.9
14.9	0	0.0%	100.0%	14 - 14.9
15.9	0	0.0%	100.0%	15 - 15.9
16.9	0	0.0%	100.0%	16 - 16.9
17.9	0	0.0%	100.0%	17 - 17.9
18.9	0	0.0%	100.0%	18 - 18.9
19.9	0	0.0%	100.0%	19 - 19.9
20.9	0	0.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9
Sum	300			

**Table B5. Widths for 300 Riebeckite Particles: TEM  
PCME (10,000X Magnification) Finer Detail**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>
0.09	8	2.7%	2.7%	<= 0.1
0.19	8	2.7%	5.3%	0.10 - 0.19
0.24	2	0.7%	6.0%	0.20 - 0.24
0.29	6	2.0%	8.0%	0.25 - 0.29
0.39	32	10.7%	18.7%	0.30 - 0.39
0.49	0	0.0%	18.7%	0.40 - 0.49
0.59	15	5.0%	23.7%	0.50 - 0.59
0.69	36	12.0%	35.7%	0.60 - 0.69
0.79	21	7.0%	42.7%	0.70 - 0.79
0.89	20	6.7%	49.3%	0.80 - 0.89
0.99	13	4.3%	53.7%	0.90 - 0.99
1.09	13	4.3%	58.0%	1 - 1.09
1.19	1	0.3%	58.3%	1.1 - 1.19
1.29	21	7.0%	65.3%	1.2 - 1.29
1.39	0	0.0%	65.3%	1.3 - 1.39
1.49	3	1.0%	66.3%	1.4 - 1.49
1.59	12	4.0%	70.3%	1.5 - 1.59
1.69	13	4.3%	74.7%	1.6 - 1.69
1.79	6	2.0%	76.7%	1.7 - 1.79
1.89	0	0.0%	76.7%	1.8 - 1.89
1.99	13	4.3%	81.0%	1.9 - 1.99
2.09	1	0.3%	81.3%	2.0 - 2.09
2.19	0	0.0%	81.3%	2.1 - 2.19
2.29	10	3.3%	84.7%	2.2 - 2.29
2.39	0	0.0%	84.7%	2.3 - 2.39
2.49	0	0.0%	84.7%	2.4 - 2.49
2.59	10	3.3%	88.0%	2.5 - 2.59
2.69	1	0.3%	88.3%	2.6 - 2.69
2.79	0	0.0%	88.3%	2.7 - 2.79
2.89	4	1.3%	89.7%	2.8 - 2.89
2.99	5	1.7%	91.3%	2.9 - 2.99
3.09	0	0.0%	91.3%	3.0 - 3.09
3.19	0	0.0%	91.3%	3.1 - 3.19
3.29	0	0.0%	91.3%	3.2 - 3.29
3.39	3	1.0%	92.3%	3.3 - 3.39
3.49	2	0.7%	93.0%	3.4 - 3.49
3.59	7	2.3%	95.3%	3.5 - 3.59
3.69	0	0.0%	95.3%	3.6 - 3.69
3.79	0	0.0%	95.3%	3.7 - 3.79
3.89	0	0.0%	95.3%	3.8 - 3.89
3.99	0	0.0%	95.3%	3.9 - 3.99
4.09	0	0.0%	95.3%	4.0 - 4.09
4.19	0	0.0%	95.3%	4.1 - 4.19
4.29	1	0.3%	95.7%	4.2 - 4.29
4.39	0	0.0%	95.7%	4.3 - 4.39
4.49	3	1.0%	96.7%	4.4 - 4.49
4.59	2	0.7%	97.3%	4.5 - 4.59
4.69	0	0.0%	97.3%	4.6 - 4.69
4.79	1	0.3%	97.7%	4.7 - 4.79
4.89	1	0.3%	98.0%	4.8 - 4.89
More	6	2.0%	100.0%	> 4.89
Sum	300			



Particle Size Data for Riebeckite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

Filter	Particle	Length (microns)	Width (microns)	Aspect Ratio			Meet Fiber Criteria	Percent Fibers	Percent non-fibers
	27	7.5	4.0	1.9	17.9	17 - 17.9			
	28	8.0	2.5	3.2	18.9	18 - 18.9	Fiber		
	29	20.0	10.0	2.0	19.9	19 - 19.9			
	30	10.0	2.0	5.0	20.9	20 - 20.9	Fiber		
	31	5.0	1.0	5.0	More	> 20.9	Fiber		
	32	9.0	3.0	3.0			Fiber		
	33	6.0	2.0	3.0			Fiber		
	34	9.0	3.0	3.0	Bin		Fiber		
	35	30.0	5.0	6.0	0.24	<= 0.25	Fiber		
	36	12.0	2.0	6.0	0.9	0.25-0.9	Fiber		
	37	6.0	2.0	3.0	1.9	1 - 1.9	Fiber		
	38	9.0	3.0	3.0	2.9	2 - 2.9	Fiber		
	39	7.0	2.0	3.5	3.9	3 - 3.9	Fiber		
	40	25.0	2.5	10.0	4.9	4 - 4.9	Fiber		
	41	10.0	3.0	3.3	5.9	5 - 5.9	Fiber		
	42	9.0	2.0	4.5	6.9	6 - 6.9	Fiber		
	43	6.0	1.5	4.0	7.9	7 - 7.9	Fiber		
	44	5.0	5.0	1.0	8.9	8 - 8.9			
	45	10.0	1.0	10.0	9.9	9 - 9.9	Fiber		
	46	5.0	2.0	2.5	10.9	10 - 10.9			
	47	5.0	1.0	5.0	11.9	11 - 11.9	Fiber		
	48	15.0	4.0	3.8	12.9	12 - 12.9	Fiber		
	49	10.0	3.0	3.3	13.9	13 - 13.9	Fiber		
	50	6.0	2.0	3.0	14.9	14 - 14.9	Fiber		
Structure numbers	51	6.0	3.0	2.0	15.9	15 - 15.9			
51-100	52	4.0	1.0	4.0	16.9	16 - 16.9			
LCG on	53	7.5	3.0	2.5	17.9	17 - 17.9			
Filter 2	54	11.0	1.0	11.0	18.9	18 - 18.9	Fiber		
	55	2.5	2.5	1.0	19.9	19 - 19.9			
	56	7.5	1.0	7.5	20.9	20 - 20.9	Fiber		
	57	7.5	1.0	7.5	More	> 20.9	Fiber		
	58	6.0	0.5	12.0			Fiber		
	59	5.0	1.5	3.3			Fiber		
	60	11.0	1.0	11.0			Fiber		

Particle Size Data for Riebeckite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

Filter	Particle	Length (microns)	Width (microns)	Aspect Ratio
	61	13.0	3.0	4.3
	62	10.0	3.0	3.3
	63	3.0	1.0	3.0
	64	7.0	1.0	7.0
	65	9.0	1.5	6.0
	66	12.5	2.0	6.3
	67	7.5	1.5	5.0
	68	15.0	5.0	3.0
	69	12.0	7.5	1.6
	70	15.0	5.0	3.0
	71	7.5	3.0	2.5
	72	9.0	1.0	9.0
	73	9.0	1.0	9.0
	74	21.0	4.0	5.3
	75	7.0	3.0	2.3
	76	3.5	1.5	2.3
	77	7.5	2.0	3.8
	78	12.0	1.0	12.0
	79	5.0	2.0	2.5
	80	9.0	1.3	7.2
	81	5.0	1.0	5.0
	82	5.0	1.5	3.3
	83	9.0	3.0	3.0
	84	7.5	4.0	1.9
	85	6.0	1.5	4.0
	86	15.0	5.0	3.0
	87	9.0	1.5	6.0
	88	3.0	1.0	3.0
	89	5.0	2.0	2.5
	90	12.5	2.5	5.0
	91	4.0	1.5	2.7
	92	3.0	1.0	3.0
	93	5.0	1.0	5.0
	94	7.5	2.0	3.8

Meet Fiber Criteria	Percent Fibers	Percent non-fibers
Fiber		
Fiber		
Fiber		
Fiber		
Fiber		
Fiber		
Fiber		
Fiber		
Fiber		
Fiber		
Fiber		
Fiber		
Fiber		
Fiber		
Fiber		
Fiber		
Fiber		

Particle Size Data for Riebeckite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

Filter	Particle	Length (microns)	Width (microns)	Aspect Ratio
	95	7.0	1.5	4.7
	96	3.0	2.5	1.2
	97	7.5	5.0	1.5
	98	9.0	1.5	6.0
	99	7.5	7.5	1.0
	100	5.0	1.5	3.3

Meet Fiber Criteria	Percent Fibers	Percent non-fibers
Fiber		
Fiber		
Fiber		

**Table C1. Summary Statistics: Particle Size Data for Riebeckite Particles:  
Dimensions Measured by PCM using Walton-Beckett Graticule (400X  
Magnification)**

<i>Length (microns)</i>		<i>Width (microns)</i>		<i>Aspect Ratio</i>	
<b>Mean</b>	8.58	<b>Mean</b>	2.44	<b>Mean</b>	4.31
<b>Standard Error</b>	0.48	<b>Standard Error</b>	0.16	<b>Standard Error</b>	0.25
<b>Median</b>	7.50	<b>Median</b>	2.00	<b>Median</b>	3.42
<b>Mode</b>	9.00	<b>Mode</b>	1.00	<b>Mode</b>	3.00
<b>Standard Deviation</b>	4.75	<b>Standard Deviation</b>	1.61	<b>Standard Deviation</b>	2.47
<b>Sample Variance</b>	22.60	<b>Sample Variance</b>	2.59	<b>Sample Variance</b>	6.11
<b>Kurtosis</b>	4.62	<b>Kurtosis</b>	5.05	<b>Kurtosis</b>	1.52
<b>Skewness</b>	1.78	<b>Skewness</b>	1.87	<b>Skewness</b>	1.29
<b>Range</b>	27.50	<b>Range</b>	9.50	<b>Range</b>	11.00
<b>Minimum</b>	2.50	<b>Minimum</b>	0.50	<b>Minimum</b>	1.00
<b>Maximum</b>	30.00	<b>Maximum</b>	10.00	<b>Maximum</b>	12.00
<b>Sum</b>	858.00	<b>Sum</b>	244.00	<b>Sum</b>	431.07
<b>Count</b>	100	<b>Count</b>	100	<b>Count</b>	100



**Table C2. Aspect Ratios for Riebeckite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)**

<i>Bin</i>	<i>Frequency (Number of Counts)</i>	<i>Relative</i>	<i>Cumulative %</i>	<i>Aspect Ratio</i>
0.9	0	0.0%	0.0%	<= 1
1.9	12	12.0%	12.0%	1 - 1.9
2.9	12	12.0%	24.0%	2 - 2.9
3.9	30	30.0%	54.0%	3 - 3.9
4.9	13	13.0%	67.0%	4 - 4.9
5.9	10	10.0%	77.0%	5 - 5.9
6.9	9	9.0%	86.0%	6 - 6.9
7.9	5	5.0%	91.0%	7 - 7.9
8.9	1	1.0%	92.0%	8 - 8.9
9.9	2	2.0%	94.0%	9 - 9.9
10.9	2	2.0%	96.0%	10 - 10.9
11.9	2	2.0%	98.0%	11 - 11.9
12.9	2	2.0%	100.0%	12 - 12.9
13.9	0	0.0%	100.0%	13 - 13.9
14.9	0	0.0%	100.0%	14 - 14.9
15.9	0	0.0%	100.0%	15 - 15.9
16.9	0	0.0%	100.0%	16 - 16.9
17.9	0	0.0%	100.0%	17 - 17.9
18.9	0	0.0%	100.0%	18 - 18.9
19.9	0	0.0%	100.0%	19 - 19.9
20.9	0	0.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9

Sum 100

**Table C3. Lengths for Riebeckite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Length (microns)</i>
0.9	0	0.0%	0.0%	<= 1
1.9	0	0.0%	0.0%	1 - 1.9
2.9	1	1.0%	1.0%	2 - 2.9
3.9	9	9.0%	10.0%	3 - 3.9
4.9	5	5.0%	15.0%	4 - 4.9
5.9	13	13.0%	28.0%	5 - 5.9
6.9	8	8.0%	36.0%	6 - 6.9
7.9	17	17.0%	53.0%	7 - 7.9
8.9	4	4.0%	57.0%	8 - 8.9
9.9	14	14.0%	71.0%	9 - 9.9
10.9	8	8.0%	79.0%	10 - 10.9
11.9	2	2.0%	81.0%	11 - 11.9
12.9	6	6.0%	87.0%	12 - 12.9
13.9	1	1.0%	88.0%	13 - 13.9
14.9	0	0.0%	88.0%	14 - 14.9
15.9	5	5.0%	93.0%	15 - 15.9
16.9	1	1.0%	94.0%	16 - 16.9
17.9	0	0.0%	94.0%	17 - 17.9
18.9	2	2.0%	96.0%	18 - 18.9
19.9	0	0.0%	96.0%	19 - 19.9
20.9	1	1.0%	97.0%	20 - 20.9
More	3	3.0%	100.0%	> 20.9

Sum 100

**Table C4. Widths for Riebeckite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>
0.24	0	0.0%	0.0%	<= 0.25
0.9	2	2.0%	2.0%	0.25-0.9
1.9	40	40.0%	42.0%	1 - 1.9
2.9	21	21.0%	63.0%	2 - 2.9
3.9	19	19.0%	82.0%	3 - 3.9
4.9	7	7.0%	89.0%	4 - 4.9
5.9	8	8.0%	97.0%	5 - 5.9
6.9	0	0.0%	97.0%	6 - 6.9
7.9	2	2.0%	99.0%	7 - 7.9
8.9	0	0.0%	99.0%	8 - 8.9
9.9	0	0.0%	99.0%	9 - 9.9
10.9	1	1.0%	100.0%	10 - 10.9
11.9	0	0.0%	100.0%	11 - 11.9
12.9	0	0.0%	100.0%	12 - 12.9
13.9	0	0.0%	100.0%	13 - 13.9
14.9	0	0.0%	100.0%	14 - 14.9
15.9	0	0.0%	100.0%	15 - 15.9
16.9	0	0.0%	100.0%	16 - 16.9
17.9	0	0.0%	100.0%	17 - 17.9
18.9	0	0.0%	100.0%	18 - 18.9
19.9	0	0.0%	100.0%	19 - 19.9
20.9	0	0.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9

Sum 100

Figure 1. Frequency Distribution of Aspect Ratios for 300 Riebeckite Particles:  
 Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

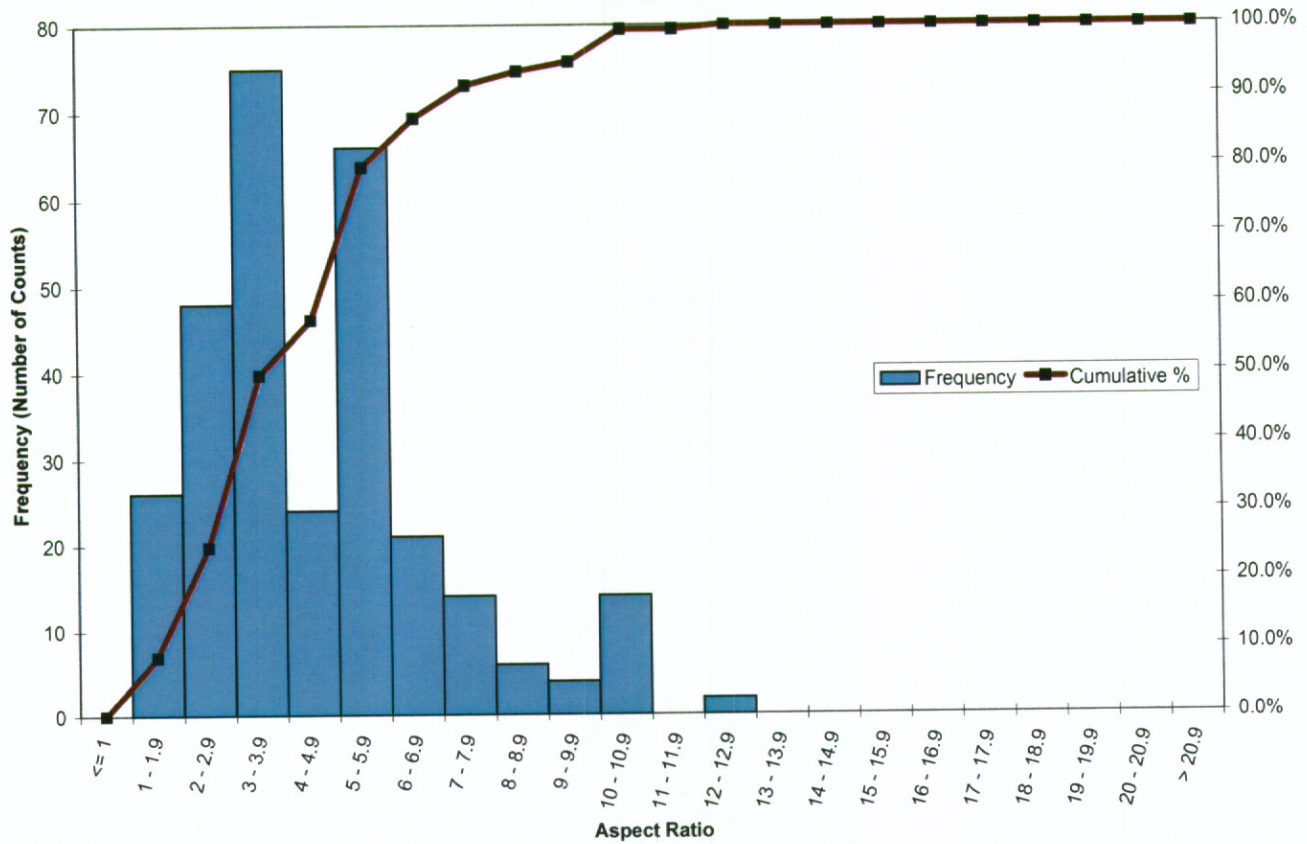


Figure 2. Frequency Distribution of Lengths for 300 Riebeckite Particles:  
 Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

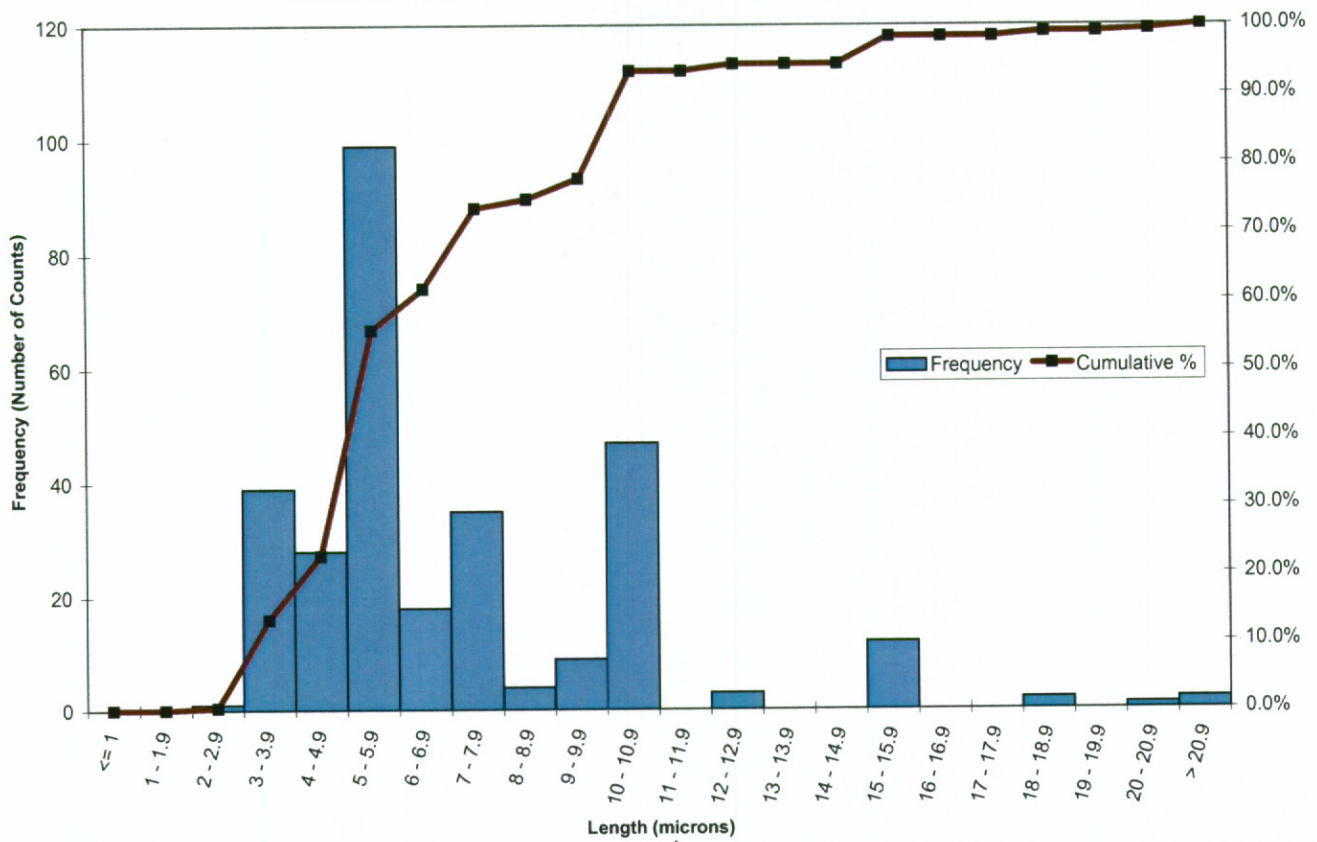


Figure 3. Frequency Distribution of Widths for 300 Riebeckite Particles:  
 Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

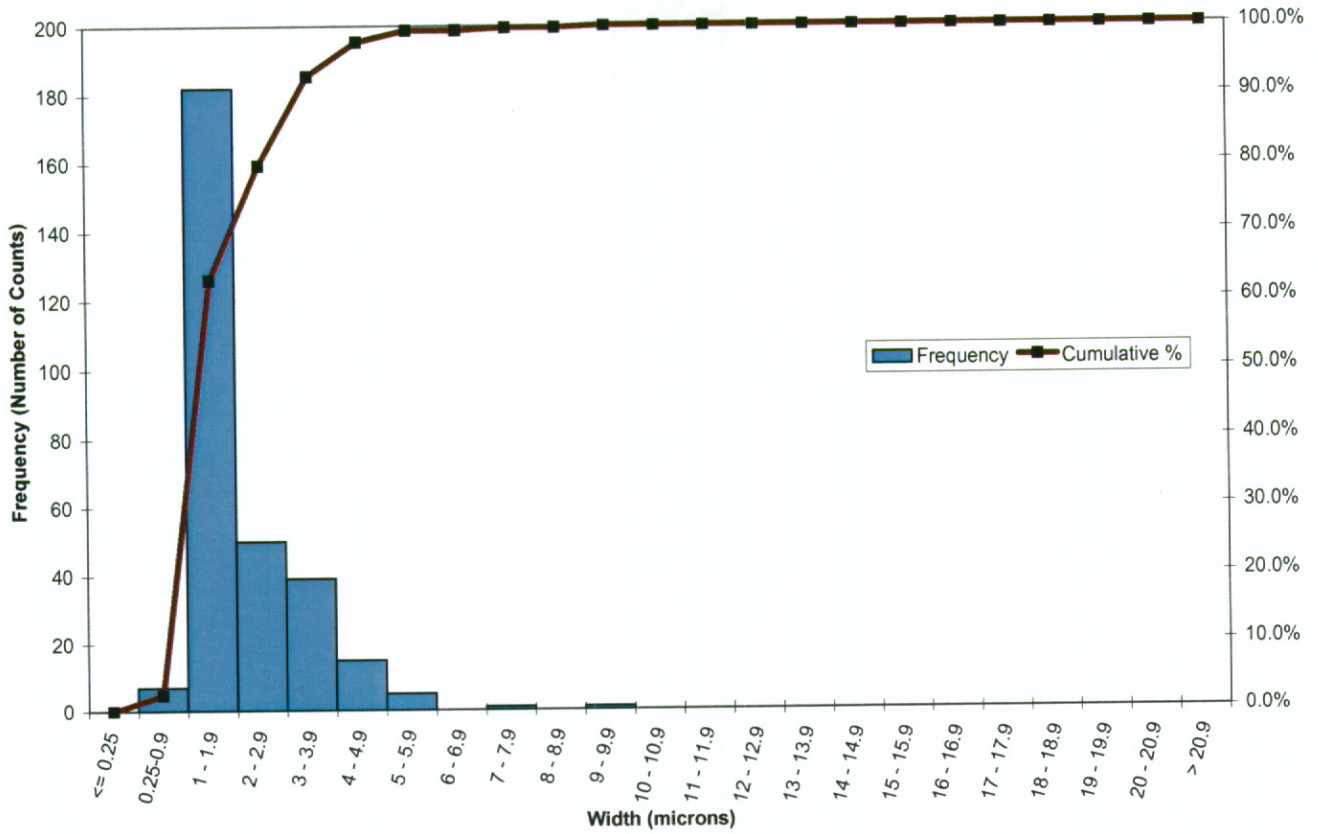


Figure 4. Frequency Distribution of Aspect Ratios for 300 Riebeckite Particles:  
Dimensions Measured by TEM PCME (10,000X Magnification)

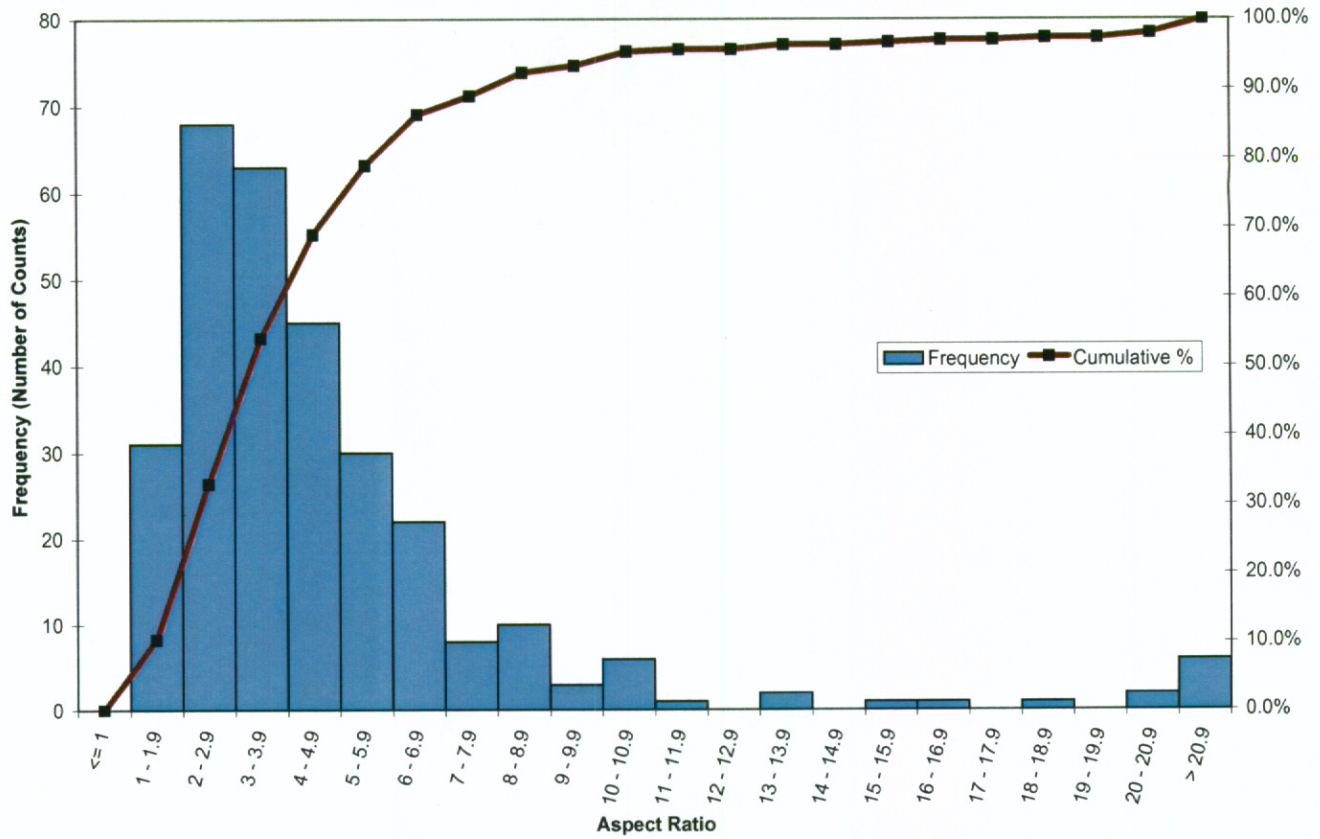


Figure 5. Frequency Distribution of Lengths for 300 Riebeckite Particles:  
Dimensions Measured by TEM PCME (10,000X Magnification)

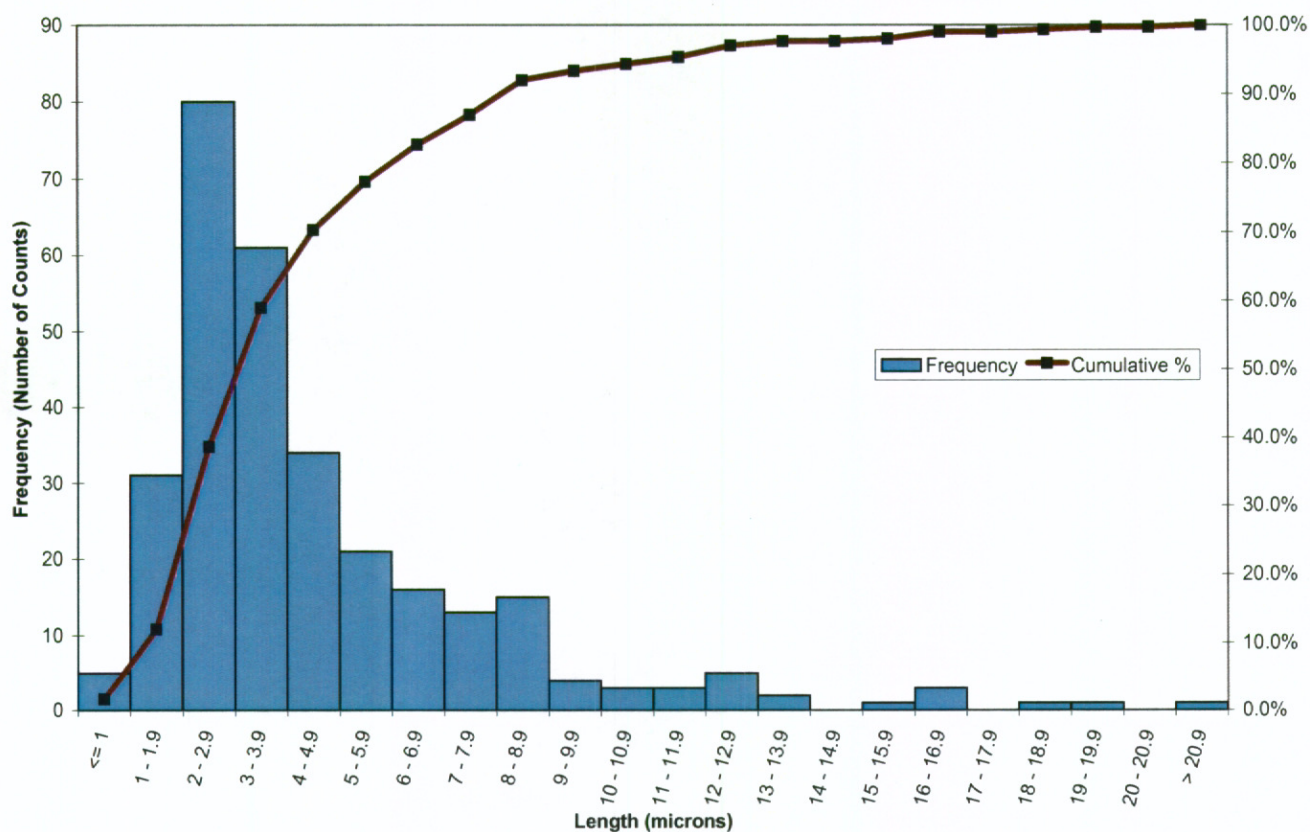




Figure 6. Frequency Distribution of Widths for 300 Riebeckite Particles:  
Dimensions Measured by TEM PCME (10,000X Magnification)

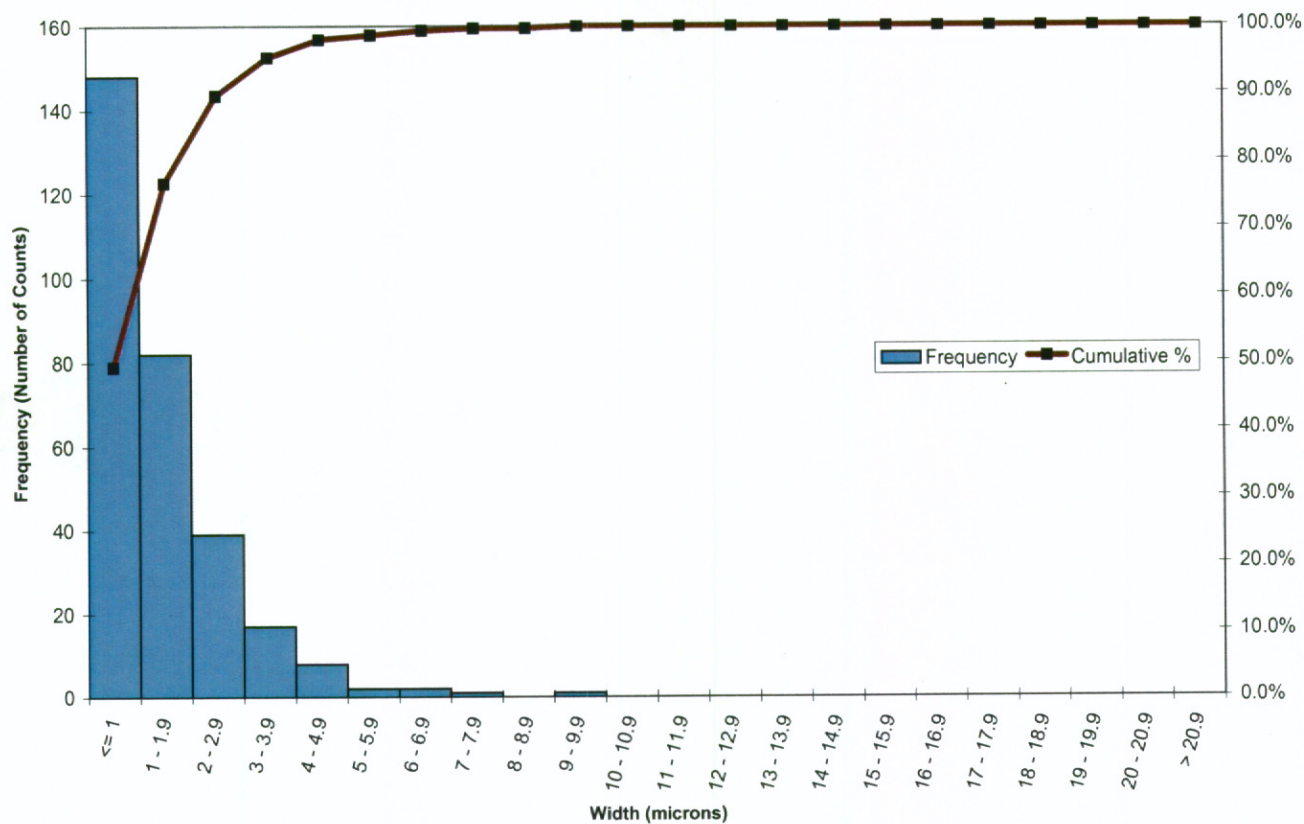


Figure 7. Frequency Distribution of Widths for 300 Riebeckite Particles: Dimensions Measured by TEM PCME (10,000X Magnification) Finer Detail

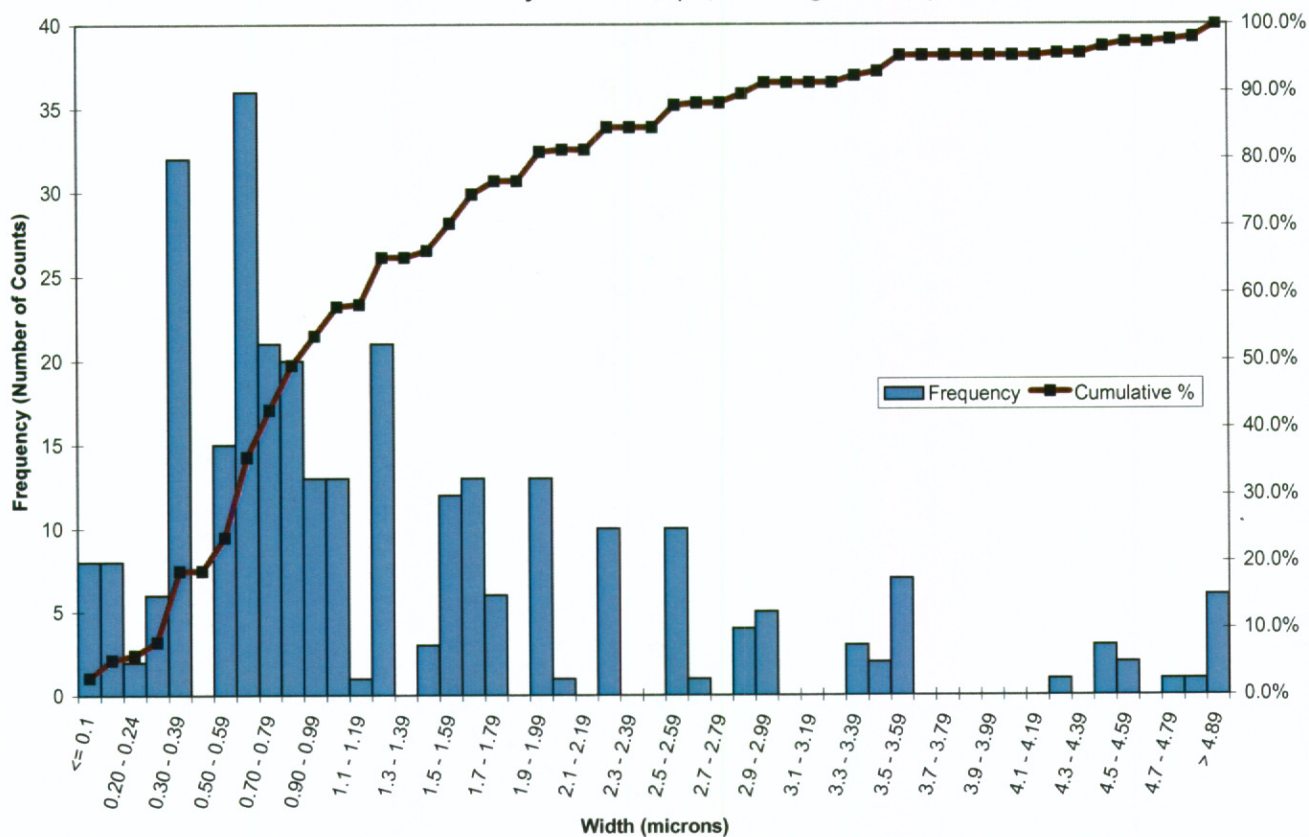


Figure 8. Frequency Distribution of Aspect Ratios for Riebeckite Particles:  
Comparison of TEM PCME and PCM Data

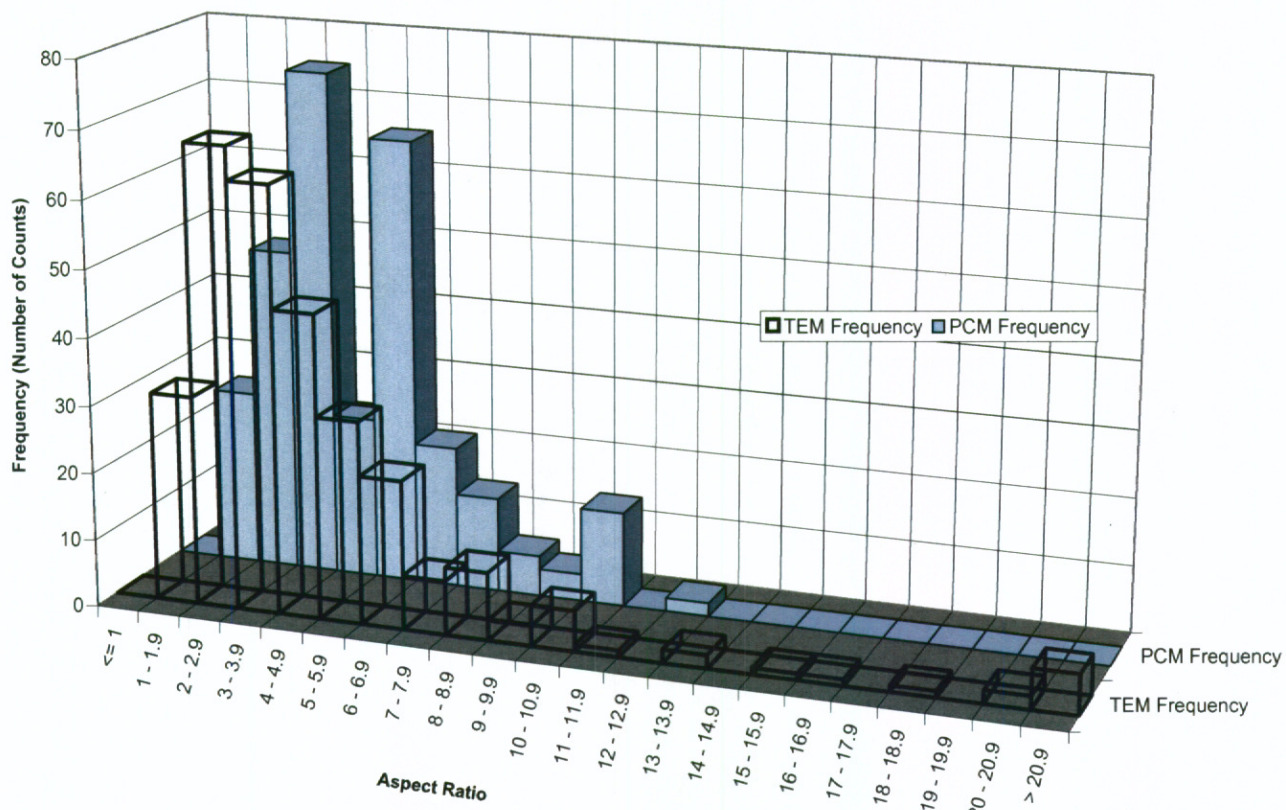


Figure 9. Frequency Distribution of Lengths for Riebeckite Particles:  
Comparison of TEM PCME and PCM Data

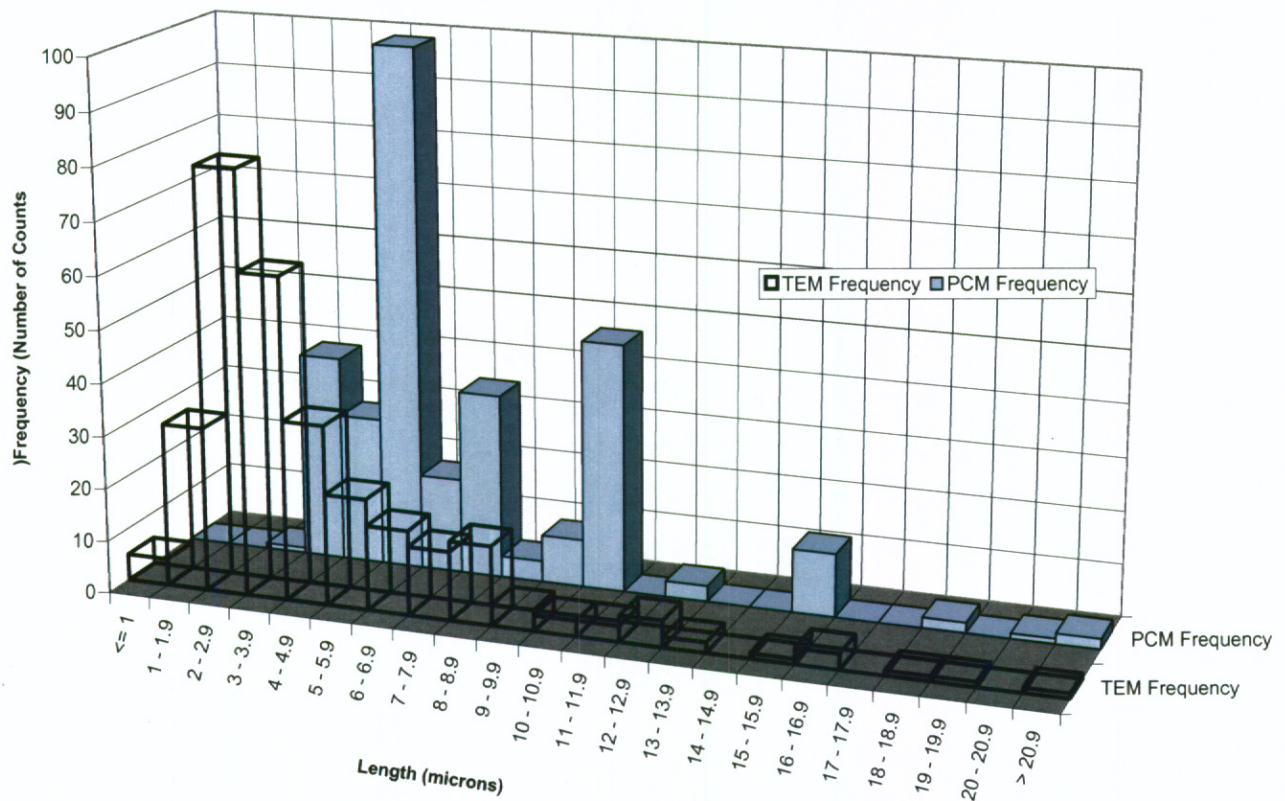
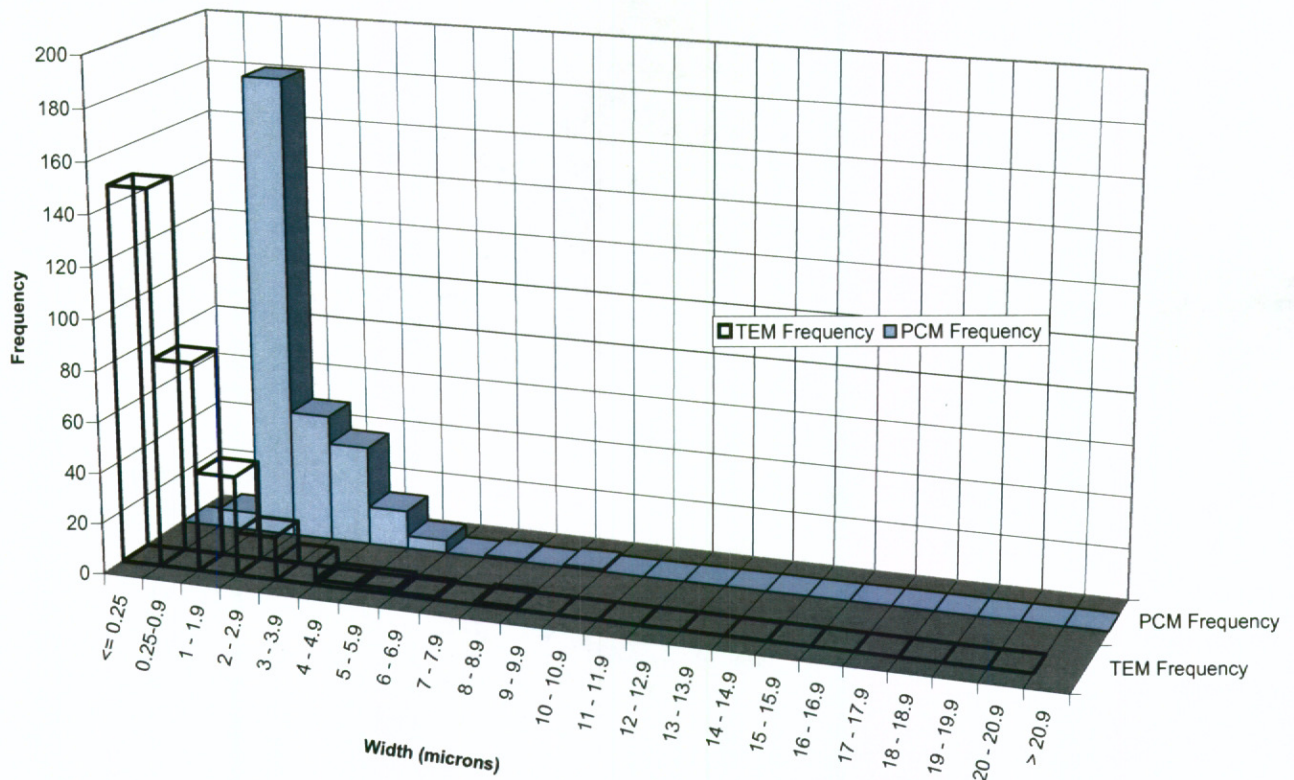


Figure 10. Frequency Distribution of Widths for Riebeckite Particles:  
Comparison of TEM PCME and PCM Data



**Figure 11. Frequency Distribution of Aspect Ratios for Riebeckite Particles:  
Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)**

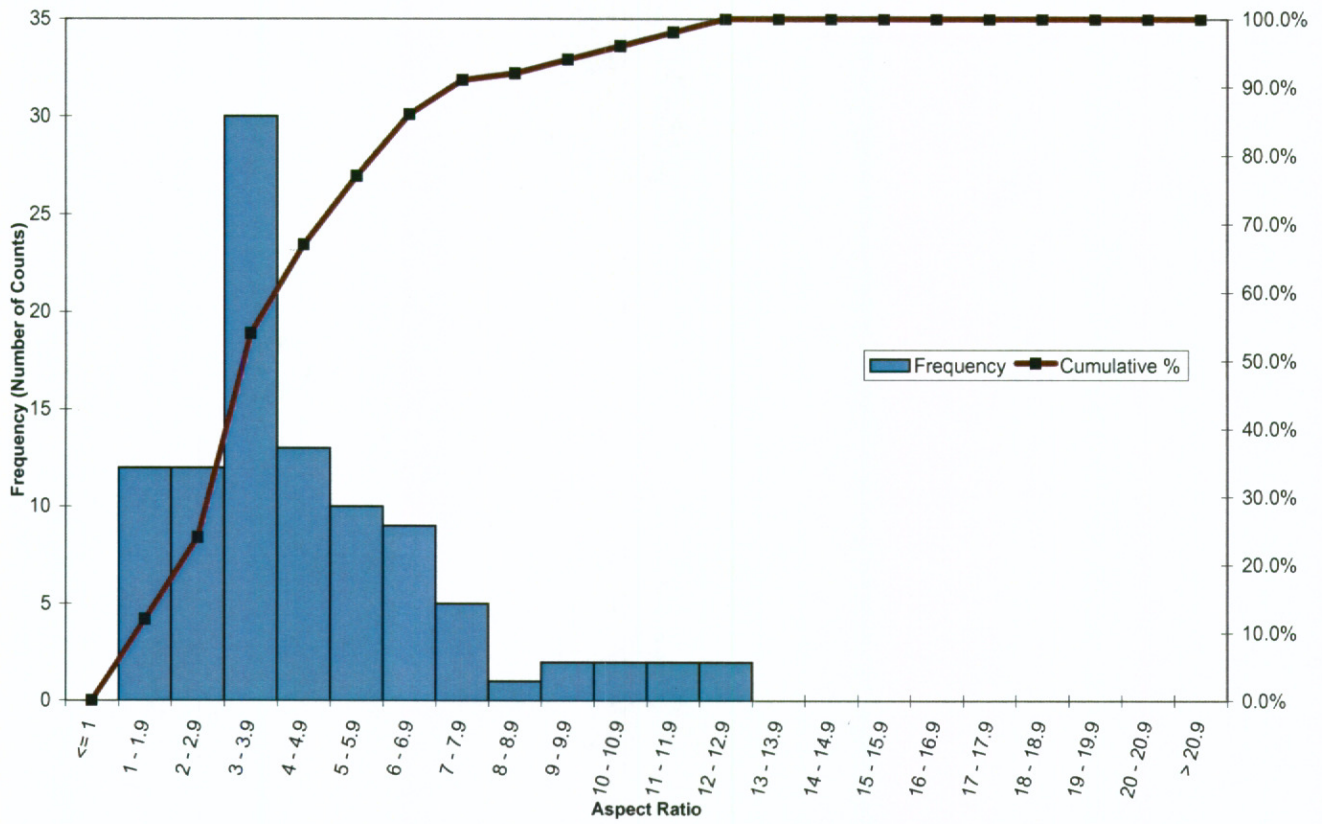


Figure 12. Frequency Distribution of Lengths for Riebeckite Particles:  
 Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

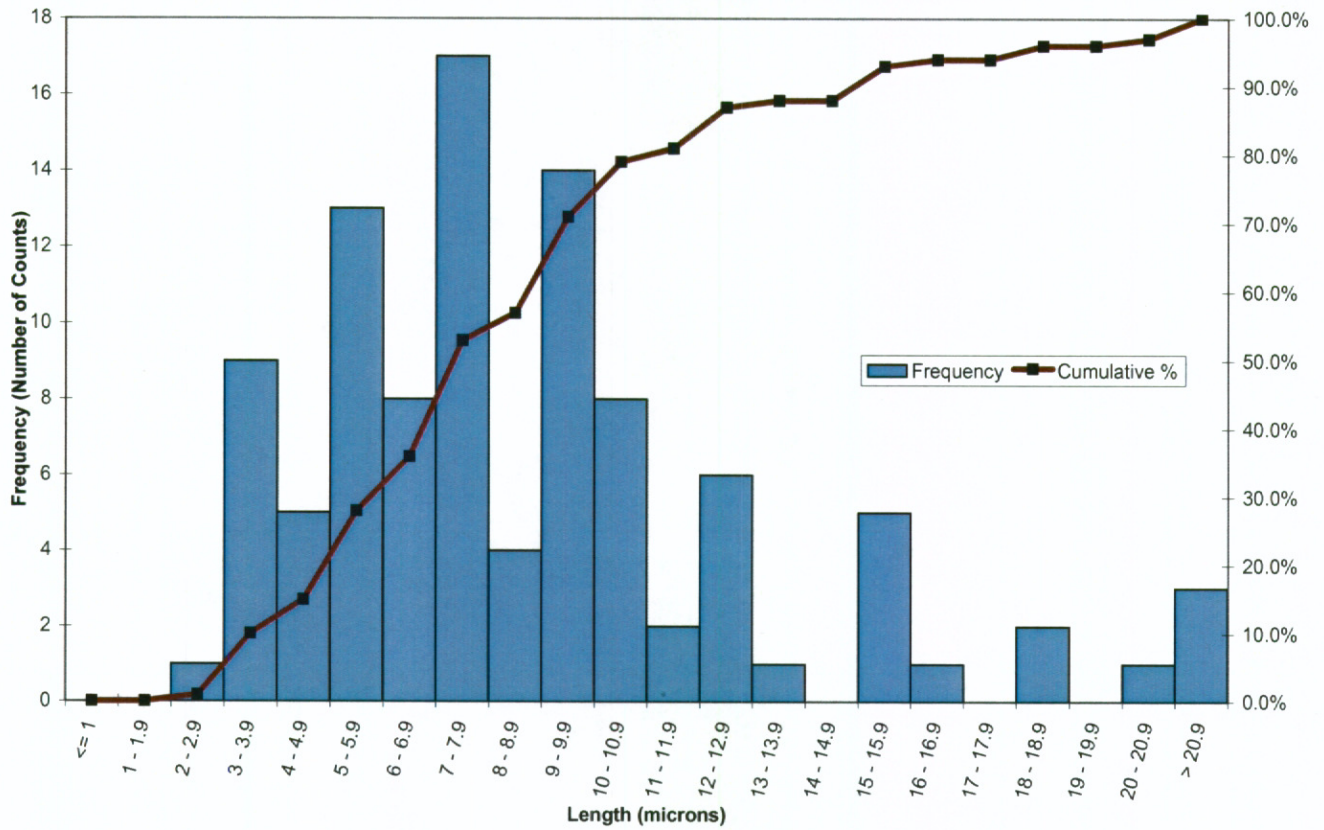
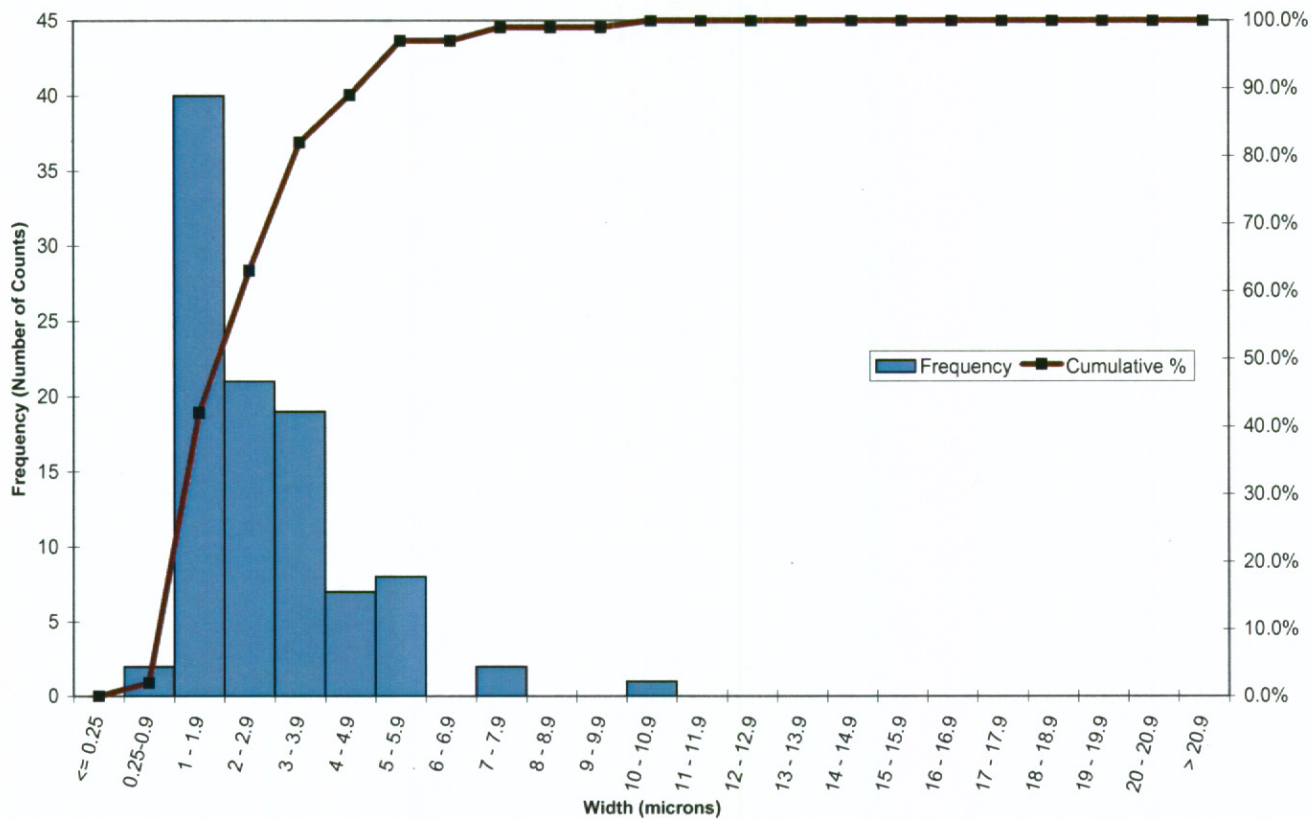


Figure 13. Frequency Distribution of Widths for Riebeckite Particles:  
Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)





**Figure 14. Frequency Distribution of Aspect Ratios for Riebeckite Particles:  
Comparison of Dimensions from PCM Measured by Calibrated Visual Estimation and Walton-Beckett  
Graticule**

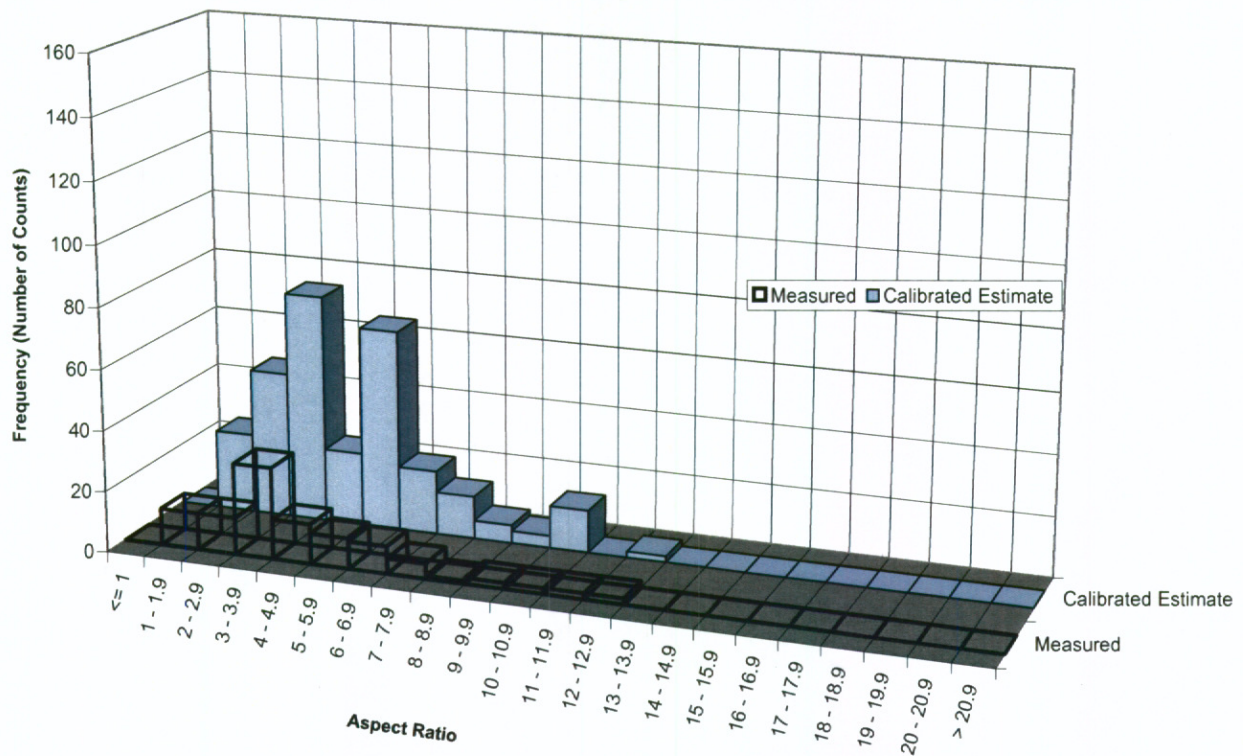


Figure 15. Frequency Distribution of Lengths for Riebeckite Particles:  
 Comparison of Dimensions from PCM Measured by Calibrated Visual Estimation and Walton-Beckett  
 Graticule

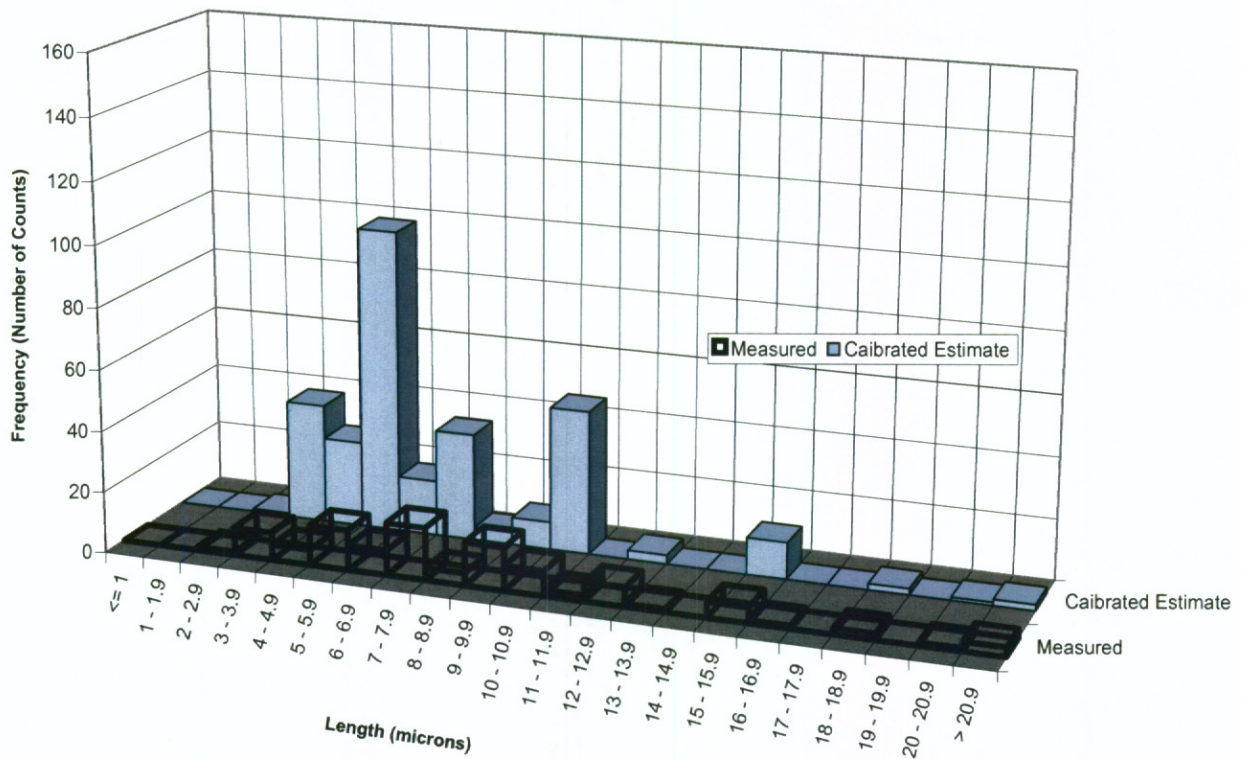
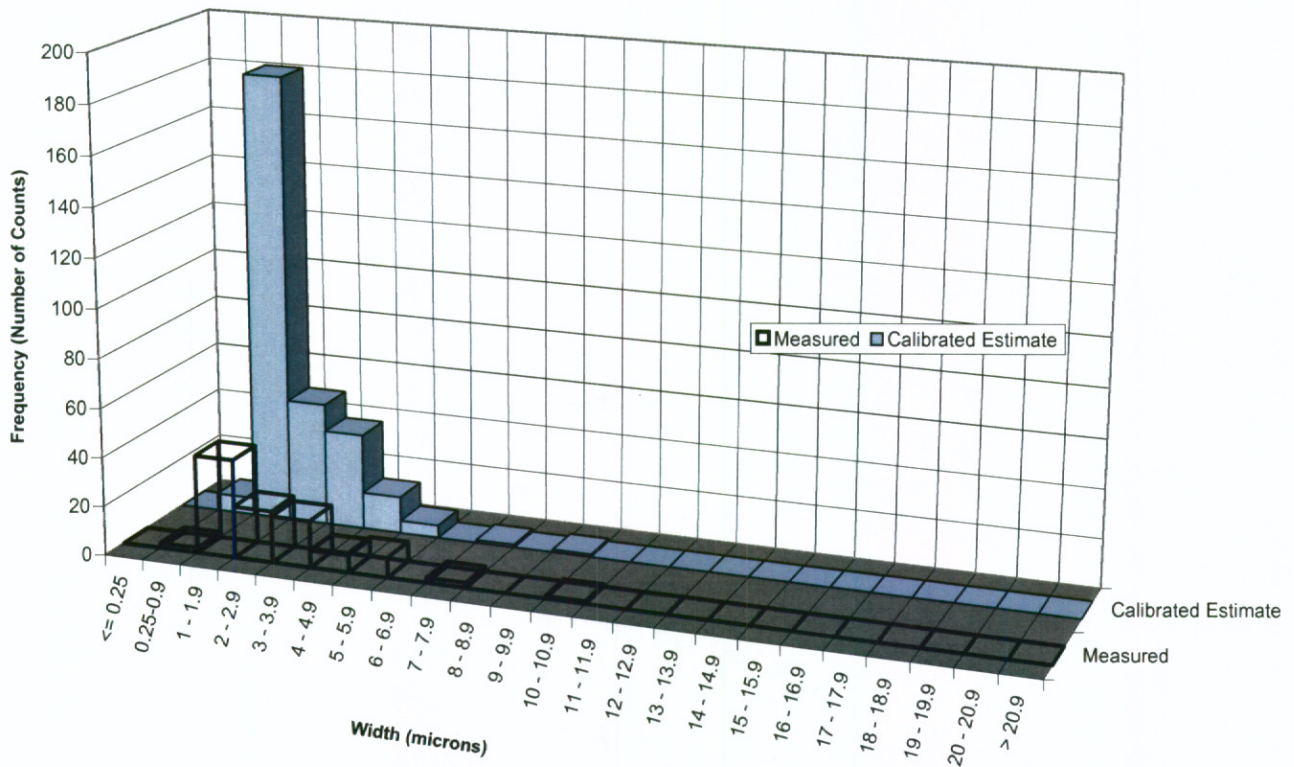


Figure 16. Frequency Distribution of Widths for Riebeckite Particles:  
Comparison of Dimensions from PCM Measured by Calibrated Visual Estimation and Walton-Beckett Graticule



## **Analytical Data Summaries**

### **3D. Grunerite**

Grunerite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

**Table A: Grunerite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

Note: data in red does not meet criteria for counting; ie.  $\geq 5 \mu\text{m}$  in length or  $\geq 3:1$  aspect ratio.

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	1	7.0	1.5	4.7
numbers	2	5.0	3.0	1.7
1-50	3	6.0	1.0	6.0
BWH	4	9.0	3.0	3.0
on	5	7.0	2.0	3.5
filter 1	6	8.0	1.5	5.3
	7	7.0	3.0	2.3
	8	4.0	1.0	4.0
	9	10.0	1.0	10.0
	10	4.0	1.0	4.0
	11	6.0	2.0	3.0
	12	6.0	2.0	3.0
	13	4.0	1.0	4.0
	14	6.0	3.0	2.0
	15	7.0	4.0	1.8
	16	5.0	1.0	5.0
	17	7.0	1.0	7.0
	18	5.0	1.5	3.3
	19	5.0	1.5	3.3
	20	5.0	1.0	5.0
	21	6.0	1.0	6.0
	22	5.0	1.5	3.3
	23	28.0	6.0	4.7
	24	6.0	3.0	2.0
	25	9.0	3.0	3.0

Bin	Count of fibers	Count of non-fibers	Total Structures Counted	Percent Fibers	Percent non-fibers	Meet Fiber Criteria
	194	106	300	64.7%	35.3%	
Bin						
0.9						<= 1 Fiber
1.9						1 - 1.9 Fiber
2.9						2 - 2.9 Fiber
3.9						3 - 3.9 Fiber
4.9						4 - 4.9
5.9						5 - 5.9
6.9						6 - 6.9 Fiber
7.9						7 - 7.9
8.9						8 - 8.9 Fiber
9.9						9 - 9.9 Fiber
10.9						10 - 10.9
11.9						11 - 11.9
12.9						12 - 12.9
13.9						13 - 13.9 Fiber
14.9						14 - 14.9 Fiber
15.9						15 - 15.9 Fiber
16.9						16 - 16.9 Fiber
17.9						17 - 17.9 Fiber
18.9						18 - 18.9 Fiber
19.9						19 - 19.9 Fiber
20.9						20 - 20.9 Fiber
More						> 20.9 Fiber

Grunerite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	26	4.0	1.0	4.0
	27	6.0	1.0	6.0
	28	7.0	2.0	3.5
	29	15.0	4.0	3.8
	30	5.0	1.5	3.3
	31	6.0	5.0	1.2
	32	4.0	1.0	4.0
	33	5.0	1.5	3.3
	34	11.0	3.0	3.7
	35	5.0	1.0	5.0
	36	10.0	2.0	5.0
	37	7.0	1.0	7.0
	38	5.0	3.0	1.7
	39	5.0	1.5	3.3
	40	9.0	1.5	6.0
	41	9.0	2.0	4.5
	42	4.0	1.0	4.0
	43	10.0	3.0	3.3
	44	5.0	2.0	2.5
	45	6.0	4.0	1.5
	46	4.0	1.0	4.0
	47	4.0	1.5	2.7
	48	9.0	6.0	1.5
	49	8.0	3.0	2.7
	50	6.0	2.5	2.4
Structure	51	5.0	1.5	3.3
numbers	52	9.0	2.5	3.6
51-100	53	7.0	4.0	1.8
BWH	54	9.0	1.5	6.0
on	55	8.0	3.0	2.7
filter 2	56	5.0	1.0	5.0
	57	7.0	1.5	4.7
	58	12.0	3.0	4.0
	59	5.0	1.5	3.3

Meet  
Fiber  
Criteria      64.7%      35.3%

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Grunerite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	60	5.0	1.0	5.0
	61	6.0	2.5	2.4
	62	3.0	1.0	3.0
	63	7.0	2.5	2.8
	64	7.0	1.0	7.0
	65	11.0	3.0	3.7
	66	5.0	1.5	3.3
	67	5.0	3.0	1.7
	68	10.0	4.0	2.5
	69	13.0	3.0	4.3
	70	5.0	1.5	3.3
	71	8.0	1.0	8.0
	72	6.0	2.5	2.4
	73	6.0	1.5	4.0
	74	9.0	2.0	4.5
	75	5.0	0.5	10.0
	76	11.0	3.0	3.7
	77	3.0	1.0	3.0
	78	4.0	1.0	4.0
	79	4.0	1.0	4.0
	80	12.0	2.0	6.0
	81	9.0	1.0	9.0
	82	5.0	3.0	1.7
	83	10.0	2.5	4.0
	84	8.0	2.0	4.0
	85	7.0	2.0	3.5
	86	4.0	1.0	4.0
	87	5.0	1.0	5.0
	88	7.0	2.0	3.5
	89	5.0	2.0	2.5
	90	6.0	1.5	4.0
	91	4.0	1.5	2.7
	92	4.0	1.5	2.7
	93	10.0	3.0	3.3

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Criteria     64.7%     35.3%

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Grunerite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	94	6.0	1.5	4.0
	95	7.0	2.0	3.5
	96	6.0	2.0	3.0
	97	7.0	5.0	1.4
	98	6.0	2.5	2.4
	99	9.0	3.0	3.0
	100	17.0	4.0	4.3
Structure numbers	101	4.0	1.0	4.0
	102	4.0	1.5	2.7
101-150	103	5.0	2.0	2.5
BWH on filter 3	104	5.0	1.0	5.0
	105	6.0	2.0	3.0
	106	18.0	4.0	4.5
	107	12.0	5.0	2.4
	108	5.0	1.0	5.0
	109	10.0	3.0	3.3
	110	10.0	2.5	4.0
	111	4.0	1.0	4.0
	112	8.0	4.0	2.0
	113	5.0	1.5	3.3
	114	7.0	2.0	3.5
	115	6.0	2.0	3.0
	116	10.0	2.0	5.0
	117	7.0	2.0	3.5
	118	6.0	1.5	4.0
	119	6.0	2.0	3.0
	120	7.0	1.0	7.0
	121	7.0	1.0	7.0
	122	8.0	2.5	3.2
	123	8.0	2.0	4.0
	124	6.0	2.5	2.4
	125	8.0	2.5	3.2
	126	5.0	2.0	2.5
	127	11.0	2.0	5.5

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64.7%      35.3%

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Grunerite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	128	4.0	1.0	4.0
	129	4.0	1.0	4.0
	130	7.0	1.5	4.7
	131	5.0	3.0	1.7
	132	7.0	1.0	7.0
	133	5.0	0.5	10.0
	134	7.0	1.5	4.7
	135	5.0	2.0	2.5
	136	26.0	3.0	8.7
	137	5.0	1.5	3.3
	138	7.0	1.5	4.7
	139	13.0	1.5	8.7
	140	6.0	1.5	4.0
	141	8.0	3.0	2.7
	142	8.0	2.5	3.2
	143	8.0	1.0	8.0
	144	6.0	1.0	6.0
	145	4.0	1.5	2.7
	146	5.0	2.0	2.5
	147	9.0	2.0	4.5
	148	12.0	2.0	6.0
	149	6.0	2.5	2.4
	150	7.0	4.0	1.8
Structure numbers	151	7.0	1.5	4.7
	152	7.0	4.0	1.8
151-200	153	11.0	4.0	2.8
BWH	154	7.0	4.0	1.8
on	155	9.0	2.5	3.6
filter 4	156	10.0	2.5	4.0
	157	9.0	5.0	1.8
	158	10.0	1.5	6.7
	159	6.0	2.0	3.0
	160	6.0	2.0	3.0
	161	6.0	2.0	3.0

Meet Fiber Criteria 64.7% 35.3%

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Grunerite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	162	4.0	1.0	4.0
	163	4.0	1.0	4.0
	164	4.0	1.5	2.7
	165	5.0	1.5	3.3
	166	7.0	1.5	4.7
	167	4.0	3.0	1.3
	168	17.0	5.0	3.4
	169	5.0	2.0	2.5
	170	5.0	1.5	3.3
	171	6.0	1.5	4.0
	172	5.0	1.0	5.0
	173	6.0	1.0	6.0
	174	8.0	5.0	1.6
	175	6.0	2.0	3.0
	176	5.0	1.5	3.3
	177	14.0	6.0	2.3
	178	8.0	4.0	2.0
	179	7.0	1.0	7.0
	180	18.0	4.5	4.0
	181	7.0	1.5	4.7
	182	9.0	2.0	4.5
	183	9.0	3.5	2.6
	184	5.0	1.5	3.3
	185	6.0	1.5	4.0
	186	4.0	1.0	4.0
	187	6.0	2.0	3.0
	188	7.0	2.0	3.5
	189	8.0	2.0	4.0
	190	9.0	3.0	3.0
	191	5.0	3.0	1.7
	192	5.0	1.5	3.3
	193	5.0	2.0	2.5
	194	10.0	2.5	4.0
	195	8.0	6.0	1.3

Meet  
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Criteria      64.7%      35.3%

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Grunerite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	230	6.0	1.0	6.0
	231	6.0	2.0	3.0
	232	9.0	3.0	3.0
	233	7.0	1.0	7.0
	234	5.0	1.0	5.0
	235	7.0	1.5	4.7
	236	9.0	5.0	1.8
	237	6.0	1.5	4.0
	238	16.0	5.0	3.2
	239	7.0	1.5	4.7
	240	9.0	2.0	4.5
	241	16.0	3.0	5.3
	242	5.0	0.5	10.0
	243	6.0	1.5	4.0
	244	5.0	1.5	3.3
	245	5.0	1.5	3.3
	246	13.0	5.0	2.6
	247	7.0	3.0	2.3
	248	10.0	3.0	3.3
	249	11.0	3.0	3.7
	250	5.0	1.5	3.3
Structure numbers	251	6.0	1.0	6.0
	252	9.0	1.5	6.0
251-300	253	7.0	3.0	2.3
BWH	254	5.0	1.0	5.0
on	255	6.0	1.0	6.0
filter 6	256	6.0	2.0	3.0
	257	17.0	5.0	3.4
	258	4.0	1.0	4.0
	259	6.0	2.0	3.0
	260	5.0	1.0	5.0
	261	4.0	1.0	4.0
	262	4.0	1.0	4.0
	263	9.0	3.0	3.0

Meet  
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64.7%      35.3%

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Grunerite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	264	11.0	5.0	2.2
	265	8.0	1.0	8.0
	266	10.0	3.0	3.3
	267	9.0	2.5	3.6
	268	5.0	1.0	5.0
	269	12.0	7.0	1.7
	270	6.0	1.5	4.0
	271	7.0	2.0	3.5
	272	7.0	3.0	2.3
	273	13.0	3.0	4.3
	274	6.0	1.0	6.0
	275	15.0	3.0	5.0
	276	10.0	1.0	10.0
	277	6.0	2.0	3.0
	278	10.0	4.0	2.5
	279	9.0	2.5	3.6
	280	8.0	1.0	8.0
	281	10.0	2.0	5.0
	282	4.0	1.5	2.7
	283	9.0	2.5	3.6
	284	5.0	3.0	1.7
	285	5.0	1.5	3.3
	286	7.0	1.5	4.7
	287	6.0	1.0	6.0
	288	5.0	1.5	3.3
	289	5.0	1.0	5.0
	290	12.0	1.0	12.0
	291	7.0	5.0	1.4
	292	4.0	1.0	4.0
	293	10.0	1.5	6.7
	294	6.0	1.5	4.0
	295	7.0	1.5	4.7
	296	6.0	1.0	6.0
	297	13.0	5.0	2.6

Meet  
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Criteria 64.7% 35.3%

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Grunerite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	298	5.0	1.0	5.0
	299	5.0	1.0	5.0
	300	6.0	1.5	4.0

**Meet**  
**Fiber**  
**Criteria**    64.7%    35.3%  
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**Table A1: Summary Statistics for Grunerite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

<i>Length (microns)</i>		<i>Width (microns)</i>		<i>Aspect Ratio</i>	
<b>Mean</b>	7.37	<b>Mean</b>	2.22	<b>Mean</b>	3.92
<b>Standard Error</b>	0.19	<b>Standard Error</b>	0.07	<b>Standard Error</b>	0.10
<b>Median</b>	6.00	<b>Median</b>	2.00	<b>Median</b>	3.50
<b>Mode</b>	5.00	<b>Mode</b>	1.00	<b>Mode</b>	4.00
<b>Standard Deviation</b>	3.33	<b>Standard Deviation</b>	1.28	<b>Standard Deviation</b>	1.80
<b>Sample Variance</b>	11.10	<b>Sample Variance</b>	1.65	<b>Sample Variance</b>	3.25
<b>Kurtosis</b>	8.16	<b>Kurtosis</b>	1.52	<b>Kurtosis</b>	3.12
<b>Skewness</b>	2.24	<b>Skewness</b>	1.33	<b>Skewness</b>	1.54
<b>Range</b>	25.00	<b>Range</b>	6.50	<b>Range</b>	10.80
<b>Minimum</b>	3.00	<b>Minimum</b>	0.50	<b>Minimum</b>	1.20
<b>Maximum</b>	28.00	<b>Maximum</b>	7.00	<b>Maximum</b>	12.00
<b>Sum</b>	2211.00	<b>Sum</b>	664.50	<b>Sum</b>	1175.15
<b>Count</b>	300	<b>Count</b>	300	<b>Count</b>	300

**Table A2. Aspect Ratios for Grunerite Particles:  
Calibrated Visual Estimation of Dimensions by PCM (400X  
Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Aspect Ratio</i>
0.9	0	0.0%	0.0%	<= 1
1.9	26	8.7%	8.7%	1 - 1.9
2.9	56	18.7%	27.3%	2 - 2.9
3.9	82	27.3%	54.7%	3 - 3.9
4.9	71	23.7%	78.3%	4 - 4.9
5.9	23	7.7%	86.0%	5 - 5.9
6.9	18	6.0%	92.0%	6 - 6.9
7.9	9	3.0%	95.0%	7 - 7.9
8.9	6	2.0%	97.0%	8 - 8.9
9.9	1	0.3%	97.3%	9 - 9.9
10.9	7	2.3%	99.7%	10 - 10.9
11.9	0	0.0%	99.7%	11 - 11.9
12.9	1	0.3%	100.0%	12 - 12.9
13.9	0	0.0%	100.0%	13 - 13.9
14.9	0	0.0%	100.0%	14 - 14.9
15.9	0	0.0%	100.0%	15 - 15.9
16.9	0	0.0%	100.0%	16 - 16.9
17.9	0	0.0%	100.0%	17 - 17.9
18.9	0	0.0%	100.0%	18 - 18.9
19.9	0	0.0%	100.0%	19 - 19.9
20.9	0	0.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9
Sum	300			



**Table A3. Lengths for Grunerite Particles: Calibrated  
Visual Estimation of Dimensions by PCM (400X  
Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Length (microns)</i>
0.9	0	0.0%	0.0%	<= 1
1.9	0	0.0%	0.0%	1 - 1.9
2.9	0	0.0%	0.0%	2 - 2.9
3.9	2	0.7%	0.7%	3 - 3.9
4.9	33	11.0%	11.7%	4 - 4.9
5.9	62	20.7%	32.3%	5 - 5.9
6.9	56	18.7%	51.0%	6 - 6.9
7.9	43	14.3%	65.3%	7 - 7.9
8.9	21	7.0%	72.3%	8 - 8.9
9.9	25	8.3%	80.7%	9 - 9.9
10.9	21	7.0%	87.7%	10 - 10.9
11.9	9	3.0%	90.7%	11 - 11.9
12.9	8	2.7%	93.3%	12 - 12.9
13.9	5	1.7%	95.0%	13 - 13.9
14.9	2	0.7%	95.7%	14 - 14.9
15.9	2	0.7%	96.3%	15 - 15.9
16.9	4	1.3%	97.7%	16 - 16.9
17.9	3	1.0%	98.7%	17 - 17.9
18.9	2	0.7%	99.3%	18 - 18.9
19.9	0	0.0%	99.3%	19 - 19.9
20.9	0	0.0%	99.3%	20 - 20.9
More	2	0.7%	100.0%	> 20.9

Sum 300

**Table A4. Widths for Grunerite Particles: Calibrated  
Visual Estimation of Dimensions by PCM (400X  
Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>
0.9	5	1.7%	1.7%	<= 1
1.9	134	44.7%	46.3%	1 - 1.9
2.9	75	25.0%	71.3%	2 - 2.9
3.9	44	14.7%	86.0%	3 - 3.9
4.9	19	6.3%	92.3%	4 - 4.9
5.9	15	5.0%	97.3%	5 - 5.9
6.9	6	2.0%	99.3%	6 - 6.9
7.9	2	0.7%	100.0%	7 - 7.9
8.9	0	0.0%	100.0%	8 - 8.9
9.9	0	0.0%	100.0%	9 - 9.9
10.9	0	0.0%	100.0%	10 - 10.9
11.9	0	0.0%	100.0%	11 - 11.9
12.9	0	0.0%	100.0%	12 - 12.9
13.9	0	0.0%	100.0%	13 - 13.9
14.9	0	0.0%	100.0%	14 - 14.9
15.9	0	0.0%	100.0%	15 - 15.9
16.9	0	0.0%	100.0%	16 - 16.9
17.9	0	0.0%	100.0%	17 - 17.9
18.9	0	0.0%	100.0%	18 - 18.9
19.9	0	0.0%	100.0%	19 - 19.9
20.9	0	0.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9

Sum 300

Grunerite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

**Table B. Grunerite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)**

\* Note: data in red does not meet criteria for counting; ie.  $\geq 5 \mu m$  in length or  $\geq 3.1$  aspect ratio.

Filter	Grid	Grid Opening	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
1	A1	E1	1	4.2	2.2	1.9
1	A1	E1	2	2.4	0.9	2.7
1	A1	E1	3	1.2	0.4	3.3
1	A1	E1	4	2.4	0.4	6.7
1	A1	E1	5	2.4	0.9	2.7
1	A1	E1	6	1.2	0.3	4.0
1	A1	E1	7	1.8	0.5	3.8
1	A1	E1	8	1.5	0.3	4.8
1	A1	E1	9	2.1	0.5	4.3
1	A1	E1	10	1.9	1.2	1.6
1	A1	E1	11	1.3	0.1	22.0
1	A1	E1	12	1.8	0.7	2.5
1	A1	E1	13	1.5	0.8	1.7
1	A1	E1	14	1.5	0.5	3.0
1	A1	E1	15	1.5	0.5	3.0
1	A1	E1	16	0.9	0.1	7.5
1	A1	E1	17	1.5	0.4	4.0
1	A1	E1	18	2.1	1.8	1.1
1	A1	E1	19	1.2	0.5	2.5
1	A1	E11	20	2.7	0.8	3.1
1	A1	E11	21	2.7	0.5	5.6
1	A1	E11	22	2.1	0.4	5.7
1	A1	E11	23	1.0	0.1	16.0
1	A1	E11	24	1.5	0.7	2.0
1	A1	E11	25	1.8	0.8	2.1
1	A1	E11	26	1.8	0.7	2.5
1	A1	E11	27	4.2	1.2	3.5
1	A1	E11	28	2.7	1.2	2.3
1	A2	E11	29	2.1	0.2	8.5
1	A2	E11	30	3.0	0.6	5.0
1	A2	E11	31	1.0	0.2	4.0
1	A2	E11	32	1.1	0.1	9.0
1	A2	E11	33	1.2	0.1	10.0
1	A2	E11	34	1.8	0.7	2.5
1	A2	E11	35	1.0	0.4	2.7
1	A2	E11	36	12.1	3.0	4.0
1	A2	E11	37	3.3	0.9	3.6
1	A2	E11	38	2.1	0.3	7.0
1	A2	E11	39	1.7	0.8	2.0

Bin	PCM- Equivalent Fiber	TEM- only Fiber	Length <5 $\mu m$ or Width < 3 $\mu m$	Count of Structures			
0.9	35	0	265	300			
1.9	Percent PCM- Equivalent Fibers 11.7%	Percent TEM- only Fibers 0.0%	Percent non-Fibers 88.3%				
Bin	PCM- Equivalent Fiber	TEM- only Fiber	Length Frequency	Width Frequency	Width(2) Frequency	Width(2) Frequency	Bin
0.9	Yes	Yes	0	3	178	5	0.09
1.9	Yes	Yes	16	84	99	15	0.19
2.9	Yes	Yes	74	85	15	16	0.29
3.9	Yes	Yes	64	57	4	48	0.39
4.9	Yes	Yes	50	24	3	28	0.49
5.9	Yes	Yes	29	23	0	0	0.59
6.9	Yes	Yes	23	6	1	25	0.69
7.9	Yes	Yes	10	2	0	23	0.79
8.9	Yes	Yes	7	5	0	18	0.89
9.9	Yes	Yes	6	2	0	39	0.99
10.9	Yes	Yes	7	4	0	5	1.09
11.9	Yes	Yes	3	1	0	0	1.19
12.9	Yes	Yes	2	3	0	23	1.29
13.9	Yes	Yes	2	0	0	0	1.39
14.9	Yes	Yes	1	0	0	13	1.49
15.9	Yes	Yes	0	0	0	10	1.59
16.9	Yes	Yes	1	0	0	0	1.69
17.9	Yes	Yes	1	0	0	2	1.79
18.9	Yes	Yes	0	0	0	7	1.89
19.9	Yes	Yes	0	0	0	0	1.99
20.9	Yes	Yes	0	0	0	2	2.09
More	Yes	Yes	4	1	0	4	2.19
	Yes	Yes				0	2.29
	Yes	Yes	300	300	300	1	2.39
	Yes	Yes				3	2.49
	Yes	Yes				0	2.59
	Yes	Yes				0	2.69
	Yes	Yes				5	2.79
	Yes	Yes				0	2.89
	Yes	Yes				0	2.99
	Yes	Yes				1	3.09
	Yes	Yes				0	3.19
	Yes	Yes				1	3.29













Grunerite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

Filter	Grid	Grid Opening	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
6	A6	E1	271	5.1	0.9	5.6
6	A6	E1	272	1.6	0.6	2.6
6	A6	E1	273	5.2	0.8	6.1
6	A6	E1	274	5.4	0.7	7.5
6	A6	E1	275	3.3	1.8	1.8
6	A6	E1	276	4.8	1.2	4.0
6	A6	D4	277	3.6	2.3	1.6
6	A6	D4	278	7.5	1.5	5.0
6	A6	D4	279	1.6	0.6	2.6
6	A6	D4	280	12.5	1.0	12.9
6	A6	D4	281	7.9	1.2	6.5
6	A6	D4	282	1.8	0.3	6.0
6	A6	D4	283	4.2	0.5	8.8
6	A6	D4	284	3.0	0.6	5.0
6	A6	D4	285	9.7	2.7	3.6
6	A6	D4	286	3.9	1.5	2.7
6	A6	D4	287	2.4	0.4	6.7
6	A6	D4	288	3.9	1.5	2.6
6	A6	D4	289	1.5	0.2	6.0
6	A6	D4	290	2.2	0.3	7.2
6	A6	D4	291	5.7	1.6	3.7
6	A6	D4	292	3.3	0.7	4.5
6	A6	D4	293	6.7	1.6	4.2
6	A6	D4	294	1.5	0.4	4.0
6	A6	E9	295	8.2	1.2	6.8
6	A6	E9	296	6.1	3.4	1.8
6	A6	E9	297	2.8	0.7	3.8
6	A6	E9	298	1.2	0.1	10.0
6	A6	E9	299	3.6	0.9	4.0
6	A6	E9	300	5.4	1.5	3.8

PCM Fiber	TEM Equ Fiber	Length only fiber	<5 or A.R. <3	Percent PCM-Equivalent Fibers	Percent TEM-only Fibers	Percent non-Fibers
Fiber PEF						
		Yes				
Fiber PEF						
Fiber PEF						
		Yes				
		Yes				
		Yes				
Fiber PEF						
		Yes				
Fiber PEF						
Fiber PEF						
		Yes				
		Yes				
		Yes				
		Yes				
		Yes				
		Yes				
Fiber PEF						
		Yes				
Fiber PEF						
		Yes				
Fiber PEF						
		Yes				
		Yes				
		Yes				
		Yes				
Fiber PEF						

**Table B1: Summary Statistics for Grunerite Particle Size Data: TEM PCME  
(10,000X Magnification)**

<i>Length (microns)</i>		<i>Width (microns)</i>		<i>Aspect Ratio</i>	
<b>Mean</b>	3.25	<b>Mean</b>	0.91	<b>Mean</b>	4.94
<b>Standard Error</b>	0.14	<b>Standard Error</b>	0.04	<b>Standard Error</b>	0.28
<b>Median</b>	2.66	<b>Median</b>	0.73	<b>Median</b>	3.83
<b>Mode</b>	2.42	<b>Mode</b>	0.36	<b>Mode</b>	4.00
<b>Standard Deviation</b>	2.36	<b>Standard Deviation</b>	0.78	<b>Standard Deviation</b>	4.88
<b>Sample Variance</b>	5.56	<b>Sample Variance</b>	0.61	<b>Sample Variance</b>	23.77
<b>Kurtosis</b>	13.36	<b>Kurtosis</b>	10.31	<b>Kurtosis</b>	47.19
<b>Skewness</b>	2.88	<b>Skewness</b>	2.61	<b>Skewness</b>	6.04
<b>Range</b>	20.69	<b>Range</b>	5.99	<b>Range</b>	48.87
<b>Minimum</b>	0.48	<b>Minimum</b>	0.06	<b>Minimum</b>	1.13
<b>Maximum</b>	21.18	<b>Maximum</b>	6.05	<b>Maximum</b>	50.00
<b>Sum</b>	975.18	<b>Sum</b>	272.07	<b>Sum</b>	1483.34
<b>Count</b>	300	<b>Count</b>	300	<b>Count</b>	300

**Table B2. Aspect Ratios for 300 Grunerite Particles:  
TEM PCME (10,000X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Aspect Ratio</i>
0.9	0	0.0%	0.0%	<= 0.9
1.9	16	5.3%	5.3%	.9 - 1.9
2.9	74	24.7%	30.0%	1.9 - 2.9
3.9	64	21.3%	51.3%	2.9 - 3.9
4.9	50	16.7%	68.0%	3.9 - 4.9
5.9	29	9.7%	77.7%	4.9 - 5.9
6.9	23	7.7%	85.3%	5.9 - 6.9
7.9	10	3.3%	88.7%	6.9 - 7.9
8.9	7	2.3%	91.0%	7.9 - 8.9
9.9	6	2.0%	93.0%	8.9 - 9.9
10.9	7	2.3%	95.3%	9.9 - 10.9
11.9	3	1.0%	96.3%	10.0 - 11.9
12.9	2	0.7%	97.0%	11.9 - 12.9
13.9	2	0.7%	97.7%	12.9 - 13.9
14.9	1	0.3%	98.0%	13.9 - 14.9
15.9	0	0.0%	98.0%	14.9 - 15.9
16.9	1	0.3%	98.3%	15.9 - 16.9
17.9	1	0.3%	98.7%	16.9 - 17.9
18.9	0	0.0%	98.7%	17.98 - 18.9
19.9	0	0.0%	98.7%	18.9 - 19.9
20.9	0	0.0%	98.7%	19.9 - 20.9
More	4	1.3%	100.0%	> 20.9

Sum 300

**Table B3. Lengths for 300 Grunerite Particles: TEM  
PCME (10,000X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Length (microns)</i>
0.9	3	1.0%	1.0%	<= 0.9
1.9	84	28.0%	29.0%	.9 - 1.9
2.9	85	28.3%	57.3%	1.9 - 2.9
3.9	57	19.0%	76.3%	2.9 - 3.9
4.9	24	8.0%	84.3%	3.9 - 4.9
5.9	23	7.7%	92.0%	4.9 - 5.9
6.9	6	2.0%	94.0%	5.9 - 6.9
7.9	2	0.7%	94.7%	6.9 - 7.9
8.9	5	1.7%	96.3%	7.9 - 8.9
9.9	2	0.7%	97.0%	8.9 - 9.9
10.9	4	1.3%	98.3%	9.9 - 10.9
11.9	1	0.3%	98.7%	10.0 - 11.9
12.9	3	1.0%	99.7%	11.9 - 12.9
13.9	0	0.0%	99.7%	12.9 - 13.9
14.9	0	0.0%	99.7%	13.9 - 14.9
15.9	0	0.0%	99.7%	14.9 - 15.9
16.9	0	0.0%	99.7%	15.9 - 16.9
17.9	0	0.0%	99.7%	16.9 - 17.9
18.9	0	0.0%	99.7%	17.9 - 18.9
19.9	0	0.0%	99.7%	18.9 - 19.9
20.9	0	0.0%	99.7%	19.9 - 20.9
More	1	0.3%	100.0%	> 20.9

Sum 300

**Table B4. Widths for 300 Grunerite Particles: TEM  
PCME (10,000X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>		
0.9	178	59.3%	59.3%	<= 0.9		<= 0.9
1.9	99	33.0%	92.3%	1 - 1.9	1	1.9
2.9	15	5.0%	97.3%	2 - 2.9	2	2.9
3.9	4	1.3%	98.7%	3 - 3.9	3	3.9
4.9	3	1.0%	99.7%	4 - 4.9	4	4.9
5.9	0	0.0%	99.7%	5 - 5.9	5	5.9
6.9	1	0.3%	100.0%	6 - 6.9	6	6.9
7.9	0	0.0%	100.0%	7 - 7.9	7	7.9
8.9	0	0.0%	100.0%	8 - 8.9	8	8.9
9.9	0	0.0%	100.0%	9 - 9.9	9	9.9
10.9	0	0.0%	100.0%	10 - 10.9	10	10.9
11.9	0	0.0%	100.0%	11 - 11.9	11	11.9
12.9	0	0.0%	100.0%	12 - 12.9	12	12.9
13.9	0	0.0%	100.0%	13 - 13.9	13	13.9
14.9	0	0.0%	100.0%	14 - 14.9	14	14.9
15.9	0	0.0%	100.0%	15 - 15.9	15	15.9
16.9	0	0.0%	100.0%	16 - 16.9	16	16.9
17.9	0	0.0%	100.0%	17 - 17.9	17	17.9
18.9	0	0.0%	100.0%	18 - 18.9	18	18.9
19.9	0	0.0%	100.0%	19 - 19.9	19	19.9
20.9	0	0.0%	100.0%	20 - 20.9	20	20.9
More	0	0.0%	100.0%	> 20.9		> 20.9
Sum	300					

**Table B5. Widths for 300 Grunerite Particles: TEM  
PCME (10,000X Magnification) Finer Detail**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>	<i>Start</i>	<i>End</i>
0.09	5	1.7%	1.7%	<= 0.09		< 0.09
0.19	15	5.0%	6.7%	0.1 - 0.19	0.1	0.19
0.29	16	5.3%	12.0%	0.2 - 0.29	0.2	0.29
0.39	48	16.0%	28.0%	0.3 - 0.39	0.3	0.39
0.49	28	9.3%	37.3%	0.4 - 0.49	0.4	0.49
0.59	0	0.0%	37.3%	0.5 - 0.59	0.5	0.59
0.69	25	8.3%	45.7%	0.6 - 0.69	0.6	0.69
0.79	23	7.7%	53.3%	0.7 - 0.79	0.7	0.79
0.89	18	6.0%	59.3%	0.8 - 0.89	0.8	0.89
0.99	39	13.0%	72.3%	0.9 - 0.99	0.9	0.99
1.09	5	1.7%	74.0%	1.0 - 1.09	1.0	1.09
1.19	0	0.0%	74.0%	1.1 - 1.19	1.1	1.19
1.29	23	7.7%	81.7%	1.2 - 1.29	1.2	1.29
1.39	0	0.0%	81.7%	1.3 - 1.39	1.3	1.39
1.49	13	4.3%	86.0%	1.4 - 1.49	1.4	1.49
1.59	10	3.3%	89.3%	1.5 - 1.59	1.5	1.59
1.69	0	0.0%	89.3%	1.6 - 1.69	1.6	1.69
1.79	2	0.7%	90.0%	1.7 - 1.79	1.7	1.79
1.89	7	2.3%	92.3%	1.8 - 1.89	1.8	1.89
1.99	0	0.0%	92.3%	1.9 - 1.99	1.9	1.99
2.09	2	0.7%	93.0%	2.0 - 2.09	2.0	2.09
2.19	4	1.3%	94.3%	2.1 - 2.19	2.1	2.19
2.29	0	0.0%	94.3%	2.2 - 2.29	2.2	2.29
2.39	1	0.3%	94.7%	2.3 - 2.39	2.3	2.39
2.49	3	1.0%	95.7%	2.4 - 2.49	2.4	2.49
2.59	0	0.0%	95.7%	2.5 - 2.59	2.5	2.59
2.69	0	0.0%	95.7%	2.6 - 2.69	2.6	2.69
2.79	5	1.7%	97.3%	2.7 - 2.79	2.7	2.79
2.89	0	0.0%	97.3%	2.8 - 2.89	2.8	2.89
2.99	0	0.0%	97.3%	2.9 - 2.99	2.9	2.99
3.09	1	0.3%	97.7%	3.0 - 3.09	3.0	3.09
3.19	0	0.0%	97.7%	3.1 - 3.19	3.1	3.19
3.29	1	0.3%	98.0%	3.2 - 3.29	3.2	3.29
3.39	2	0.7%	98.7%	3.3 - 3.39	3.3	3.39
3.49	0	0.0%	98.7%	3.4 - 3.49	3.4	3.49
3.59	0	0.0%	98.7%	3.5 - 3.59	3.5	3.59
3.69	0	0.0%	98.7%	3.6 - 3.69	3.6	3.69
3.79	0	0.0%	98.7%	3.7 - 3.79	3.7	3.79
3.89	0	0.0%	98.7%	3.8 - 3.89	3.8	3.89
3.99	1	0.3%	99.0%	3.9 - 3.99	3.9	3.99
4.09	0	0.0%	99.0%	4.0 - 4.09	4.0	4.09
4.19	0	0.0%	99.0%	4.1 - 4.19	4.1	4.19
4.29	0	0.0%	99.0%	4.2 - 4.29	4.2	4.29
4.39	0	0.0%	99.0%	4.3 - 4.39	4.3	4.39
4.49	0	0.0%	99.0%	4.4 - 4.49	4.4	4.49
4.59	1	0.3%	99.3%	4.5 - 4.59	4.5	4.59
4.69	0	0.0%	99.3%	4.6 - 4.69	4.6	4.69
4.79	0	0.0%	99.3%	4.7 - 4.79	4.7	4.79
4.89	1	0.3%	99.7%	4.8 - 4.89	4.8	4.89
More	1	0.3%	100.0%	> 4.89	More	

Sum 300



Particle Size Data for Grunerite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

Filter	Particle	Length (microns)	Width (microns)	Aspect Ratio			Meet Fiber Criteria	Percent Fibers	Percent non-fibers
1	27	4.0	1.0	4.0	17.9	17 - 17.9	Fiber		
1	28	5.0	1.5	3.3	18.9	18 - 18.9	Fiber		
1	29	9.0	3.0	3.0	19.9	19 - 19.9	Fiber		
1	30	9.0	2.0	4.5	20.9	20 - 20.9	Fiber		
1	31	6.0	1.5	4.0	More	> 20.9	Fiber		
1	32	7.0	1.5	4.7			Fiber		
1	33	5.0	1.5	3.3			Fiber		
1	34	6.0	1.0	6.0			Fiber		
1	35	5.0	1.5	3.3					
1	36	4.5	3.5	1.3					
1	37	6.0	3.0	2.0					
1	38	5.0	2.0	2.5			Fiber		
1	39	11.0	3.0	3.7			Fiber		
1	40	5.0	0.5	10.0			Fiber		
1	41	7.0	1.0	7.0			Fiber		
1	42	6.0	1.5	4.0			Fiber		
1	43	6.0	2.0	3.0			Fiber		
1	44	6.0	0.5	12.0			Fiber		
1	45	7.0	1.5	4.7					
1	46	4.0	1.0	4.0			Fiber		
1	47	9.0	2.5	3.6					
1	48	6.0	2.5	2.4			Fiber		
1	49	12.0	2.0	6.0			Fiber		
1	50	5.0	1.5	3.3					
4	51	3.0	1.0	3.0			Fiber		
4	52	5.0	1.0	5.0			Fiber		
4	53	10.0	3.0	3.3					
4	54	4.0	1.0	4.0					
4	55	4.5	1.0	4.5					
4	56	6.0	2.5	2.4			Fiber		
4	57	15.0	4.0	3.8			Fiber		
4	58	7.0	1.5	4.7					
4	59	4.5	1.5	3.0			Fiber		
4	60	6.0	1.5	4.0					



Particle Size Data for Grunerite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

Filter	Particle	Length (microns)	Width (microns)	Aspect Ratio	Meet Fiber Criteria	Percent Fibers	Percent non-fibers
4	61	10.0	4.0	2.5	Fiber		
4	62	8.0	1.5	5.3	Fiber		
4	63	7.0	1.5	4.7	Fiber		
4	64	14.0	2.0	7.0	Fiber		
4	65	8.0	1.5	5.3	Fiber		
4	66	12.0	3.5	3.4			
4	67	7.0	2.5	2.8	Fiber		
4	68	7.0	2.0	3.5			
4	69	4.5	1.5	3.0	Fiber		
4	70	5.0	1.0	5.0	Fiber		
4	71	8.0	1.5	5.3			
4	72	10.0	5.0	2.0	Fiber		
4	73	5.0	1.0	5.0			
4	74	7.0	3.0	2.3	Fiber		
4	75	13.0	3.0	4.3	Fiber		
4	76	6.5	2.0	3.3	Fiber		
4	77	5.0	1.0	5.0	Fiber		
4	78	6.0	1.5	4.0			
4	79	7.0	3.0	2.3			
4	80	6.0	2.5	2.4			
4	81	9.0	3.5	2.6	Fiber		
4	82	7.5	2.0	3.8	Fiber		
4	83	5.0	1.5	3.3	Fiber		
4	84	6.0	1.0	6.0	Fiber		
4	85	8.0	2.5	3.2	Fiber		
4	86	6.0	2.0	3.0	Fiber		
4	87	7.5	1.5	5.0	Fiber		
4	88	5.0	1.5	3.3	Fiber		
4	89	5.0	0.5	10.0	Fiber		
4	90	11.5	1.5	7.7	Fiber		
4	91	7.5	1.5	5.0	Fiber		
4	92	11.0	2.0	5.5	Fiber		
4	93	5.0	1.0	5.0	Fiber		
4	94	5.0	1.5	3.3	Fiber		

Particle Size Data for Grunerite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

Filter	Particle	Length (microns)	Width (microns)	Aspect Ratio
4	95	12.0	4.0	3.0
4	96	12.0	5.0	2.4
4	97	16.0	4.0	4.0
4	98	5.0	1.5	3.3
4	99	5.0	1.5	3.3
4	100	4.5	1.0	4.5

Meet Fiber Criteria	Percent Fibers	Percent non- fibers
Fiber		
Fiber		
Fiber		

**Table C1. Summary Statistics: Particle Size Data for Grunerite Particles:  
Dimensions Measured by PCM using Walton-Beckett Graticule (400X  
Magnification)**

<i>Length (microns)</i>		<i>Width (microns)</i>		<i>Aspect Ratio</i>	
<b>Mean</b>	7.64	<b>Mean</b>	2.11	<b>Mean</b>	4.09
<b>Standard Error</b>	0.39	<b>Standard Error</b>	0.12	<b>Standard Error</b>	0.17
<b>Median</b>	6.25	<b>Median</b>	1.50	<b>Median</b>	3.75
<b>Mode</b>	5.00	<b>Mode</b>	1.50	<b>Mode</b>	4.00
<b>Standard Deviation</b>	3.92	<b>Standard Deviation</b>	1.16	<b>Standard Deviation</b>	1.72
<b>Sample Variance</b>	15.38	<b>Sample Variance</b>	1.34	<b>Sample Variance</b>	2.97
<b>Kurtosis</b>	11.63	<b>Kurtosis</b>	1.71	<b>Kurtosis</b>	5.55
<b>Skewness</b>	2.84	<b>Skewness</b>	1.33	<b>Skewness</b>	1.86
<b>Range</b>	27.00	<b>Range</b>	5.50	<b>Range</b>	10.75
<b>Minimum</b>	3.00	<b>Minimum</b>	0.50	<b>Minimum</b>	1.25
<b>Maximum</b>	30.00	<b>Maximum</b>	6.00	<b>Maximum</b>	12.00
<b>Sum</b>	764.00	<b>Sum</b>	210.50	<b>Sum</b>	409.47
<b>Count</b>	100	<b>Count</b>	100	<b>Count</b>	100

**Table C2. Aspect Ratios for Grunerite Particles:  
Dimensions Measured by PCM using Walton-Beckett  
Graticule (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Aspect Ratio</i>
0.9	0	0.0%	0.0%	<= 1
1.9	2	2.0%	2.0%	1 - 1.9
2.9	17	17.0%	19.0%	2 - 2.9
3.9	32	32.0%	51.0%	3 - 3.9
4.9	23	23.0%	74.0%	4 - 4.9
5.9	13	13.0%	87.0%	5 - 5.9
6.9	7	7.0%	94.0%	6 - 6.9
7.9	3	3.0%	97.0%	7 - 7.9
8.9	0	0.0%	97.0%	8 - 8.9
9.9	0	0.0%	97.0%	9 - 9.9
10.9	2	2.0%	99.0%	10 - 10.9
11.9	0	0.0%	99.0%	11 - 11.9
12.9	1	1.0%	100.0%	12 - 12.9
13.9	0	0.0%	100.0%	13 - 13.9
14.9	0	0.0%	100.0%	14 - 14.9
15.9	0	0.0%	100.0%	15 - 15.9
16.9	0	0.0%	100.0%	16 - 16.9
17.9	0	0.0%	100.0%	17 - 17.9
18.9	0	0.0%	100.0%	18 - 18.9
19.9	0	0.0%	100.0%	19 - 19.9
20.9	0	0.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9

Sum 100

**Table C3. Lengths for Grunerite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Length (microns)</i>
0.9	0	0.0%	0.0%	<= 1
1.9	0	0.0%	0.0%	1 - 1.9
2.9	0	0.0%	0.0%	2 - 2.9
3.9	1	1.0%	1.0%	3 - 3.9
4.9	10	10.0%	11.0%	4 - 4.9
5.9	20	20.0%	31.0%	5 - 5.9
6.9	20	20.0%	51.0%	6 - 6.9
7.9	13	13.0%	64.0%	7 - 7.9
8.9	9	9.0%	73.0%	8 - 8.9
9.9	7	7.0%	80.0%	9 - 9.9
10.9	6	6.0%	86.0%	10 - 10.9
11.9	3	3.0%	89.0%	11 - 11.9
12.9	4	4.0%	93.0%	12 - 12.9
13.9	1	1.0%	94.0%	13 - 13.9
14.9	1	1.0%	95.0%	14 - 14.9
15.9	1	1.0%	96.0%	15 - 15.9
16.9	1	1.0%	97.0%	16 - 16.9
17.9	0	0.0%	97.0%	17 - 17.9
18.9	0	0.0%	97.0%	18 - 18.9
19.9	1	1.0%	98.0%	19 - 19.9
20.9	0	0.0%	98.0%	20 - 20.9
More	2	2.0%	100.0%	> 20.9

Sum 100

**Table C4. Widths for Grunerite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>
0.9	3	3.0%	3.0%	<= 1
1.9	49	49.0%	52.0%	1 - 1.9
2.9	22	22.0%	74.0%	2 - 2.9
3.9	16	16.0%	90.0%	3 - 3.9
4.9	5	5.0%	95.0%	4 - 4.9
5.9	3	3.0%	98.0%	5 - 5.9
6.9	2	2.0%	100.0%	6 - 6.9
7.9	0	0.0%	100.0%	7 - 7.9
8.9	0	0.0%	100.0%	8 - 8.9
9.9	0	0.0%	100.0%	9 - 9.9
10.9	0	0.0%	100.0%	10 - 10.9
11.9	0	0.0%	100.0%	11 - 11.9
12.9	0	0.0%	100.0%	12 - 12.9
13.9	0	0.0%	100.0%	13 - 13.9
14.9	0	0.0%	100.0%	14 - 14.9
15.9	0	0.0%	100.0%	15 - 15.9
16.9	0	0.0%	100.0%	16 - 16.9
17.9	0	0.0%	100.0%	17 - 17.9
18.9	0	0.0%	100.0%	18 - 18.9
19.9	0	0.0%	100.0%	19 - 19.9
20.9	0	0.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9

Sum 100

Figure 1. Frequency Distribution of Aspect Ratios for 300 Grunerite Particles:  
 Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

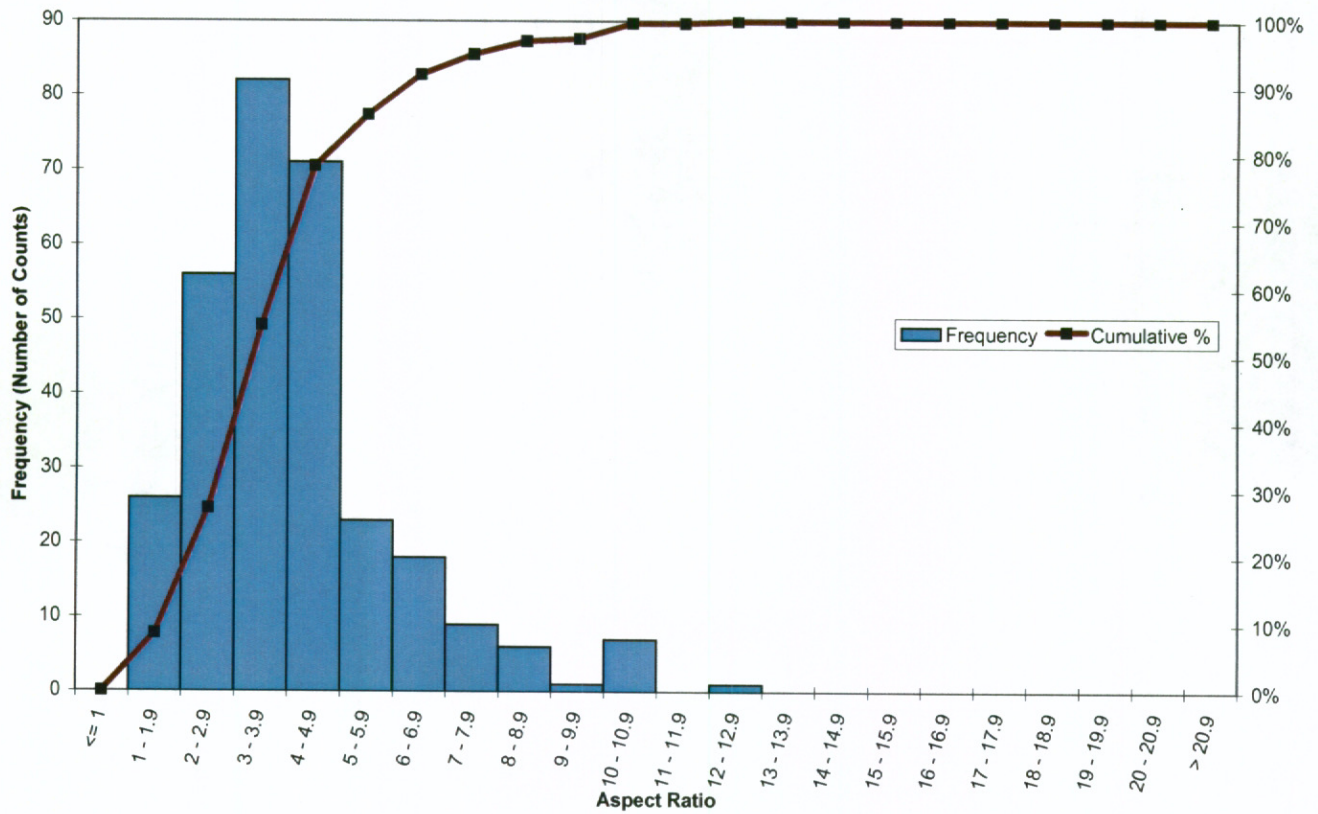


Figure 2. Frequency Distribution of Lengths for 300 Grunerite Particles:  
 Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

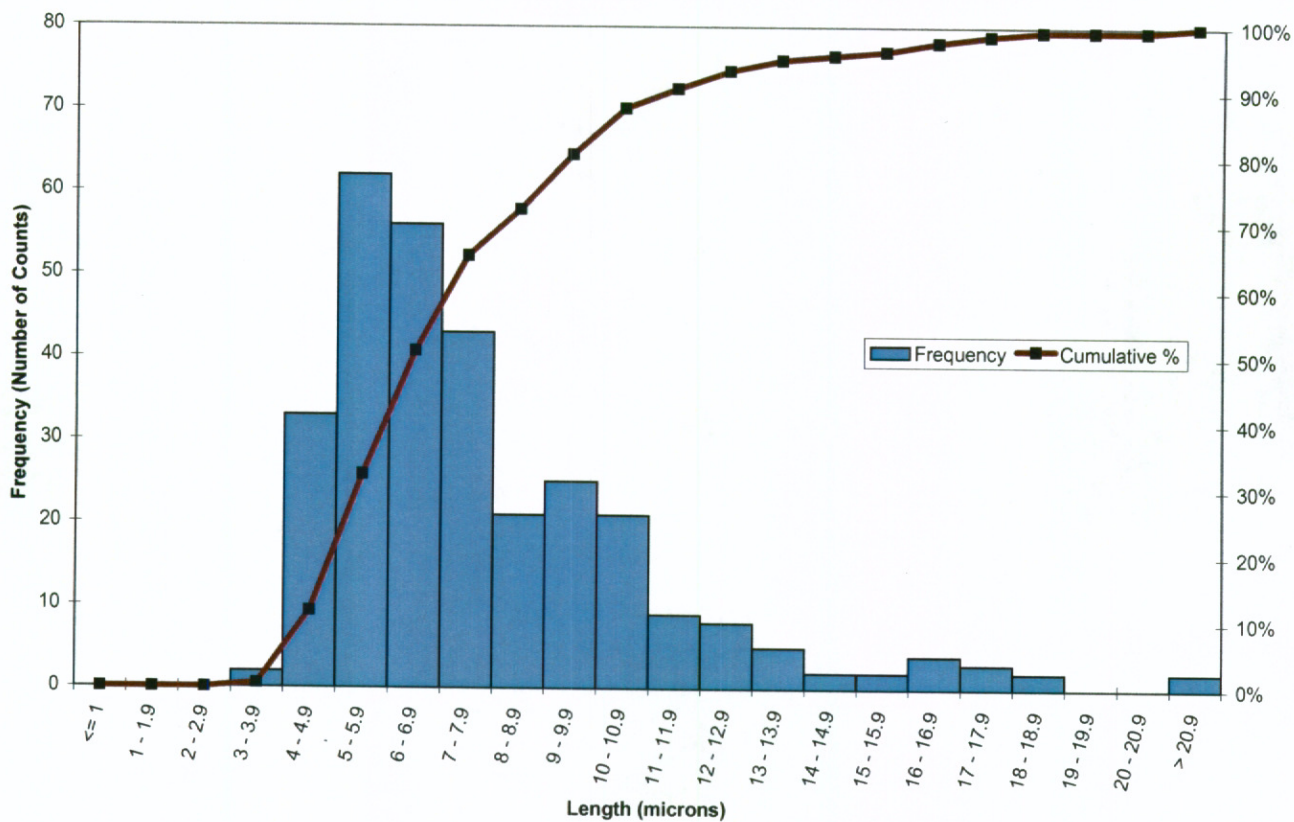




Figure 3. Frequency Distribution of Widths for 300 Grunerite Particles:  
 Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

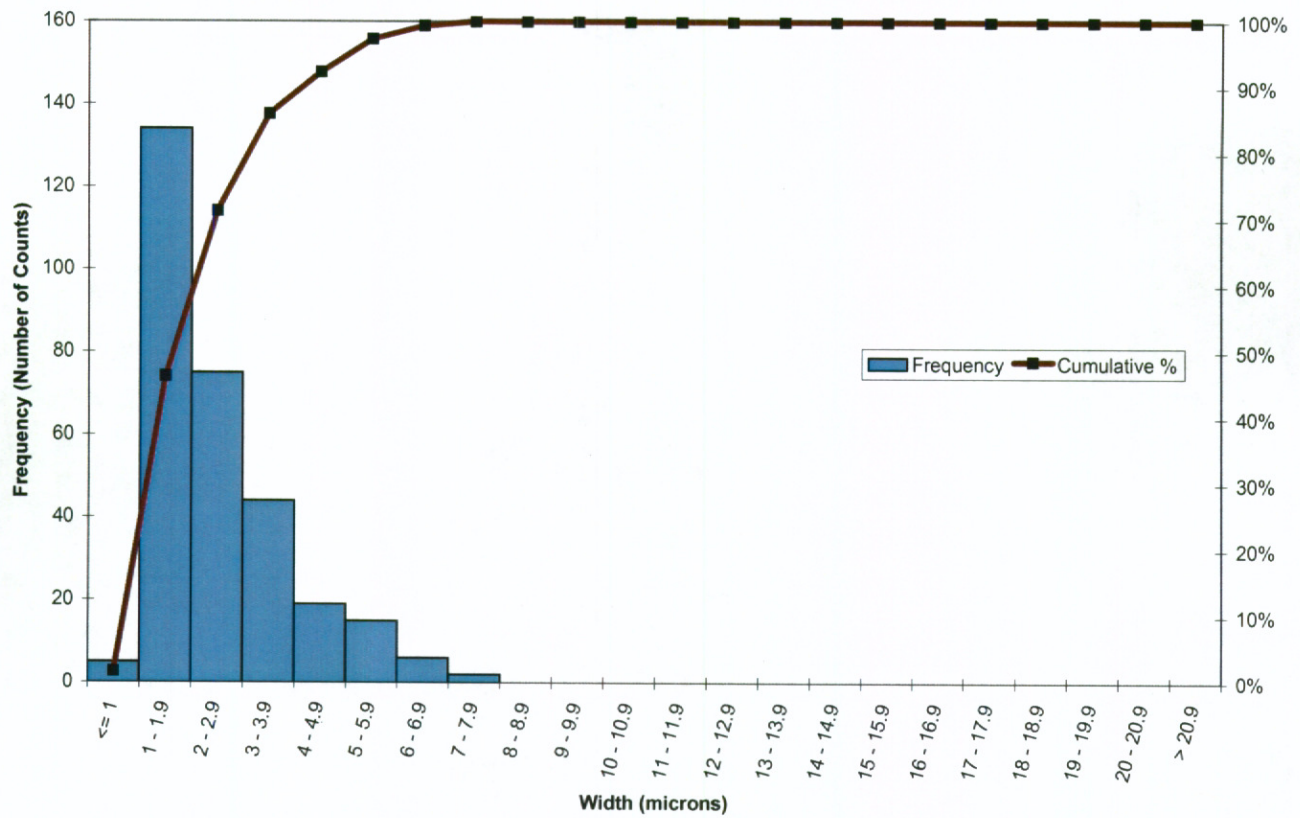


Figure 4. Frequency Distribution of Aspect Ratios for 300 Grunerite Particles:  
Dimensions Measured by TEM PCME (10,000X Magnification)

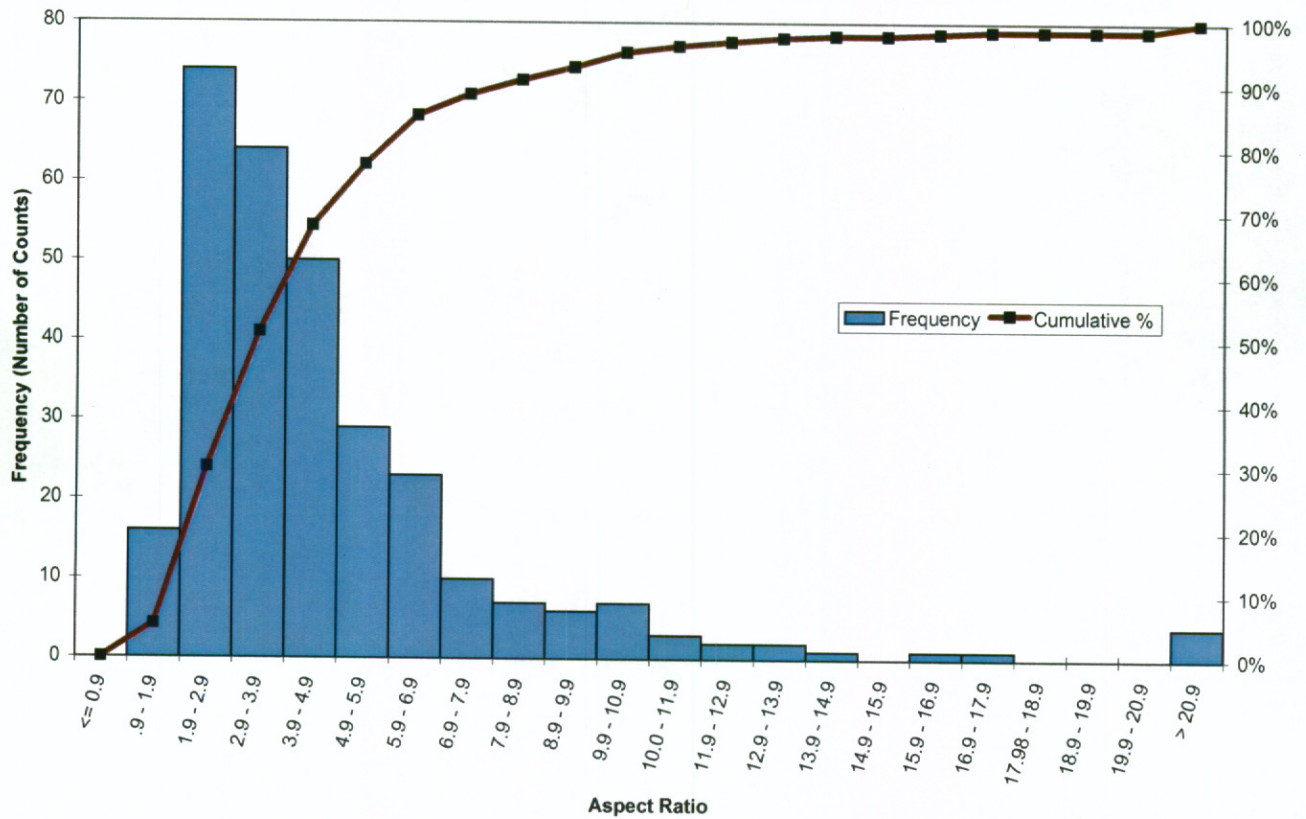


Figure 5. Frequency Distribution of Lengths for 300 Grunerite Particles:  
Dimensions Measured by TEM PCME (10,000X Magnification)

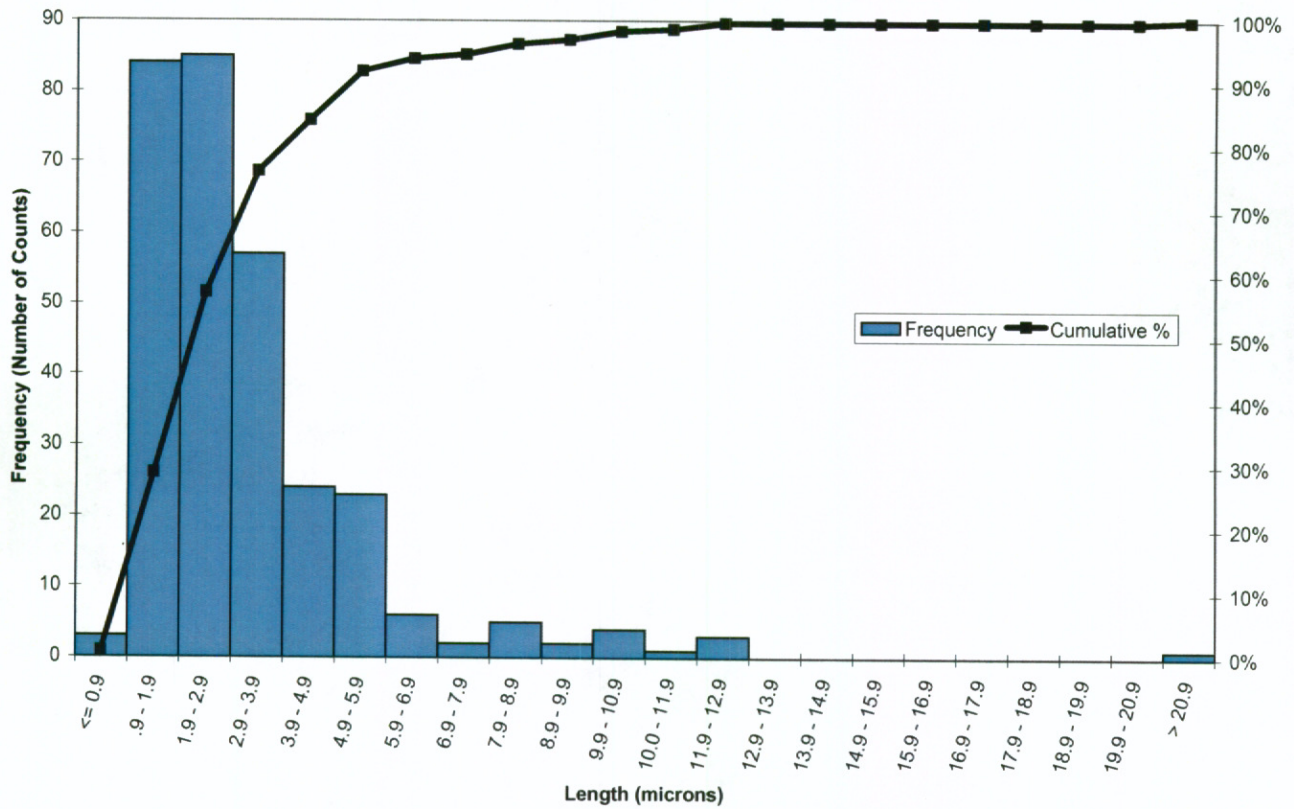


Figure 6. Frequency Distribution of Widths for 300 Grunerite Particles:  
Dimensions Measured by TEM PCME (10,000X Magnification)

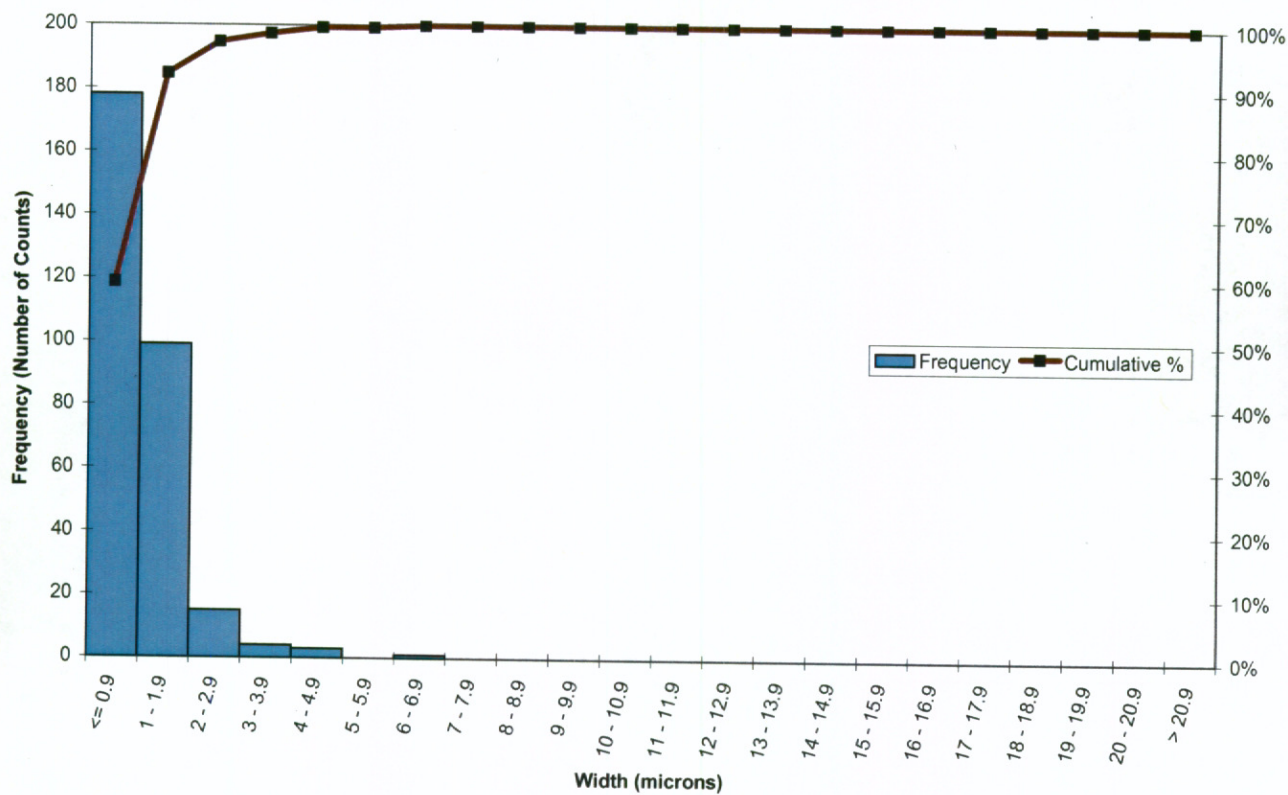


Figure 7. Frequency Distribution of Widths for 300 Grunerite Particles:  
 Dimensions Measured by TEM PCME (10,000X Magnification) Finer Detail

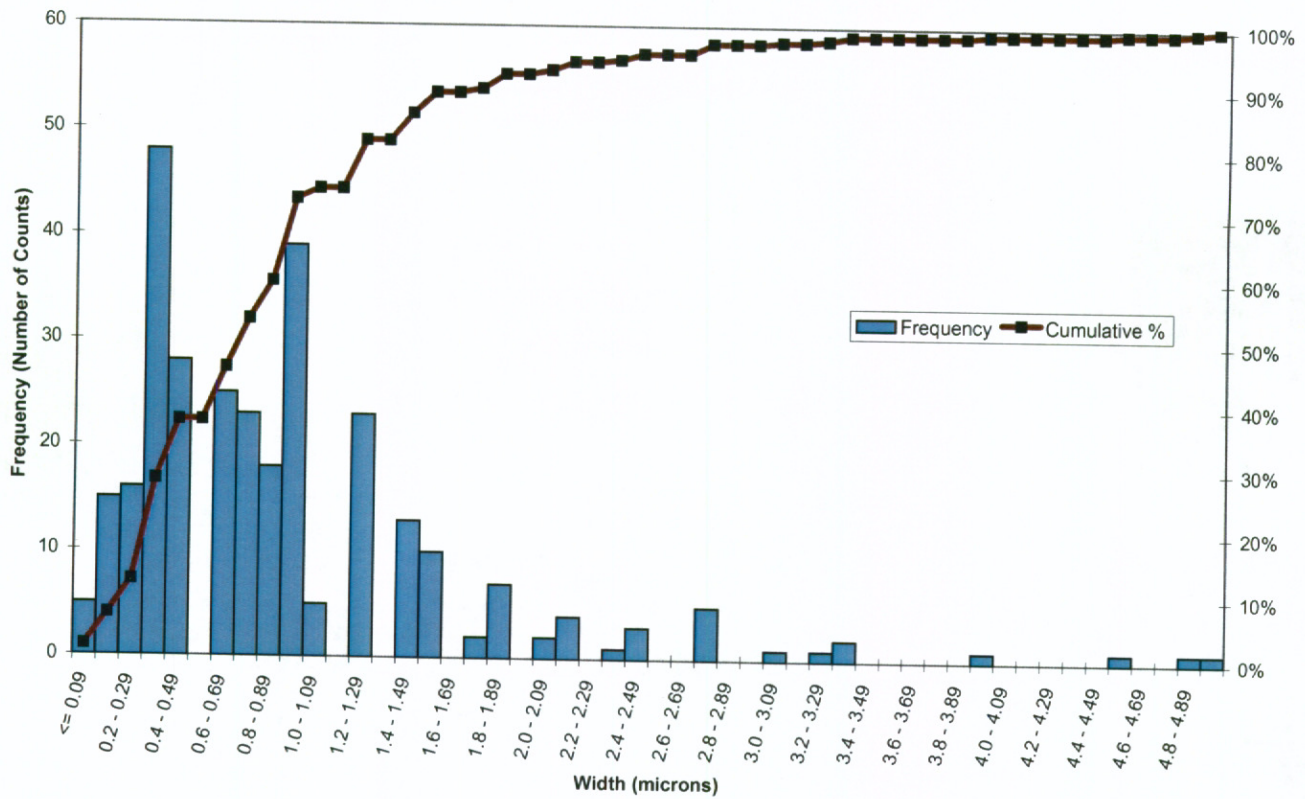


Figure 8. Frequency Distribution of Aspect Ratios for Grunerite Particles:  
Comparison of TEM and PCM Data

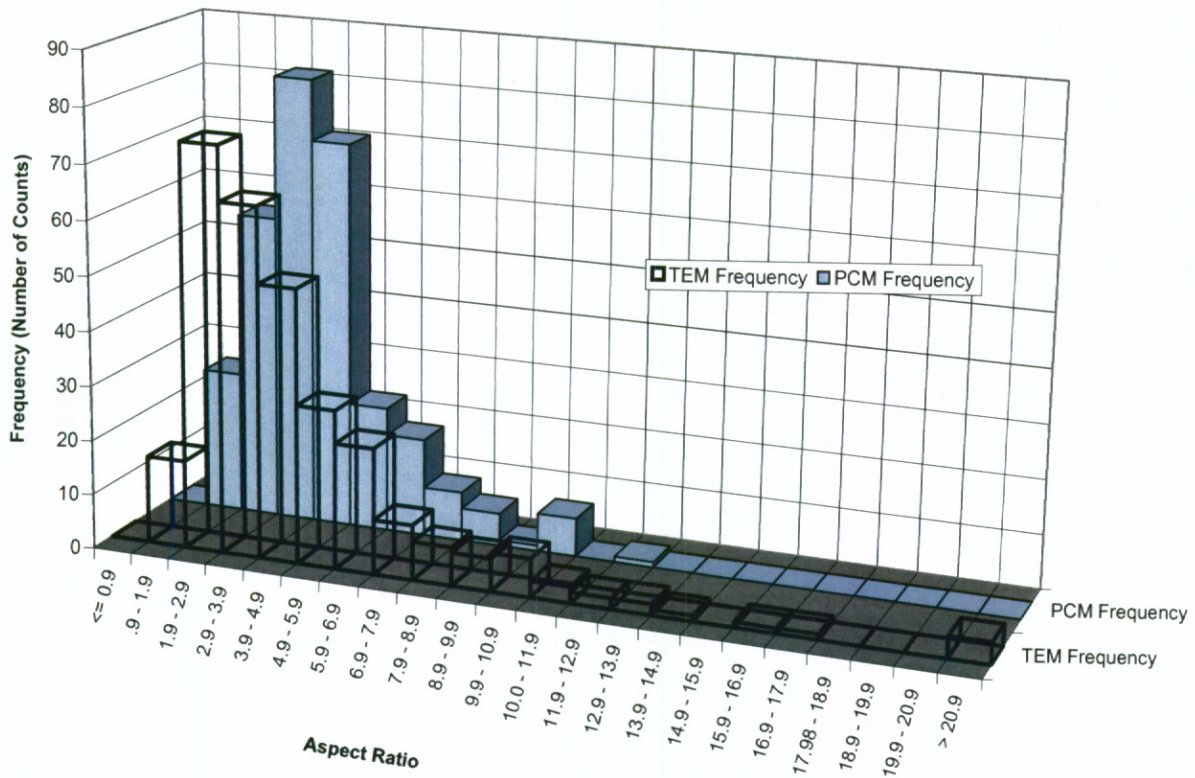


Figure 9. Frequency Distribution of Lengths for Grunerite Particles:  
Comparison of TEM and PCM Data

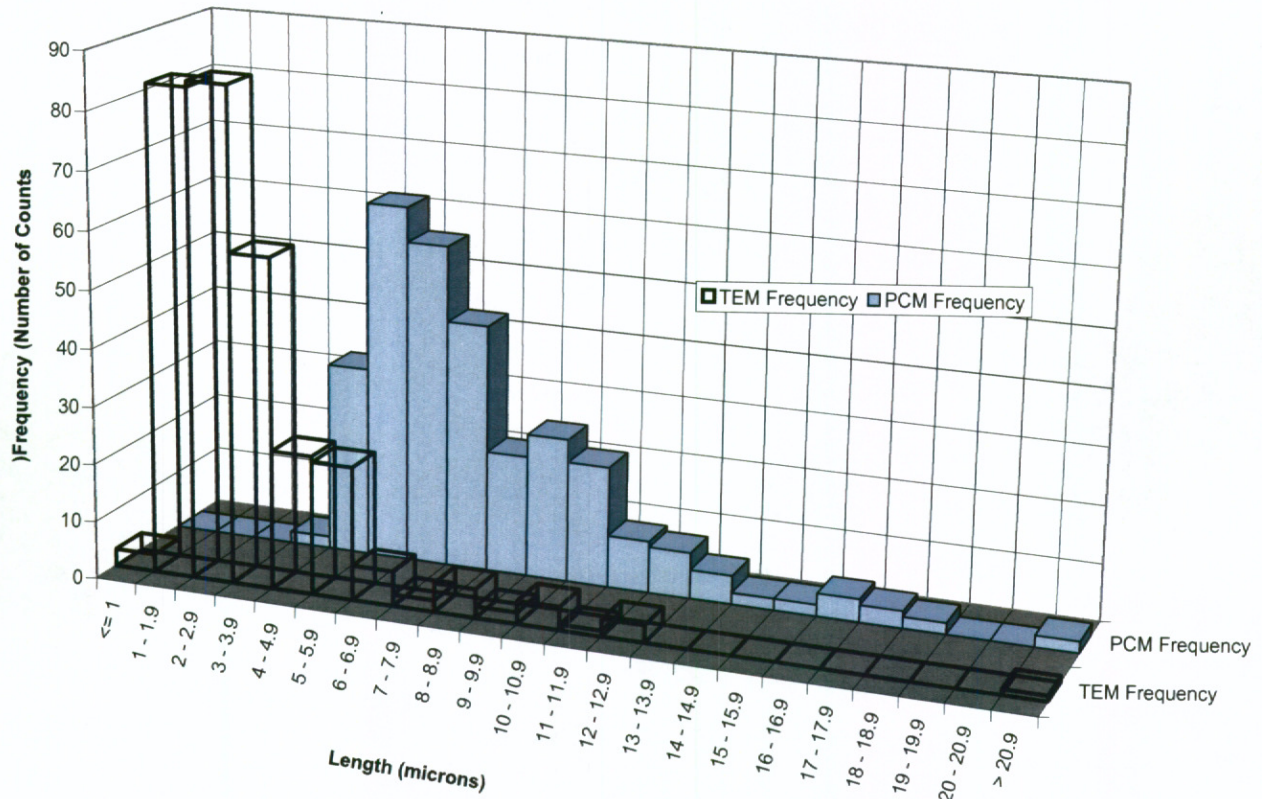


Figure 10. Frequency Distribution of Widths for Grunerite Particles:  
Comparison of TEM and PCM Data

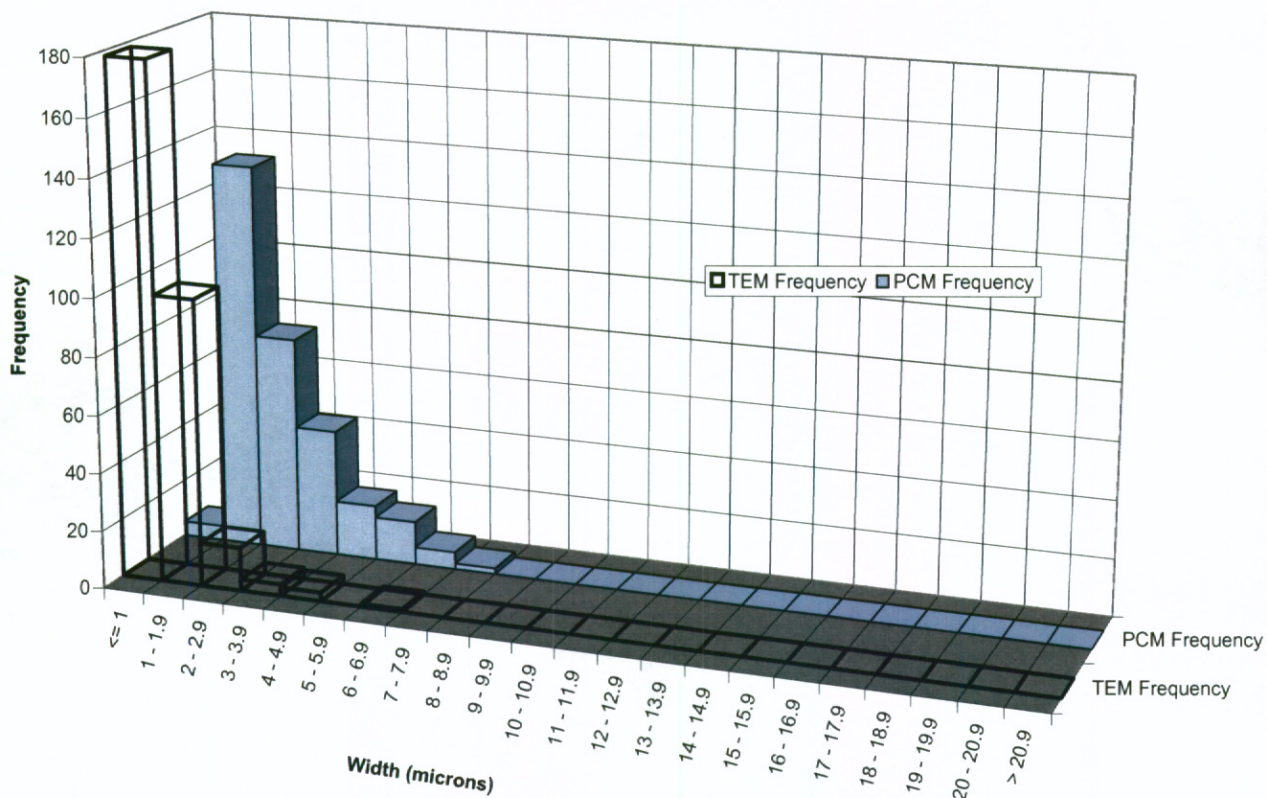




Figure 11. Frequency Distribution of Aspect Ratios for Grunerite Particles:  
Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

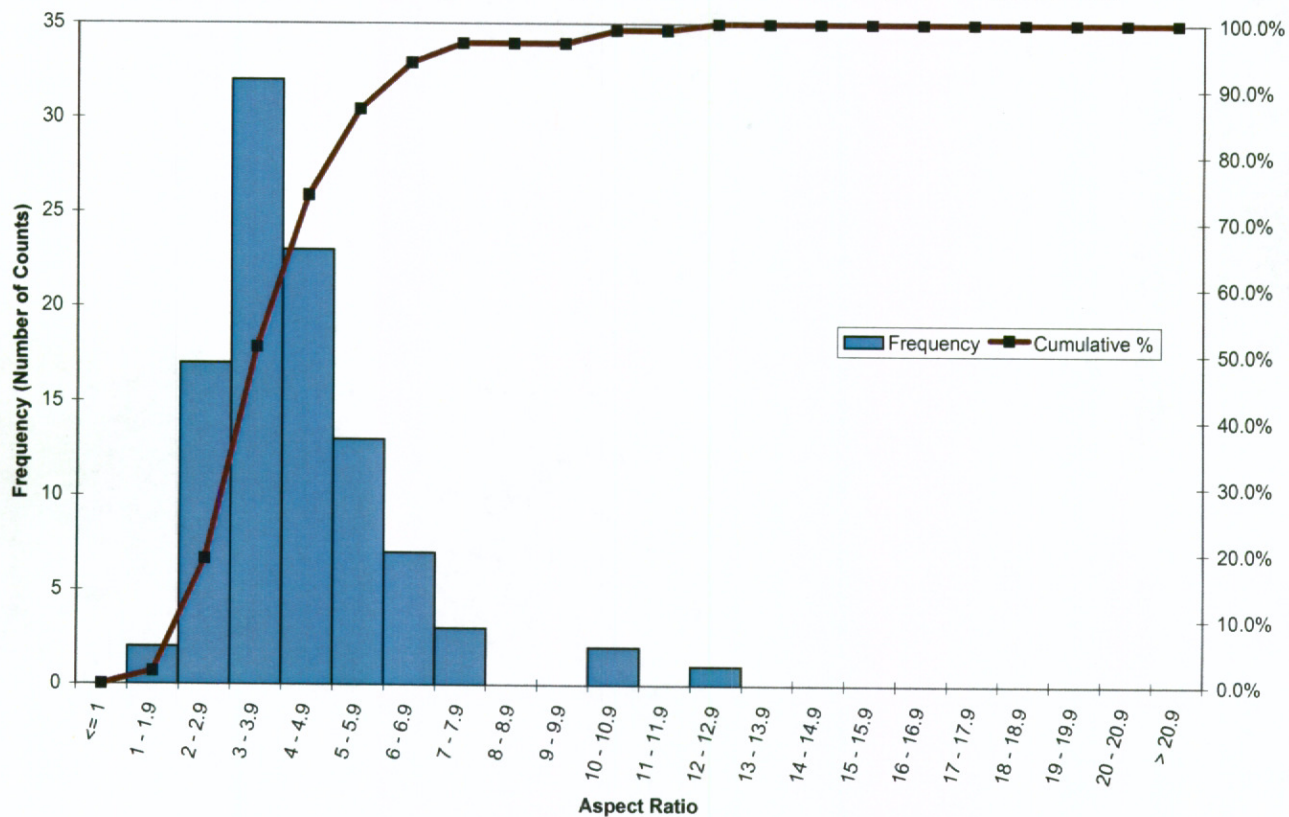


Figure 12. Frequency Distribution of Lengths for Grunerite Particles:  
Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

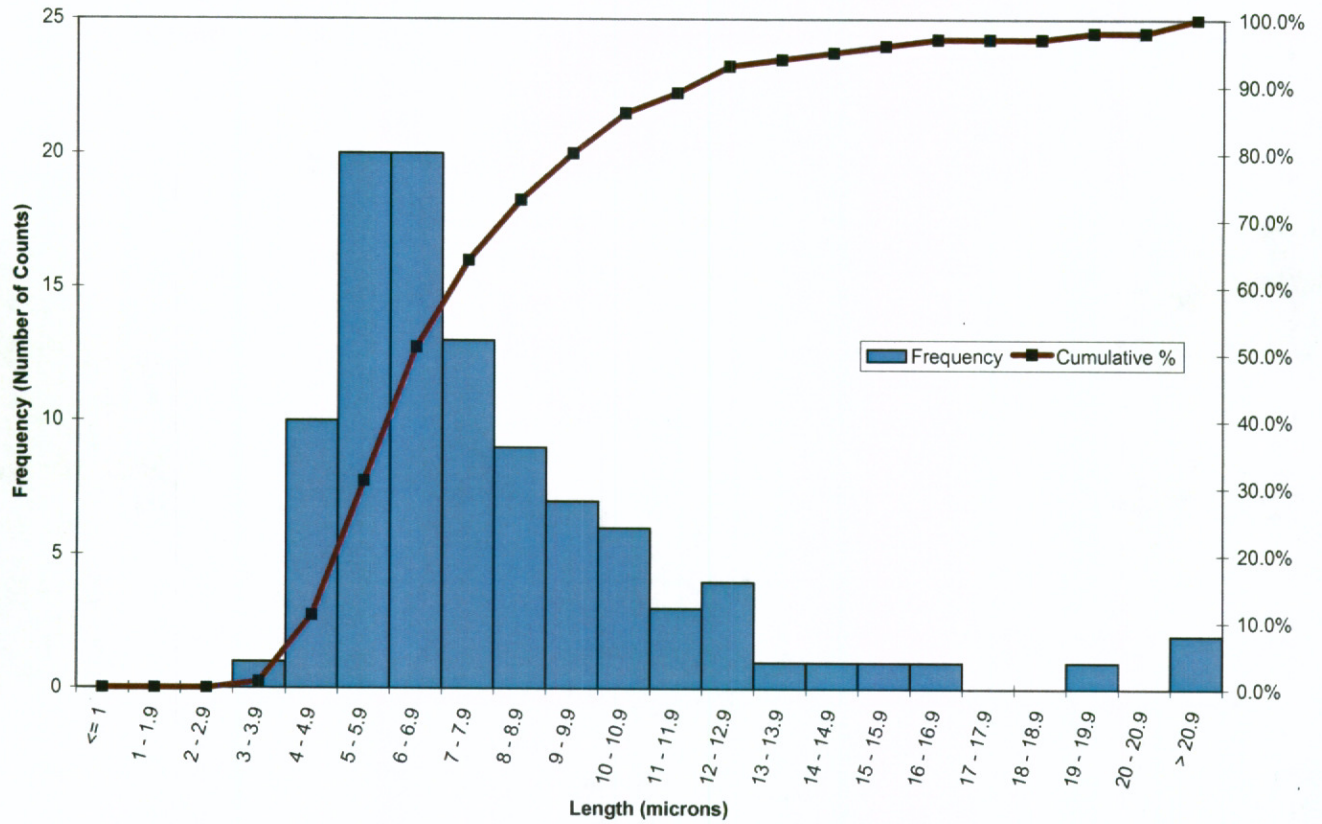


Figure 13. Frequency Distribution of Widths for Grunerite Particles:  
 Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

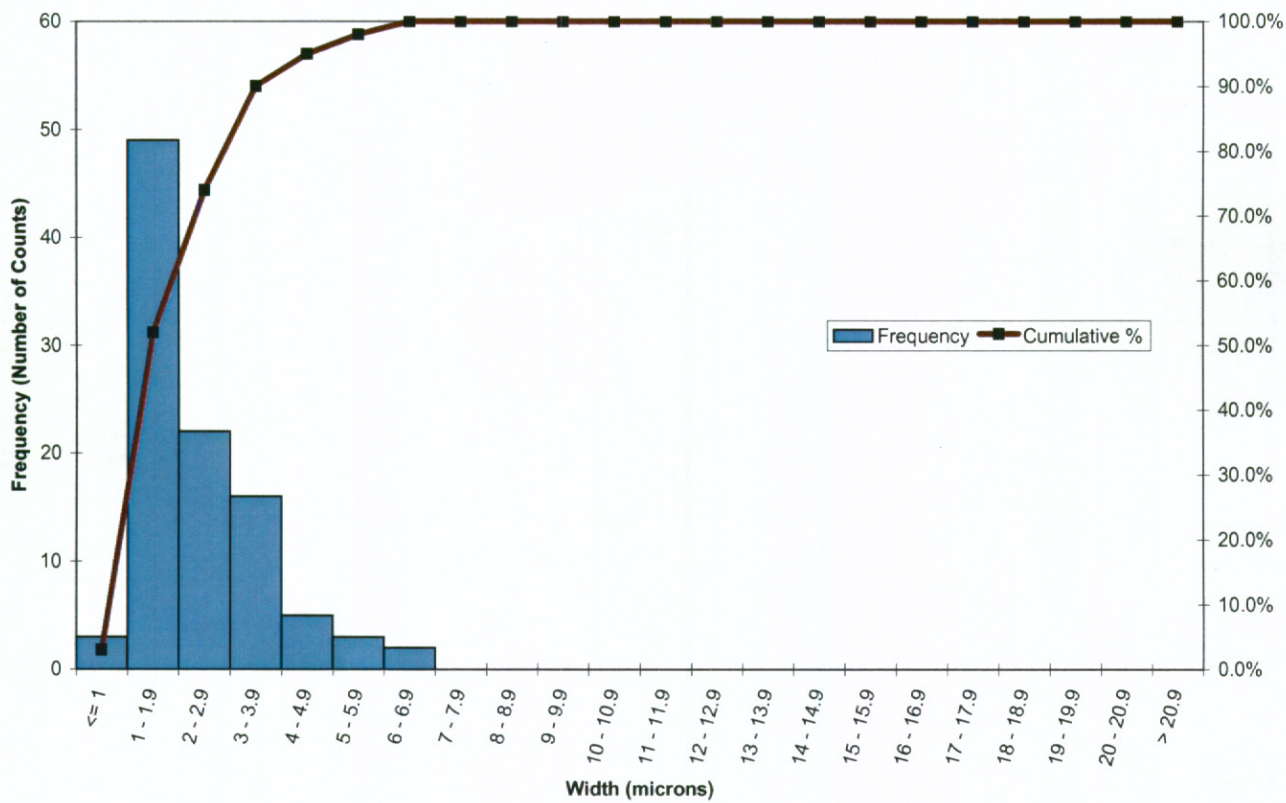
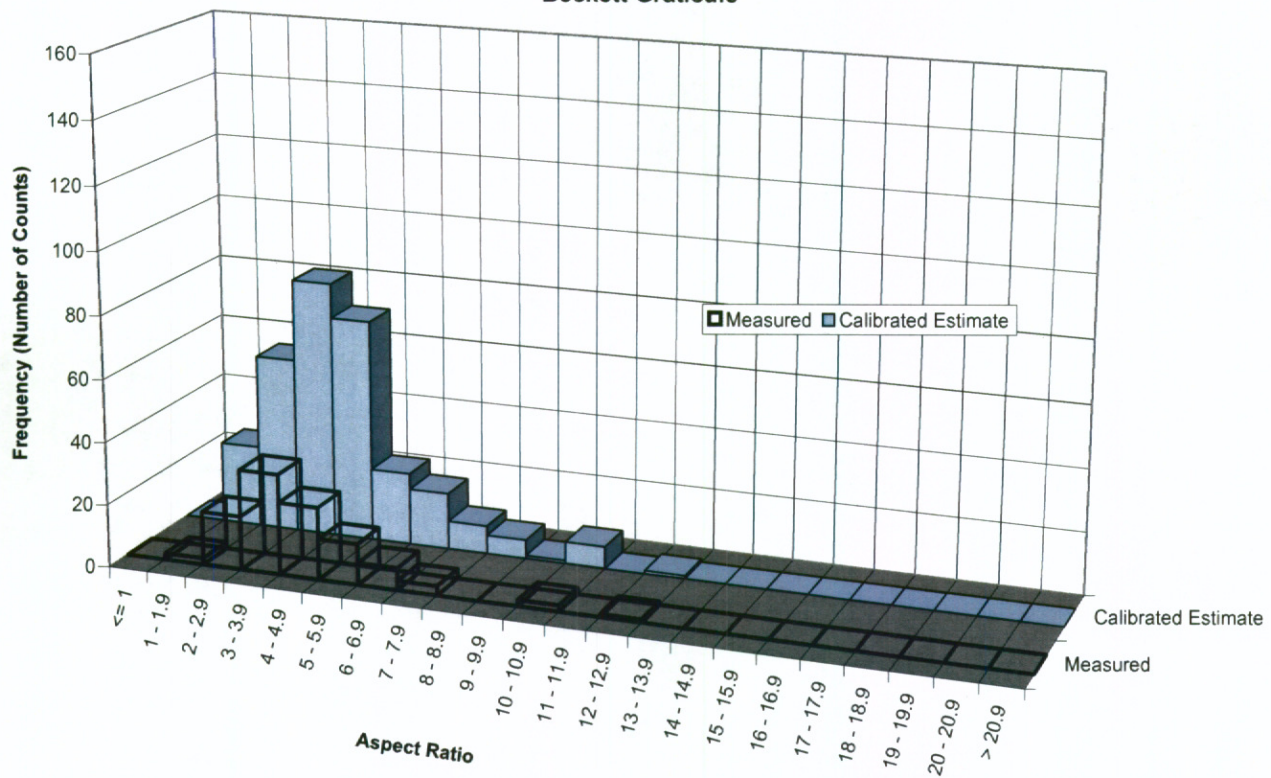


Figure 14. Frequency Distribution of Aspect Ratios for Grunerite Particles:  
Comparison of Dimensions from PCM Measured by Calibrated Visual Estimation and Walton-  
Beckett Graticule



**Figure 15. Frequency Distribution of Lengths for Grunerite Particles:  
Comparison of Dimensions from PCM Measured by Calibrated Visual Estimation and Walton-Beckett Graticule**

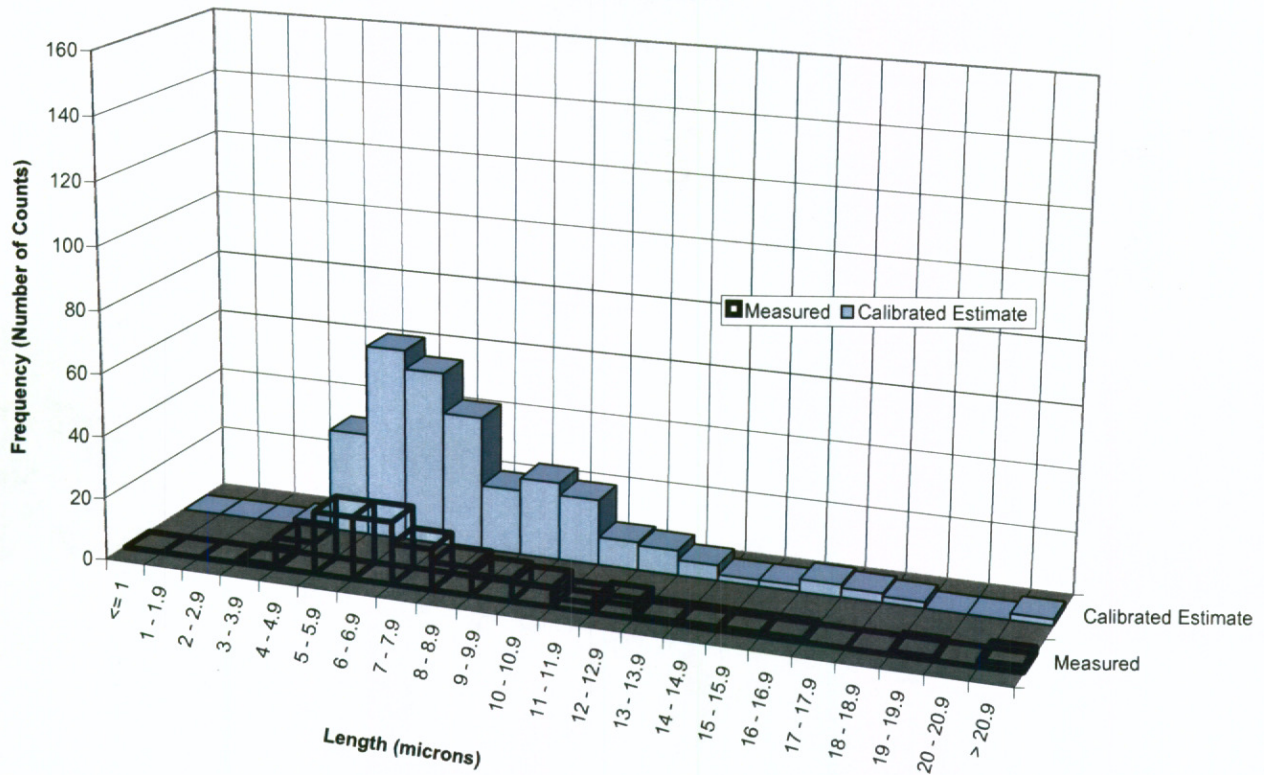
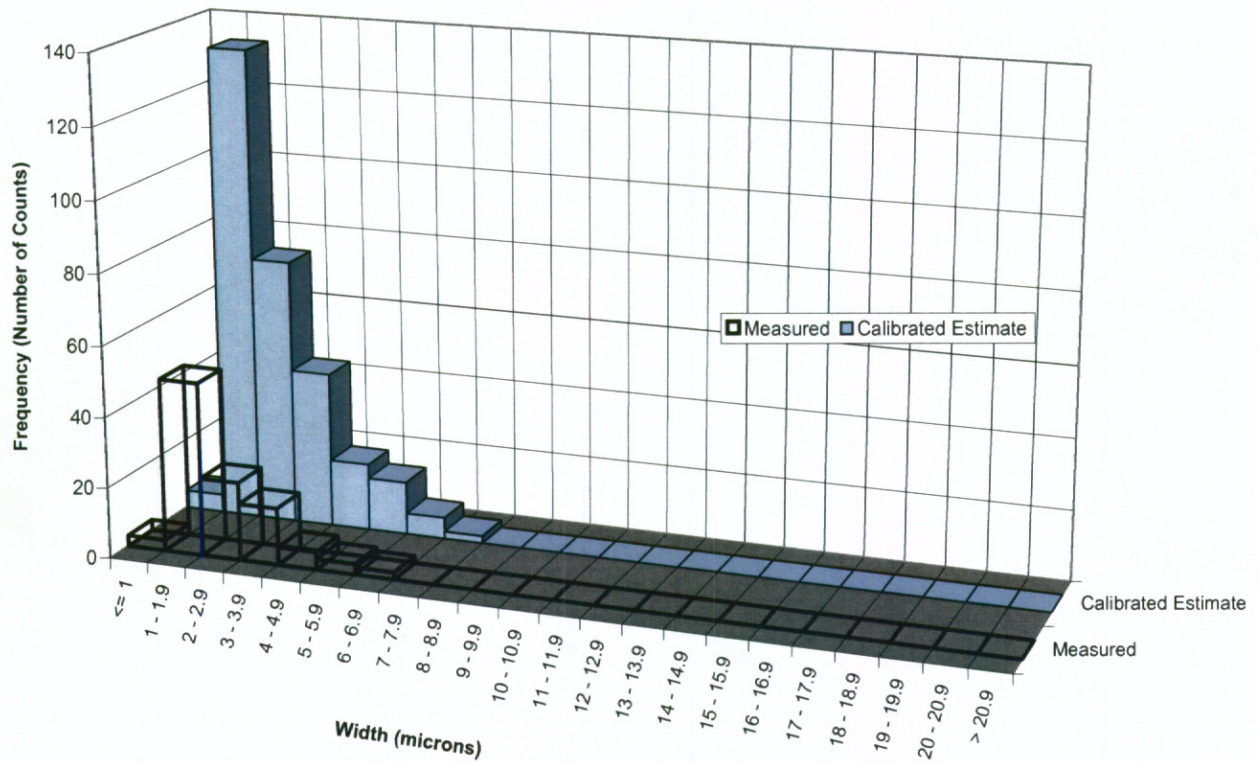


Figure 16. Frequency Distribution of Widths for Grunerite Particles:  
Comparison of Dimensions from PCM Measured by Calibrated Visual Estimation and Walton-Beckett Graticule



## **Analytical Data Summaries**

### **3E. Anthophyllite**

Anthophyllite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

**Table A: Anthophyllite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

Note: data in red does not meet criteria for counting; i.e.  $\geq 5 \mu\text{m}$  in length or  $\geq 3:1$  aspect ratio.

Count of fibers 274  
Count of non-fibers 26  
Total Structures Counted 300

Percent Fibers 91.3%  
Percent non-fibers 8.7%

Meet Fiber Criteria

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	1	8.0	1.0	8.0
numbers	2	5.0	1.0	5.0
1-50	3	6.0	1.5	4.0
BWH	4	11.0	3.0	3.7
on	5	7.0	1.0	7.0
filter 1	6	7.0	1.0	7.0
	7	15.0	3.0	5.0
	8	30.0	2.0	15.0
	9	15.0	4.0	3.8
	10	5.0	1.0	5.0
	11	5.0	1.0	5.0
	12	5.0	2.0	2.5
	13	15.0	1.0	15.0
	14	18.0	5.0	3.6
	15	9.0	1.5	6.0
	16	10.0	1.0	10.0
	17	17.0	3.0	5.7
	18	21.0	2.0	10.5
	19	11.0	1.0	11.0
	20	4.0	1.0	4.0
	21	6.0	1.5	4.0
	22	7.0	1.0	7.0
	23	9.0	5.0	1.8
	24	5.0	1.5	3.3
	25	7.0	1.5	4.7

Bin	Bin Range	Meet Fiber Criteria
	<= 1	Fiber
0.9		Fiber
1.9	1 - 1.9	Fiber
2.9	2 - 2.9	Fiber
3.9	3 - 3.9	Fiber
4.9	4 - 4.9	Fiber
5.9	5 - 5.9	Fiber
6.9	6 - 6.9	Fiber
7.9	7 - 7.9	Fiber
8.9	8 - 8.9	Fiber
9.9	9 - 9.9	
10.9	10 - 10.9	Fiber
11.9	11 - 11.9	Fiber
12.9	12 - 12.9	Fiber
13.9	13 - 13.9	Fiber
14.9	14 - 14.9	Fiber
15.9	15 - 15.9	Fiber
16.9	16 - 16.9	Fiber
17.9	17 - 17.9	
18.9	18 - 18.9	Fiber
19.9	19 - 19.9	Fiber
20.9	20 - 20.9	
More	> 20.9	Fiber
		Fiber





















Anthophyllite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	298	12.0	1.5	8.0
	299	10.0	1.0	10.0
	300	15.0	3.0	5.0

**Meet  
Fiber  
Criteria**    91.3%    8.7%  
 Fiber  
 Fiber  
 Fiber

**Table A1: Summary Statistics for Anthophyllite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

<i>Length (microns)</i>		<i>Width (microns)</i>		<i>Aspect Ratio</i>	
<b>Mean</b>	10.03	<b>Mean</b>	1.74	<b>Mean</b>	7.42
<b>Standard Error</b>	0.33	<b>Standard Error</b>	0.07	<b>Standard Error</b>	0.32
<b>Median</b>	8.00	<b>Median</b>	1.50	<b>Median</b>	5.83
<b>Mode</b>	7.00	<b>Mode</b>	1.00	<b>Mode</b>	5.00
<b>Standard Deviation</b>	5.68	<b>Standard Deviation</b>	1.20	<b>Standard Deviation</b>	5.51
<b>Sample Variance</b>	32.31	<b>Sample Variance</b>	1.44	<b>Sample Variance</b>	30.32
<b>Kurtosis</b>	10.93	<b>Kurtosis</b>	9.26	<b>Kurtosis</b>	14.68
<b>Skewness</b>	2.62	<b>Skewness</b>	2.36	<b>Skewness</b>	3.06
<b>Range</b>	44.00	<b>Range</b>	9.50	<b>Range</b>	48.60
<b>Minimum</b>	4.00	<b>Minimum</b>	0.50	<b>Minimum</b>	1.40
<b>Maximum</b>	48.00	<b>Maximum</b>	10.00	<b>Maximum</b>	50.00
<b>Sum</b>	3010.00	<b>Sum</b>	521.50	<b>Sum</b>	2226.22
<b>Count</b>	300	<b>Count</b>	300	<b>Count</b>	300

**Table A2. Aspect Ratios for Anthophyllite Particles:  
Calibrated Visual Estimation of Dimensions by PCM (400X  
Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Aspect Ratio</i>
0.9	0	0.0%	0.0%	<= 1
1.9	5	1.7%	1.7%	1 - 1.9
2.9	12	4.0%	5.7%	2 - 2.9
3.9	41	13.7%	19.3%	3 - 3.9
4.9	41	13.7%	33.0%	4 - 4.9
5.9	51	17.0%	50.0%	5 - 5.9
6.9	32	10.7%	60.7%	6 - 6.9
7.9	22	7.3%	68.0%	7 - 7.9
8.9	23	7.7%	75.7%	8 - 8.9
9.9	8	2.7%	78.3%	9 - 9.9
10.9	15	5.0%	83.3%	10 - 10.9
11.9	8	2.7%	86.0%	11 - 11.9
12.9	9	3.0%	89.0%	12 - 12.9
13.9	4	1.3%	90.3%	13 - 13.9
14.9	4	1.3%	91.7%	14 - 14.9
15.9	3	1.0%	92.7%	15 - 15.9
16.9	5	1.7%	94.3%	16 - 16.9
17.9	0	0.0%	94.3%	17 - 17.9
18.9	4	1.3%	95.7%	18 - 18.9
19.9	1	0.3%	96.0%	19 - 19.9
20.9	3	1.0%	97.0%	20 - 20.9
More	9	3.0%	100.0%	> 20.9
Sum	300			

**Table A3. Lengths for Anthophyllite Particles:  
Calibrated Visual Estimation of Dimensions by PCM  
(400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Length (microns)</i>
0.9	0	0.0%	0.0%	<= 1
1.9	0	0.0%	0.0%	1 - 1.9
2.9	0	0.0%	0.0%	2 - 2.9
3.9	0	0.0%	0.0%	3 - 3.9
4.9	9	3.0%	3.0%	4 - 4.9
5.9	41	13.7%	16.7%	5 - 5.9
6.9	26	8.7%	25.3%	6 - 6.9
7.9	46	15.3%	40.7%	7 - 7.9
8.9	31	10.3%	51.0%	8 - 8.9
9.9	20	6.7%	57.7%	9 - 9.9
10.9	22	7.3%	65.0%	10 - 10.9
11.9	19	6.3%	71.3%	11 - 11.9
12.9	20	6.7%	78.0%	12 - 12.9
13.9	9	3.0%	81.0%	13 - 13.9
14.9	9	3.0%	84.0%	14 - 14.9
15.9	16	5.3%	89.3%	15 - 15.9
16.9	5	1.7%	91.0%	16 - 16.9
17.9	6	2.0%	93.0%	17 - 17.9
18.9	2	0.7%	93.7%	18 - 18.9
19.9	1	0.3%	94.0%	19 - 19.9
20.9	6	2.0%	96.0%	20 - 20.9
More	12	4.0%	100.0%	> 20.9
Sum	300			

**Table A4. Widths for Anthophyllite Particles: Calibrated  
Visual Estimation of Dimensions by PCM (400X  
Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>
0.9	32	10.7%	10.7%	<= 1
1.9	157	52.3%	63.0%	1 - 1.9
2.9	59	19.7%	82.7%	2 - 2.9
3.9	33	11.0%	93.7%	3 - 3.9
4.9	8	2.7%	96.3%	4 - 4.9
5.9	7	2.3%	98.7%	5 - 5.9
6.9	2	0.7%	99.3%	6 - 6.9
7.9	1	0.3%	99.7%	7 - 7.9
8.9	0	0.0%	99.7%	8 - 8.9
9.9	0	0.0%	99.7%	9 - 9.9
10.9	1	0.3%	100.0%	10 - 10.9
11.9	0	0.0%	100.0%	11 - 11.9
12.9	0	0.0%	100.0%	12 - 12.9
13.9	0	0.0%	100.0%	13 - 13.9
14.9	0	0.0%	100.0%	14 - 14.9
15.9	0	0.0%	100.0%	15 - 15.9
16.9	0	0.0%	100.0%	16 - 16.9
17.9	0	0.0%	100.0%	17 - 17.9
18.9	0	0.0%	100.0%	18 - 18.9
19.9	0	0.0%	100.0%	19 - 19.9
20.9	0	0.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9

Sum 300



Anthophyllite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

Filter	Grid	Grid Opening	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
1	A2	D14	40	6.2	0.9	6.7
1	A2	H1	41	3.8	0.3	12.4
1	A2	H1	42	4.3	0.2	17.5
1	A2	H1	43	5.9	1.2	4.8
1	A2	H1	44	4.9	1.0	5.0
1	A2	H1	45	7.1	0.9	8.3
1	A2	H1	46	9.8	1.6	6.2
1	A2	H1	47	7.6	0.9	8.3
1	A2	H1	48	11.1	1.2	9.0
1	A2	H1	49	3.9	0.1	32.0
1	A2	H1	50	6.2	0.9	6.7
2	B2	H1	51	3.7	0.6	6.0
2	B2	E10	52	5.2	0.9	5.6
2	B2	E10	53	6.2	0.1	50.0
2	B2	E10	54	3.7	0.5	7.5
2	B2	E10	55	5.9	1.2	4.8
2	B2	E10	56	3.7	0.4	10.0
2	B2	E10	57	7.6	0.5	15.5
2	B2	E10	58	10.5	0.7	14.2
2	B2	E10	59	3.7	0.6	6.0
2	B2	E10	60	23.1	1.5	15.6
2	B2	E10	61	4.9	0.7	6.7
2	B2	E10	62	4.9	0.9	5.7
2	B2	E10	63	5.2	0.9	6.0
2	B2	E10	64	3.3	0.1	27.0
2	B2	E10	65	6.8	1.2	5.5
2	B2	E10	66	9.2	0.6	15.0
2	B2	E10	67	7.4	1.5	5.0
2	B2	E1	68	4.1	0.1	33.0
2	B2	E1	69	6.2	0.6	10.0
2	B2	E1	70	1.7	0.1	28.0
2	B2	E1	71	3.1	0.5	6.3
2	B2	E1	72	5.9	0.9	6.9
2	B2	E1	73	3.1	0.4	8.3
2	B2	E1	74	3.7	0.3	12.0
2	B2	E1	75	17.5	1.8	9.5
2	B2	E1	76	2.7	0.3	8.8
2	B2	E1	77	4.3	0.4	11.7
2	B2	E1	78	6.2	0.9	7.1
2	B2	E1	79	5.2	0.2	21.3
2	B2	E1	80	3.2	0.9	3.7
2	B2	E1	81	13.5	1.2	11.0
2	B2	E1	82	12.9	1.7	7.5
2	B2	E1	83	3.3	0.7	4.5
2	B2	E9	84	15.6	0.9	18.1
2	B2	E9	85	6.2	0.7	8.3

PCM Fiber	TEM Equ Fiber	Length only <5 or A.R. <3	Percent PCM-Equivalent Fibers	Percent TEM-only Fibers	Percent non-Fibers
Fiber PEF					0
		Yes			3.39
		Yes			2
					3.49
					0
Fiber PEF					3.59
		Yes			3
					3.69
					0
Fiber PEF					3.79
					0
Fiber PEF					3.89
					1
Fiber PEF					3.99
					1
Fiber PEF					4.09
					1
		Yes			4.19
Fiber PEF					0
					4.29
		Yes			0
					4.39
Fiber PEF					0
					4.49
Fiber	TEM				0
		Yes			4.59
					0
Fiber PEF					4.69
					0
					4.79
					0
					4.89
					2
					<u>More</u>

Anthrophyllite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

Filter	Grid	Grid Opening	Structure Number	Length (microns)	Width (microns)	Aspect Ratio	PCM Fiber	TEM Equ Fiber	Length only fiber	Length <5 or A.R. <3	Percent PCM-Equivalent Fibers	Percent TEM-only Fibers	Percent non-Fibers
2	B2	E9	86	10.1	0.6	16.4							
2	B2	E9	87	8.9	1.5	6.0							
2	B2	E9	88	16.0	1.8	8.7							
2	B2	E9	89	2.8	0.4	7.7							
2	B2	E9	90	7.0	0.9	7.6			Yes				
2	B2	E9	91	4.7	0.6	7.6			Yes				
2	B2	E9	92	3.9	0.4	10.7			Yes				
2	B2	E9	93	8.6	0.7	11.7							
2	B2	E9	94	2.2	0.2	9.0			Yes				
2	B2	E9	95	5.5	0.5	11.3							
2	B2	F15	96	12.3	3.4	3.6							
2	B2	F15	97	4.9	0.2	20.0			Yes				
2	B2	F15	98	2.8	0.2	15.0			Yes				
2	B2	F15	99	5.4	0.6	8.8							
2	B2	F15	100	3.1	0.3	10.0			Yes				
3	C1	E5	101	3.4	0.1	28.0			Yes				
3	C1	E5	102	7.6	1.0	7.8			Yes				
3	C1	E5	103	4.7	0.4	12.7			Yes				
3	C1	E5	104	2.8	0.3	9.0			Yes				
3	C1	E5	105	4.9	0.5	10.0			Yes				
3	C1	E5	106	6.8	1.2	5.5							
3	C1	E5	107	12.3	1.8	6.7							
3	C1	E5	108	2.5	0.2	10.0			Yes				
3	C1	E5	109	3.3	0.6	5.4			Yes				
3	C1	E5	110	6.2	1.0	6.3							
3	C1	E5	111	9.2	1.2	7.5							
3	C1	E5	112	19.7	1.5	13.3							
3	C1	E5	113	3.4	0.4	9.3			Yes				
3	C1	E5	114	3.8	0.2	15.5			Yes				
3	C1	E5	115	1.8	0.3	6.0			Yes				
3	C1	E5	116	5.3	1.5	3.4							
3	C1	D19	117	14.8	0.9	17.1							
3	C1	D19	118	3.7	0.2	15.0							
3	C1	D19	119	2.2	0.1	18.0			Yes				
3	C1	D19	120	2.5	0.1	20.0			Yes				
3	C1	D19	121	3.4	0.6	5.6			Yes				
3	C1	D19	122	19.7	3.1	6.4							
3	C1	D19	123	6.2	0.9	7.1							
3	C1	D19	124	2.5	0.6	4.0							
3	C1	D19	125	3.9	0.6	6.4			Yes				
3	C1	D19	126	2.7	0.5	5.5			Yes				
3	C1	H6	127	5.2	0.6	8.4							
3	C1	H6	128	3.7	0.4	10.0							
3	C1	H6	129	3.7	0.9	4.0			Yes				
3	C1	H6	130	11.7	2.5	4.8			Yes				
3	C1	H6	131	1.8	0.6	3.0							



Anthophyllite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

Filter	Grid	Grid Opening	Structure Number	Length (microns)	Width (microns)	Aspect Ratio	PCM Fiber	TEM Equ Fiber	Length only fiber	Length <5 or A.R. <3	Percent PCM-Equivalent Fibers	Percent TEM-only Fibers	Percent non-Fibers
3	C1	H6	132	3.1	0.1	25.0							
3	C1	H6	133	2.1	0.5	4.3							
3	C1	H6	134	5.9	0.6	9.6							
3	C1	H6	135	5.5	1.2	4.5							
3	C1	H6	136	1.5	0.1	12.5							
3	C1	H6	137	9.8	2.2	4.4							
3	C1	H6	138	3.1	0.3	10.0							
3	C1	H6	139	1.2	0.1	10.0							
3	C1	H6	140	13.2	1.8	7.2							
3	C1	H6	141	3.4	0.7	4.6							
3	C1	B20	142	3.1	0.6	5.0							
3	C1	B20	143	13.2	3.1	4.3							
3	C1	B20	144	3.7	0.5	7.5							
3	C1	B20	145	1.4	0.3	4.4							
3	C1	B20	146	8.6	1.2	7.0							
3	C1	B20	147	4.0	0.3	13.0							
3	C1	B20	148	4.3	0.1	35.0							
3	C1	B20	149	13.5	1.6	8.5							
3	C1	B20	150	6.2	0.2	25.0							
4	D2	A24	151	6.2	0.6	10.0							
4	D2	A24	152	3.9	0.5	8.0							
4	D2	A24	153	1.2	0.1	13.3							
4	D2	A24	154	2.5	0.1	20.0							
4	D2	A24	155	3.3	0.6	5.4							
4	D2	A24	156	5.2	0.3	16.8							
4	D2	A24	157	8.6	0.6	14.0							
4	D2	A24	158	2.7	0.4	7.3							
4	D2	A24	159	2.2	0.9	2.5							
4	D2	A24	160	1.5	0.9	1.6							
4	D2	A24	161	1.5	0.3	5.0							
4	D2	A24	162	4.3	1.0	4.4							
4	D2	A24	163	14.8	0.7	20.0							
4	D2	A24	164	1.8	0.2	10.0							
4	D2	A24	165	4.3	0.7	5.8							
4	D2	A24	166	8.3	0.9	9.6							
4	D2	A24	167	2.8	1.0	2.8							
4	D2	A24	168	5.5	1.5	3.6							
4	D2	A24	169	6.5	0.4	17.5							
4	D2	A24	170	2.5	0.9	2.9							
4	D2	A24	171	9.8	1.8	5.3							
4	D2	A24	172	4.6	1.2	3.8							
4	D2	A24	173	6.8	1.5	4.4							
4	D2	A24	174	6.2	0.1	50.0							
4	D2	E10	175	2.5	1.2	2.0							
4	D2	E10	176	3.7	0.7	5.0							
4	D2	E10	177	2.2	0.9	2.6							
4	D2	E10	178	1.0	0.1	16.0							

Anthrophyllite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

Filter	Grid	Grid Opening	Structure Number	Length (microns)	Width (microns)	Aspect Ratio	PCM Fiber	TEM Equ Fiber	Length only <5 or A.R. <3	Percent PCM-Equivalent Fibers	Percent TEM-only Fibers	Percent non-Fibers
4	D2	E10	179	4.9	0.4	11.4						
4	D2	E10	180	5.2	0.2	28.0						
4	D2	E10	181	2.0	1.0	2.0						
4	D2	E10	182	4.6	0.9	5.0	Fiber	TEM	Yes			
4	D2	E10	183	6.2	1.8	3.3						
4	D2	E10	184	3.7	0.5	7.5	Fiber	PEF	Yes			
4	D2	E10	185	3.1	0.5	6.3						
4	D2	E10	186	6.5	0.4	17.5						
4	D2	E10	187	5.2	0.9	6.0	Fiber	PEF	Yes			
4	D2	E10	188	6.2	0.4	16.7	Fiber	PEF	Yes			
4	D2	E10	189	2.7	1.2	2.2						
4	D2	E10	190	3.1	0.6	5.0			Yes			
4	D2	E10	191	2.6	0.7	3.5			Yes			
4	D2	E10	192	3.7	0.1	60.0			Yes			
4	D2	E10	193	4.9	2.5	2.0			Yes			
4	D2	E10	194	4.9	1.8	2.7			Yes			
4	D2	E10	195	12.3	4.2	2.9			Yes			
4	D2	E10	196	3.9	1.0	4.0			Yes			
4	D2	E10	197	4.3	2.7	1.6			Yes			
4	D2	E10	198	4.9	0.7	6.7			Yes			
4	D2	E10	199	2.7	0.5	5.5			Yes			
4	D2	E10	200	1.2	0.1	20.0			Yes			
5	E3	E6	201	6.5	1.8	3.5	Fiber	PEF	Yes			
5	E3	E6	202	2.8	0.5	5.8			Yes			
5	E3	E6	203	3.9	0.9	4.6			Yes			
5	E3	E6	204	4.6	0.4	12.3			Yes			
5	E3	E6	205	2.7	0.5	5.5			Yes			
5	E3	E6	206	1.8	0.9	2.1			Yes			
5	E3	E6	207	1.2	0.5	2.5			Yes			
5	E3	E6	208	3.7	0.9	4.3			Yes			
5	E3	E6	209	2.0	0.6	3.2			Yes			
5	E3	E6	210	2.8	0.5	5.8			Yes			
5	E3	E6	211	2.1	0.6	3.4			Yes			
5	E3	E6	212	3.9	0.6	6.4			Yes			
5	E3	E6	213	8.2	0.4	22.3	Fiber	PEF	Yes			
5	E3	E6	214	27.3	3.9	6.9	Fiber	PEF	Yes			
5	E3	E6	215	4.7	0.9	5.4			Yes			
5	E3	E6	216	3.1	0.6	5.0			Yes			
5	E3	E6	217	3.7	0.5	7.5			Yes			
5	E3	E6	218	11.7	0.6	19.0	Fiber	PEF	Yes			
5	E3	E6	219	1.8	0.7	2.5			Yes			
5	E3	E6	220	2.5	0.6	4.0			Yes			
5	E3	E6	221	3.1	1.0	3.1			Yes			
5	E3	E6	222	6.8	0.9	7.3	Fiber	PEF	Yes			
5	E3	E6	223	6.2	0.9	7.1	Fiber	PEF	Yes			
5	E3	E6	224	1.5	0.3	5.0			Yes			

Anthophyllite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

Filter	Grid	Grid Opening	Structure Number	Length (microns)	Width (microns)	Aspect Ratio	PCM Fiber	TEM Equ Fiber	Length only <5 or A.R. <3	Percent PCM-Equivalent Fibers	Percent TEM-only Fibers	Percent non-Fibers
5	E3	E6	225	5.5	0.5	11.3						
5	E3	E6	226	2.7	0.5	5.5						
5	E3	E6	227	16.2	5.5	2.9						
5	E3	E6	228	3.9	1.2	3.2						
5	E3	E6	229	22.8	3.7	6.2						
5	E3	E6	230	3.1	0.9	3.3						
5	E3	E6	231	3.7	0.5	7.5						
5	E3	E6	232	7.0	0.7	9.5						
5	E3	E6	233	6.2	0.9	6.7						
5	E3	E6	234	2.7	0.2	14.7						
5	E3	E6	235	1.8	0.1	15.0						
5	E3	E6	236	4.7	0.9	5.1						
5	E3	E6	237	3.9	1.5	2.6						
5	E3	E6	238	3.3	1.2	2.7						
5	E3	D19	239	4.9	1.0	5.0						
5	E3	D19	240	3.0	0.6	4.8						
5	E3	D19	241	14.1	0.6	23.0						
5	E3	D19	242	7.4	2.5	3.0						
5	E3	D19	243	2.2	0.9	2.5						
5	E3	D19	244	2.2	0.1	18.0						
5	E3	D19	245	14.1	2.8	5.1						
5	E3	D19	246	2.5	0.6	4.0						
5	E3	D19	247	4.9	0.9	5.7						
5	E3	D19	248	7.4	4.0	1.8						
5	E3	D19	249	8.3	3.2	2.6						
5	E3	D19	250	3.9	0.4	10.7						
6	A6	E6	251	2.8	0.2	11.5						
6	A6	E6	252	10.1	0.6	16.5						
6	A6	E6	253	13.5	1.2	11.0						
6	A6	E6	254	3.4	0.3	11.0						
6	A6	E6	255	4.3	0.9	4.7						
6	A6	E6	256	2.7	0.5	5.5						
6	A6	E6	257	4.4	0.5	9.0						
6	A6	E6	258	19.1	3.7	5.2						
6	A6	E6	259	3.4	0.4	9.2						
6	A6	E6	260	2.3	0.9	2.5						
6	A6	E6	261	3.4	0.2	18.7						
6	A6	E6	262	3.4	0.9	3.7						
6	A6	E6	263	1.4	0.1	11.0						
6	A6	E6	264	1.5	0.2	6.0						
6	A6	E6	265	4.9	0.9	5.7						
6	A6	E6	266	24.0	2.7	8.9						
6	A6	E6	267	9.8	0.9	10.7						
6	A6	E6	268	3.7	0.7	5.0						
6	A6	E6	269	5.4	2.5	2.2						
6	A6	E6	270	7.0	0.9	7.6						

PCM Fiber  
 Fiber PEF  
 Yes  
 Yes  
 Yes  
 Fiber PEF  
 Yes  
 Yes  
 Fiber PEF  
 Fiber PEF  
 Yes  
 Yes  
 Yes  
 Yes  
 Yes  
 Fiber PEF  
 Fiber PEF  
 Yes  
 Yes  
 Fiber PEF  
 Yes  
 Yes  
 Yes  
 Yes  
 Yes  
 Yes  
 Yes  
 Yes  
 Fiber PEF  
 Fiber PEF  
 Yes  
 Yes  
 Fiber PEF  
 Yes



**Table B1: Summary Statistics for Anthophyllite Particle Size Data: TEM PCME  
(10,000X Magnification)**

<i>Length (microns)</i>		<i>Width (microns)</i>		<i>Aspect Ratio</i>	
<b>Mean</b>	6.14	<b>Mean</b>	0.90	<b>Mean</b>	10.71
<b>Standard Error</b>	0.31	<b>Standard Error</b>	0.05	<b>Standard Error</b>	0.71
<b>Median</b>	4.64	<b>Median</b>	0.62	<b>Median</b>	7.33
<b>Mode</b>	3.69	<b>Mode</b>	0.62	<b>Mode</b>	5.00
<b>Standard Deviation</b>	5.44	<b>Standard Deviation</b>	0.85	<b>Standard Deviation</b>	12.27
<b>Sample Variance</b>	29.58	<b>Sample Variance</b>	0.73	<b>Sample Variance</b>	150.44
<b>Kurtosis</b>	11.64	<b>Kurtosis</b>	6.61	<b>Kurtosis</b>	27.47
<b>Skewness</b>	3.00	<b>Skewness</b>	2.33	<b>Skewness</b>	4.59
<b>Range</b>	39.24	<b>Range</b>	5.47	<b>Range</b>	108.86
<b>Minimum</b>	0.74	<b>Minimum</b>	0.06	<b>Minimum</b>	1.14
<b>Maximum</b>	39.98	<b>Maximum</b>	5.54	<b>Maximum</b>	110.00
<b>Sum</b>	1843.34	<b>Sum</b>	269.65	<b>Sum</b>	3212.41
<b>Count</b>	300	<b>Count</b>	300	<b>Count</b>	300

**Table B2. Aspect Ratios for 300 Anthophyllite  
Particles: TEM PCME (10,000X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Aspect Ratio</i>
0.9	0	0.0%	0.0%	<= 0.9
1.9	5	1.7%	1.7%	.9 - 1.9
2.9	19	6.3%	8.0%	1.9 - 2.9
3.9	22	7.3%	15.3%	2.9 - 3.9
4.9	29	9.7%	25.0%	3.9 - 4.9
5.9	37	12.3%	37.3%	4.9 - 5.9
6.9	28	9.3%	46.7%	5.9 - 6.9
7.9	26	8.7%	55.3%	6.9 - 7.9
8.9	15	5.0%	60.3%	7.9 - 8.9
9.9	14	4.7%	65.0%	8.9 - 9.9
10.9	16	5.3%	70.3%	9.9 - 10.9
11.9	13	4.3%	74.7%	10.0 - 11.9
12.9	10	3.3%	78.0%	11.9 - 12.9
13.9	5	1.7%	79.7%	12.9 - 13.9
14.9	5	1.7%	81.3%	13.9 - 14.9
15.9	7	2.3%	83.7%	14.9 - 15.9
16.9	7	2.3%	86.0%	15.9 - 16.9
17.9	4	1.3%	87.3%	16.9 - 17.9
18.9	5	1.7%	89.0%	17.98 - 18.9
19.9	1	0.3%	89.3%	18.9 - 19.9
20.9	7	2.3%	91.7%	19.9 - 20.9
More	25	8.3%	100.0%	> 20.9

Sum 300

**Table B3. Lengths for 300 Anthophyllite Particles:  
TEM PCME (10,000X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Length (microns)</i>
0.9	1	0.3%	0.3%	<= 0.9
1.9	21	7.0%	7.3%	.9 - 1.9
2.9	44	14.7%	22.0%	1.9 - 2.9
3.9	57	19.0%	41.0%	2.9 - 3.9
4.9	31	10.3%	51.3%	3.9 - 4.9
5.9	38	12.7%	64.0%	4.9 - 5.9
6.9	35	11.7%	75.7%	5.9 - 6.9
7.9	16	5.3%	81.0%	6.9 - 7.9
8.9	13	4.3%	85.3%	7.9 - 8.9
9.9	6	2.0%	87.3%	8.9 - 9.9
10.9	3	1.0%	88.3%	9.9 - 10.9
11.9	3	1.0%	89.3%	10.0 - 11.9
12.9	3	1.0%	90.3%	11.9 - 12.9
13.9	7	2.3%	92.7%	12.9 - 13.9
14.9	4	1.3%	94.0%	13.9 - 14.9
15.9	1	0.3%	94.3%	14.9 - 15.9
16.9	2	0.7%	95.0%	15.9 - 16.9
17.9	1	0.3%	95.3%	16.9 - 17.9
18.9	2	0.7%	96.0%	17.9 - 18.9
19.9	4	1.3%	97.3%	18.9 - 19.9
20.9	0	0.0%	97.3%	19.9 - 20.9
More	8	2.7%	100.0%	> 20.9
Sum	300			

**Table B4. Widths for 300 Anthophyllite Particles:  
TEM PCME (10,000X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>		
0.9	200	66.7%	66.7%	<= 0.9		<= 0.9
1.9	75	25.0%	91.7%	1 - 1.9	1	1.9
2.9	11	3.7%	95.3%	2 - 2.9	2	2.9
3.9	9	3.0%	98.3%	3 - 3.9	3	3.9
4.9	3	1.0%	99.3%	4 - 4.9	4	4.9
5.9	2	0.7%	100.0%	5 - 5.9	5	5.9
6.9	0	0.0%	100.0%	6 - 6.9	6	6.9
7.9	0	0.0%	100.0%	7 - 7.9	7	7.9
8.9	0	0.0%	100.0%	8 - 8.9	8	8.9
9.9	0	0.0%	100.0%	9 - 9.9	9	9.9
10.9	0	0.0%	100.0%	10 - 10.9	10	10.9
11.9	0	0.0%	100.0%	11 - 11.9	11	11.9
12.9	0	0.0%	100.0%	12 - 12.9	12	12.9
13.9	0	0.0%	100.0%	13 - 13.9	13	13.9
14.9	0	0.0%	100.0%	14 - 14.9	14	14.9
15.9	0	0.0%	100.0%	15 - 15.9	15	15.9
16.9	0	0.0%	100.0%	16 - 16.9	16	16.9
17.9	0	0.0%	100.0%	17 - 17.9	17	17.9
18.9	0	0.0%	100.0%	18 - 18.9	18	18.9
19.9	0	0.0%	100.0%	19 - 19.9	19	19.9
20.9	0	0.0%	100.0%	20 - 20.9	20	20.9
More	0	0.0%	100.0%	> 20.9		> 20.9
Sum	300					



**Table B5. Widths for 300 Anthophyllite Particles: TEM  
PCME (10,000X Magnification) Finer Detail**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>	<i>Start</i>	<i>End</i>
0.09	9	3.0%	3.0%	<= 0.09		< 0.09
0.19	28	9.3%	12.3%	0.1 - 0.19	0.1	0.19
0.29	13	4.3%	16.7%	0.2 - 0.29	0.2	0.29
0.39	38	12.7%	29.3%	0.3 - 0.39	0.3	0.39
0.49	1	0.3%	29.7%	0.4 - 0.49	0.4	0.49
0.59	29	9.7%	39.3%	0.5 - 0.59	0.5	0.59
0.69	36	12.0%	51.3%	0.6 - 0.69	0.6	0.69
0.79	20	6.7%	58.0%	0.7 - 0.79	0.7	0.79
0.89	26	8.7%	66.7%	0.8 - 0.89	0.8	0.89
0.99	28	9.3%	76.0%	0.9 - 0.99	0.9	0.99
1.09	0	0.0%	76.0%	1.0 - 1.09	1.0	1.09
1.19	1	0.3%	76.3%	1.1 - 1.19	1.1	1.19
1.29	20	6.7%	83.0%	1.2 - 1.29	1.2	1.29
1.39	1	0.3%	83.3%	1.3 - 1.39	1.3	1.39
1.49	8	2.7%	86.0%	1.4 - 1.49	1.4	1.49
1.59	5	1.7%	87.7%	1.5 - 1.59	1.5	1.59
1.69	2	0.7%	88.3%	1.6 - 1.69	1.6	1.69
1.79	1	0.3%	88.7%	1.7 - 1.79	1.7	1.79
1.89	9	3.0%	91.7%	1.8 - 1.89	1.8	1.89
1.99	0	0.0%	91.7%	1.9 - 1.99	1.9	1.99
2.09	0	0.0%	91.7%	2.0 - 2.09	2.0	2.09
2.19	1	0.3%	92.0%	2.1 - 2.19	2.1	2.19
2.29	1	0.3%	92.3%	2.2 - 2.29	2.2	2.29
2.39	0	0.0%	92.3%	2.3 - 2.39	2.3	2.39
2.49	5	1.7%	94.0%	2.4 - 2.49	2.4	2.49
2.59	0	0.0%	94.0%	2.5 - 2.59	2.5	2.59
2.69	0	0.0%	94.0%	2.6 - 2.69	2.6	2.69
2.79	4	1.3%	95.3%	2.7 - 2.79	2.7	2.79
2.89	0	0.0%	95.3%	2.8 - 2.89	2.8	2.89
2.99	0	0.0%	95.3%	2.9 - 2.99	2.9	2.99
3.09	3	1.0%	96.3%	3.0 - 3.09	3.0	3.09
3.19	0	0.0%	96.3%	3.1 - 3.19	3.1	3.19
3.29	1	0.3%	96.7%	3.2 - 3.29	3.2	3.29
3.39	0	0.0%	96.7%	3.3 - 3.39	3.3	3.39
3.49	2	0.7%	97.3%	3.4 - 3.49	3.4	3.49
3.59	0	0.0%	97.3%	3.5 - 3.59	3.5	3.59
3.69	3	1.0%	98.3%	3.6 - 3.69	3.6	3.69
3.79	0	0.0%	98.3%	3.7 - 3.79	3.7	3.79
3.89	0	0.0%	98.3%	3.8 - 3.89	3.8	3.89
3.99	1	0.3%	98.7%	3.9 - 3.99	3.9	3.99
4.09	1	0.3%	99.0%	4.0 - 4.09	4.0	4.09
4.19	1	0.3%	99.3%	4.1 - 4.19	4.1	4.19
4.29	0	0.0%	99.3%	4.2 - 4.29	4.2	4.29
4.39	0	0.0%	99.3%	4.3 - 4.39	4.3	4.39
4.49	0	0.0%	99.3%	4.4 - 4.49	4.4	4.49
4.59	0	0.0%	99.3%	4.5 - 4.59	4.5	4.59
4.69	0	0.0%	99.3%	4.6 - 4.69	4.6	4.69
4.79	0	0.0%	99.3%	4.7 - 4.79	4.7	4.79
4.89	0	0.0%	99.3%	4.8 - 4.89	4.8	4.89
More	2	0.7%	100.0%	> 4.89	More	

Sum 300

Particle Size Data for Anthophyllite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

**Table C. Particle Size Data for Anthophyllite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)**

\* Note: data in red does not meet criteria for counting; ie.  $\geq 5 \mu\text{m}$  in length or  $\geq 3:1$  aspect ratio.

Filter	Particle	Length (microns)	Width (microns)	Aspect Ratio			
1	1	9.0	4.0	2.3			
1	2	5.0	1.5	3.3			
1	3	16.0	2.0	8.0			
1	4	7.0	1.0	7.0			
1	5	14.0	5.0	2.8			
1	6	11.0	0.5	22.0			
1	7	10.0	2.0	5.0			
1	8	22.0	3.0	7.3			
1	9	15.0	2.0	7.5	Bin		
1	10	5.0	2.5	2.0	0.9	<= 1	
1	11	28.0	3.0	9.3	1.9	1 - 1.9	
1	12	6.0	2.0	3.0	2.9	2 - 2.9	
1	13	10.0	1.0	10.0	3.9	3 - 3.9	
1	14	10.0	2.5	4.0	4.9	4 - 4.9	
1	15	18.0	2.0	9.0	5.9	5 - 5.9	
1	16	12.0	1.0	12.0	6.9	6 - 6.9	
1	17	65.0	5.0	13.0	7.9	7 - 7.9	
1	18	6.0	1.0	6.0	8.9	8 - 8.9	
1	19	15.0	0.5	30.0	9.9	9 - 9.9	
1	20	6.0	0.5	12.0	10.9	10 - 10.9	
1	21	7.0	1.5	4.7	11.9	11 - 11.9	
1	22	6.0	1.5	4.0	12.9	12 - 12.9	
1	23	15.0	7.0	2.1	13.9	13 - 13.9	Fiber
1	24	9.0	2.0	4.5	14.9	14 - 14.9	Fiber
1	25	12.0	1.0	12.0	15.9	15 - 15.9	Fiber
1	26	35.0	3.0	11.7	16.9	16 - 16.9	Fiber

	Count of fibers	Count of non-fibers	Total Structures Counted
Meet Fiber Criteria	90	10	100
	Percent Fibers	Percent non-fibers	
	90.0%	10.0%	

Particle Size Data for Anthophyllite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

Filter	Particle	Length (microns)	Width (microns)	Aspect Ratio			Meet Fiber Criteria	Percent Fibers	Percent non-fibers
1	27	13.0	3.0	4.3	17.9	17 - 17.9			
1	28	4.0	1.0	4.0	18.9	18 - 18.9	Fiber		
1	29	21.0	3.0	7.0	19.9	19 - 19.9	Fiber		
1	30	20.0	5.0	4.0	20.9	20 - 20.9	Fiber		
1	31	8.0	2.5	3.2	More	> 20.9	Fiber		
1	32	9.0	1.0	9.0			Fiber		
1	33	7.0	0.5	14.0			Fiber		
1	34	17.0	1.5	11.3			Fiber		
1	35	8.0	1.0	8.0			Fiber		
1	36	11.0	1.5	7.3			Fiber		
1	37	7.0	1.0	7.0			Fiber		
1	38	8.0	1.0	8.0			Fiber		
1	39	11.0	1.5	7.3			Fiber		
1	40	15.0	3.5	4.3			Fiber		
1	41	17.0	4.0	4.3			Fiber		
1	42	44.0	1.5	29.3			Fiber		
1	43	6.0	1.0	6.0			Fiber		
1	44	20.0	2.5	8.0			Fiber		
1	45	9.0	1.0	9.0			Fiber		
1	46	7.0	1.5	4.7					
1	47	13.0	5.0	2.6			Fiber		
1	48	9.0	0.5	18.0			Fiber		
1	49	8.0	1.5	5.3			Fiber		
1	50	10.0	3.0	3.3			Fiber		
4	51	16.0	1.0	16.0			Fiber		
4	52	19.0	1.5	12.7			Fiber		
4	53	10.0	0.5	20.0			Fiber		
4	54	6.0	1.0	6.0			Fiber		
4	55	9.0	1.0	9.0			Fiber		
4	56	25.0	1.0	25.0			Fiber		
4	57	13.0	2.5	5.2			Fiber		
4	58	7.0	1.5	4.7			Fiber		
4	59	9.0	1.5	6.0			Fiber		
4	60	25.0	1.5	16.7			Fiber		

Particle Size Data for Anthophyllite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

Filter	Particle	Length (microns)	Width (microns)	Aspect Ratio	Meet Fiber Criteria	Percent Fibers	Percent non-fibers
4	61	9.0	2.0	4.5	Fiber		
4	62	9.0	2.0	4.5	Fiber		
4	63	12.0	1.5	8.0	Fiber		
4	64	6.0	1.0	6.0	Fiber		
4	65	11.0	3.0	3.7	Fiber		
4	66	20.0	4.0	5.0			
4	67	5.0	2.0	2.5	Fiber		
4	68	8.0	1.0	8.0	Fiber		
4	69	55.0	2.0	27.5			
4	70	16.0	6.0	2.7	Fiber		
4	71	35.0	5.0	7.0	Fiber		
4	72	28.0	6.0	4.7	Fiber		
4	73	9.0	1.5	6.0	Fiber		
4	74	15.0	1.0	15.0	Fiber		
4	75	13.0	1.5	8.7	Fiber		
4	76	29.0	1.5	19.3	Fiber		
4	77	6.0	2.0	3.0			
4	78	6.0	3.0	2.0	Fiber		
4	79	9.0	2.0	4.5	Fiber		
4	80	33.0	6.0	5.5	Fiber		
4	81	13.0	1.5	8.7	Fiber		
4	82	16.0	1.5	10.7	Fiber		
4	83	18.0	2.0	9.0	Fiber		
4	84	6.0	1.5	4.0	Fiber		
4	85	7.0	1.0	7.0	Fiber		
4	86	14.0	1.5	9.3	Fiber		
4	87	10.0	2.0	5.0	Fiber		
4	88	37.0	3.0	12.3	Fiber		
4	89	9.0	1.5	6.0	Fiber		
4	90	8.0	2.0	4.0	Fiber		
4	91	15.0	1.5	10.0	Fiber		
4	92	21.0	3.5	6.0	Fiber		
4	93	30.0	4.5	6.7	Fiber		
4	94	30.0	5.0	6.0	Fiber		

Particle Size Data for Anthophyllite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

Filter	Particle	Length (microns)	Width (microns)	Aspect Ratio
4	95	11.0	1.5	7.3
4	96	9.0	1.0	9.0
4	97	12.0	2.5	4.8
4	98	20.0	1.0	20.0
4	99	12.0	0.5	24.0
4	100	11.0	2.0	5.5

Meet Fiber Criteria	Percent Fibers	Percent non- fibers
Fiber		
Fiber		
Fiber		
Fiber		
Fiber		

**Table C1. Summary Statistics: Particle Size Data for Anthophyllite Particles:  
Dimensions Measured by PCM using Walton-Beckett Graticule (400X  
Magnification)**

<i>Length (microns)</i>		<i>Width (microns)</i>		<i>Aspect Ratio</i>	
<b>Mean</b>	14.58	<b>Mean</b>	2.14	<b>Mean</b>	8.48
<b>Standard Error</b>	1.04	<b>Standard Error</b>	0.14	<b>Standard Error</b>	0.61
<b>Median</b>	11.00	<b>Median</b>	1.50	<b>Median</b>	7.00
<b>Mode</b>	9.00	<b>Mode</b>	1.50	<b>Mode</b>	6.00
<b>Standard Deviation</b>	10.41	<b>Standard Deviation</b>	1.43	<b>Standard Deviation</b>	6.09
<b>Sample Variance</b>	108.45	<b>Sample Variance</b>	2.04	<b>Sample Variance</b>	37.08
<b>Kurtosis</b>	6.94	<b>Kurtosis</b>	1.53	<b>Kurtosis</b>	3.08
<b>Skewness</b>	2.33	<b>Skewness</b>	1.42	<b>Skewness</b>	1.79
<b>Range</b>	61.00	<b>Range</b>	6.50	<b>Range</b>	28.00
<b>Minimum</b>	4.00	<b>Minimum</b>	0.50	<b>Minimum</b>	2.00
<b>Maximum</b>	65.00	<b>Maximum</b>	7.00	<b>Maximum</b>	30.00
<b>Sum</b>	1458.00	<b>Sum</b>	214.00	<b>Sum</b>	848.36
<b>Count</b>	100	<b>Count</b>	100	<b>Count</b>	100

**Table C2. Aspect Ratios for Anthophyllite Particles:  
Dimensions Measured by PCM using Walton-Beckett  
Graticule (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Aspect Ratio</i>
0.9	0	0.0%	0.0%	<= 1
1.9	0	0.0%	0.0%	1 - 1.9
2.9	8	8.0%	8.0%	2 - 2.9
3.9	6	6.0%	14.0%	3 - 3.9
4.9	18	18.0%	32.0%	4 - 4.9
5.9	7	7.0%	39.0%	5 - 5.9
6.9	10	10.0%	49.0%	6 - 6.9
7.9	10	10.0%	59.0%	7 - 7.9
8.9	8	8.0%	67.0%	8 - 8.9
9.9	8	8.0%	75.0%	9 - 9.9
10.9	3	3.0%	78.0%	10 - 10.9
11.9	2	2.0%	80.0%	11 - 11.9
12.9	5	5.0%	85.0%	12 - 12.9
13.9	1	1.0%	86.0%	13 - 13.9
14.9	1	1.0%	87.0%	14 - 14.9
15.9	1	1.0%	88.0%	15 - 15.9
16.9	2	2.0%	90.0%	16 - 16.9
17.9	0	0.0%	90.0%	17 - 17.9
18.9	1	1.0%	91.0%	18 - 18.9
19.9	1	1.0%	92.0%	19 - 19.9
20.9	2	2.0%	94.0%	20 - 20.9
More	6	6.0%	100.0%	> 20.9

Sum 100

**Table C3. Lengths for Anthophyllite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Length (microns)</i>
0.9	0	0.0%	0.0%	<= 1
1.9	0	0.0%	0.0%	1 - 1.9
2.9	0	0.0%	0.0%	2 - 2.9
3.9	0	0.0%	0.0%	3 - 3.9
4.9	1	1.0%	1.0%	4 - 4.9
5.9	3	3.0%	4.0%	5 - 5.9
6.9	10	10.0%	14.0%	6 - 6.9
7.9	7	7.0%	21.0%	7 - 7.9
8.9	6	6.0%	27.0%	8 - 8.9
9.9	13	13.0%	40.0%	9 - 9.9
10.9	6	6.0%	46.0%	10 - 10.9
11.9	6	6.0%	52.0%	11 - 11.9
12.9	5	5.0%	57.0%	12 - 12.9
13.9	5	5.0%	62.0%	13 - 13.9
14.9	2	2.0%	64.0%	14 - 14.9
15.9	6	6.0%	70.0%	15 - 15.9
16.9	4	4.0%	74.0%	16 - 16.9
17.9	2	2.0%	76.0%	17 - 17.9
18.9	2	2.0%	78.0%	18 - 18.9
19.9	1	1.0%	79.0%	19 - 19.9
20.9	4	4.0%	83.0%	20 - 20.9
More	17	17.0%	100.0%	> 20.9
Sum	100			



**Table C4. Widths for Anthophyllite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>
0.9	7	7.0%	7.0%	<= 1
1.9	46	46.0%	53.0%	1 - 1.9
2.9	22	22.0%	75.0%	2 - 2.9
3.9	11	11.0%	86.0%	3 - 3.9
4.9	4	4.0%	90.0%	4 - 4.9
5.9	6	6.0%	96.0%	5 - 5.9
6.9	3	3.0%	99.0%	6 - 6.9
7.9	1	1.0%	100.0%	7 - 7.9
8.9	0	0.0%	100.0%	8 - 8.9
9.9	0	0.0%	100.0%	9 - 9.9
10.9	0	0.0%	100.0%	10 - 10.9
11.9	0	0.0%	100.0%	11 - 11.9
12.9	0	0.0%	100.0%	12 - 12.9
13.9	0	0.0%	100.0%	13 - 13.9
14.9	0	0.0%	100.0%	14 - 14.9
15.9	0	0.0%	100.0%	15 - 15.9
16.9	0	0.0%	100.0%	16 - 16.9
17.9	0	0.0%	100.0%	17 - 17.9
18.9	0	0.0%	100.0%	18 - 18.9
19.9	0	0.0%	100.0%	19 - 19.9
20.9	0	0.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9

Sum 100

Figure 1. Frequency Distribution of Aspect Ratios for 300 Anthophyllite Particles: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

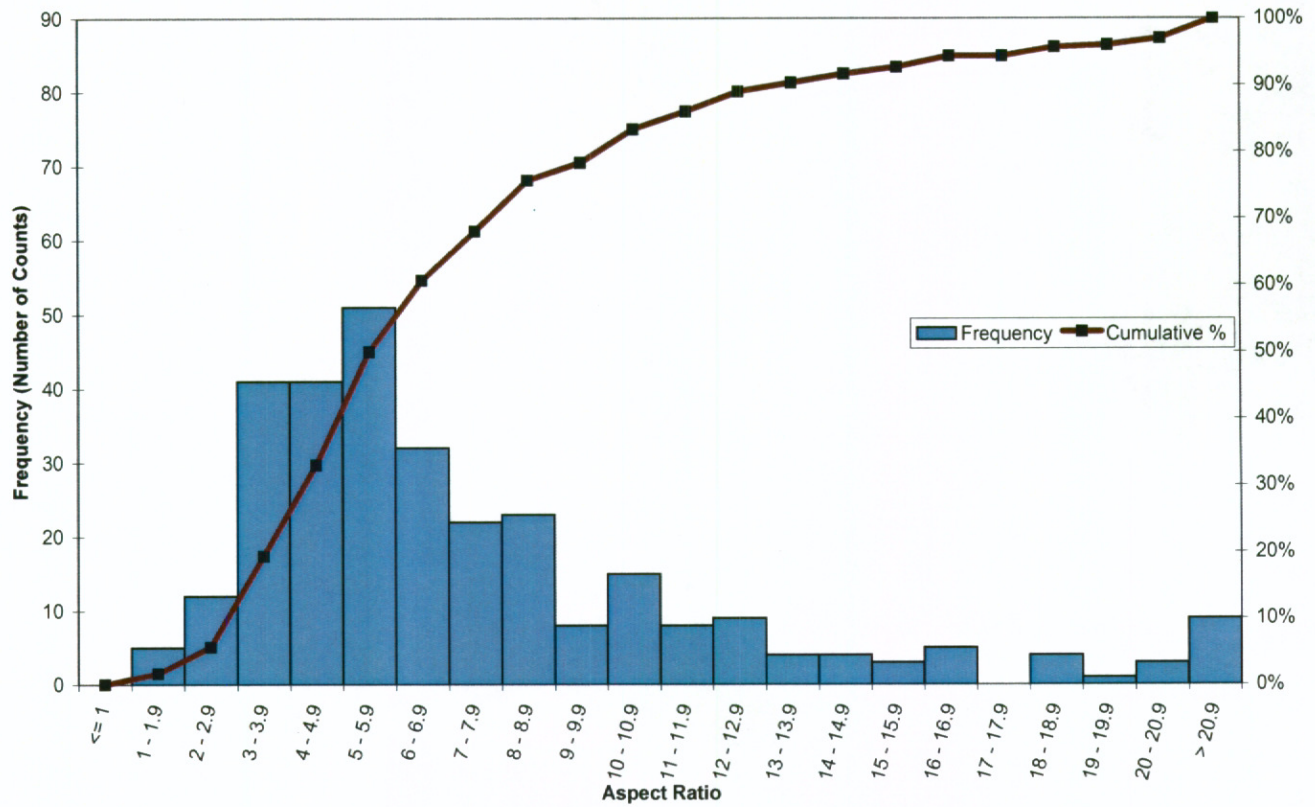


Figure 2. Frequency Distribution of Lengths for 300 Anthophyllite Particles:  
 Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

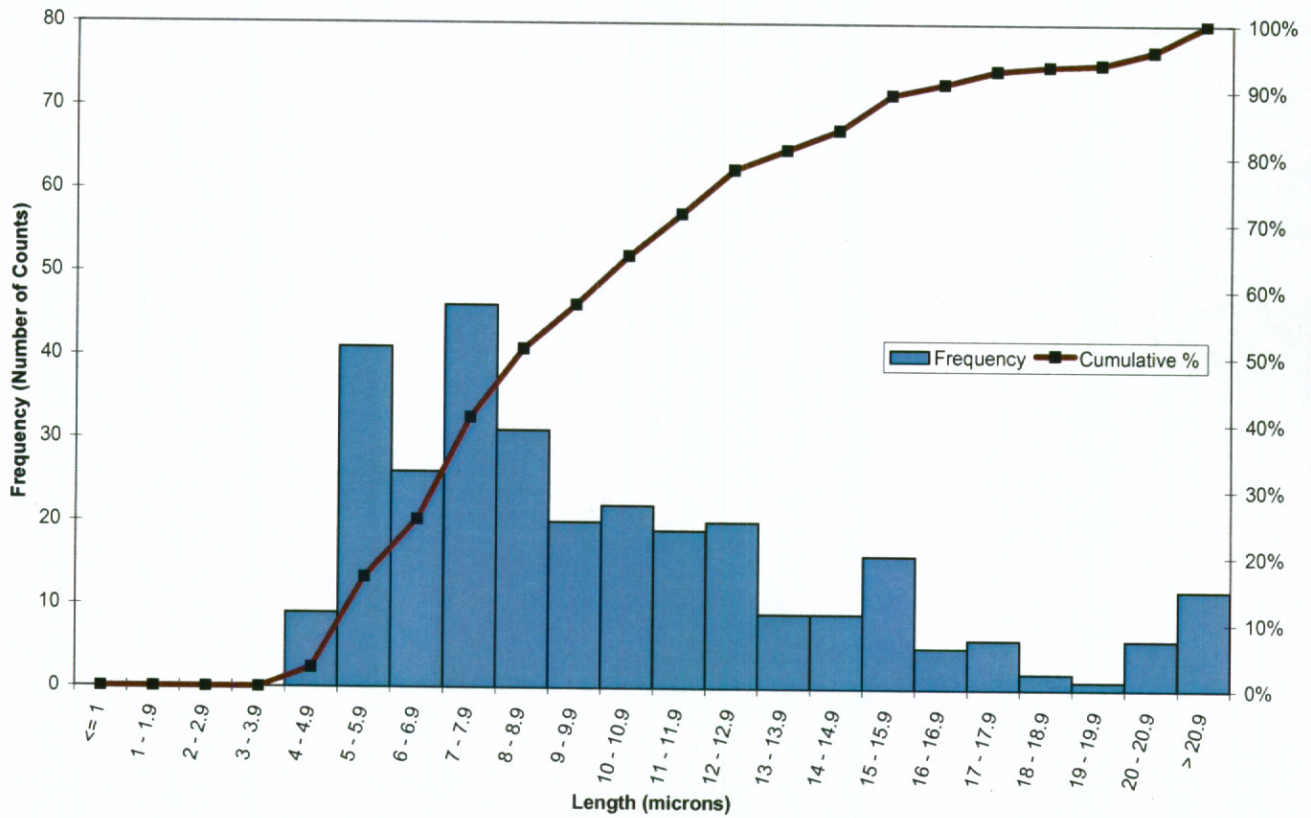


Figure 3. Frequency Distribution of Widths for 300 Anthophyllite Particles:  
Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

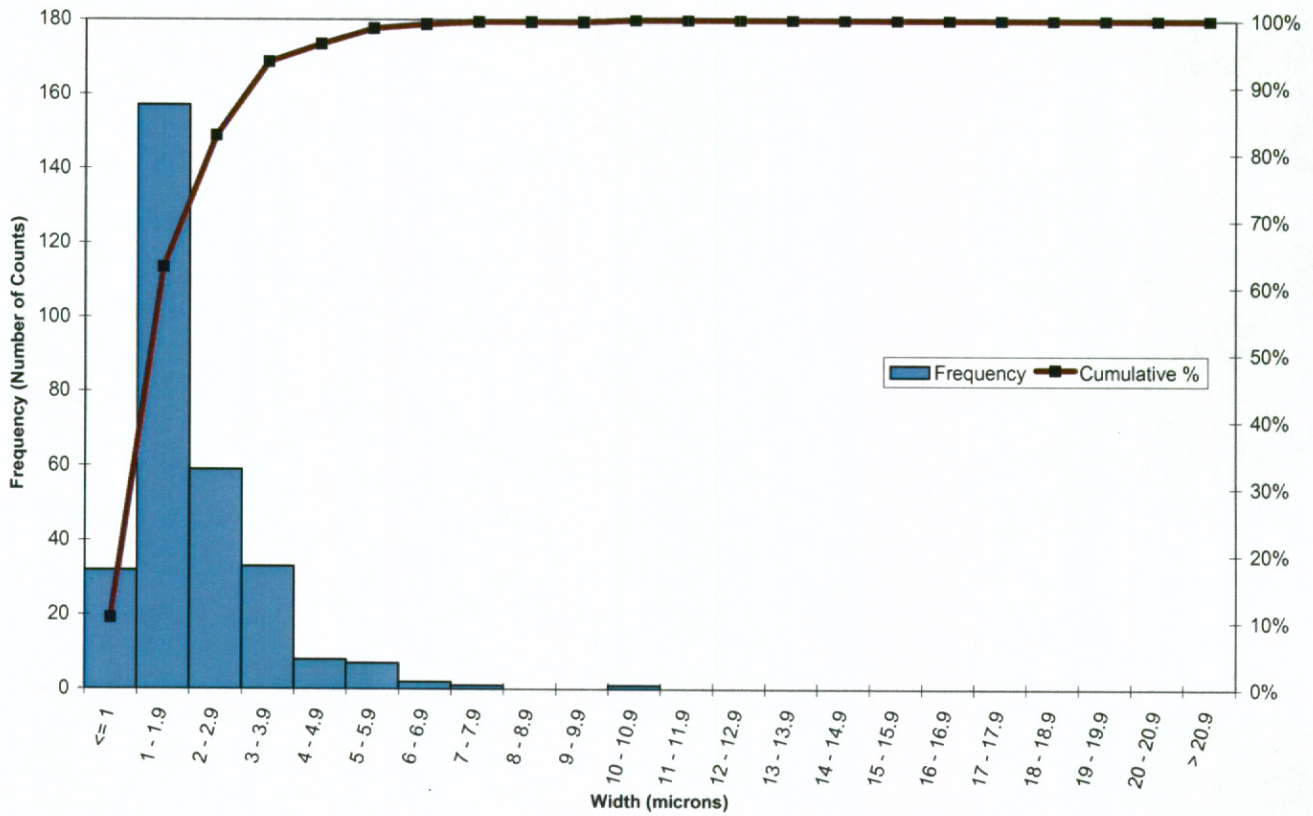


Figure 4. Frequency Distribution of Aspect Ratios for 300 Anthophyllite Particles: Dimensions Measured by TEM PCME (10,000X Magnification)

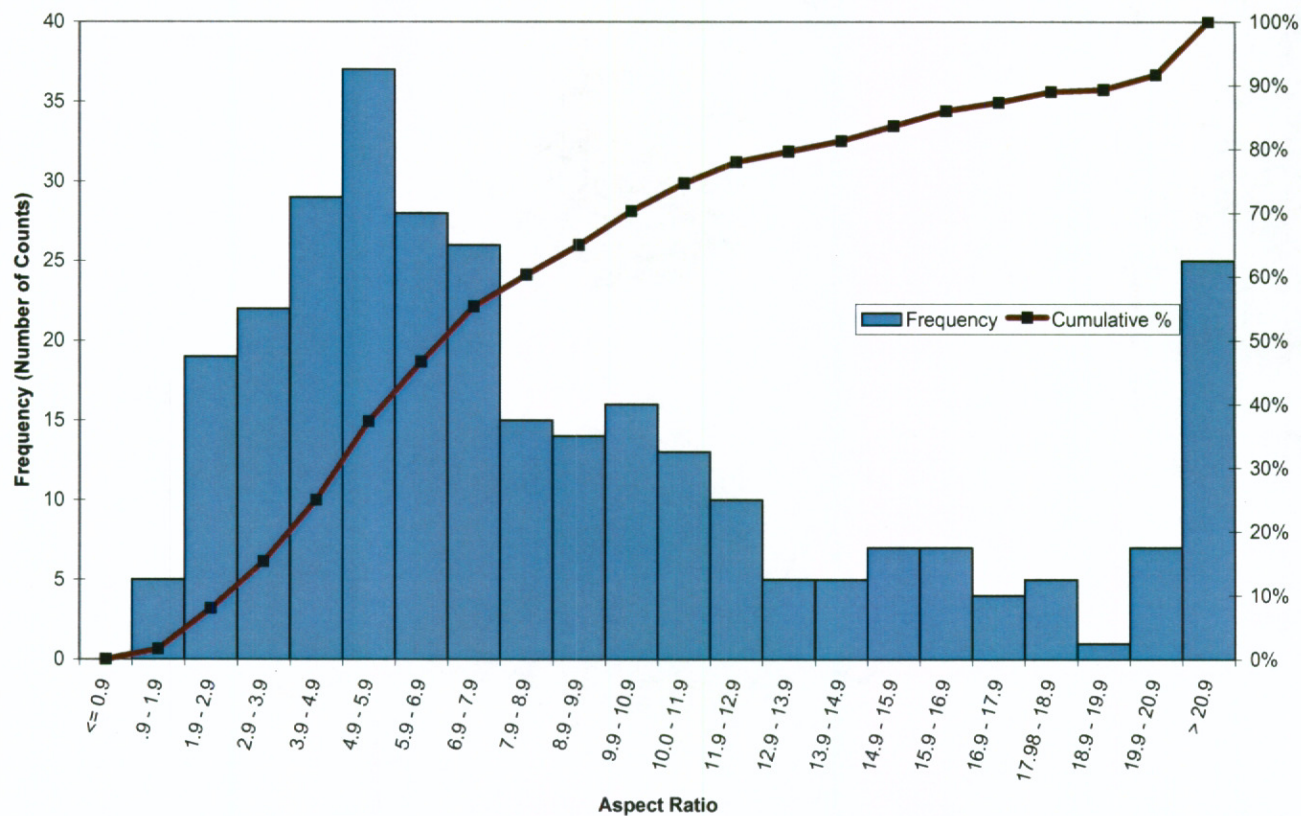


Figure 5. Frequency Distribution of Lengths for 300 Anthrophyllite Particles:  
Dimensions Measured by TEM PCME (10,000X Magnification)

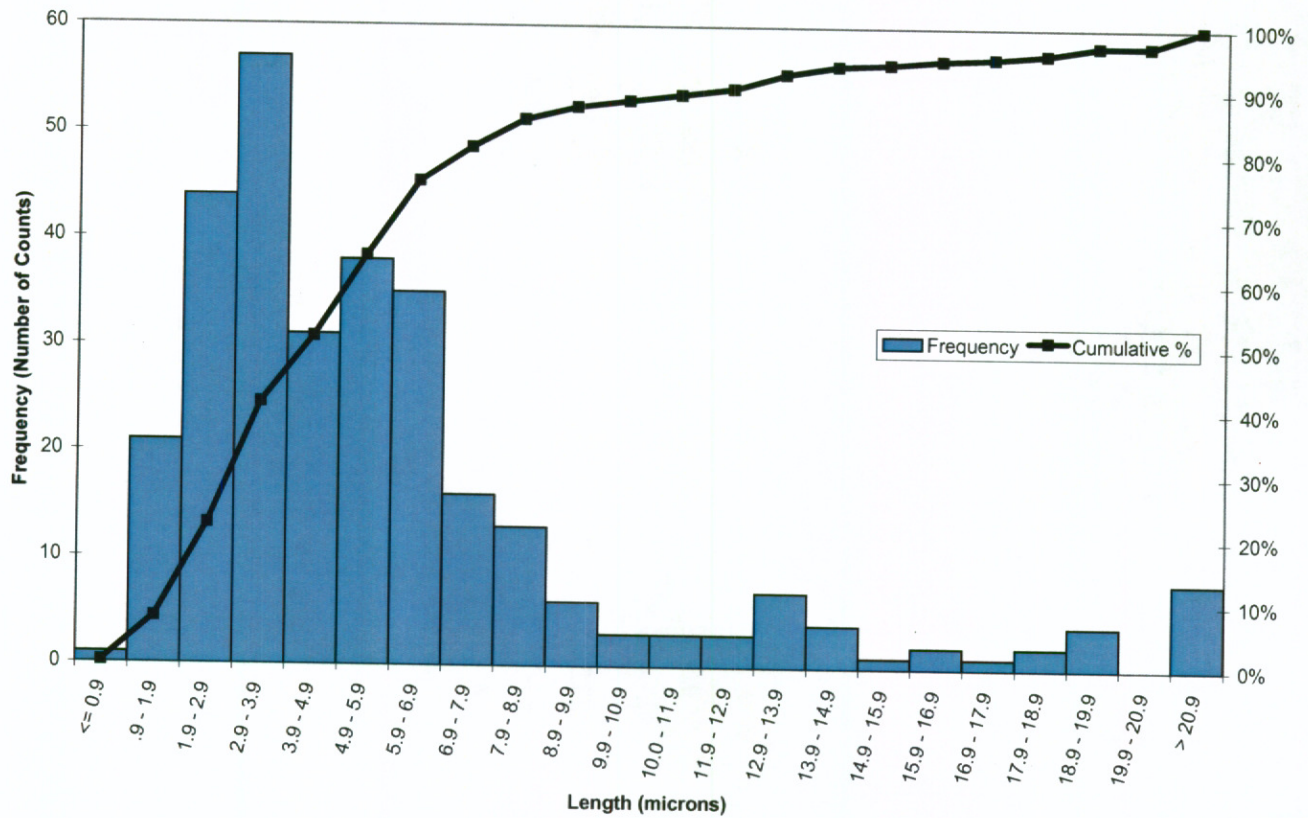


Figure 6. Frequency Distribution of Widths for 300 Anthophyllite Particles:  
Dimensions Measured by TEM PCME (10,000X Magnification)

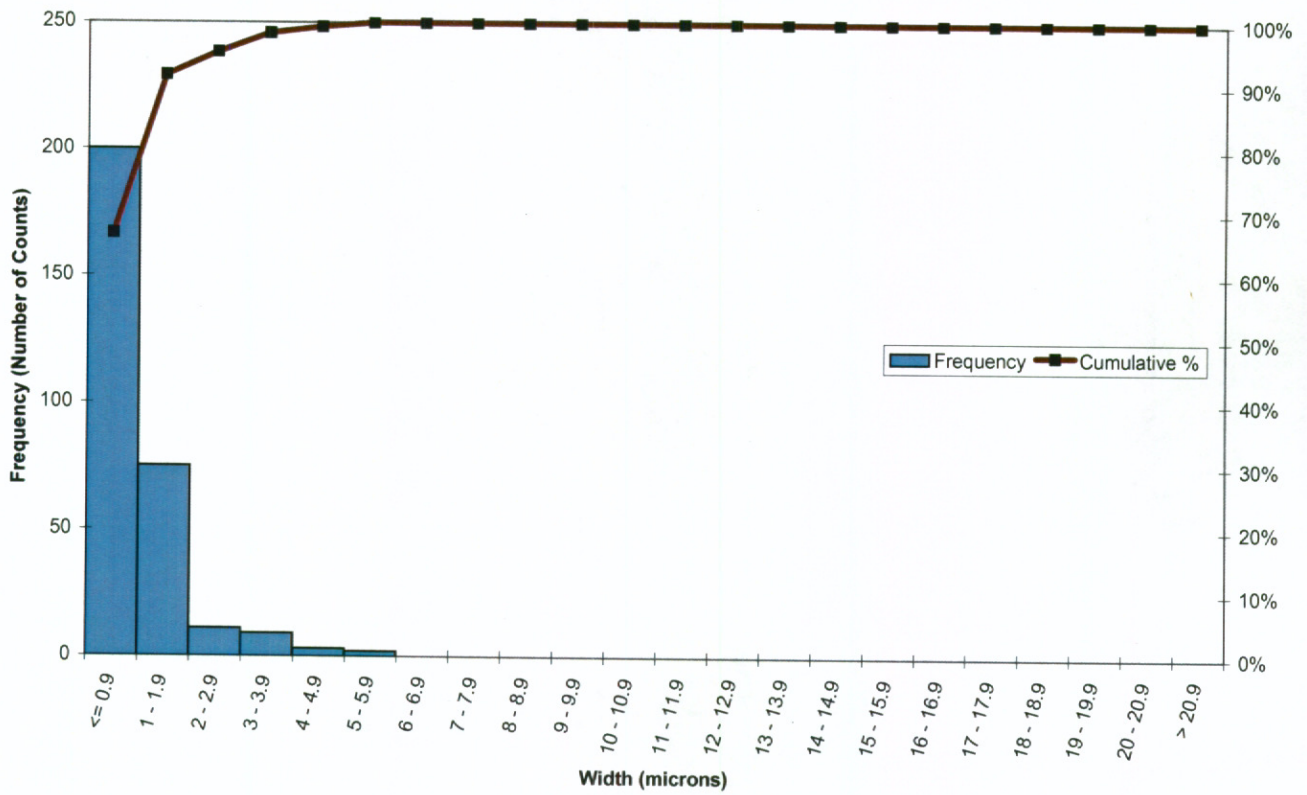


Figure 7. Frequency Distribution of Widths for 300 Anthophyllite Particles: Dimensions Measured by TEM PCME (10,000X Magnification) Finer Detail

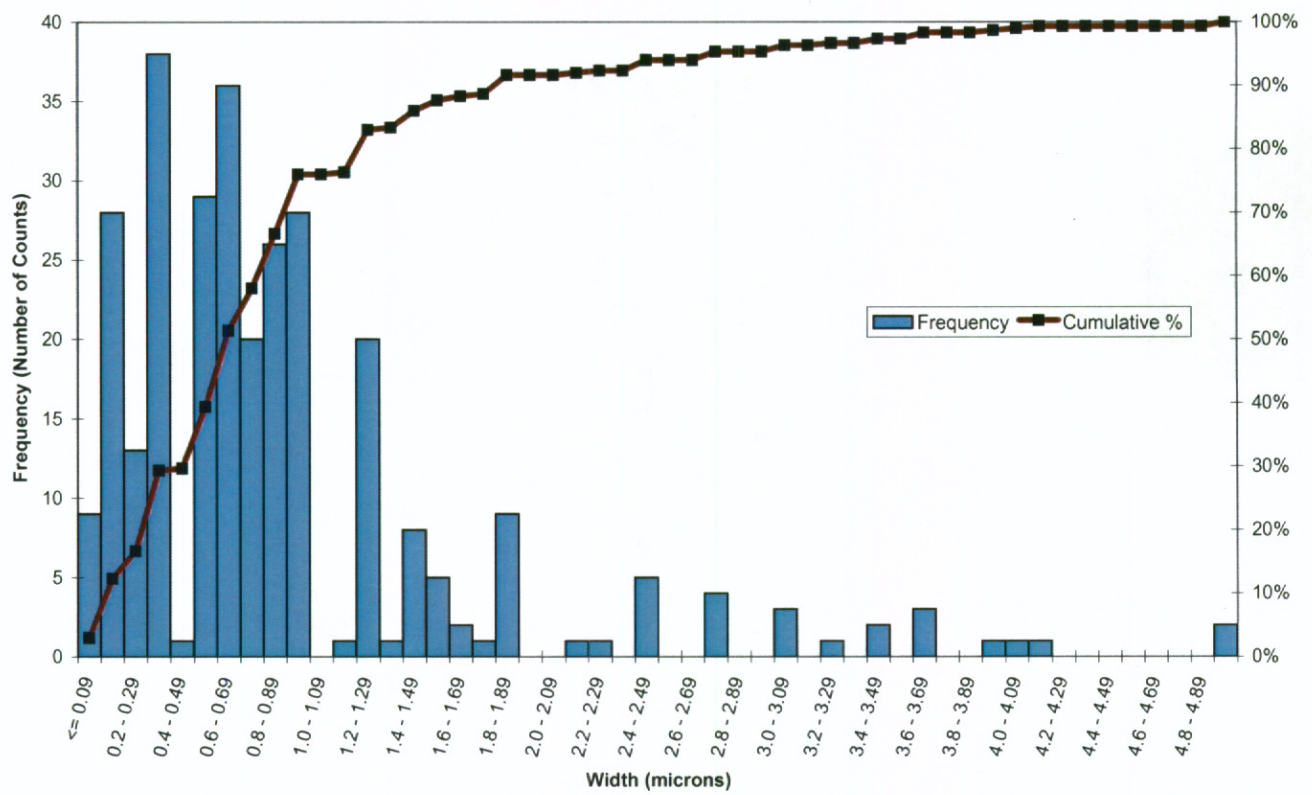




Figure 8. Frequency Distribution of Aspect Ratios for Anthophyllite Particles: Comparison of TEM and PCM Data

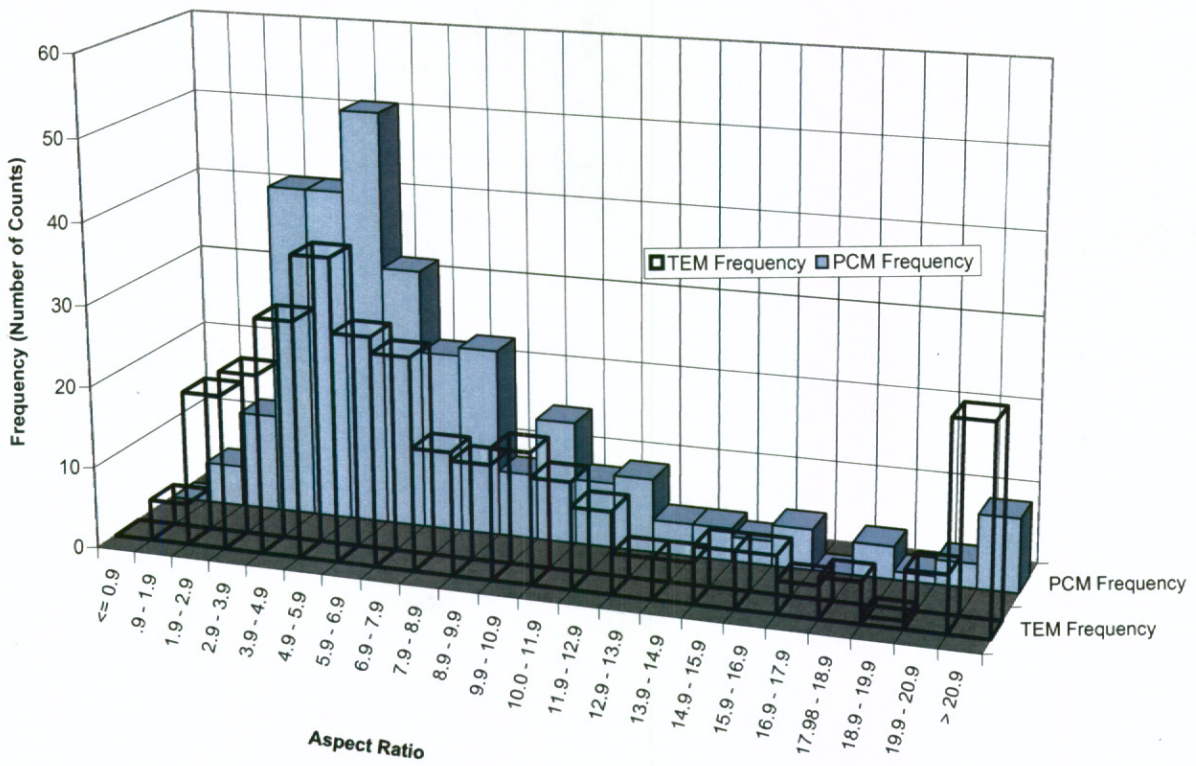


Figure 9. Frequency Distribution of Lengths for Anthophyllite Particles:  
Comparison of TEM and PCM Data

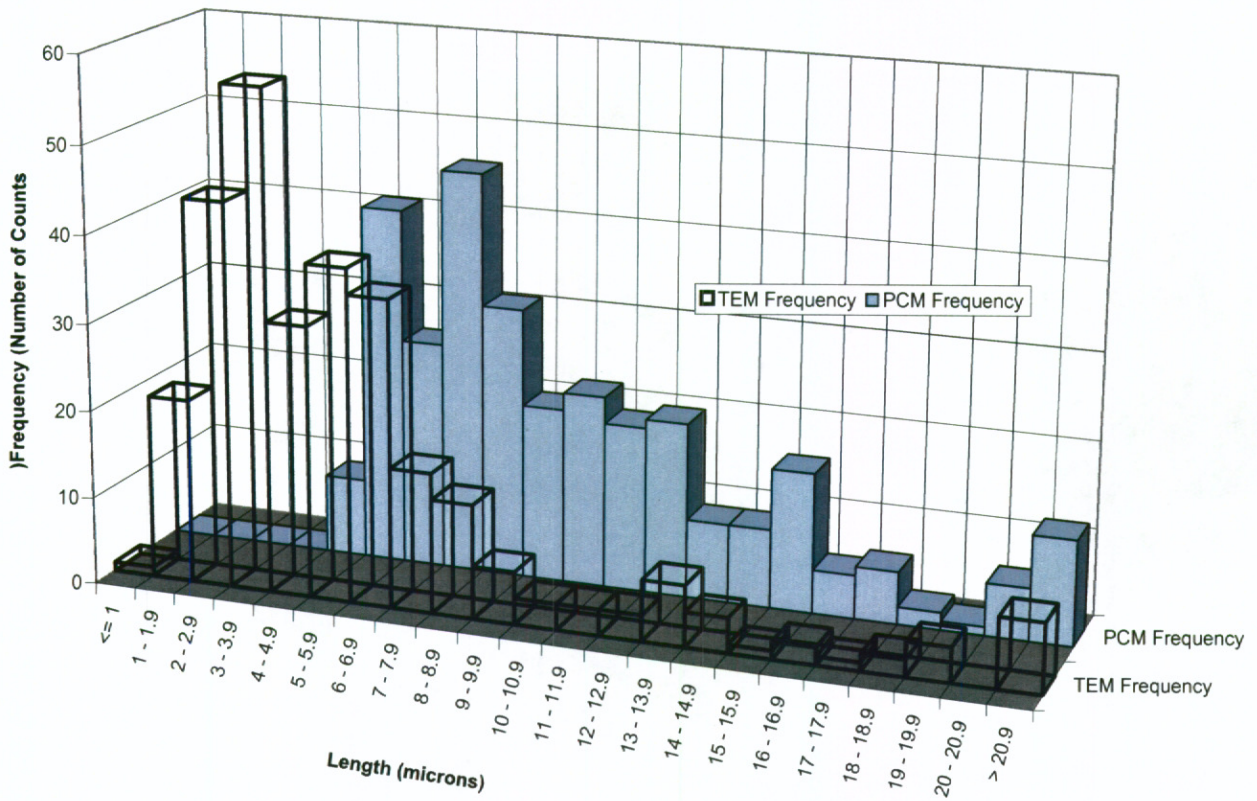


Figure 10. Frequency Distribution of Widths for Anthophyllite Particles:  
Comparison of TEM and PCM Data

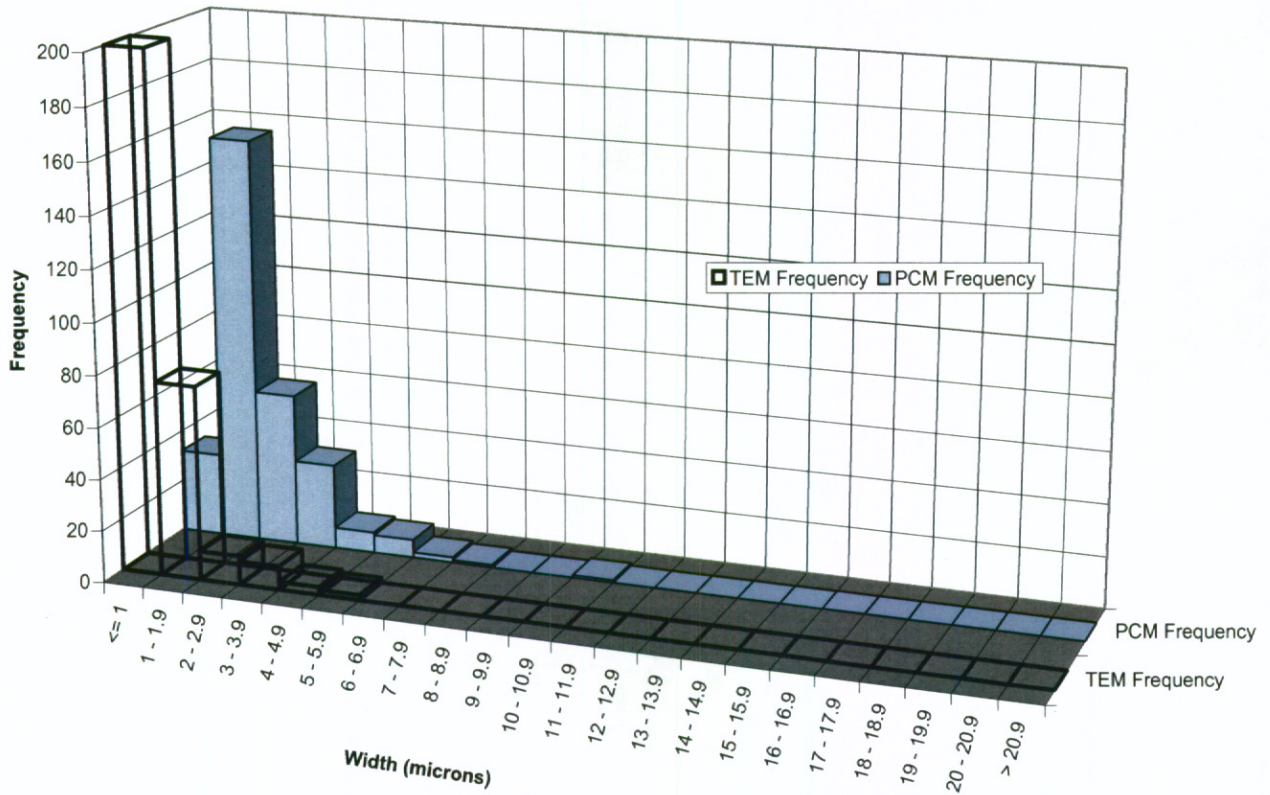


Figure 11. Frequency Distribution of Aspect Ratios for Anthophyllite Particles:  
Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

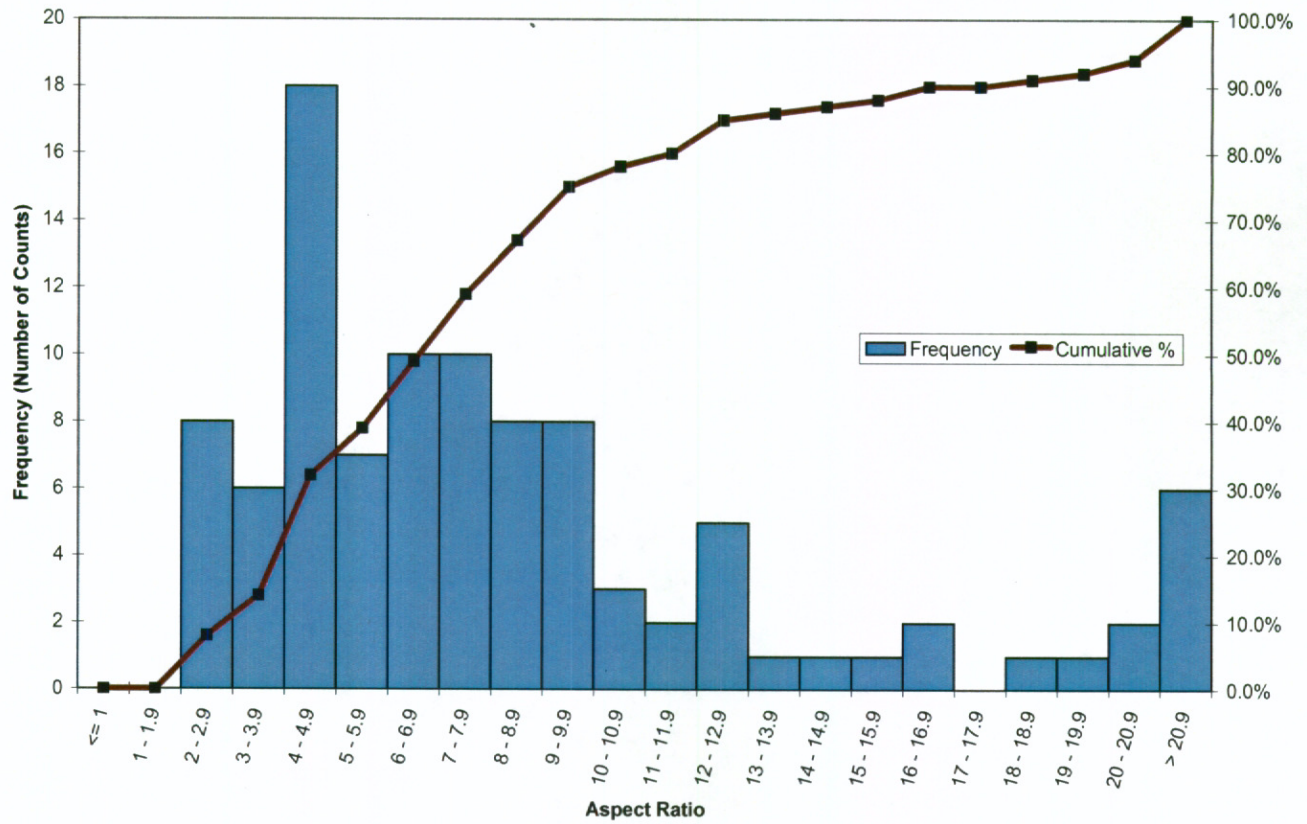


Figure 12. Frequency Distribution of Lengths for Anthophyllite Particles:  
Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

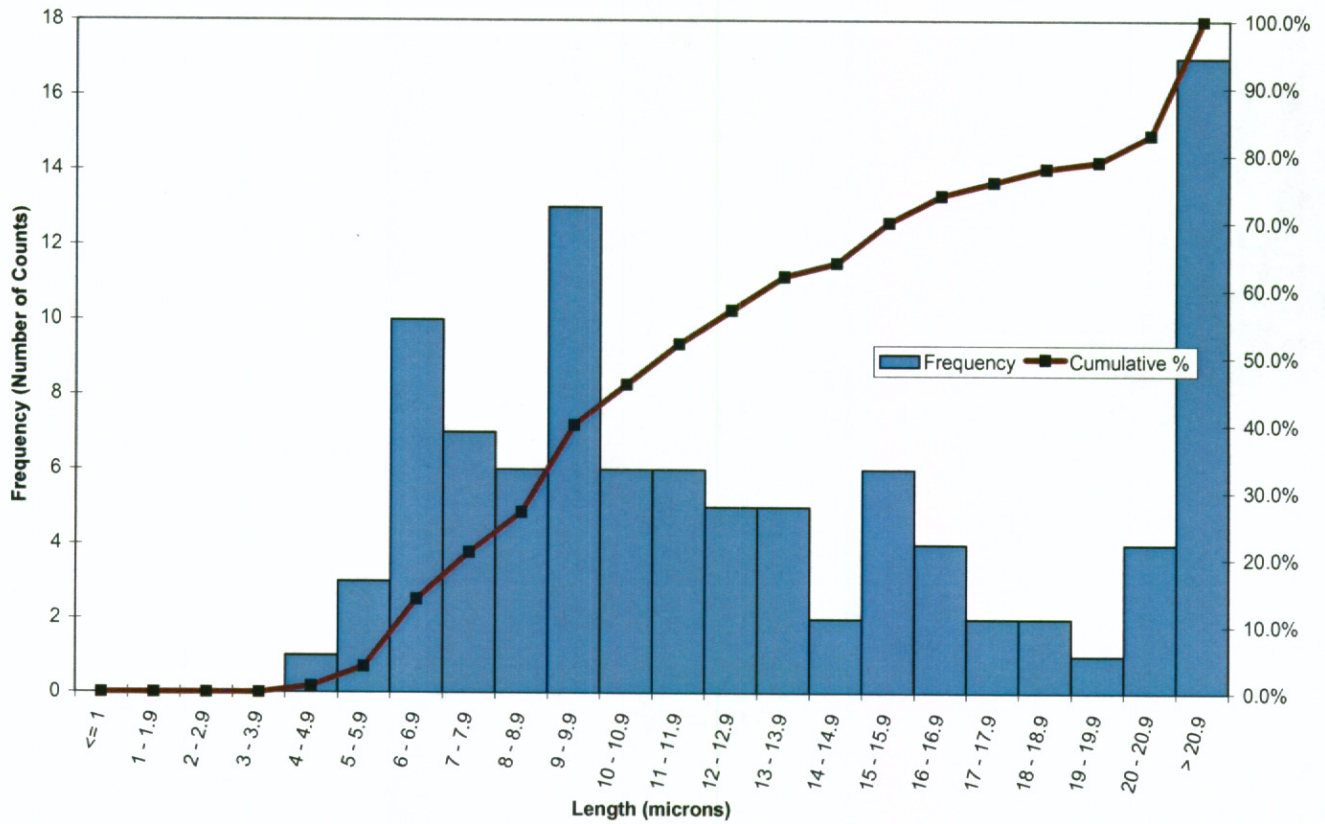
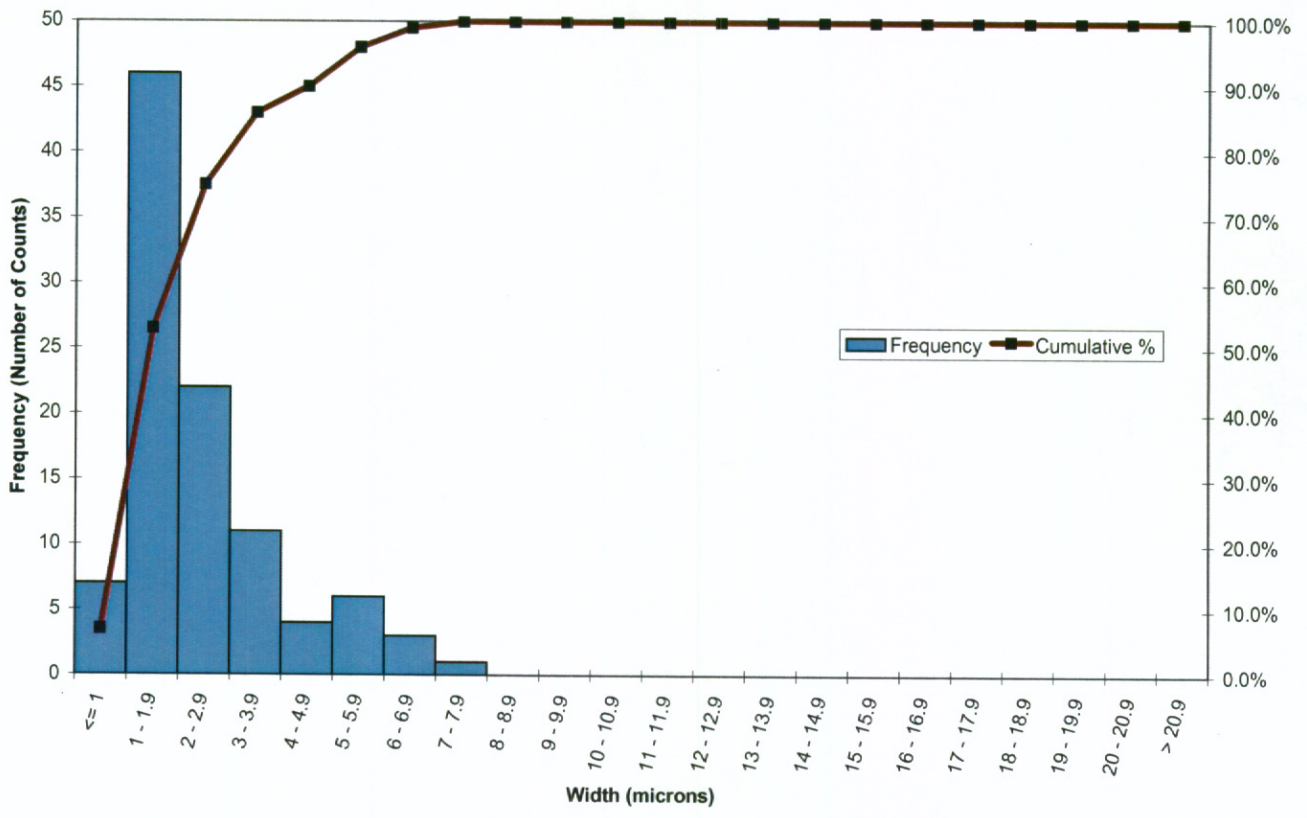


Figure 13. Frequency Distribution of Widths for Anthophyllite Particles:  
 Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)



**Figure 14. Frequency Distribution of Aspect Ratios for Anthophyllite Particles:  
Comparison of Dimensions from PCM Measured by Calibrated Visual Estimation and Walton-  
Beckett Graticule**

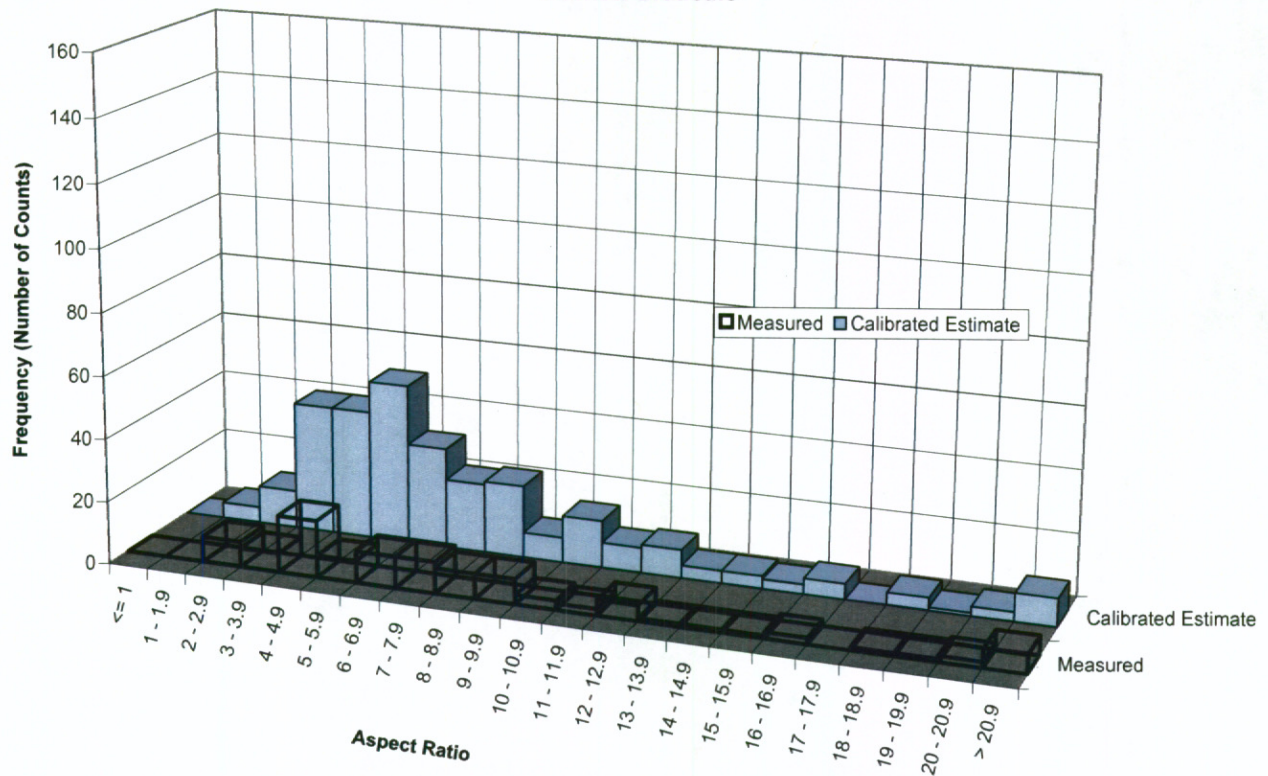


Figure 15. Frequency Distribution of Lengths for Anthophyllite Particles:  
 Comparison of Dimensions from PCM Measured by Calibrated Visual Estimation and Walton-Beckett Graticule

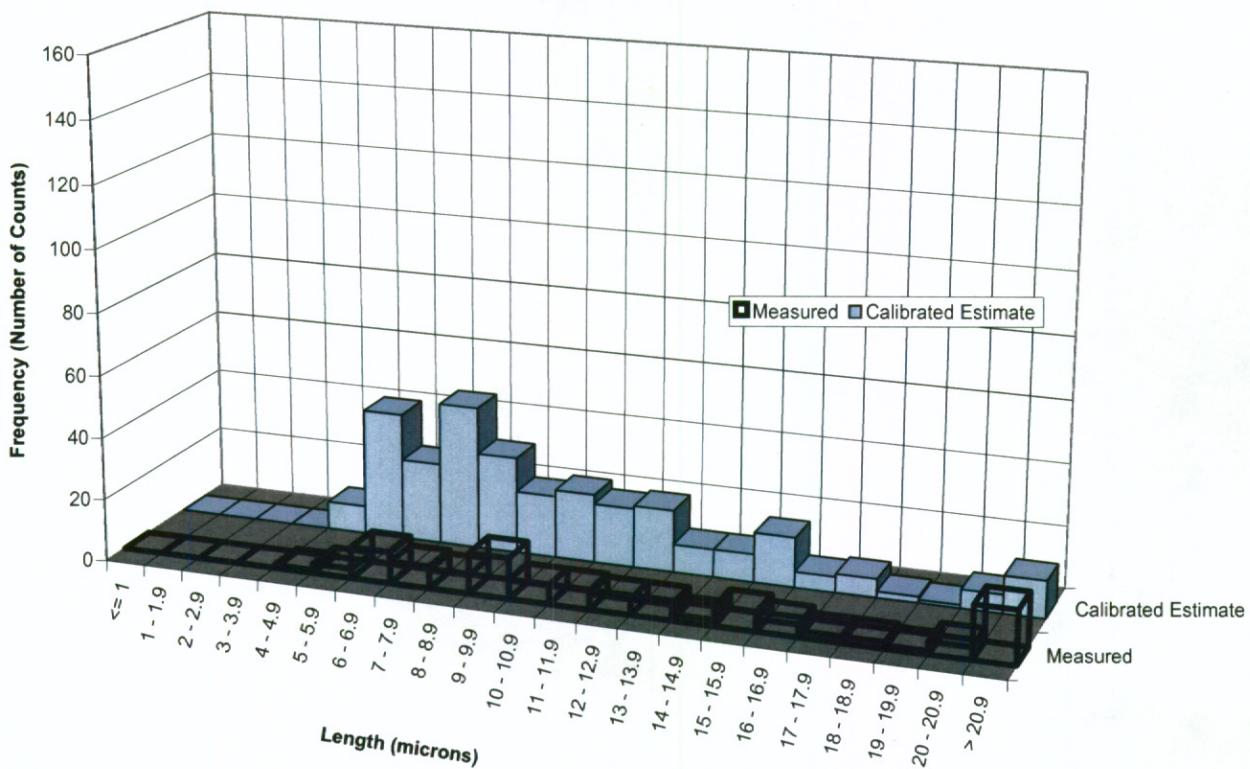
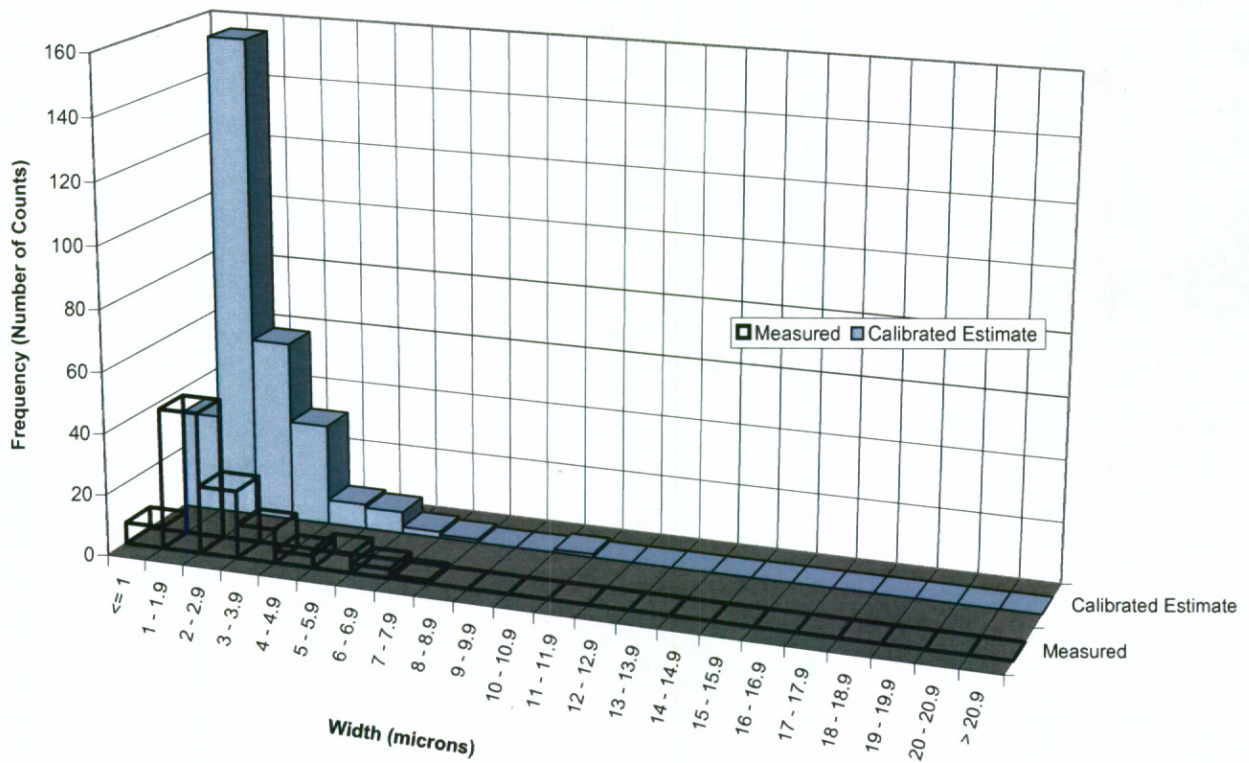




Figure 16. Frequency Distribution of Widths for Anthophyllite Particles:  
 Comparison of Dimensions from PCM Measured by Calibrated Visual Estimation and Walton-  
 Beckett Graticule



## **Analytical Data Summaries**

### **3F. NIEHS Tremolite**

NIEHS Tremolite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

**Table A: NIEHS Tremolite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

\* Note: data in red does not meet criteria for counting; ie.  $\geq 5$   $\mu\text{m}$  in length or  $\geq 3:1$  aspect ratio.

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
Structure	1	2.5	1.0	2.5
numbers	2	7.0	2.0	3.5
1-150	3	20.0	6.0	3.3
LCG	4	6.0	4.0	1.5
on	5	8.0	0.5	16.0
Filters 4-6	6	15.0	3.0	5.0
	7	5.0	1.0	5.0
	8	5.0	1.5	3.3
	9	7.0	0.5	14.0
	10	5.0	1.0	5.0
	11	5.0	1.0	5.0
	12	8.0	2.0	4.0
	13	4.0	1.5	2.7
	14	7.0	2.0	3.5
	15	5.0	2.0	2.5
	16	3.0	1.0	3.0
	17	5.0	1.0	5.0
	18	10.0	1.5	6.7
	19	3.0	1.0	3.0
	20	3.0	1.0	3.0
	21	4.0	1.5	2.7
	22	4.0	1.5	2.7
	23	13.0	10.0	1.3
	24	7.0	2.0	3.5
	25	9.0	3.0	3.0
	26	3.0	0.5	6.0
	27	4.0	1.0	4.0

Count of fibers 187  
 Count of non-fibers 113  
 Total Structures Counted 300

Percent Fibers 62.3%  
 Percent non-fibers 37.7%

Meet Fiber Criteria

Fiber  
 Fiber

Fiber  
 Fiber

Fiber  
 Fiber

Bin 0.9 <= 1

1.9 1 - 1.9 Fiber  
 2.9 2 - 2.9 Fiber

3.9 3 - 3.9  
 4.9 4 - 4.9 Fiber

5.9 5 - 5.9  
 6.9 6 - 6.9

7.9 7 - 7.9 Fiber  
 8.9 8 - 8.9 Fiber

9.9 9 - 9.9  
 10.9 10 - 10.9

11.9 11 - 11.9  
 12.9 12 - 12.9

13.9 13 - 13.9  
 14.9 14 - 14.9 Fiber

15.9 15 - 15.9 Fiber  
 16.9 16 - 16.9

17.9 17 - 17.9



NIEHS Tremolite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	62	25.0	8.0	3.1
	63	3.0	1.0	3.0
	64	5.0	1.0	5.0
	65	5.0	1.5	3.3
	66	12.0	2.5	4.8
	67	4.0	1.5	2.7
	68	15.0	3.0	5.0
	69	7.0	1.0	7.0
	70	7.0	2.0	3.5
	71	4.0	1.5	2.7
	72	5.0	1.5	3.3
	73	5.0	1.0	5.0
	74	3.0	1.0	3.0
	75	10.0	2.0	5.0
	76	10.0	2.0	5.0
	77	5.0	2.0	2.5
	78	3.0	2.0	1.5
	79	5.0	1.5	3.3
	80	5.0	1.0	5.0
	81	4.0	1.0	4.0
	82	4.0	1.5	2.7
	83	7.5	2.5	3.0
	84	20.0	4.0	5.0
	85	8.0	1.5	5.3
	86	9.0	5.0	1.8
	87	7.5	1.5	5.0
	88	4.0	1.5	2.7
	89	7.5	1.0	7.5
	90	6.0	3.0	2.0
	91	12.0	3.0	4.0
	92	5.0	1.5	3.3
	93	10.0	4.0	2.5
	94	12.0	7.0	1.7
	95	6.0	1.0	6.0

Meet  
Fiber  
Criteria 62.3% 37.7%

Fiber

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Fiber

NIEHS Tremolite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	96	18.0	7.5	2.4
	97	15.0	3.0	5.0
	98	7.0	2.0	3.5
	99	7.0	1.5	4.7
	100	5.0	1.0	5.0
	101	6.0	1.5	4.0
	102	4.0	1.5	2.7
	103	7.0	0.5	14.0
	104	5.0	1.0	5.0
	105	5.0	1.0	5.0
	106	10.0	0.5	20.0
	107	7.0	1.5	4.7
	108	3.0	0.5	6.0
	109	5.0	1.5	3.3
	110	5.0	1.5	3.3
	111	12.0	5.0	2.4
	112	5.0	1.5	3.3
	113	7.5	2.5	3.0
	114	5.0	1.0	5.0
	115	5.0	3.0	1.7
	116	25.0	8.0	3.1
	117	12.0	2.0	6.0
	118	10.0	1.0	10.0
	119	9.0	3.0	3.0
	120	4.0	1.5	2.7
	121	5.0	1.0	5.0
	122	5.0	1.0	5.0
	123	3.0	1.0	3.0
	124	9.0	3.0	3.0
	125	3.0	1.0	3.0
	126	6.0	1.5	4.0
	127	5.0	2.0	2.5
	128	3.0	1.5	2.0
	129	7.5	5.0	1.5

Meet Fiber Criteria 62.3% 37.7%

Fiber  
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NIEHS Tremolite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	198	9.0	1.0	9.0
	199	9.0	2.0	4.5
	200	12.0	5.0	2.4
	201	11.0	3.0	3.7
	202	16.0	1.0	16.0
	203	8.0	4.0	2.0
	204	7.0	3.0	2.3
	205	7.0	5.0	1.4
	206	15.0	5.0	3.0
	207	6.0	2.0	3.0
	208	10.0	4.0	2.5
	209	20.0	6.0	3.3
	210	9.0	6.0	1.5
	211	20.0	4.0	5.0
	212	8.0	2.0	4.0
	213	4.0	1.0	4.0
	214	6.0	2.0	3.0
	215	8.0	4.0	2.0
	216	8.0	2.0	4.0
	217	20.0	5.0	4.0
	218	28.0	4.0	7.0
	219	13.0	6.0	2.2
	220	5.0	1.0	5.0
	221	6.0	2.0	3.0
	222	9.0	7.0	1.3
	223	13.0	8.0	1.6
	224	10.0	3.0	3.3
	225	9.0	4.0	2.3
	226	12.0	2.0	6.0
	227	20.0	5.0	4.0
	228	16.0	9.0	1.8
	229	5.0	1.5	3.3
	230	13.0	2.0	6.5
	231	7.0	3.0	2.3

Meet  
Fiber  
Criteria 62.3% 37.7%

Fiber  
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NIEHS Tremolite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	266	12.0	4.0	3.0
	267	11.0	5.0	2.2
	268	5.0	0.5	10.0
	269	9.0	2.0	4.5
	270	20.0	6.0	3.3
	271	15.0	5.0	3.0
	272	11.0	3.0	3.7
	273	8.0	3.0	2.7
	274	12.0	2.0	6.0
	275	8.0	5.0	1.6
	276	6.0	2.0	3.0
	277	11.0	3.0	3.7
	278	10.0	3.0	3.3
	279	16.0	4.0	4.0
	280	18.0	3.0	6.0
	281	9.0	3.0	3.0
	282	12.0	3.0	4.0
	283	7.0	2.0	3.5
	284	11.0	8.0	1.4
	285	7.0	2.0	2.5
	286	8.0	4.0	2.0
	287	15.0	4.0	3.8
	288	10.0	8.0	1.3
	289	8.0	4.0	2.0
	290	10.0	5.0	2.0
	291	5.0	1.0	5.0
	292	11.0	3.0	3.7
	293	9.0	1.0	9.0
	294	22.0	6.0	3.7
	295	6.0	1.0	6.0
	296	25.0	12.0	2.1
	297	22.0	10.0	2.2
	298	15.0	4.0	3.8
	299	5.0	1.0	5.0

Meet  
Fiber  
Criteria 62.3% 37.7%

Fiber

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Fiber

NIEHS Tremolite Particle Size Data: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

Filter	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
	300	7.0	2.0	3.5

Meet  
Fiber  
Criteria 62.3% 37.7%  
Fiber

**Table A1: Summary Statistics for NIEHS Tremolite Particle Size Data:  
Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

<i>Length (microns)</i>		<i>Width (microns)</i>		<i>Aspect Ratio</i>	
<b>Mean</b>	9.23	<b>Mean</b>	2.79	<b>Mean</b>	4.47
<b>Standard Error</b>	0.32	<b>Standard Error</b>	0.13	<b>Standard Error</b>	0.20
<b>Median</b>	7.50	<b>Median</b>	2.00	<b>Median</b>	3.50
<b>Mode</b>	5.00	<b>Mode</b>	1.00	<b>Mode</b>	5.00
<b>Standard Deviation</b>	5.59	<b>Standard Deviation</b>	2.28	<b>Standard Deviation</b>	3.41
<b>Sample Variance</b>	31.27	<b>Sample Variance</b>	5.18	<b>Sample Variance</b>	11.66
<b>Kurtosis</b>	4.43	<b>Kurtosis</b>	4.63	<b>Kurtosis</b>	14.95
<b>Skewness</b>	1.72	<b>Skewness</b>	1.93	<b>Skewness</b>	3.24
<b>Range</b>	37.50	<b>Range</b>	14.50	<b>Range</b>	28.80
<b>Minimum</b>	2.50	<b>Minimum</b>	0.50	<b>Minimum</b>	1.20
<b>Maximum</b>	40.00	<b>Maximum</b>	15.00	<b>Maximum</b>	30.00
<b>Sum</b>	2768.20	<b>Sum</b>	835.50	<b>Sum</b>	1340.31
<b>Count</b>	300	<b>Count</b>	300	<b>Count</b>	300

**Table A2. Aspect Ratios for NIEHS Tremolite Particles: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Aspect Ratio</i>
0.9	0	0.0%	0.0%	<= 1
1.9	31	10.3%	10.3%	1 - 1.9
2.9	58	19.3%	29.7%	2 - 2.9
3.9	81	27.0%	56.7%	3 - 3.9
4.9	34	11.3%	68.0%	4 - 4.9
5.9	37	12.3%	80.3%	5 - 5.9
6.9	24	8.0%	88.3%	6 - 6.9
7.9	8	2.7%	91.0%	7 - 7.9
8.9	0	0.0%	91.0%	8 - 8.9
9.9	4	1.3%	92.3%	9 - 9.9
10.9	8	2.7%	95.0%	10 - 10.9
11.9	2	0.7%	95.7%	11 - 11.9
12.9	2	0.7%	96.3%	12 - 12.9
13.9	1	0.3%	96.7%	13 - 13.9
14.9	2	0.7%	97.3%	14 - 14.9
15.9	1	0.3%	97.7%	15 - 15.9
16.9	3	1.0%	98.7%	16 - 16.9
17.9	0	0.0%	98.7%	17 - 17.9
18.9	0	0.0%	98.7%	18 - 18.9
19.9	0	0.0%	98.7%	19 - 19.9
20.9	3	1.0%	99.7%	20 - 20.9
More	1	0.3%	100.0%	> 20.9
Sum	300			

**Table A3. Lengths for NIEHS Tremolite Particles: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Length (microns)</i>
0.9	0	0.0%	0.0%	<= 1
1.9	0	0.0%	0.0%	1 - 1.9
2.9	1	0.3%	0.3%	2 - 2.9
3.9	22	7.3%	7.7%	3 - 3.9
4.9	21	7.0%	14.7%	4 - 4.9
5.9	48	16.0%	30.7%	5 - 5.9
6.9	19	6.3%	37.0%	6 - 6.9
7.9	41	13.7%	50.7%	7 - 7.9
8.9	15	5.0%	55.7%	8 - 8.9
9.9	20	6.7%	62.3%	9 - 9.9
10.9	22	7.3%	69.7%	10 - 10.9
11.9	12	4.0%	73.7%	11 - 11.9
12.9	21	7.0%	80.7%	12 - 12.9
13.9	6	2.0%	82.7%	13 - 13.9
14.9	3	1.0%	83.7%	14 - 14.9
15.9	14	4.7%	88.3%	15 - 15.9
16.9	6	2.0%	90.3%	16 - 16.9
17.9	0	0.0%	90.3%	17 - 17.9
18.9	6	2.0%	92.3%	18 - 18.9
19.9	0	0.0%	92.3%	19 - 19.9
20.9	13	4.3%	96.7%	20 - 20.9
More	10	3.3%	100.0%	> 20.9

Sum 300

**Table A4. Widths for NIEHS Tremolite Particles: Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>
0.9	15	5.0%	5.0%	<= 1
1.9	110	36.7%	41.7%	1 - 1.9
2.9	58	19.3%	61.0%	2 - 2.9
3.9	40	13.3%	74.3%	3 - 3.9
4.9	23	7.7%	82.0%	4 - 4.9
5.9	22	7.3%	89.3%	5 - 5.9
6.9	9	3.0%	92.3%	6 - 6.9
7.9	7	2.3%	94.7%	7 - 7.9
8.9	8	2.7%	97.3%	8 - 8.9
9.9	1	0.3%	97.7%	9 - 9.9
10.9	4	1.3%	99.0%	10 - 10.9
11.9	0	0.0%	99.0%	11 - 11.9
12.9	2	0.7%	99.7%	12 - 12.9
13.9	0	0.0%	99.7%	13 - 13.9
14.9	0	0.0%	99.7%	14 - 14.9
15.9	1	0.3%	100.0%	15 - 15.9
16.9	0	0.0%	100.0%	16 - 16.9
17.9	0	0.0%	100.0%	17 - 17.9
18.9	0	0.0%	100.0%	18 - 18.9
19.9	0	0.0%	100.0%	19 - 19.9
20.9	0	0.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9
Sum	300			



NIEHS Tremolite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

Table B. NIEHS Tremolite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

\* Note: data in red does not meet criteria for counting; ie.  $\geq 25 \mu\text{m}$  in length or  $\geq 3:1$  aspect ratio.

Filter	Grid	Grid Opening	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
1	A1	E1	1	7.3	2.7	2.7
1	A1	E1	2	1.2	0.5	2.5
1	A1	E1	3	0.8	0.1	7.0
1	A1	E1	4	1.8	0.3	6.0
1	A1	E1	5	1.5	0.4	4.0
1	A1	E1	6	3.6	0.4	10.0
1	A1	E1	7	6.1	3.1	1.9
1	A1	E1	8	6.3	1.5	4.2
1	A1	E1	9	1.7	0.1	14.0
1	A1	E1	10	8.7	1.0	9.0
1	A1	E1	11	3.0	0.3	10.0
1	A1	E1	12	2.1	0.7	2.9
1	A1	E1	13	2.7	0.3	8.8
1	A1	E1	14	14.5	2.8	5.2
1	A1	E1	15	2.2	0.9	2.4
1	A1	E1	16	1.5	0.7	2.0
1	A1	E1	17	2.4	0.8	2.9
1	A1	E1	18	1.8	0.5	3.8
1	A1	E1	19	1.6	0.3	5.2
1	A1	E1	20	1.2	0.1	20.0
1	A1	E1	21	12.1	4.8	2.5
1	A1	E1	22	0.7	0.1	12.0
1	A1	E1	23	1.0	0.1	16.0
1	A1	E1	24	2.4	0.2	10.0
1	A1	E1	25	9.7	2.4	4.0
1	A1	E1	26	5.1	1.2	4.3
1	A1	E1	27	2.8	0.6	4.6
1	A1	E1	28	1.2	0.1	20.0
1	A1	E1	29	1.5	0.1	16.0
1	A1	E1	30	4.8	0.6	8.0
1	A1	E1	31	10.0	2.1	4.7
1	A1	E1	32	12.3	2.2	5.7
1	A1	E1	33	0.8	0.1	14.0
1	A1	E1	34	1.8	0.2	7.5
1	A1	E1	35	2.4	0.2	10.0
1	A1	E1	36	2.1	0.5	4.4
1	A1	E1	37	3.6	0.8	4.3
1	A1	E1	38	3.3	0.7	4.5
1	A1	E1	39	9.1	3.9	2.3

PCM-Equivalent Fiber 41	TEM-only fiber 0	Length <5 $\mu\text{m}$ or Width <3 $\mu\text{m}$ 259	Total Structures Counted 300
PCM-Equivalent Fibers	Percent TEM-only Fibers	Percent non-Fibers	

Bin	PCM Fiber	PCM Equ Fiber	TEM only fiber	Length <5 or A.R. <3	13.7%	0.0%	86.3%
0.9				Yes			
1.9				Yes			
1.9				Yes			
2.9				Yes			
3.9				Yes			
4.9				Yes			
5.9				Yes			
6.9				Yes			
7.9				Yes			
8.9				Yes			
9.9				Yes			
10.9				Yes			
11.9				Yes			
12.9				Yes			
13.9				Yes			
14.9				Yes			
15.9				Yes			
16.9				Yes			
17.9				Yes			
18.9				Yes			
19.9				Yes			
20.9				Yes			
More				Yes			
0.09				Yes			
0.19				Yes			
0.24				Yes			
0.29				Yes			
0.39				Yes			
0.49				Yes			







NIEHS Tremolite Particle Size Data: Dimensions Measured by TEM PCME (10,000X Magnification)

Filter	Grid	Grid Opening	Structure Number	Length (microns)	Width (microns)	Aspect Ratio
4	D1	E1	183	4.0	3.0	1.3
4	D1	E1	184	4.8	0.4	13.3
4	D1	E1	185	1.5	0.1	12.0
4	D1	E1	186	24.2	7.3	3.3
4	D1	E1	187	1.8	0.6	3.0
4	D1	E1	188	1.5	0.6	2.4
4	D1	E1	189	1.1	0.1	9.0
4	D1	E1	190	1.5	0.5	3.1
4	D1	E1	191	1.9	0.6	3.2
4	D1	E1	192	6.1	1.8	3.3
4	D1	E1	193	1.5	0.1	12.5
4	D1	E1	194	1.2	0.1	20.0
4	D1	E1	195	2.4	1.2	2.0
4	D1	E1	196	1.8	0.9	2.0
4	D1	E1	197	2.1	0.6	3.4
4	D1	E1	198	3.0	0.6	5.0
4	D1	E1	199	4.2	0.8	5.0
4	D1	E1	200	3.3	0.7	4.6
5	E1	E13	201	1.8	1.5	1.2
5	E1	E13	202	5.4	2.1	2.6
5	E1	E13	203	1.9	0.3	6.4
5	E1	E13	204	3.3	0.6	5.5
5	E1	E13	205	8.0	4.8	1.7
5	E1	E13	206	4.1	1.8	2.3
5	E1	E13	207	3.9	0.7	5.3
5	E1	E13	208	4.8	1.8	2.7
5	E1	E13	209	11.2	2.7	4.1
5	E1	E13	210	3.8	0.5	7.8
5	E1	E13	211	1.3	0.1	22.0
5	E1	E13	212	1.5	0.1	12.5
5	E1	E13	213	3.3	0.6	5.4
5	E1	E13	214	1.2	0.1	20.0
5	E1	E13	215	19.4	2.7	7.1
5	E1	E13	216	1.5	0.1	24.0
5	E1	E13	217	3.9	1.2	3.2
5	E1	E13	218	3.0	0.4	8.3
5	E1	E13	219	1.6	0.6	2.6
5	E1	E13	220	1.0	0.1	8.0
5	E1	E13	221	1.5	0.6	2.5
5	E1	E13	222	2.7	1.8	1.5
5	E1	E13	223	4.5	1.2	3.8
5	E1	E13	224	1.2	0.1	20.0
5	E1	E13	225	1.1	0.2	6.0
5	E1	E13	226	2.8	1.5	1.9
5	E1	E13	227	1.8	0.1	15.0
5	E1	E13	228	10.9	1.8	6.0
5	E1	E20	229	3.0	1.0	3.1

PCM Fiber	PCM Equ Fiber	TEM only fiber	Length <5 or A.R. <3	13.7%	0.0%	86.3%
			Yes			
			Yes			
			Yes			
Fiber	PEF		Yes			
			Yes			
			Yes			
			Yes			
			Yes			
Fiber	PEF		Yes			
			Yes			
			Yes			
			Yes			
			Yes			
			Yes			
			Yes			
			Yes			
			Yes			
			Yes			
			Yes			
Fiber	PEF		Yes			
			Yes			
			Yes			
			Yes			
			Yes			
			Yes			
			Yes			
			Yes			
			Yes			
			Yes			
			Yes			
			Yes			
			Yes			
			Yes			
			Yes			
			Yes			
			Yes			
			Yes			
			Yes			
			Yes			
Fiber	PEF		Yes			





**Table B1: Summary Statistics for NIEHS Tremolite Particle Size Data: TEM PCME  
(10,000X Magnification)**

<i>Length (microns)</i>		<i>Width (microns)</i>		<i>Aspect Ratio</i>	
<b>Mean</b>	3.57	<b>Mean</b>	0.90	<b>Mean</b>	7.22
<b>Standard Error</b>	0.20	<b>Standard Error</b>	0.07	<b>Standard Error</b>	0.39
<b>Median</b>	2.42	<b>Median</b>	0.61	<b>Median</b>	5.00
<b>Mode</b>	1.82	<b>Mode</b>	0.12	<b>Mode</b>	4.00
<b>Standard Deviation</b>	3.50	<b>Standard Deviation</b>	1.13	<b>Standard Deviation</b>	6.73
<b>Sample Variance</b>	12.25	<b>Sample Variance</b>	1.29	<b>Sample Variance</b>	45.33
<b>Kurtosis</b>	15.55	<b>Kurtosis</b>	13.68	<b>Kurtosis</b>	18.19
<b>Skewness</b>	3.28	<b>Skewness</b>	3.13	<b>Skewness</b>	3.35
<b>Range</b>	29.04	<b>Range</b>	8.41	<b>Range</b>	58.89
<b>Minimum</b>	0.61	<b>Minimum</b>	0.06	<b>Minimum</b>	1.11
<b>Maximum</b>	29.65	<b>Maximum</b>	8.47	<b>Maximum</b>	60.00
<b>Sum</b>	1070.40	<b>Sum</b>	271.19	<b>Sum</b>	2166.07
<b>Count</b>	300	<b>Count</b>	300	<b>Count</b>	300



Tremolite.xls  
 Aspect Ratio\_TEM 300

**Table B2. Aspect Ratios for 300 NIEHS Tremolite  
 Particles: TEM PCME (10,000X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Aspect Ratio</i>
0.9	0	0.0%	0.0%	<= 1
1.9	18	6.0%	6.0%	1 - 1.9
2.9	47	15.7%	21.7%	2 - 2.9
3.9	34	11.3%	33.0%	3 - 3.9
4.9	47	15.7%	48.7%	4 - 4.9
5.9	30	10.0%	58.7%	5 - 5.9
6.9	16	5.3%	64.0%	6 - 6.9
7.9	16	5.3%	69.3%	7 - 7.9
8.9	19	6.3%	75.7%	8 - 8.9
9.9	5	1.7%	77.3%	9 - 9.9
10.9	13	4.3%	81.7%	10 - 10.9
11.9	4	1.3%	83.0%	11 - 11.9
12.9	10	3.3%	86.3%	12 - 12.9
13.9	2	0.7%	87.0%	13 - 13.9
14.9	5	1.7%	88.7%	14 - 14.9
15.9	7	2.3%	91.0%	15 - 15.9
16.9	5	1.7%	92.7%	16 - 16.9
17.9	1	0.3%	93.0%	17 - 17.9
18.9	1	0.3%	93.3%	18 - 18.9
19.9	0	0.0%	93.3%	19 - 19.9
20.9	9	3.0%	96.3%	20 - 20.9
More	11	3.7%	100.0%	> 20.9

Sum 300

**Table B3. Lengths for 300 NIEHS Tremolite  
Particles: TEM PCME (10,000X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Length (microns)</i>
0.9	9	3.0%	3.0%	<= 1
1.9	97	32.3%	35.3%	1 - 1.9
2.9	81	27.0%	62.3%	2 - 2.9
3.9	36	12.0%	74.3%	3 - 3.9
4.9	19	6.3%	80.7%	4 - 4.9
5.9	15	5.0%	85.7%	5 - 5.9
6.9	10	3.3%	89.0%	6 - 6.9
7.9	4	1.3%	90.3%	7 - 7.9
8.9	5	1.7%	92.0%	8 - 8.9
9.9	6	2.0%	94.0%	9 - 9.9
10.9	5	1.7%	95.7%	10 - 10.9
11.9	1	0.3%	96.0%	11 - 11.9
12.9	5	1.7%	97.7%	12 - 12.9
13.9	1	0.3%	98.0%	13 - 13.9
14.9	1	0.3%	98.3%	14 - 14.9
15.9	2	0.7%	99.0%	15 - 15.9
16.9	0	0.0%	99.0%	16 - 16.9
17.9	0	0.0%	99.0%	17 - 17.9
18.9	0	0.0%	99.0%	18 - 18.9
19.9	1	0.3%	99.3%	19 - 19.9
20.9	0	0.0%	99.3%	20 - 20.9
More	2	0.7%	100.0%	> 20.9

Sum 300

**Table B4. Widths for 300 NIEHS Tremolite Particles:  
TEM PCME (10,000X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>
0.9	199	66.3%	66.3%	<= 1
1.9	62	20.7%	87.0%	1 - 1.9
2.9	22	7.3%	94.3%	2 - 2.9
3.9	9	3.0%	97.3%	3 - 3.9
4.9	5	1.7%	99.0%	4 - 4.9
5.9	0	0.0%	99.0%	5 - 5.9
6.9	0	0.0%	99.0%	6 - 6.9
7.9	2	0.7%	99.7%	7 - 7.9
8.9	1	0.3%	100.0%	8 - 8.9
9.9	0	0.0%	100.0%	9 - 9.9
10.9	0	0.0%	100.0%	10 - 10.9
11.9	0	0.0%	100.0%	11 - 11.9
12.9	0	0.0%	100.0%	12 - 12.9
13.9	0	0.0%	100.0%	13 - 13.9
14.9	0	0.0%	100.0%	14 - 14.9
15.9	0	0.0%	100.0%	15 - 15.9
16.9	0	0.0%	100.0%	16 - 16.9
17.9	0	0.0%	100.0%	17 - 17.9
18.9	0	0.0%	100.0%	18 - 18.9
19.9	0	0.0%	100.0%	19 - 19.9
20.9	0	0.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9
Sum	300			

**Table B5. Widths for 300 NIEHS Tremolite Particles: TEM  
PCME (10,000X Magnification) Finer Detail**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>
0.09	25	8.3%	8.3%	<= 0.1
0.19	41	13.7%	22.0%	0.10 - 0.19
0.24	0	0.0%	22.0%	0.20 - 0.24
0.29	22	7.3%	29.3%	0.25 - 0.29
0.39	42	14.0%	43.3%	0.30 - 0.39
0.49	17	5.7%	49.0%	0.40 - 0.49
0.59	0	0.0%	49.0%	0.50 - 0.59
0.69	33	11.0%	60.0%	0.60 - 0.69
0.79	12	4.0%	64.0%	0.70 - 0.79
0.89	7	2.3%	66.3%	0.80 - 0.89
0.99	26	8.7%	75.0%	0.90 - 0.99
1.09	0	0.0%	75.0%	1 - 1.09
1.19	0	0.0%	75.0%	1.1 - 1.19
1.29	17	5.7%	80.7%	1.2 - 1.29
1.39	0	0.0%	80.7%	1.3 - 1.39
1.49	3	1.0%	81.7%	1.4 - 1.49
1.59	8	2.7%	84.3%	1.5 - 1.59
1.69	0	0.0%	84.3%	1.6 - 1.69
1.79	1	0.3%	84.7%	1.7 - 1.79
1.89	7	2.3%	87.0%	1.8 - 1.89
1.99	1	0.3%	87.3%	1.9 - 1.99
2.09	0	0.0%	87.3%	2.0 - 2.09
2.19	10	3.3%	90.7%	2.1 - 2.19
2.29	0	0.0%	90.7%	2.2 - 2.29
2.39	0	0.0%	90.7%	2.3 - 2.39
2.49	4	1.3%	92.0%	2.4 - 2.49
2.59	0	0.0%	92.0%	2.5 - 2.59
2.69	1	0.3%	92.3%	2.6 - 2.69
2.79	6	2.0%	94.3%	2.7 - 2.79
2.89	0	0.0%	94.3%	2.8 - 2.89
2.99	0	0.0%	94.3%	2.9 - 2.99
3.09	5	1.7%	96.0%	3.0 - 3.09
3.19	1	0.3%	96.3%	3.1 - 3.19
3.29	0	0.0%	96.3%	3.2 - 3.29
3.39	1	0.3%	96.7%	3.3 - 3.39
3.49	0	0.0%	96.7%	3.4 - 3.49
3.59	0	0.0%	96.7%	3.5 - 3.59
3.69	2	0.7%	97.3%	3.6 - 3.69
3.79	0	0.0%	97.3%	3.7 - 3.79
3.89	0	0.0%	97.3%	3.8 - 3.89
3.99	1	0.3%	97.7%	3.9 - 3.99
4.09	0	0.0%	97.7%	4.0 - 4.09
4.19	0	0.0%	97.7%	4.1 - 4.19
4.29	2	0.7%	98.3%	4.2 - 4.29
4.39	0	0.0%	98.3%	4.3 - 4.39
4.49	0	0.0%	98.3%	4.4 - 4.49
4.59	0	0.0%	98.3%	4.5 - 4.59
4.69	0	0.0%	98.3%	4.6 - 4.69
4.79	0	0.0%	98.3%	4.7 - 4.79
4.89	2	0.7%	99.0%	4.8 - 4.89
More	3	1.0%	100.0%	> 4.89
Sum	300			



Particle Size Data for NIEHS Tremolite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

Filter	Particle	Length (microns)	Width (microns)	Aspect Ratio		meet Fiber Criteria	Percent Fibers	Percent non-fibers
6	27	7.5	2.0	3.8	17.9	17 - 17.9		
6	28	3.0	1.0	3.0	18.9	18 - 18.9		
6	29	10.0	0.5	20.0	19.9	19 - 19.9		
6	30	5.0	0.5	10.0	20.9	20 - 20.9		
6	31	7.5	2.0	3.8	More	> 20.9		
6	32	7.5	2.0	3.8				
6	33	7.5	1.0	7.5				
6	34	17.5	3.0	5.8				
6	35	12.0	3.0	4.0	Bin			
6	36	7.5	1.5	5.0	0.24	<= 0.25		
6	37	3.0	0.5	6.0	0.9	0.25-0.9		
6	38	7.5	2.0	3.8	1.9	1 - 1.9		
6	39	3.0	1.5	2.0	2.9	2 - 2.9		
6	40	18.0	7.0	2.6	3.9	3 - 3.9		
6	41	7.5	2.0	3.8	4.9	4 - 4.9		
6	42	15.0	9.0	1.7	5.9	5 - 5.9		
6	43	10.0	5.0	2.0	6.9	6 - 6.9		
6	44	3.0	0.5	6.0	7.9	7 - 7.9		
6	45	11.0	2.5	4.4	8.9	8 - 8.9		
6	46	5.0	2.0	2.5	9.9	9 - 9.9		
6	47	7.5	2.0	3.8	10.9	10 - 10.9		
6	48	5.0	1.5	3.3	11.9	11 - 11.9		
6	49	5.0	1.0	5.0	12.9	12 - 12.9		
6	50	4.0	0.5	8.0	13.9	13 - 13.9		
1	51	11.0	4.0	2.8	14.9	14 - 14.9		
1	52	22.0	9.0	2.4	15.9	15 - 15.9		
1	53	8.0	1.5	5.3	16.9	16 - 16.9		
1	54	7.0	1.0	7.0	17.9	17 - 17.9		
1	55	15.0	3.0	5.0	18.9	18 - 18.9		
1	56	14.0	9.0	1.6	19.9	19 - 19.9		
1	57	13.0	7.0	1.9	20.9	20 - 20.9		
1	58	7.0	3.0	2.3	More	> 20.9		
1	59	5.0	1.5	3.3				
1	60	17.0	3.0	5.7				

Particle Size Data for NIEHS Tremolite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

Filter	Particle	Length (microns)	Width (microns)	Aspect Ratio
1	61	6.0	5.0	1.2
1	62	7.0	2.0	3.5
1	63	6.0	1.0	6.0
1	64	5.0	1.0	5.0
1	65	14.0	3.0	4.7
1	66	10.0	2.0	5.0
1	67	7.0	2.0	3.5
1	68	7.0	2.0	3.5
1	69	10.0	2.0	5.0
1	70	7.0	3.0	2.3
1	71	22.0	5.0	4.4
1	72	7.0	4.0	1.8
1	73	8.0	3.0	2.7
1	74	5.0	2.0	2.5
1	75	7.0	2.0	3.5
1	76	7.0	2.0	3.5
1	77	5.0	2.0	2.5
1	78	11.0	3.0	3.7
1	79	12.0	3.0	4.0
1	80	12.0	4.0	3.0
1	81	5.0	3.0	1.7
1	82	17.0	4.0	4.3
1	83	16.0	5.0	3.2
1	84	8.0	1.5	5.3
1	85	5.0	1.5	3.3
1	86	10.0	1.5	6.7
1	87	7.0	1.5	4.7
1	88	21.0	9.0	2.3
1	89	7.0	1.5	4.7
1	90	12.0	6.0	2.0
1	91	9.0	2.5	3.6
1	92	12.0	2.0	6.0
1	93	10.0	6.0	1.7
1	94	7.0	2.5	2.8

meet  
Fiber  
Criteria    Percent  
Fibers    Percent  
non-fibers

Fiber  
Fiber  
Fiber  
Fiber  
Fiber  
Fiber  
Fiber  
Fiber

Fiber

Fiber  
Fiber

Fiber  
Fiber  
Fiber

Fiber  
Fiber  
Fiber  
Fiber  
Fiber

Fiber

Fiber  
Fiber

Particle Size Data for NIEHS Tremolite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

Filter	Particle	Length (microns)	Width (microns)	Aspect Ratio
1	95	6.0	1.0	6.0
1	96	11.0	3.0	3.7
1	97	7.0	5.0	1.4
1	98	7.0	5.0	1.4
1	99	10.0	1.5	6.7
1	100	18.0	7.0	2.6

meet  
**Fiber**  
**Criteria**  
 Fiber  
 Fiber  
 Fiber

**Percent**  
**Fibers**

**Percent**  
**non-fibers**



**Table C1. Summary Statistics: Particle Size Data for NIEHS Tremolite Particles:  
Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)**

<i>Length (microns)</i>		<i>Width (microns)</i>		<i>Aspect Ratio</i>	
<b>Mean</b>	8.87	<b>Mean</b>	2.66	<b>Mean</b>	4.25
<b>Standard Error</b>	0.47	<b>Standard Error</b>	0.20	<b>Standard Error</b>	0.24
<b>Median</b>	7.50	<b>Median</b>	2.00	<b>Median</b>	3.75
<b>Mode</b>	5.00	<b>Mode</b>	2.00	<b>Mode</b>	5.00
<b>Standard Deviation</b>	4.74	<b>Standard Deviation</b>	2.02	<b>Standard Deviation</b>	2.44
<b>Sample Variance</b>	22.43	<b>Sample Variance</b>	4.09	<b>Sample Variance</b>	5.96
<b>Kurtosis</b>	1.28	<b>Kurtosis</b>	2.33	<b>Kurtosis</b>	16.90
<b>Skewness</b>	1.23	<b>Skewness</b>	1.63	<b>Skewness</b>	3.07
<b>Range</b>	22.00	<b>Range</b>	8.50	<b>Range</b>	18.80
<b>Minimum</b>	3.00	<b>Minimum</b>	0.50	<b>Minimum</b>	1.20
<b>Maximum</b>	25.00	<b>Maximum</b>	9.00	<b>Maximum</b>	20.00
<b>Sum</b>	886.50	<b>Sum</b>	265.50	<b>Sum</b>	425.35
<b>Count</b>	100	<b>Count</b>	100	<b>Count</b>	100

**Table C2. Aspect Ratios for NIEHS Tremolite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Aspect Ratio</i>
0.9	0	0.0%	0.0%	<= 1
1.9	10	10.0%	10.0%	1 - 1.9
2.9	18	18.0%	28.0%	2 - 2.9
3.9	24	24.0%	52.0%	3 - 3.9
4.9	12	12.0%	64.0%	4 - 4.9
5.9	18	18.0%	82.0%	5 - 5.9
6.9	11	11.0%	93.0%	6 - 6.9
7.9	2	2.0%	95.0%	7 - 7.9
8.9	1	1.0%	96.0%	8 - 8.9
9.9	0	0.0%	96.0%	9 - 9.9
10.9	3	3.0%	99.0%	10 - 10.9
11.9	0	0.0%	99.0%	11 - 11.9
12.9	0	0.0%	99.0%	12 - 12.9
13.9	0	0.0%	99.0%	13 - 13.9
14.9	0	0.0%	99.0%	14 - 14.9
15.9	0	0.0%	99.0%	15 - 15.9
16.9	0	0.0%	99.0%	16 - 16.9
17.9	0	0.0%	99.0%	17 - 17.9
18.9	0	0.0%	99.0%	18 - 18.9
19.9	0	0.0%	99.0%	19 - 19.9
20.9	1	1.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9

Sum 100

**Table C3. Lengths for NIEHS Tremolite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Length (microns)</i>
0.9	0	0.0%	0.0%	<= 1
1.9	0	0.0%	0.0%	1 - 1.9
2.9	0	0.0%	0.0%	2 - 2.9
3.9	9	9.0%	9.0%	3 - 3.9
4.9	3	3.0%	12.0%	4 - 4.9
5.9	14	14.0%	26.0%	5 - 5.9
6.9	6	6.0%	32.0%	6 - 6.9
7.9	25	25.0%	57.0%	7 - 7.9
8.9	5	5.0%	62.0%	8 - 8.9
9.9	3	3.0%	65.0%	9 - 9.9
10.9	8	8.0%	73.0%	10 - 10.9
11.9	4	4.0%	77.0%	11 - 11.9
12.9	5	5.0%	82.0%	12 - 12.9
13.9	1	1.0%	83.0%	13 - 13.9
14.9	2	2.0%	85.0%	14 - 14.9
15.9	5	5.0%	90.0%	15 - 15.9
16.9	1	1.0%	91.0%	16 - 16.9
17.9	3	3.0%	94.0%	17 - 17.9
18.9	2	2.0%	96.0%	18 - 18.9
19.9	0	0.0%	96.0%	19 - 19.9
20.9	0	0.0%	96.0%	20 - 20.9
More	4	4.0%	100.0%	> 20.9
Sum	100			

**Table C4. Widths for NIEHS Tremolite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)**

<i>Bin</i>	<i>Frequency</i>	<i>Relative %</i>	<i>Cumulative %</i>	<i>Width (microns)</i>
0.24	0	0.0%	0.0%	<= 0.25
0.9	7	7.0%	7.0%	0.25-0.9
1.9	32	32.0%	39.0%	1 - 1.9
2.9	26	26.0%	65.0%	2 - 2.9
3.9	14	14.0%	79.0%	3 - 3.9
4.9	4	4.0%	83.0%	4 - 4.9
5.9	7	7.0%	90.0%	5 - 5.9
6.9	3	3.0%	93.0%	6 - 6.9
7.9	3	3.0%	96.0%	7 - 7.9
8.9	0	0.0%	96.0%	8 - 8.9
9.9	4	4.0%	100.0%	9 - 9.9
10.9	0	0.0%	100.0%	10 - 10.9
11.9	0	0.0%	100.0%	11 - 11.9
12.9	0	0.0%	100.0%	12 - 12.9
13.9	0	0.0%	100.0%	13 - 13.9
14.9	0	0.0%	100.0%	14 - 14.9
15.9	0	0.0%	100.0%	15 - 15.9
16.9	0	0.0%	100.0%	16 - 16.9
17.9	0	0.0%	100.0%	17 - 17.9
18.9	0	0.0%	100.0%	18 - 18.9
19.9	0	0.0%	100.0%	19 - 19.9
20.9	0	0.0%	100.0%	20 - 20.9
More	0	0.0%	100.0%	> 20.9

Sum 100

Figure 1. Frequency Distribution of Aspect Ratios for 300 NIEHS Tremolite Particles:  
 Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

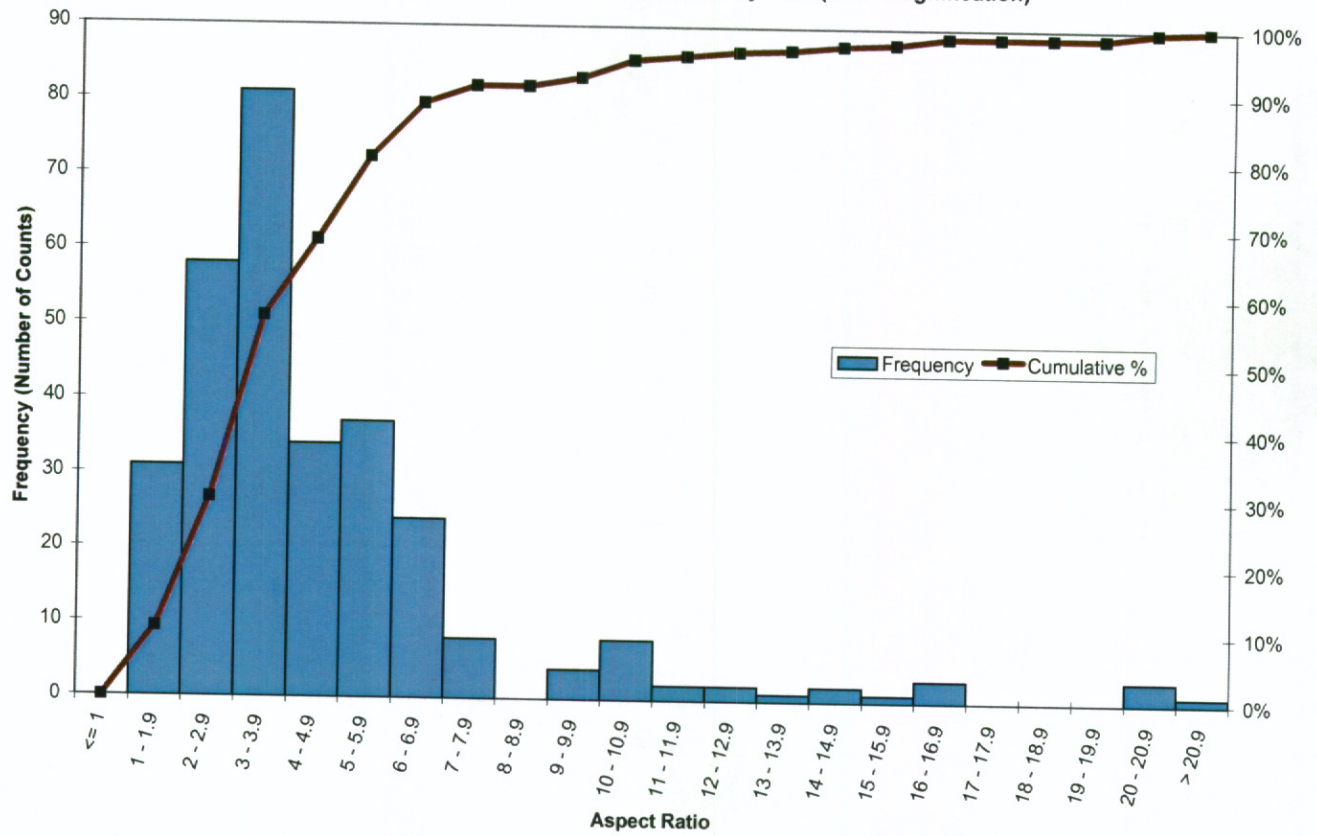


Figure 2. Frequency Distribution of Lengths for 300 NIEHS Tremolite Particles:  
 Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

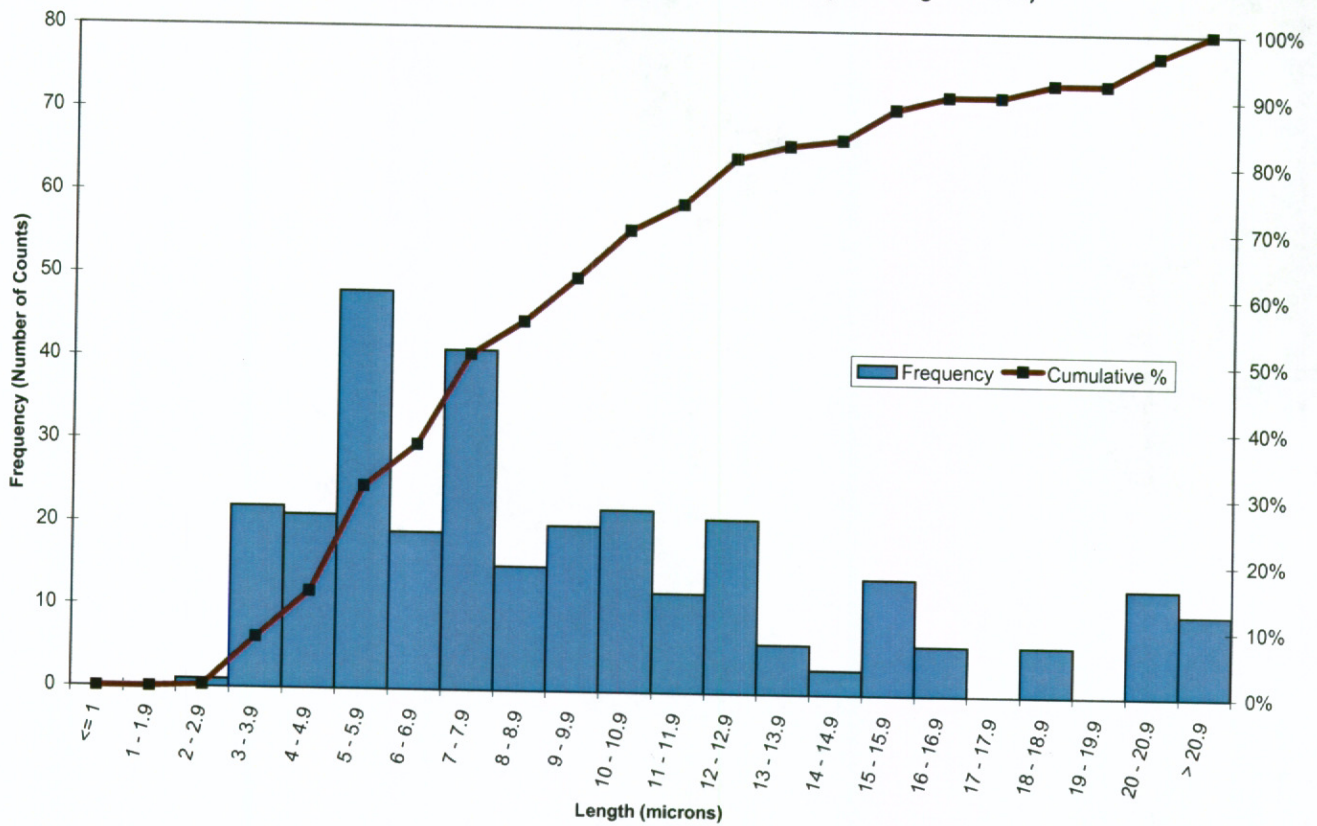


Figure 3. Frequency Distribution of Widths for 300 NIEHS Tremolite Particles:  
 Calibrated Visual Estimation of Dimensions by PCM (400X Magnification)

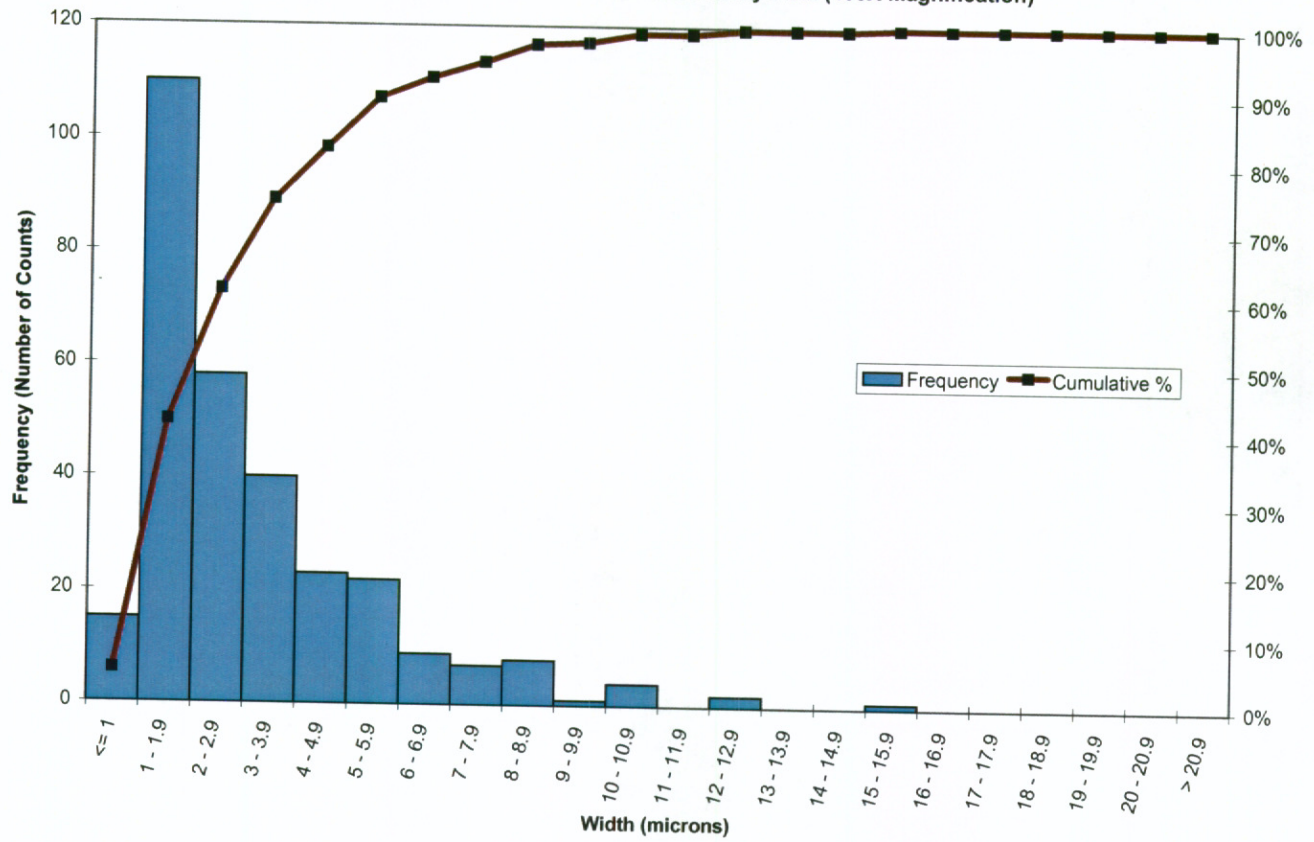


Figure 4. Frequency Distribution of Aspect Ratios for 300 NIEHS Tremolite Particles:  
Dimensions Measured by TEM PCME (10,000X Magnification)

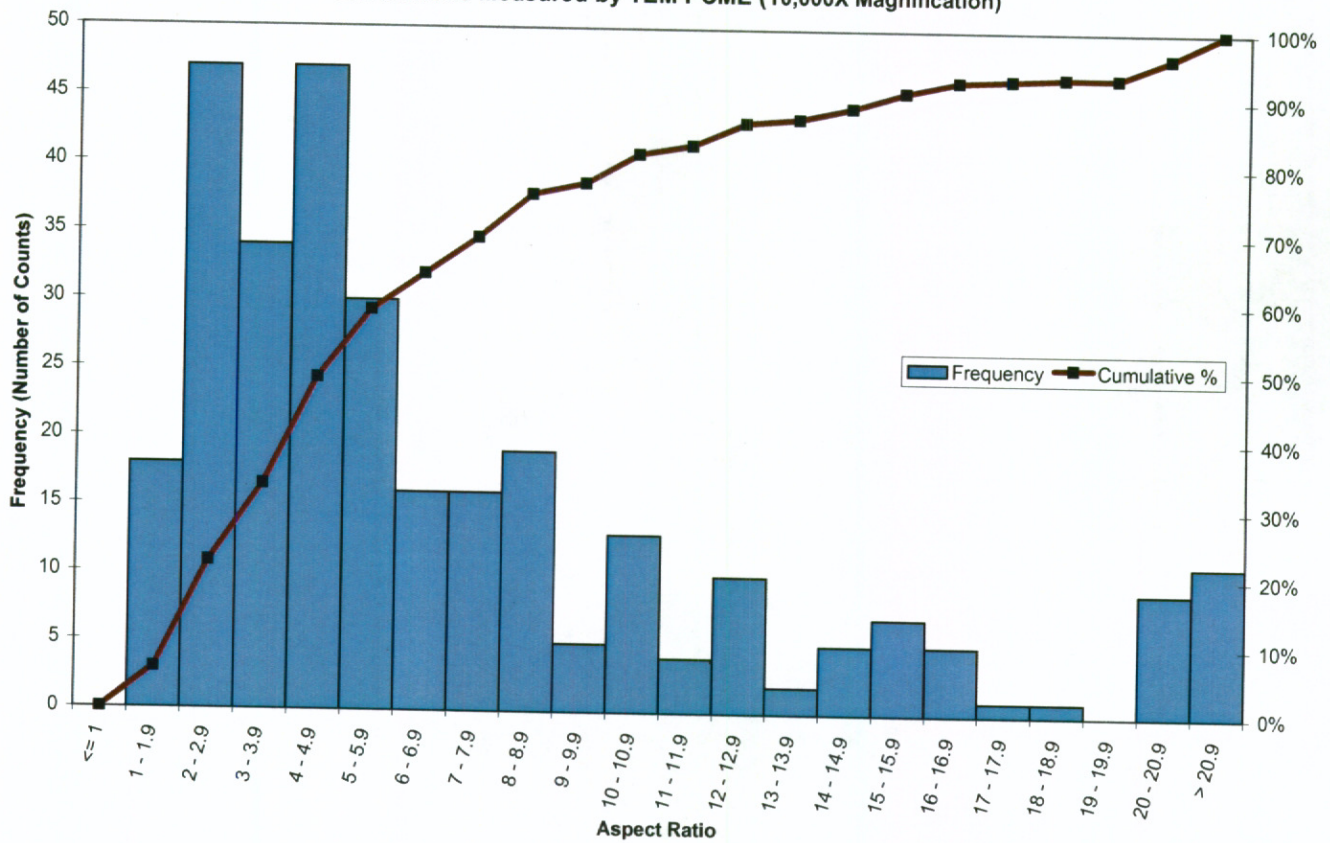




Figure 5. Frequency Distribution of Lengths for 300 NIEHS Tremolite Particles:  
Dimensions Measured by TEM PCME (10,000X Magnification)

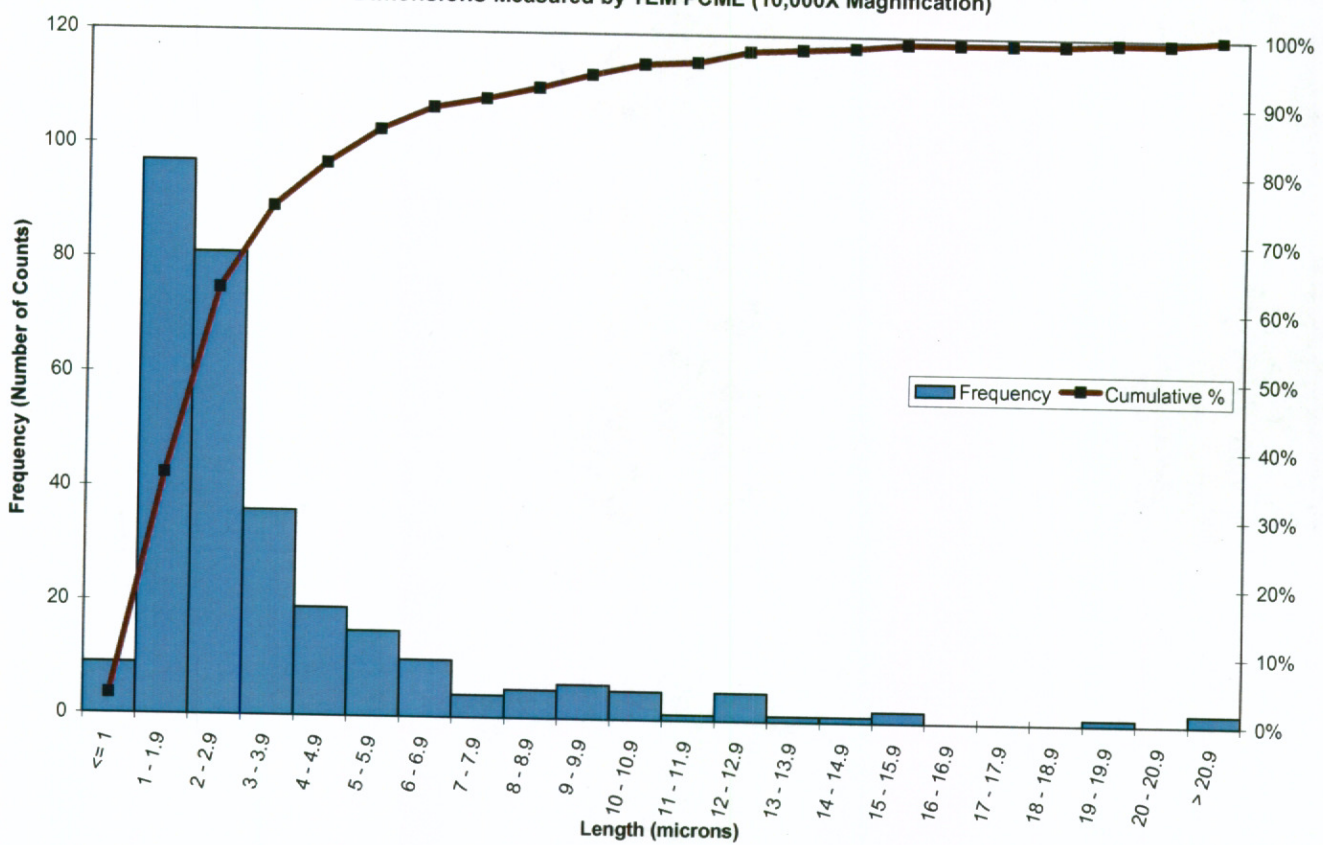


Figure 6. Frequency Distribution of Widths for 300 NIEHS Tremolite Particles:  
Dimensions Measured by TEM PCME (10,000X Magnification)

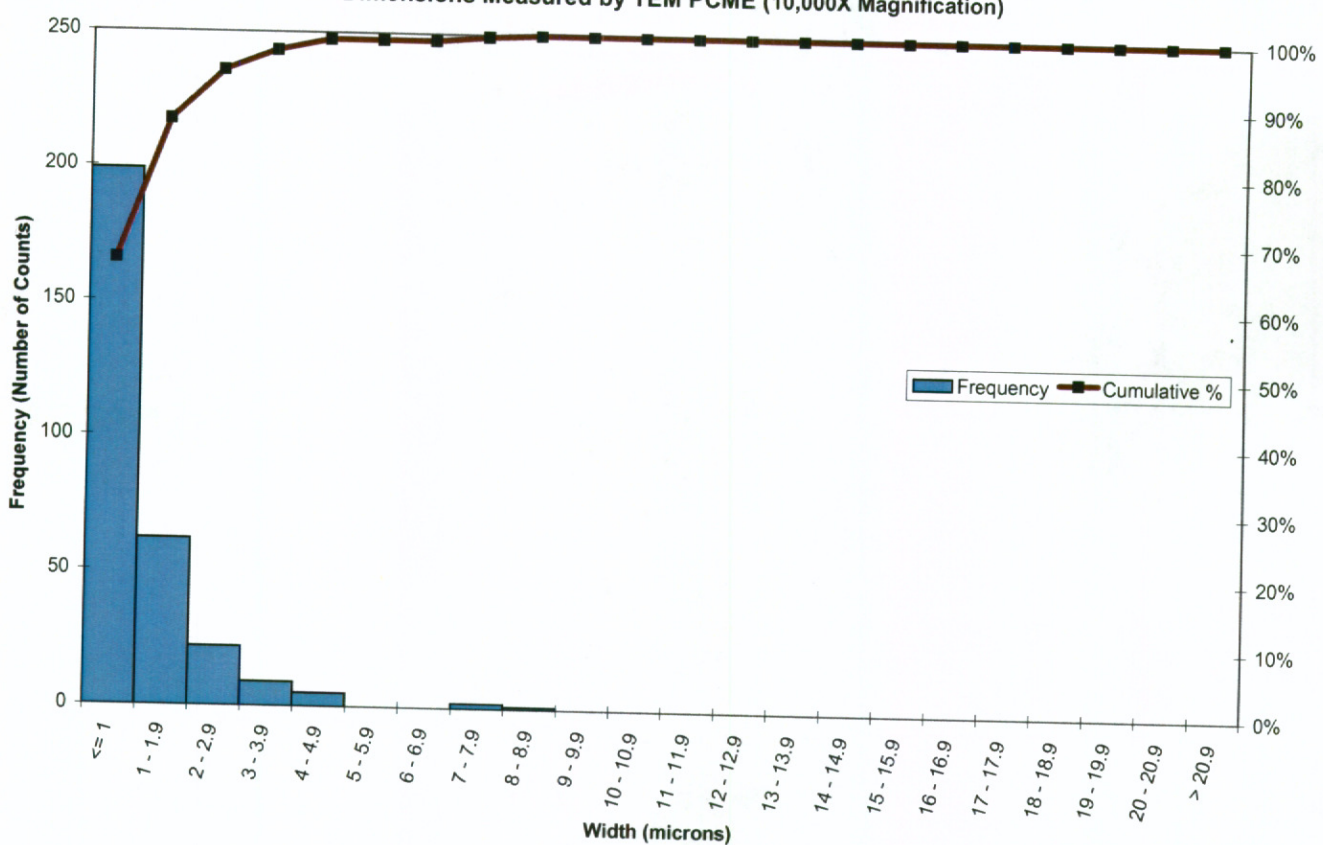


Figure 7. Frequency Distribution of Widths for 300 NIEHS Tremolite Particles:  
 Dimensions Measured by TEM PCME (10,000X Magnification) Finer Detail

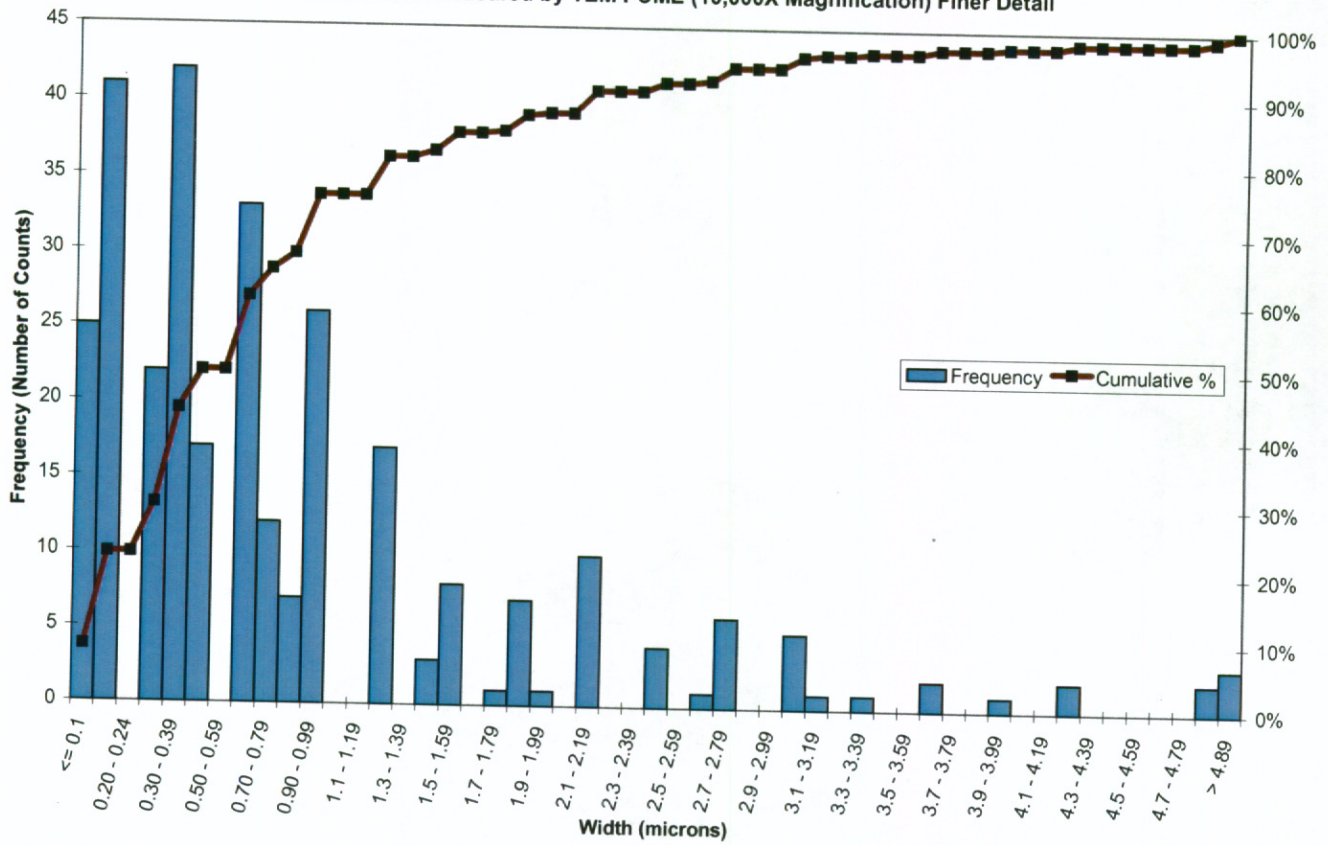


Figure 8. Frequency Distribution of Aspect Ratios for NIEHS Tremolite Particles:  
Comparison of TEM PCME and PCM Data

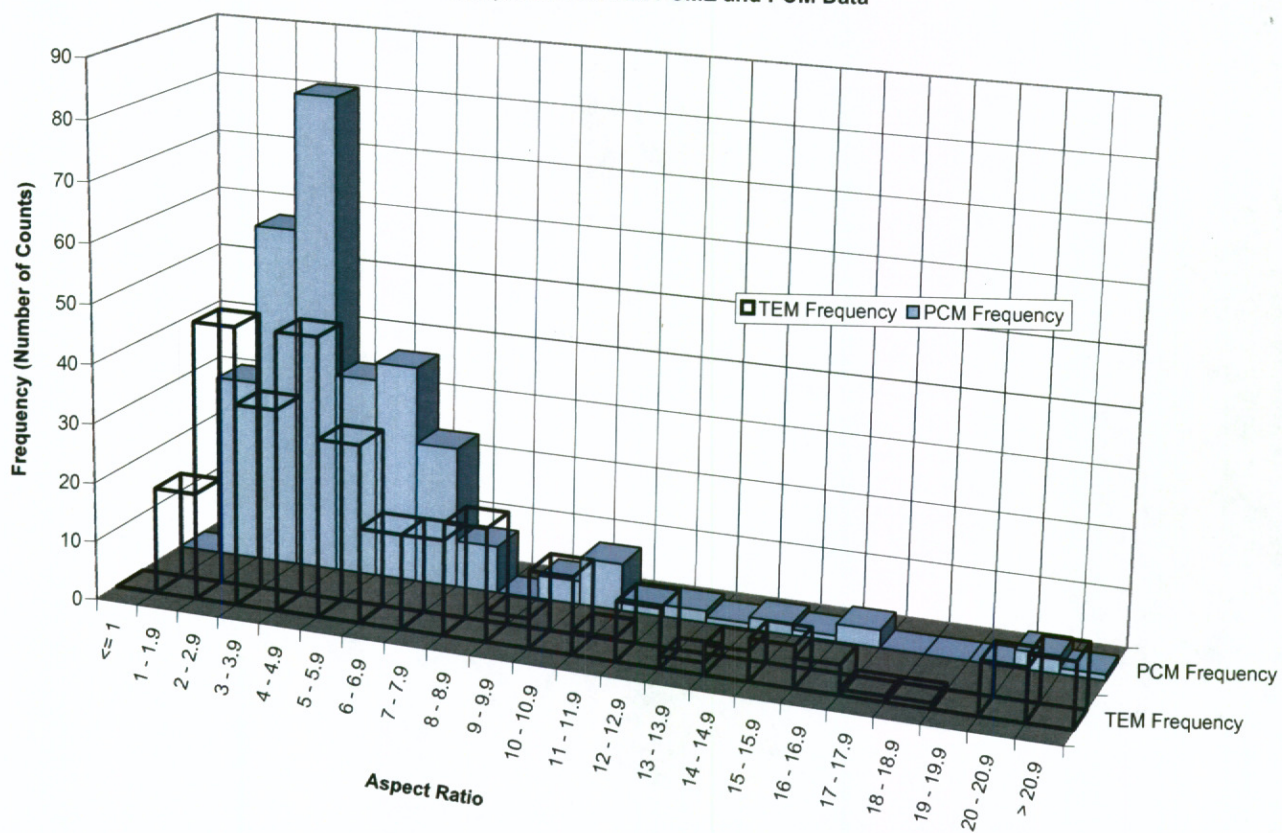


Figure 9. Frequency Distribution of Lengths for NIEHS Tremolite Particles:  
Comparison of TEM PCME and PCM Data

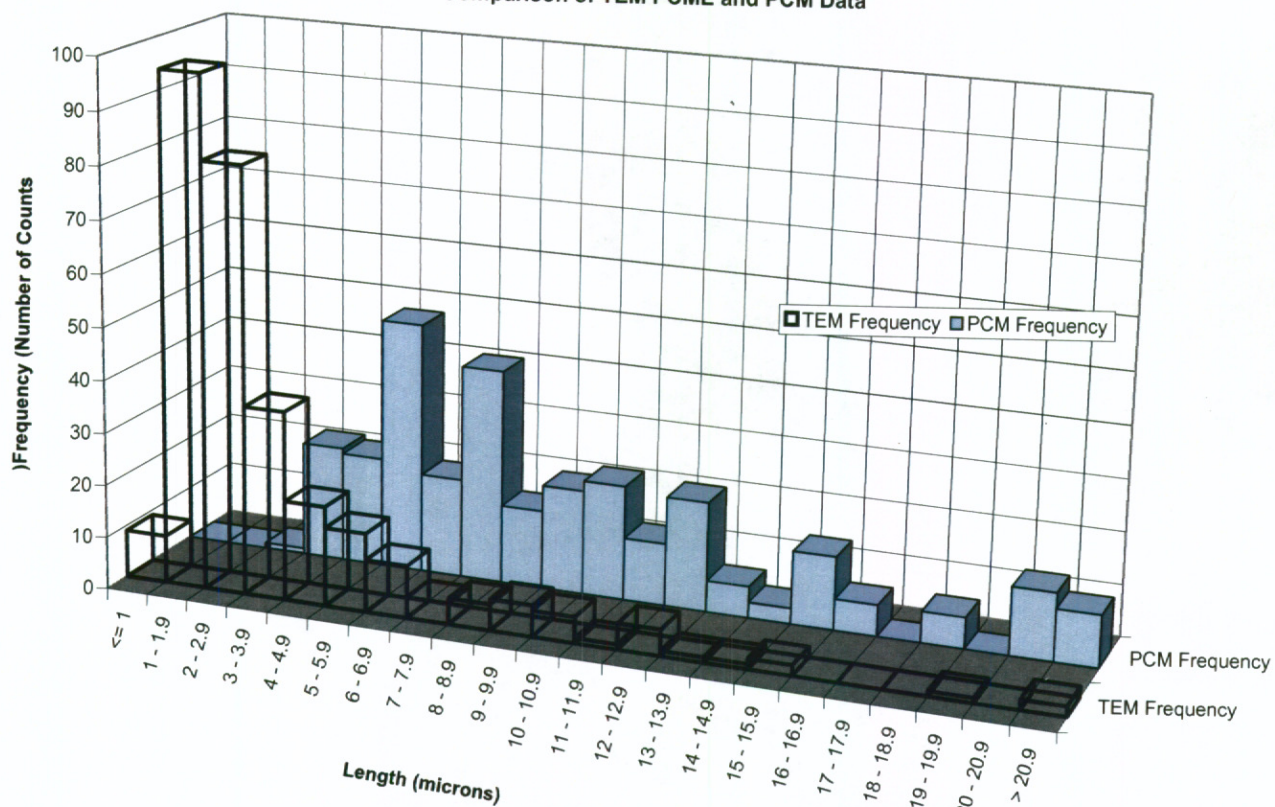


Figure 10. Frequency Distribution of Widths for NIEHS Tremolite Particles:  
Comparison of TEM PCME and PCM Data

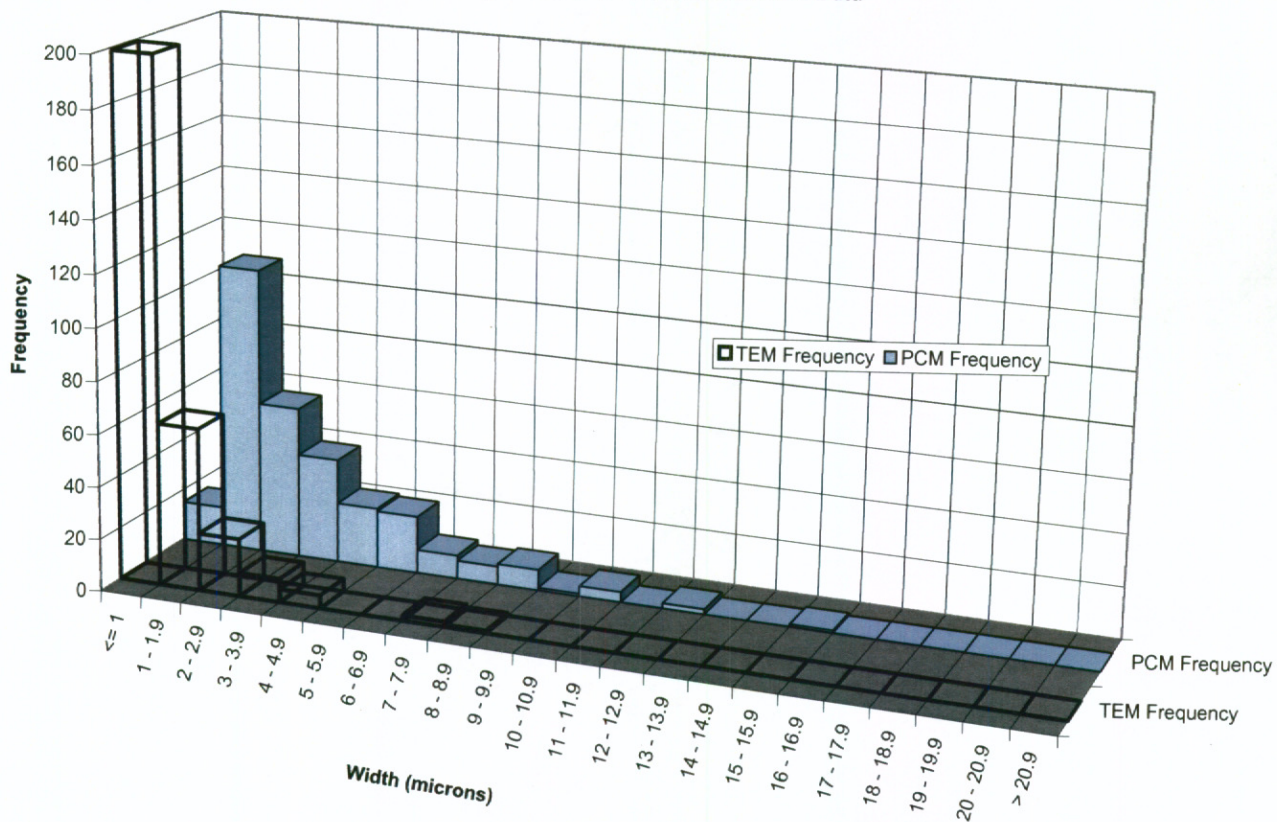


Figure 11. Frequency Distribution of Aspect Ratios for NIEHS Tremolite Particles: Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

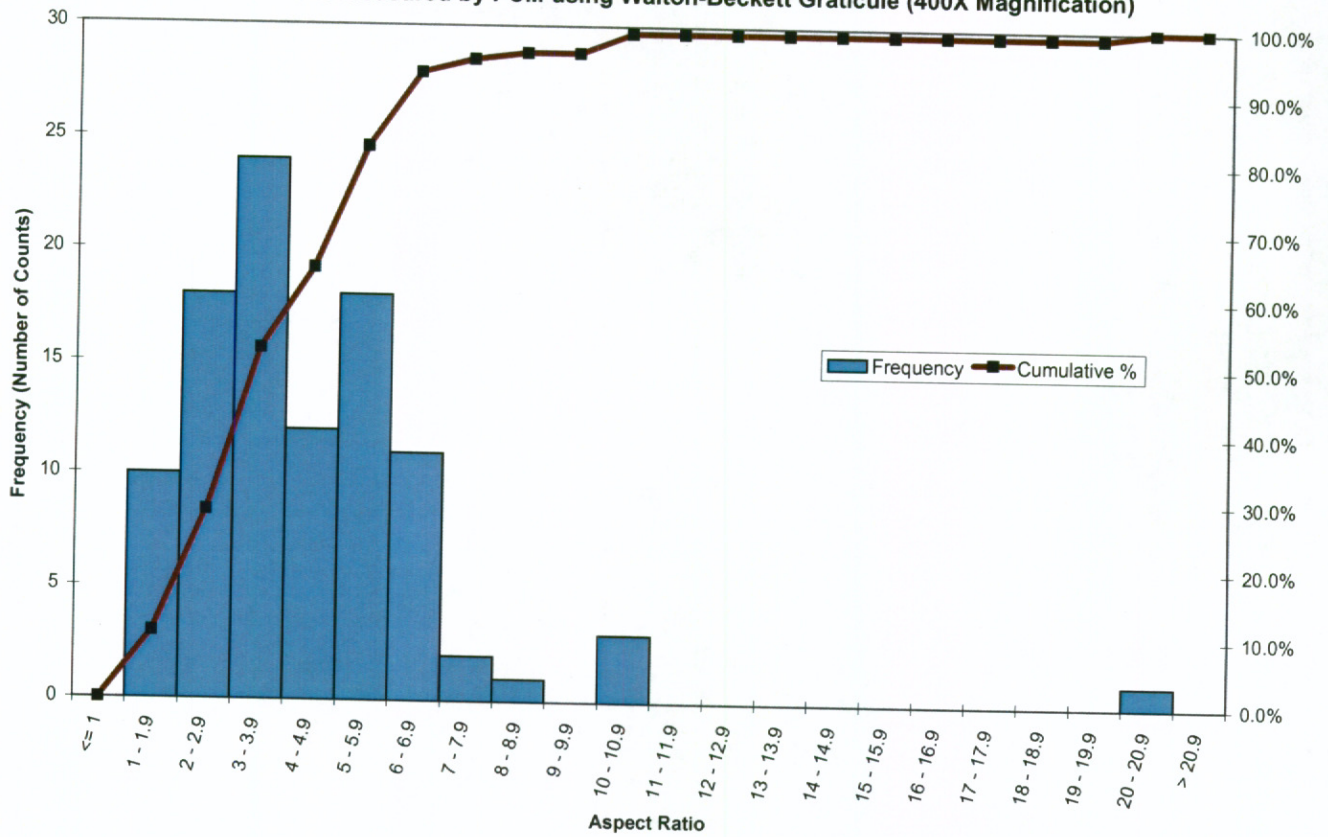


Figure 12. Frequency Distribution of Lengths for NIEHS Tremolite Particles:  
 Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

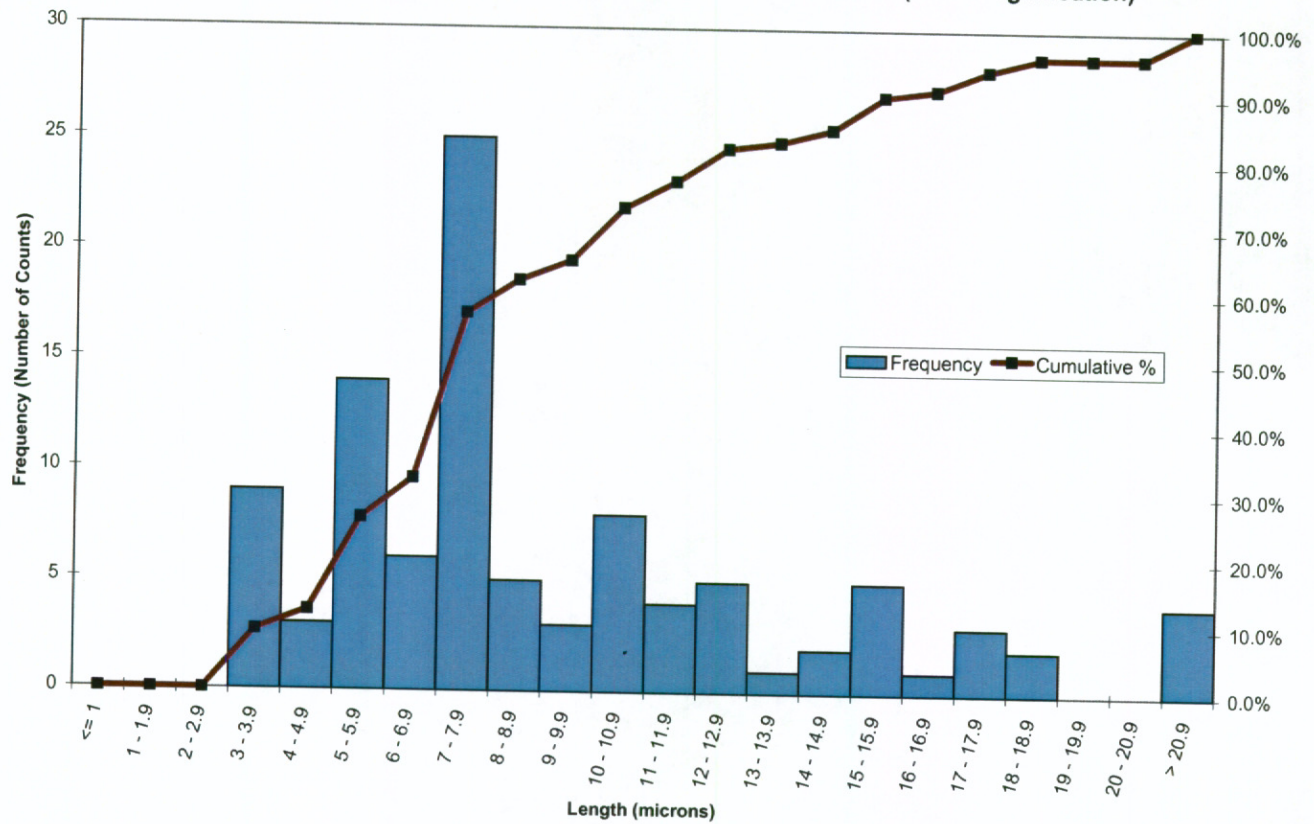




Figure 13. Distribution of Widths for NIEHS Tremolite Particles:  
Dimensions Measured by PCM using Walton-Beckett Graticule (400X Magnification)

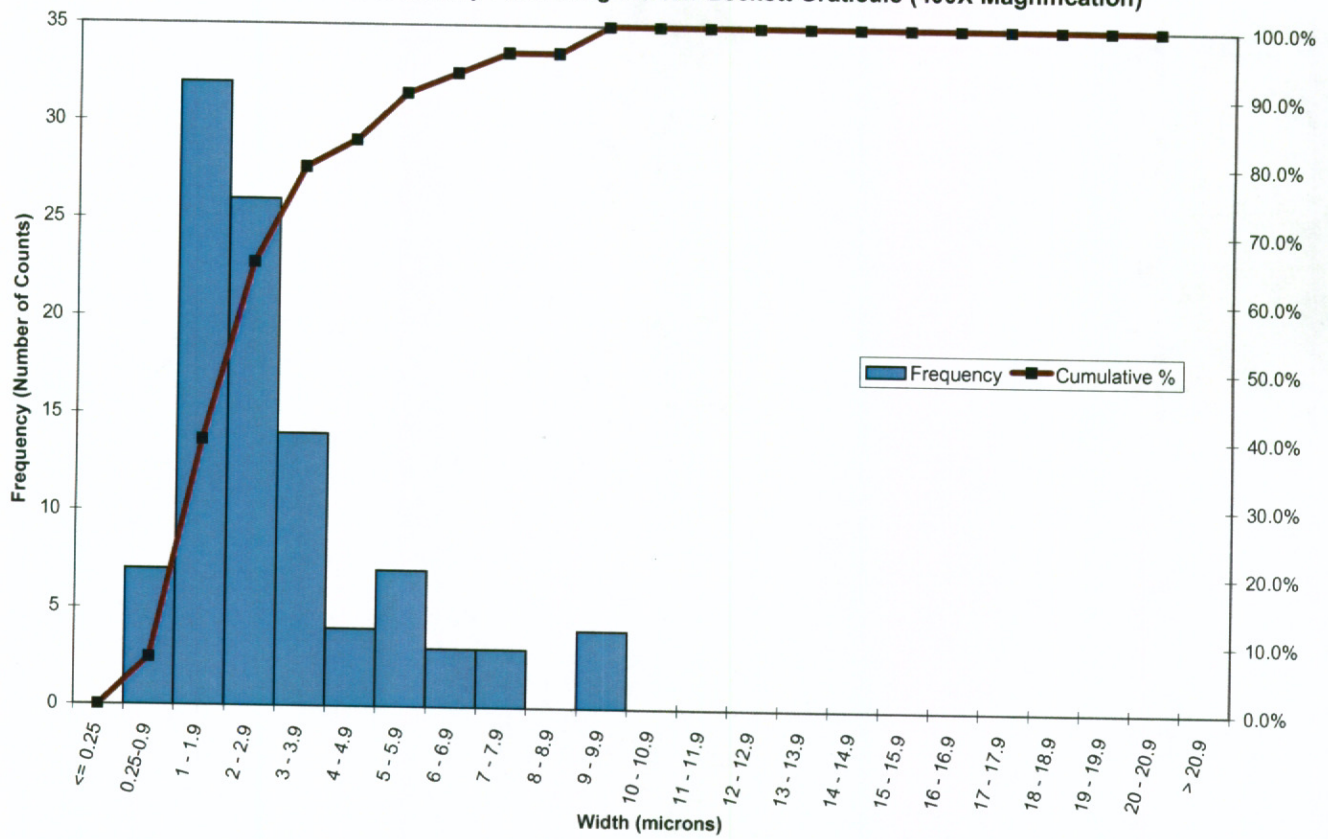
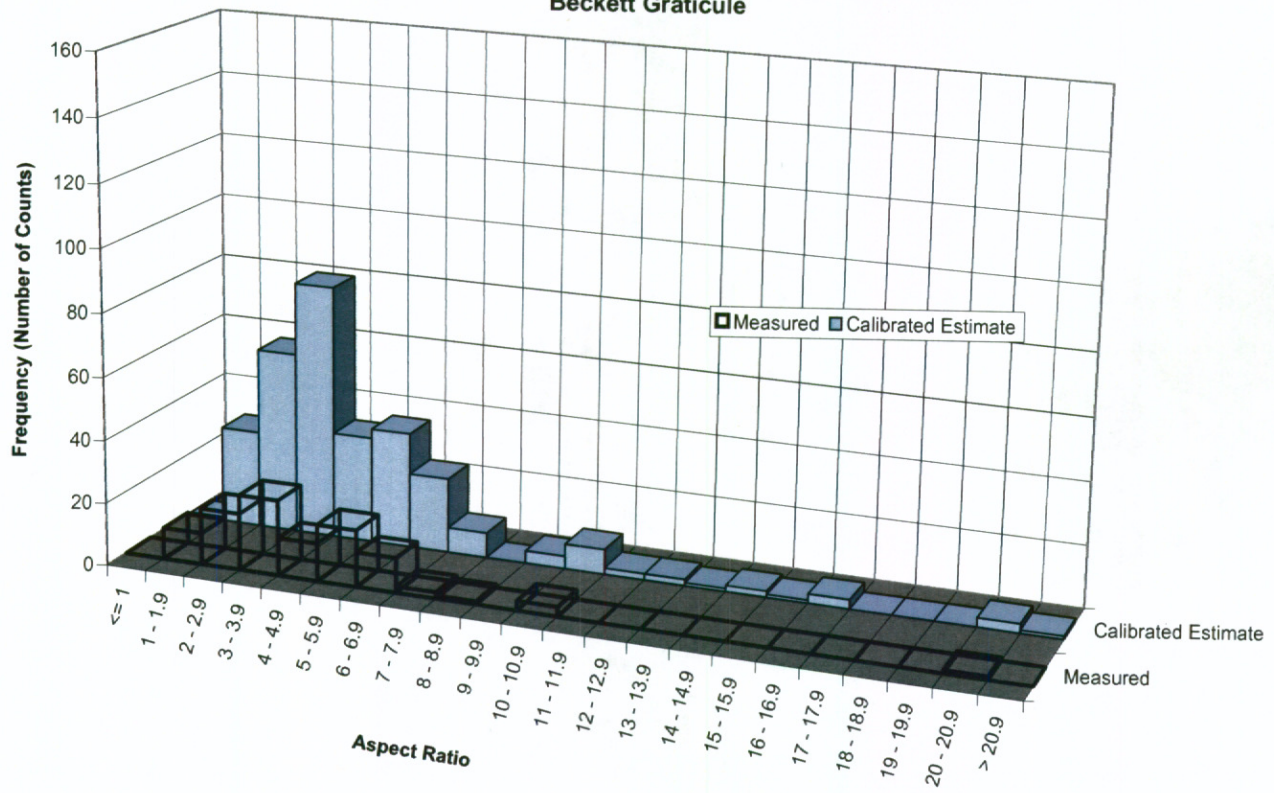


Figure 14. Frequency Distribution of Aspect Ratios for NIEHS Tremolite Particles: Comparison of Dimensions from PCM Measured by Calibrated Visual Estimation and Walton-Beckett Graticule



**Figure 15. Frequency Distribution of Lengths for NIEHS Tremolite Particles:  
Comparison of Dimensions from PCM Measured by Calibrated Visual Estimation and Walton-Beckett  
Graticule**

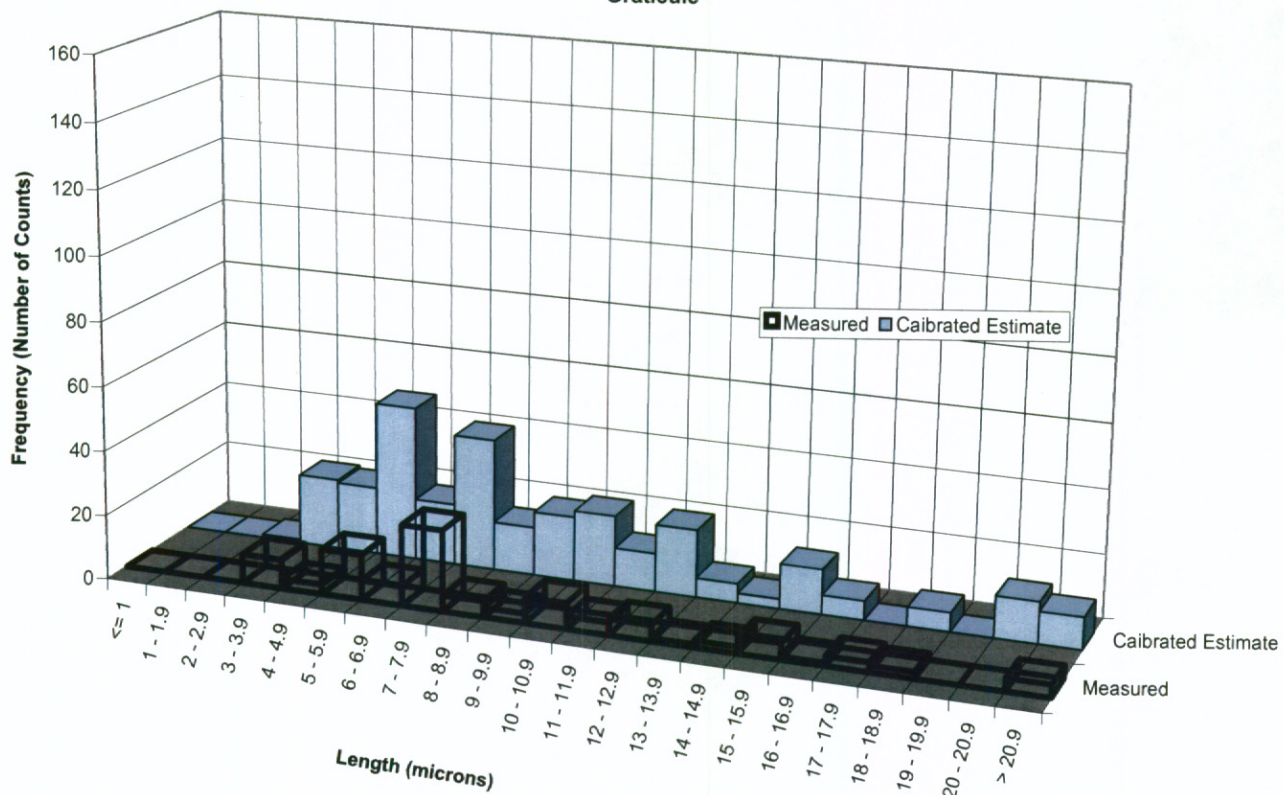
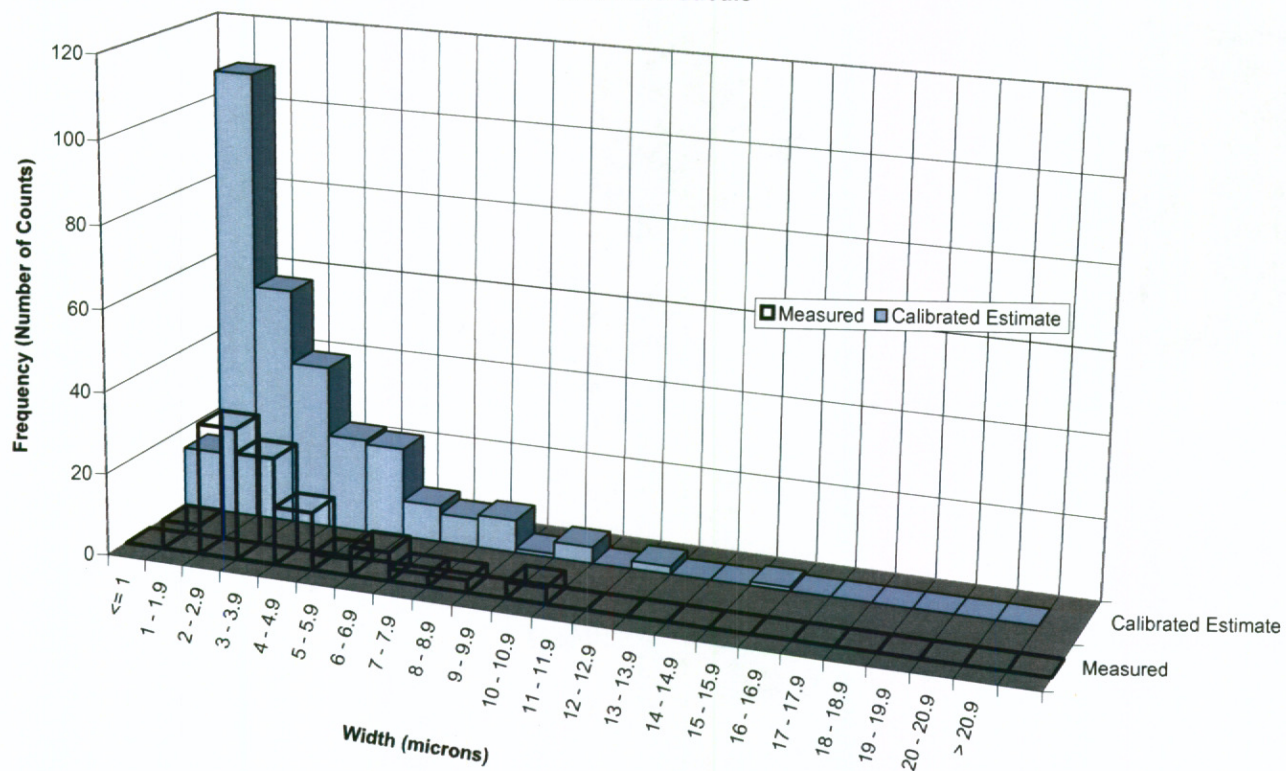


Figure 16. Frequency Distribution of Widths for NIEHS Tremolite Particles:  
 Comparison of Dimensions from PCM Measured by Calibrated Visual Estimation and Walton-  
 Beckett Graticule



**Appendix 4. NIOSH 7400 Count Sheets for Each Analyst**