Asbestos in Soil

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Soil Samples

Why Analyze for Asbestos in Soil/Rock?

EMSL ANALYTICAL, INC.

Naturally Occurring Asbestos (NOA)

Why Analyze for Asbestos in Soil/Rock?

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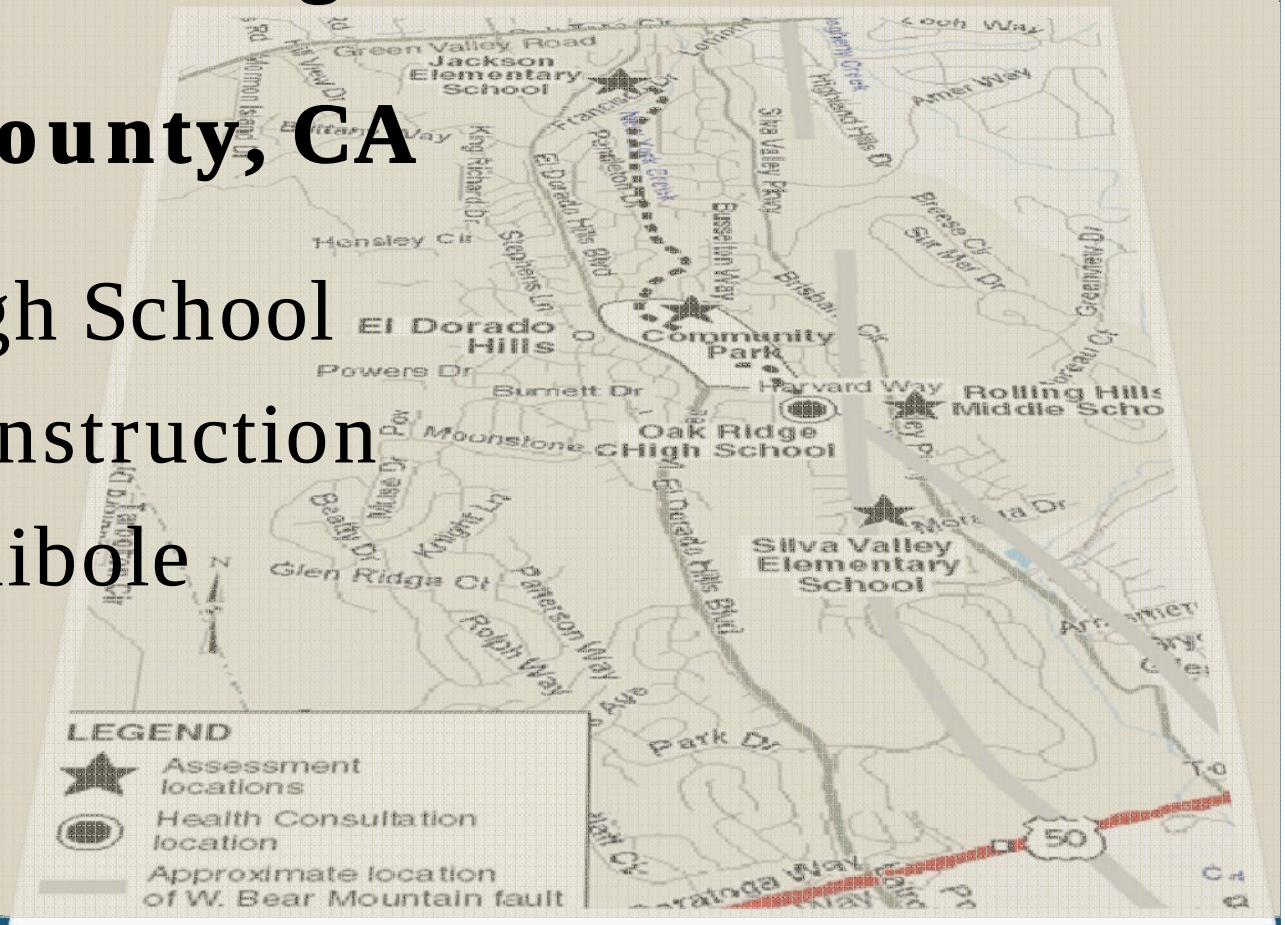
Naturally Occurring Asbestos

El Dorado County, CA

Oak Ridge High School soccer field construction disturbs amphibole asbestos.



Why Analyze for Asbestos in Soil/Rock?

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Naturally Occurring Asbestos

Serpentine (including Chrysotile asbestos) is the state rock of California.

The aggregate used for roadbeds, rail beds, and on construction sites of all types is always a question mark.

Staten Island Serpentinite

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I 278 road cut. Up to 50% Chrysotile

Picture and info: Brooklyn CUNY.edu

So Why is Soil so Hard to Test for Asbestos?

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Soil is a Great Hiding Place

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- 1% Unconsolidated Chrysotile

- 1% Consolidated Chrysotile

Soil is a Great Hiding Place

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Why is Soil so Hard to Analyze?

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Non-Homogeneity

Grain size

Scales of Non-Homogeneity

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The Big Picture

- Obtaining representative samples in the field can be difficult.
- Samples tend to be very non-homogeneous especially over the large areas that are typical on outdoor sites.
- How many samples for a baseball field or 100 miles of road or rail bed?

Scales on Non-Homogeneity

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The Medium Picture

- How deep to go?
- What layers to include?

Scales on Non-Homogeneity

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The Fine Picture

Obtaining a representative **sub**-sample in the lab is important.

Scales on Non-Homogeneity

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The Very Fine Picture

Low mag stereoscopic view of play sand

"Large" particle size makes it difficult to get good slide mounts for light microscopy or grid preps for TEM.

The presence of even sand sized quartz crystals are a problem.

One way to help homogenize the samples either in the field or after submittal to the lab

Riffle Splitting

Analytical Choices
What Method to Choose?

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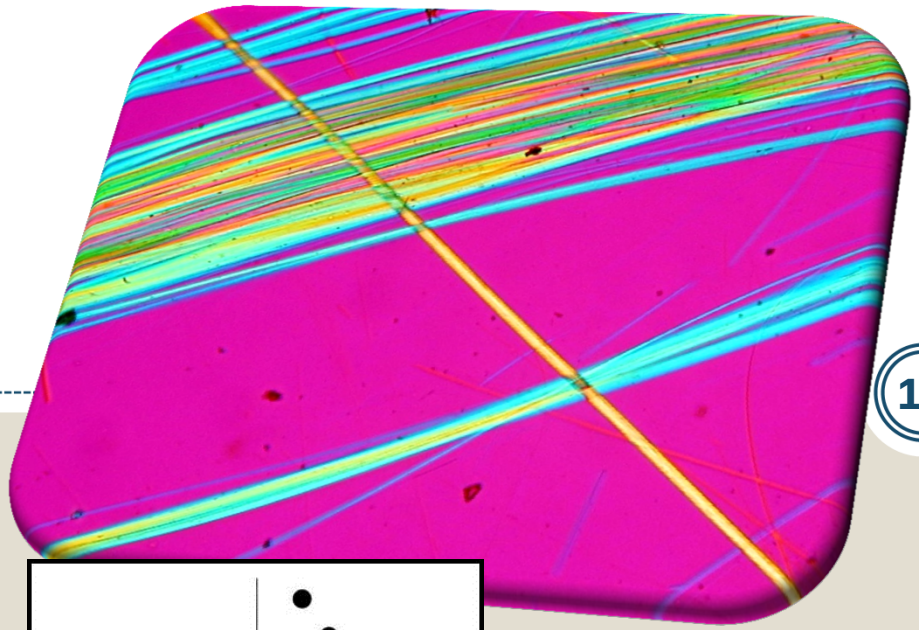

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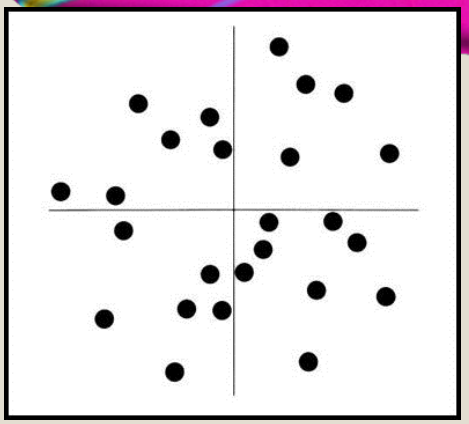

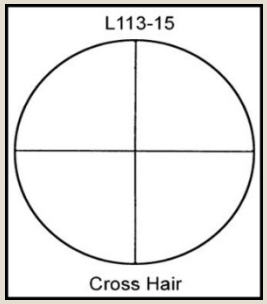

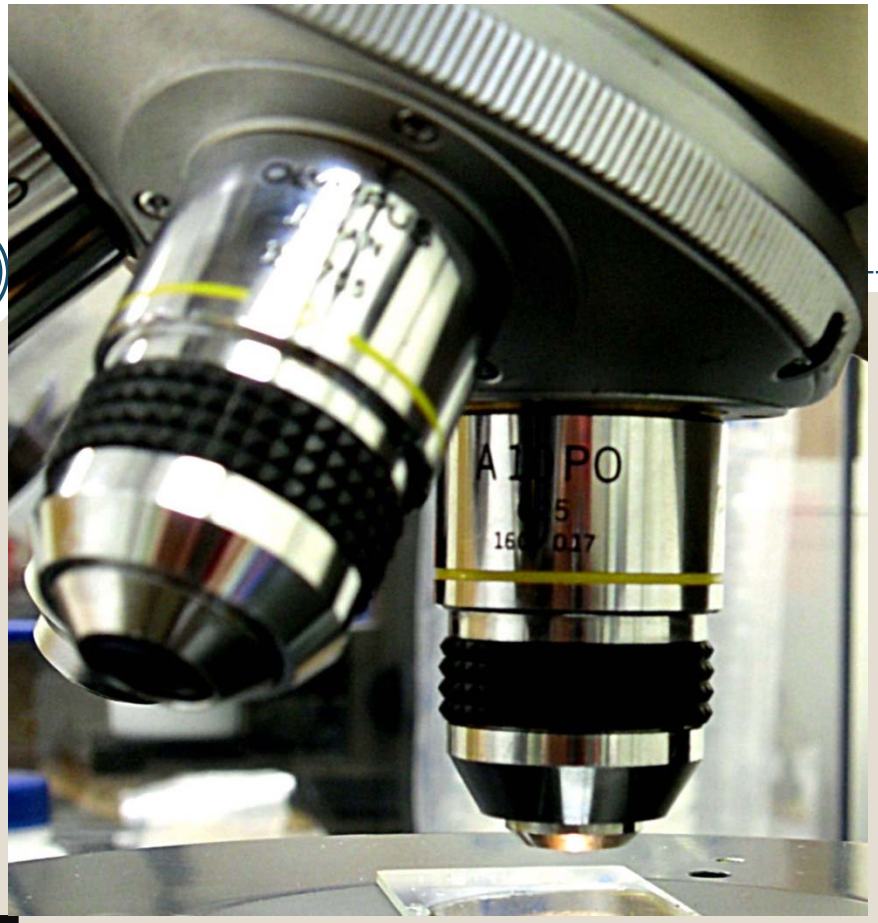

PLM Bulk

From Stereomicroscope to PLM

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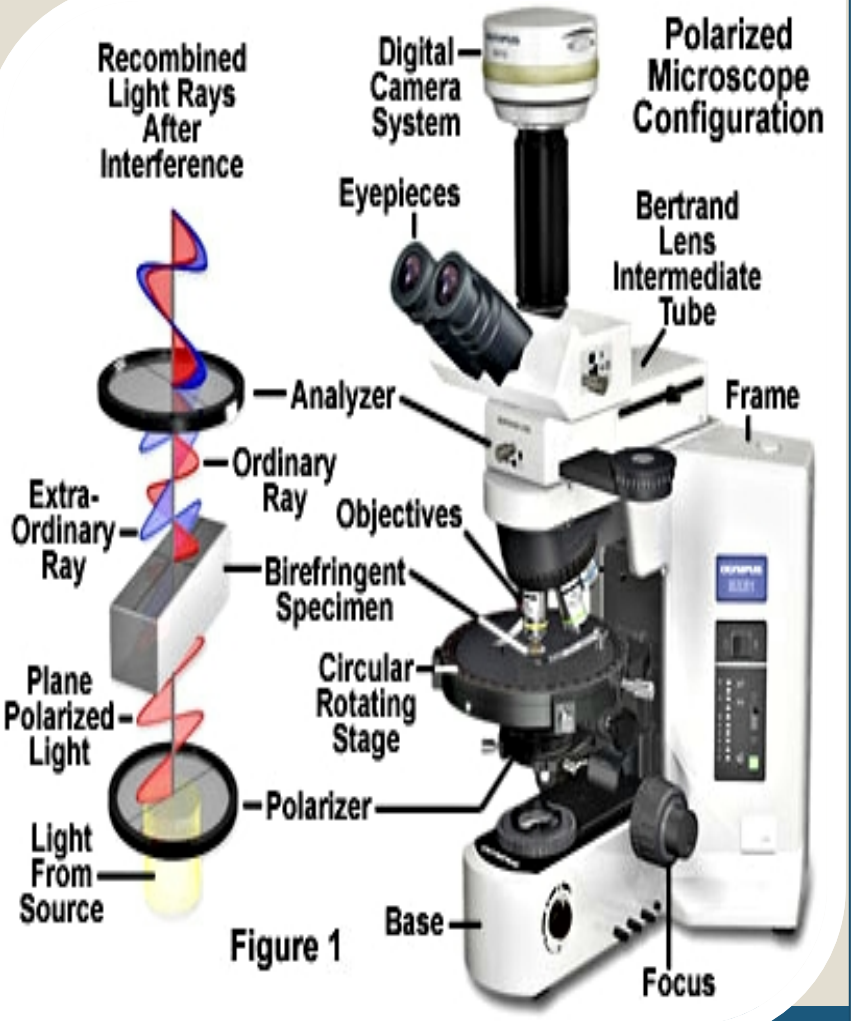

Figure 1

Identification of Asbestos

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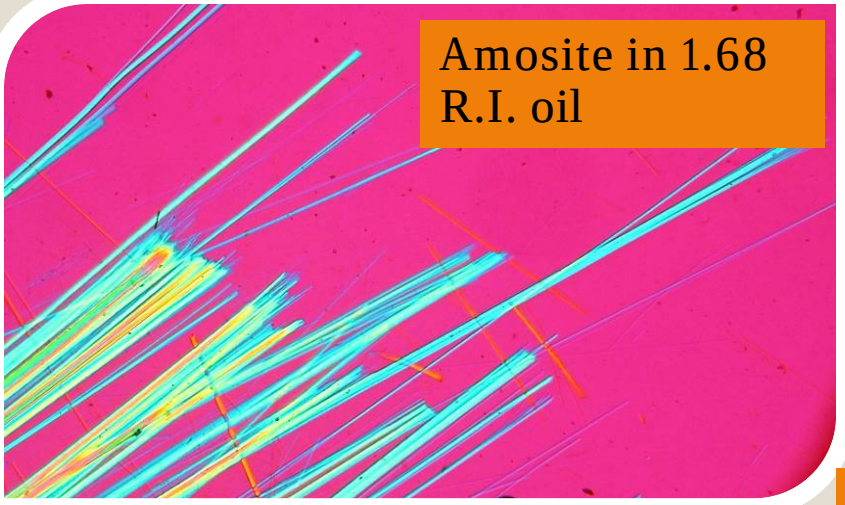
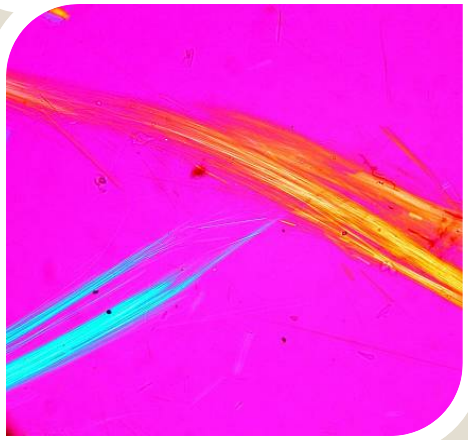
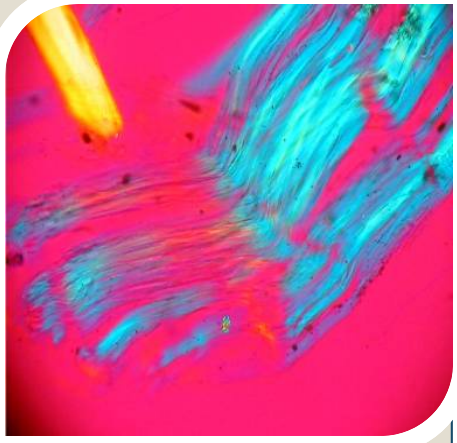
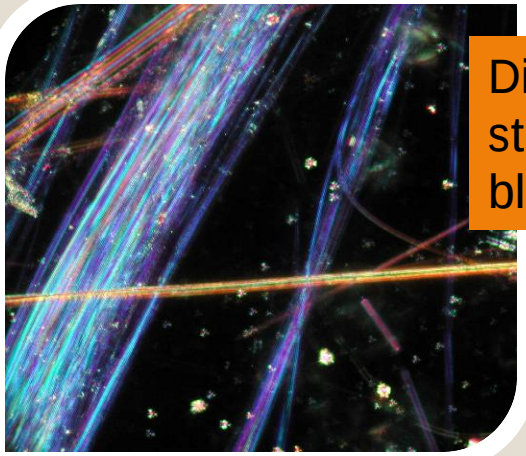




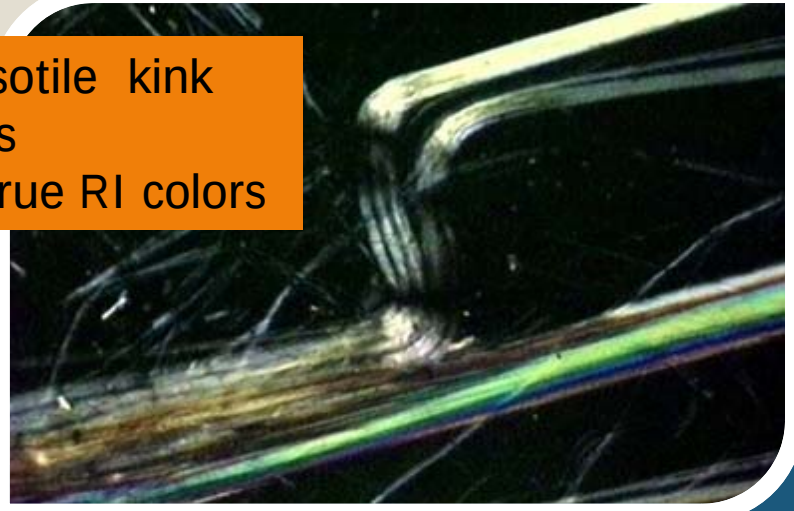


Chrysotile, crossed polars, gypsum plate in (pos. SOE)



Dispersion staining mode blue/gold)

Chrysotile kink bands
Not true RI colors



What's the Percentage?

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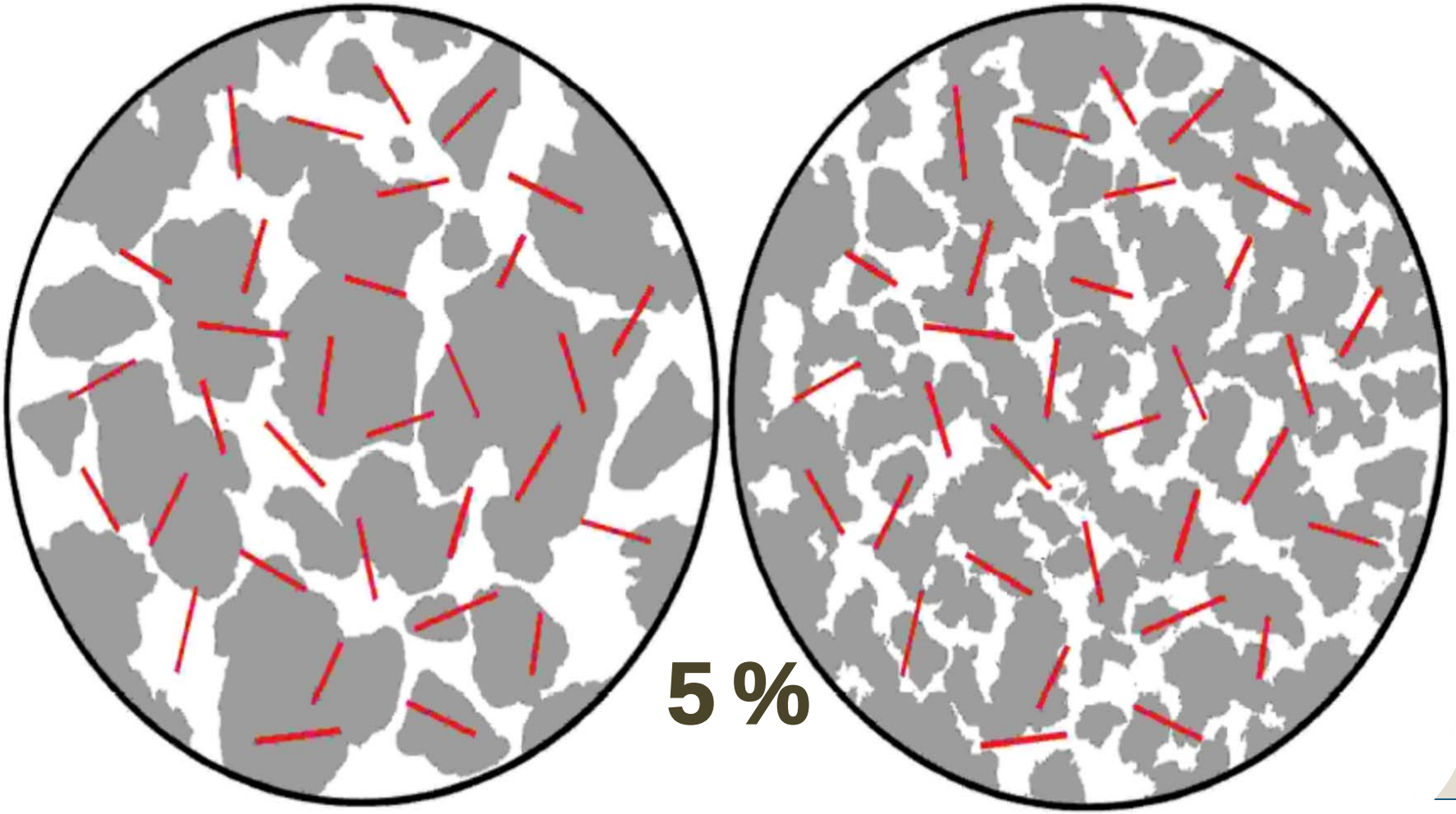

5%

Quantitation

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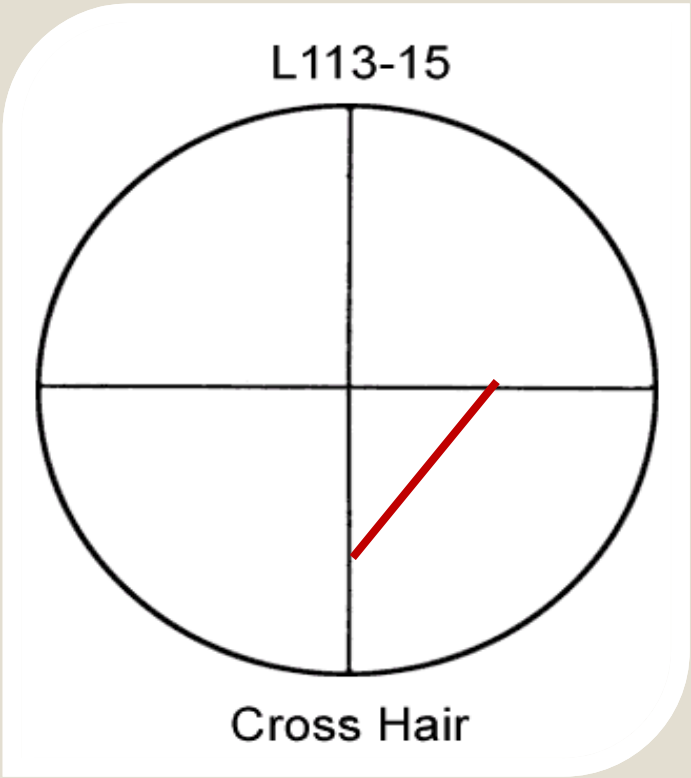
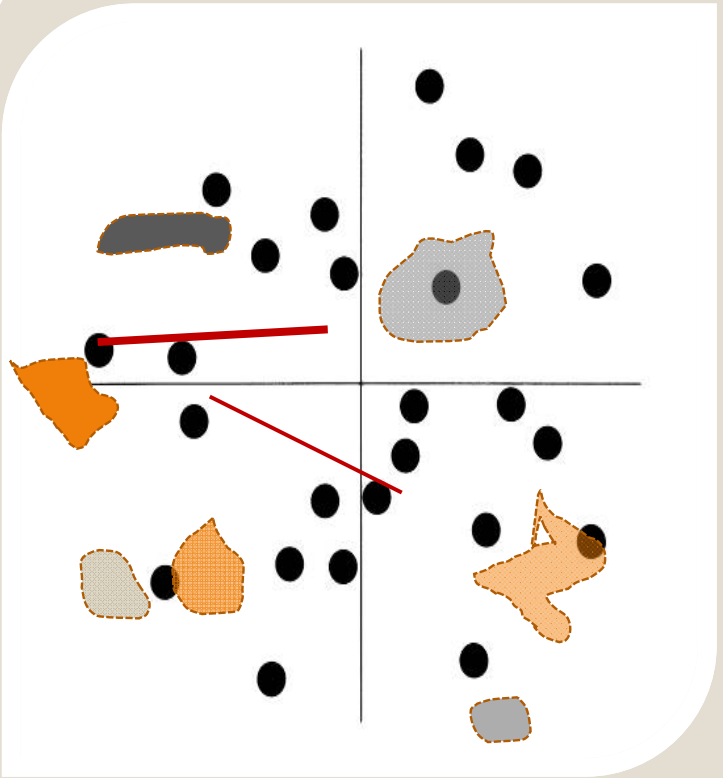
- **Calibrated Visual Estimation (CVE) of Asbestos % from stereomicroscopy and PLM**
- **Point Count**





Analysis Only Good as the Prep

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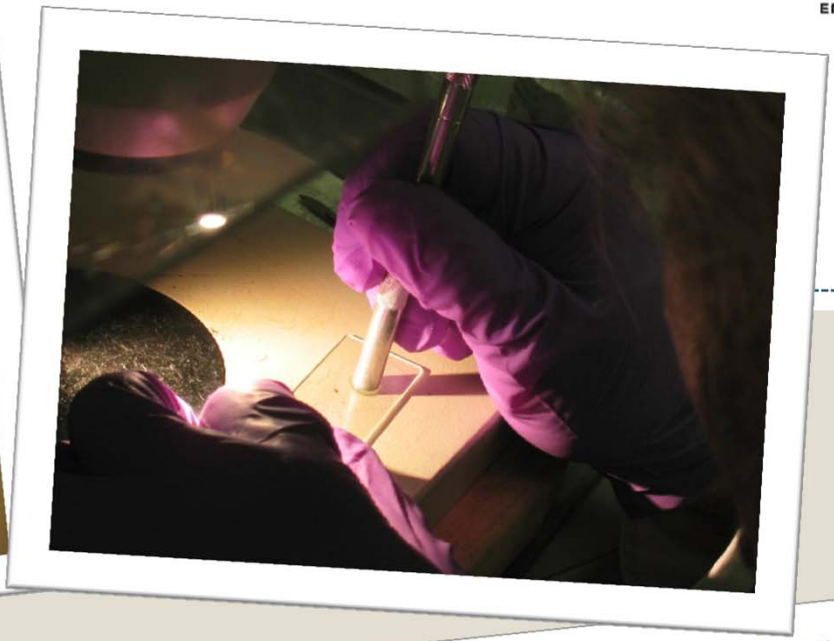

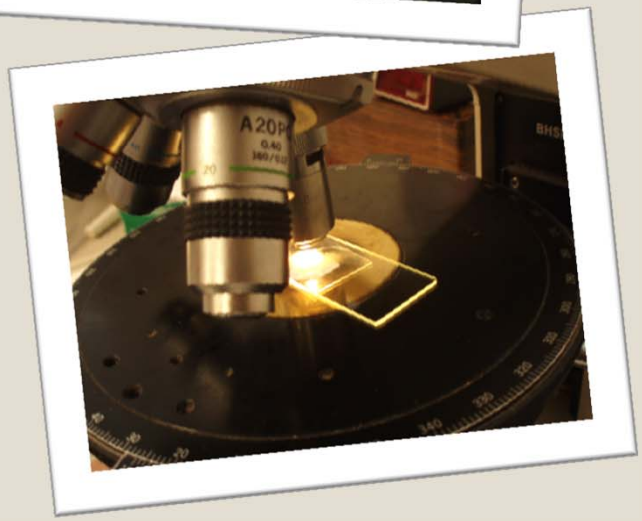

Especially for Point Count

- Uniform
- Random
- Monolayer

The 1% Rule

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Risk

- 1% asbestos bound up in a floor tile is different than
- 1% asbestos bound up in a friable material is different than
- 1% asbestos not bound up in soil or
  - Settled Dust
  - Vermiculite

Limitations of "Standard" PLM

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EPA PLM Method (EPA/600/R-93/116)

Method for the Determination of Asbestos in Bulk ***Building Materials***

- As the title suggests and the method explains, this is a method for relatively homogenous bulk building materials, not soil.
- The final version of this method is flexible though and matrix modification prior to analysis is described

Two Approaches to Soil

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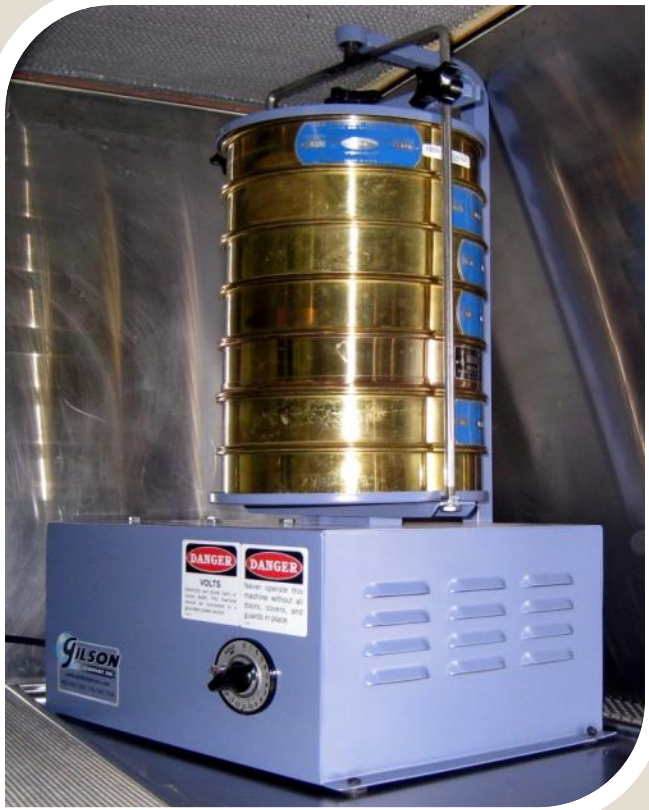
Sieving



Milling

Alternative Approaches

Sieving

Designation: D7521 – 13

Standard Test Method for Determination of Asbestos in Soil[1]

This standard is issued under the fixed designation D7521; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers a procedure to: (*1*) identify asbestos in soil, (*2*) provide an estimate of the concentration of asbestos in the sampled soil (dried), and (*3*) optionally to provide a concentration of asbestos reported as the number of asbestos structures per gram of sample.

1.2 In this test method, results are produced that may be used for evaluation of sites contaminated by construction, mine and manufacturing wastes, deposits of natural occurrences of asbestos (NOA), and other sources of interest to the investigator.

1.3 This test method describes the gravimetric, sieve, and other laboratory procedures for preparing the soil for analysis as well as the identification and quantification of any asbestos detected. Pieces of collected soil and material embedded therein that pass through a 19-mm sieve will become part of the sample that is analyzed and for which results are reported.

1.3.1 Asbestos is identified and quantified by polarized light microscopy (PLM) techniques including analysis of morphology and optical properties. Optional transmission electron microscopy (TEM) identification and quantification of asbestos is based on morphology, selected area electron diffraction (SAED), and energy dispersive X-ray analysis (EDXA). Some information about fiber size may also be determined. The PLM and TEM methods use different definitions and size criteria for fibers and structures. Separate data sets may be produced.

1.4 This test method has an analytical sensitivity of 0.25 % by weight with optional procedures to allow for an analytical sensitivity of 0.1 % by weight.

1.7 *Hazards*—Asbestos fibers are acknowledged carcinogens. Breathing asbestos fibers can result in disease of the lungs including asbestosis, lung cancer, and mesothelioma. Precautions should be taken to avoid creating and breathing airborne asbestos particles when sampling and analyzing materials suspected of containing asbestos.

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C136 Test Method for Sieve Analysis of Fine and Coarse Aggregates

D1193 Specification for Reagent Water

D3670 Guide for Determination of Precision and Bias of Methods of Committee D22

D6281 Test Method for Airborne Asbestos Concentration in Ambient and Indoor Atmospheres as Determined by Transmission Electron Microscopy Direct Transfer (TEM)

D6620 Practice for Asbestos Detection Limit Based on Counts

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

2.2 *EPA Standards:*

EPA 600/R-93/116 Method for the Determination of [illegible] tos in Bulk Building Materials[2]

2.3 *ISO Standards:*[3]

ASTM Sieve Method

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1) Sample is dried
2) Weighed
3) Dry Sieved (wet option) on sieve shaker for 5 minutes
   - 19 mm sieve
   - 2 mm sieve
   - 106 micron sieve

ASTM Sieve Method

4) Weigh each fraction
5) Analyze each fraction

ASTM Sieve Method

The fine fraction is fine enough and homogenous enough for a PLM slide prep and analysis

Wet Sieving

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Sieve Stack

Coarse, Medium

The Same Sample !

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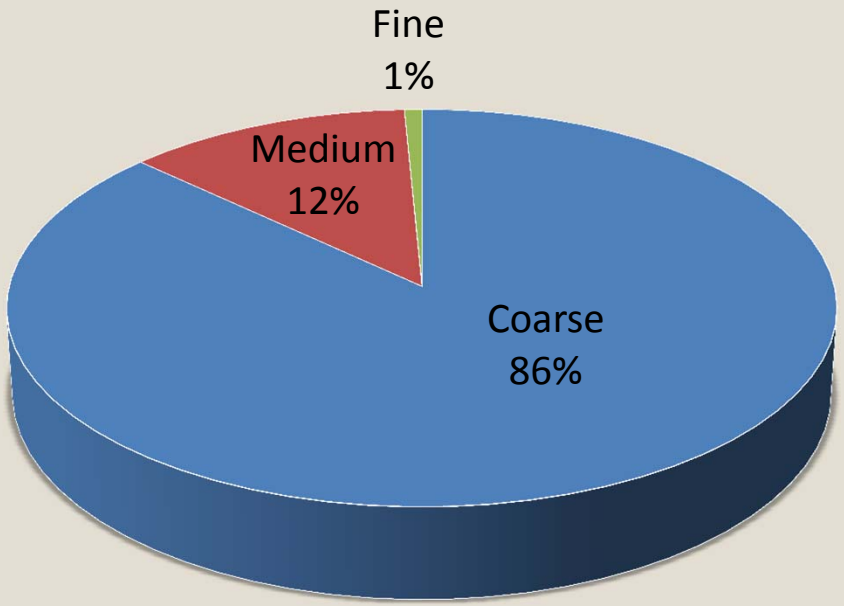
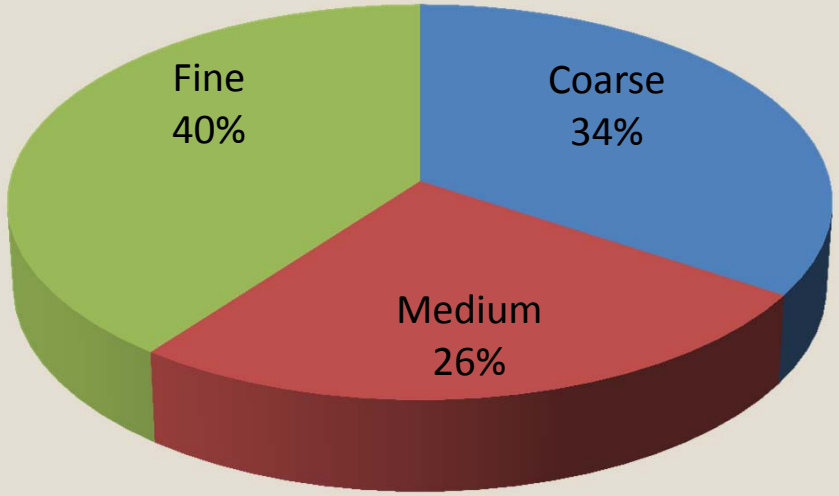
Dry Sieving



Wet Sieving



Dry vs. Wet Sieving

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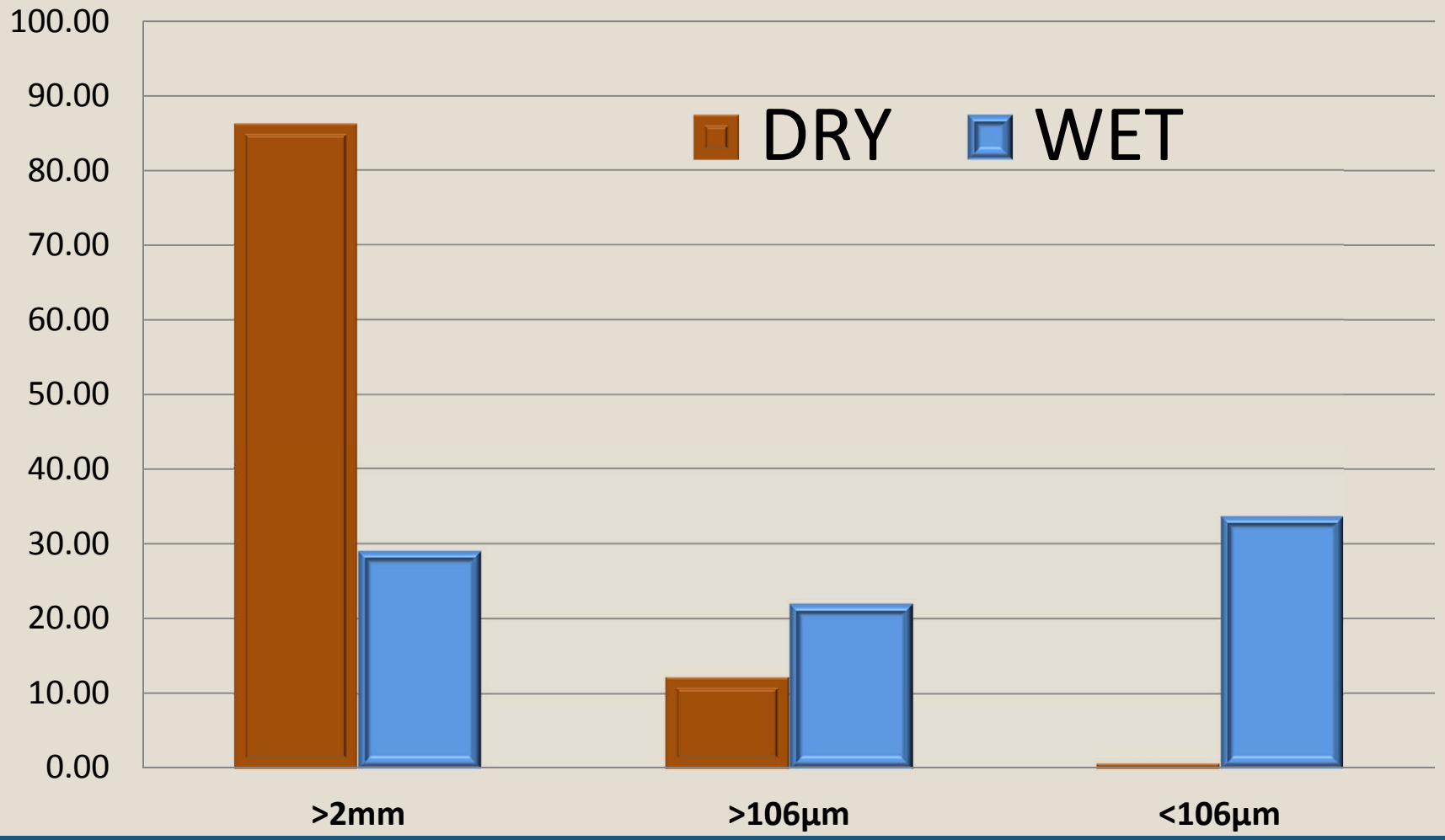

ASTM Sieve Method

EMSL ANALYTICAL, INC.

- If all three fractions are non detect by PLM then a TEM Analysis is performed.
- This TEM analysis is Qualitative only (detect/non detect). This enable us to find asbestos that is not visible by light microscopy (thinner than 0.25 microns)
- Finally, there is an optional Quantitative TEM analysis

TEM is Typically Not Required But …

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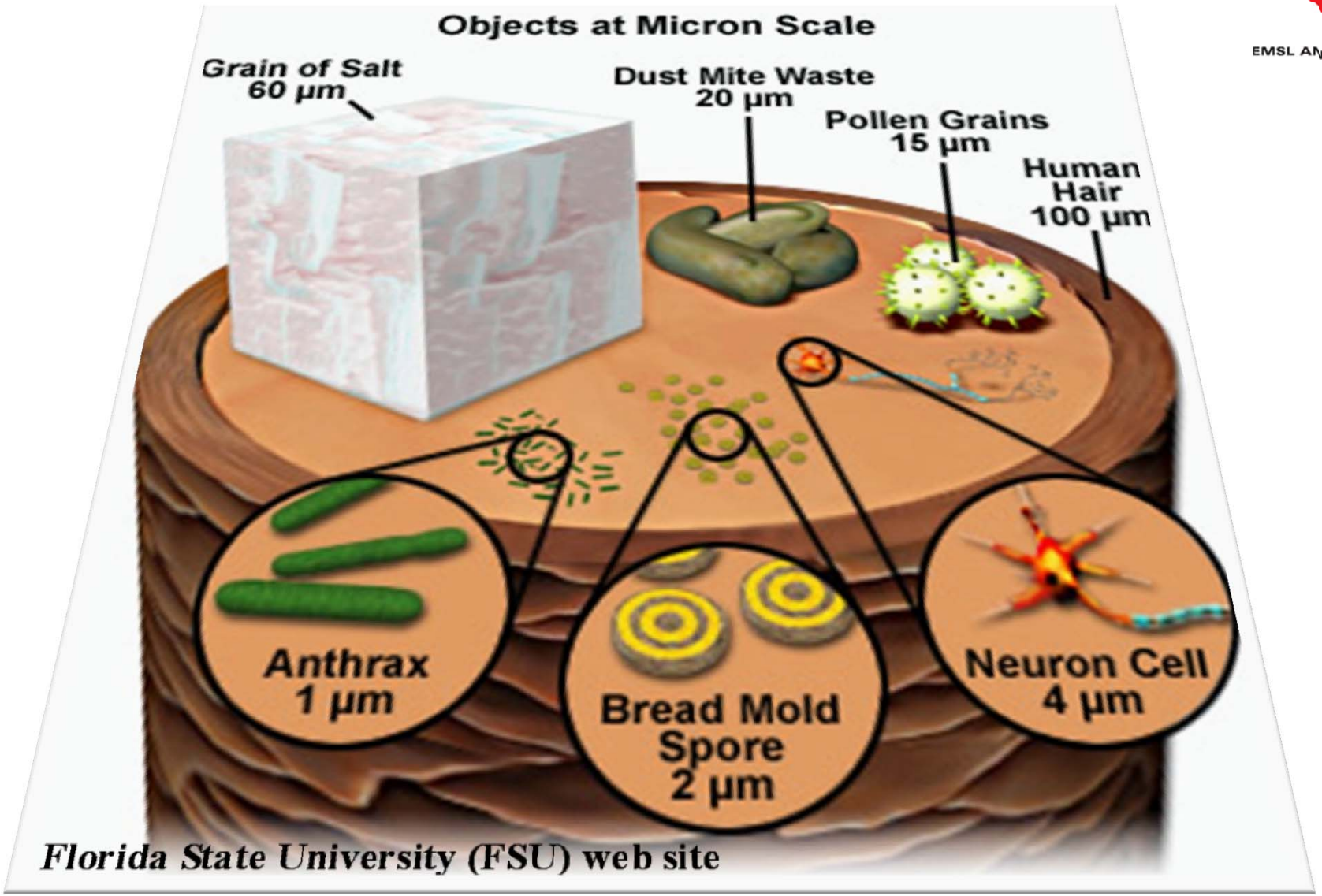
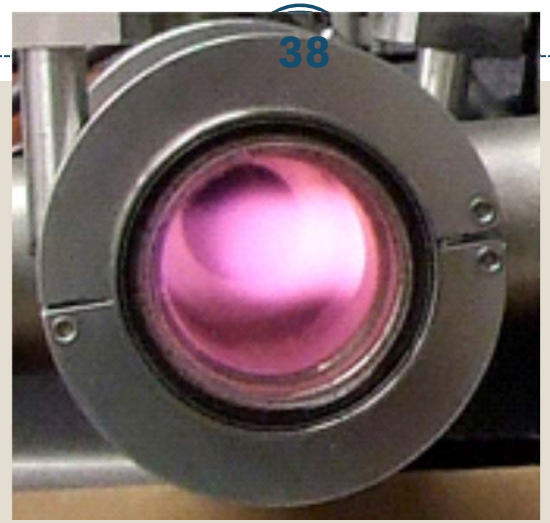
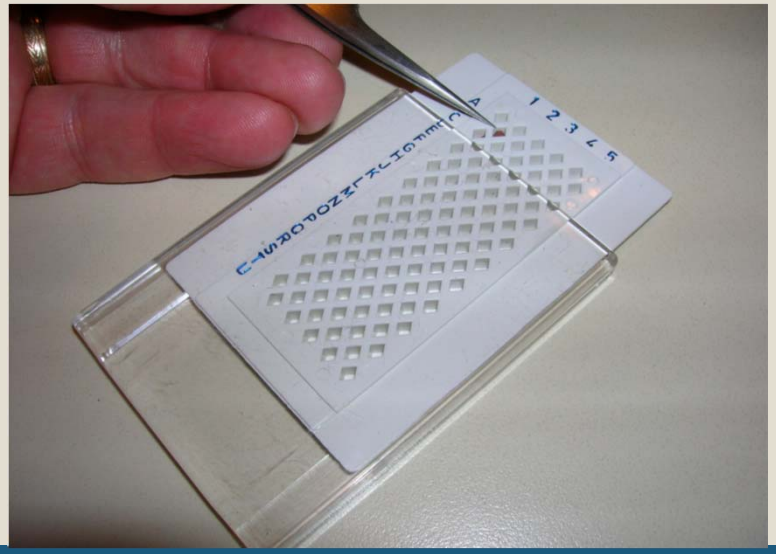
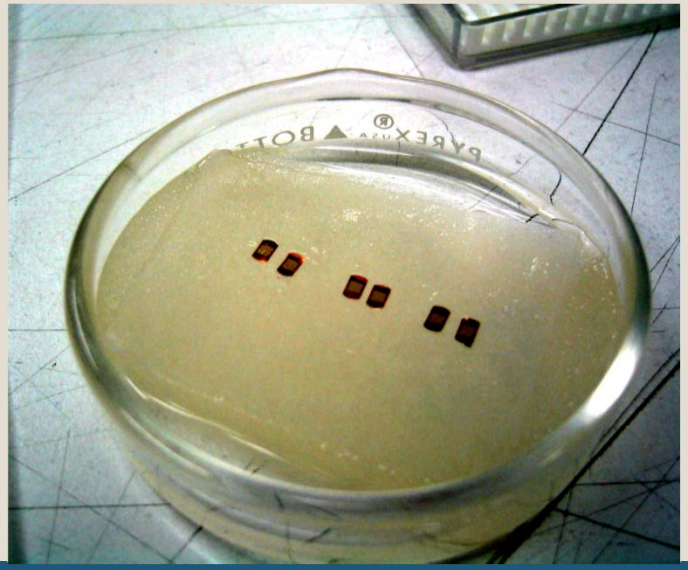


TEM Prep







The TEM Grid

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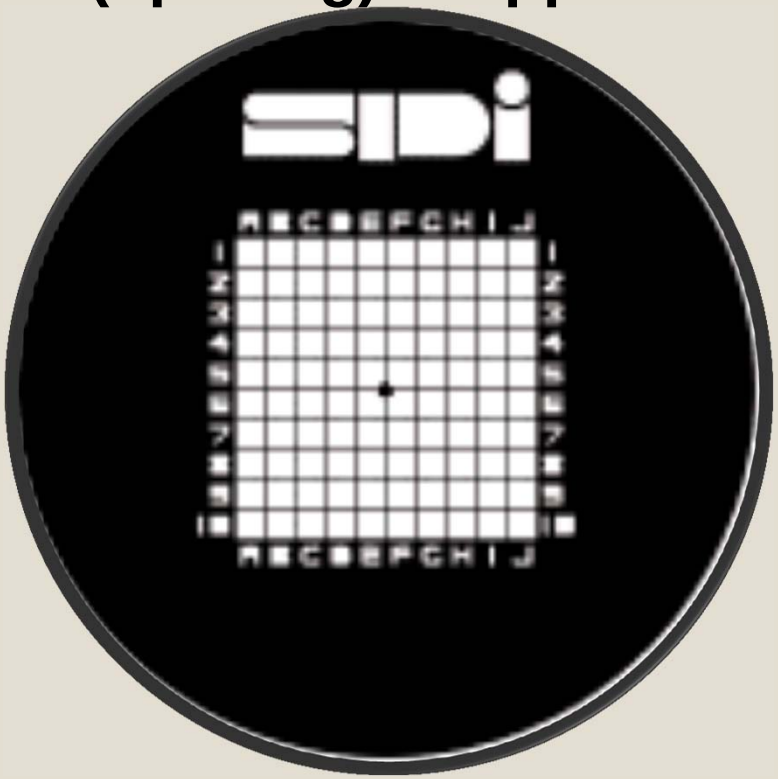
Entire grid is only 3 mm diameter

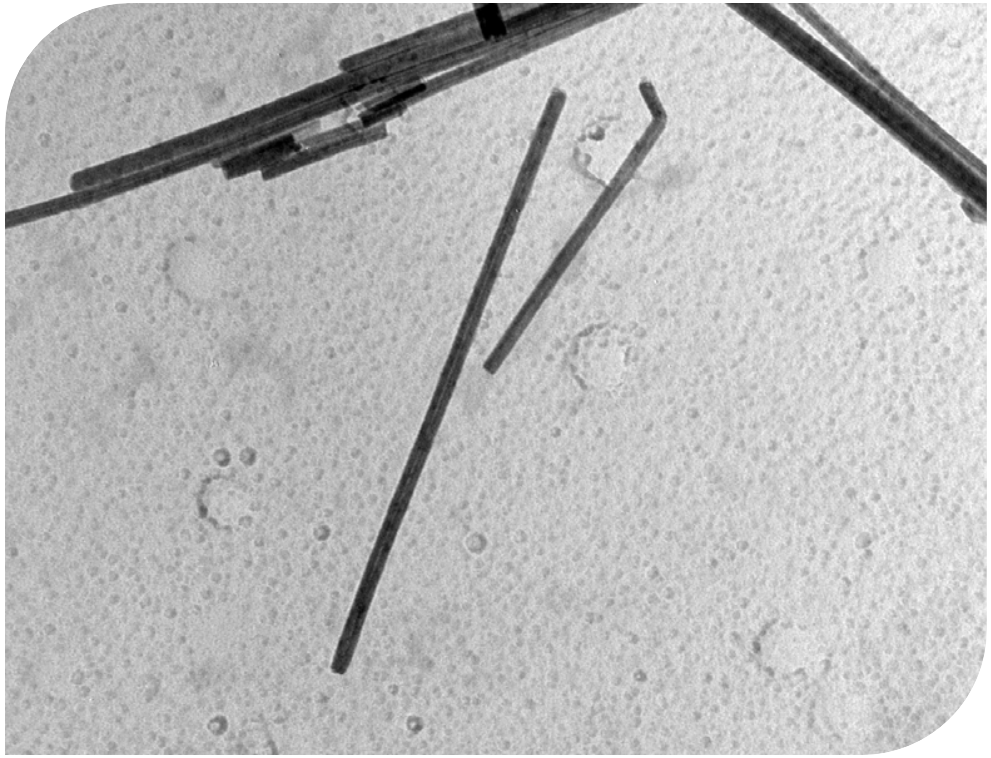
Each grid square (opening) is approximately 0.01 sq. mm



TEM Analysis

Analysis at 20,000X magnification vs. 400X for light microscopy

ASBESTOS FIBERS TOO SMALL TO SEE BY LIGHT MICROSCOPY (PCM / PLM) ARE NOW EASILY DETECTED.



Milling (the other approach)

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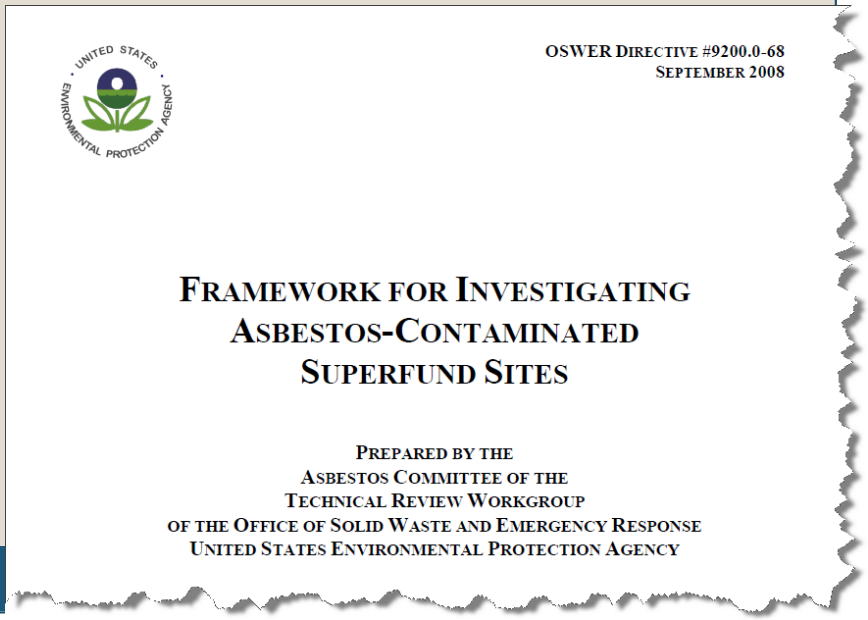
California Air Resource Board (CARB) Method 435

Determination of Asbestos Content of Serpentine Aggregate

- This is the current de facto standard for milling methods.
- It was developed to test for asbestos in stone not soil
- EPA framework document for guidance on Superfund sites recommends CARB 435 for soil.



OSWER DIRECTIVE #9200.0-68
SEPTEMBER 2008

FRAMEWORK FOR INVESTIGATING ASBESTOS-CONTAMINATED SUPERFUND SITES

PREPARED BY THE
ASBESTOS COMMITTEE OF THE
TECHNICAL REVIEW WORKGROUP
OF THE OFFICE OF SOLID WASTE AND EMERGENCY RESPONSE
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

CARB 435 Method

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The sample is dried in a drying oven and material >3/8" is removed by sieving

Milled at minus 200 degrees C for 4-8 minutes to reduce the nominal particle size to 75 microns

CARB 435

EMSL ANALYTICAL, INC.

After milling, the sample is analyzed by a PLM 400 or 1000 point count (0.25% or 0.1%)

CARB 435 Method

EMSL ANALYTICAL, INC.

- One of the main advantages of the CARB Method over the sieving methods is that it enables detection of unconsolidated (loose and unbound from matrix) asbestos fibers.
- Unfortunately the resolution of the light microscope is only about 0.25 microns.
- Asbestos fibers/bundles with widths less than this are still not detected.

CARB 435 PLUS

EMSL ANALYTICAL, INC.

TEM CARB Method for Soil

CARB Milling followed by TEM Mass Analysis by EPA 600 Section 2.5

- Milled sample is put into suspension, filtered and analyzed.
- Analysis is performed at up to 20,000X
- Identification of asbestos using X-Ray Analysis and SAED (selected area electron diffraction)
- Results are given in percent asbestos by mass
- Varying levels of analytical sensitivities are offered.

TEM CARB Method

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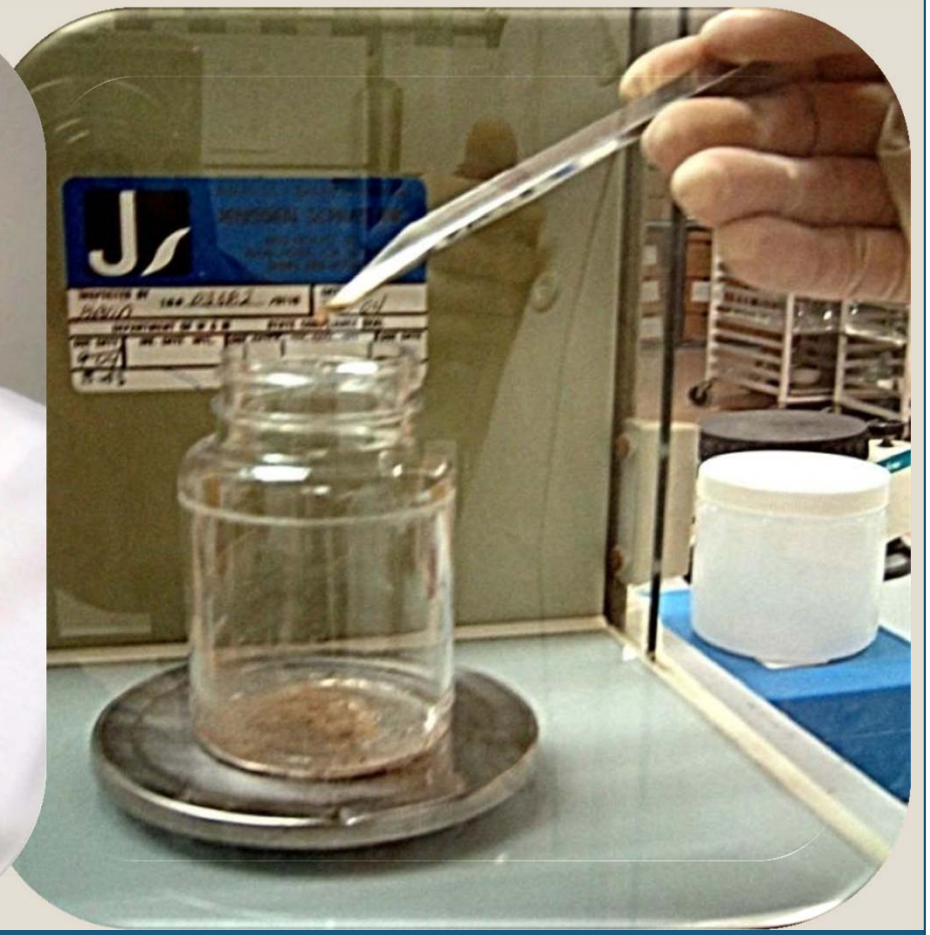
Following the standard milling, a known mass is put into solution



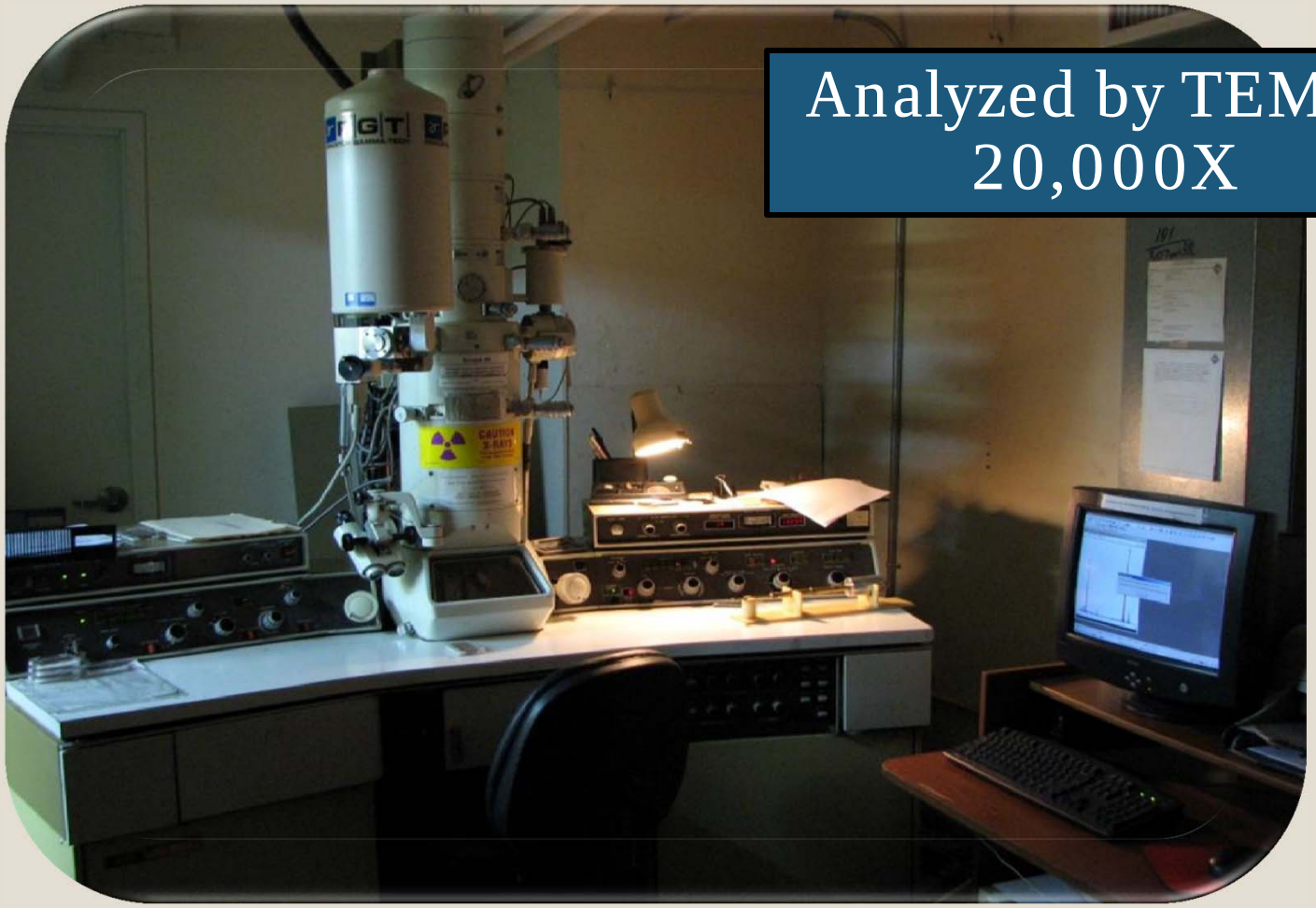
TEM CARB Method

EMSL ANALYTICAL, INC.

After sonication, the sample is filtered through a 0.4 micron filter

TEM CARB Method

EMSL ANALYTICAL, INC.



TEM CARB Method

EMSL ANALYTICAL, INC.

- By carefully measuring the lengths and widths of any asbestos fibers/bundles detected, the individual fiber masses are calculated.
- The individual weights are then totaled and a mass percent is determined

Another Approach Fiber Releasability

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- Determining the percentage of asbestos in soil is useful for knowing that there is a potential for exposure.
- But it does not give us a clue as to what the risk actually is.
- 1% is not an acceptable action level to use for asbestos in soil

Fiber Releasability Risk Assessment

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- If we can determine the amount of respirable asbestos fibers that are released from a soil upon agitation then we have an insight into risk
- The EPA is all about minimizing risk to the population.

The Elutriator Method

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The Elutriator Method

- With this method a soil sample is gravimetrically tracked through sieving into course and fine fractions
- The fine fraction is then tumbled in a closed chamber and any respirable dust generated is collected on air cassettes
- Analysis is performed by ISO 10312 counting rules

This method is peer reviewed and (arguably) acceptable for risk assessment studies

Risk Assessment Methods

The Elutriator Method

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Tumbler apparatus filled with soil

Risk Assessment Methods

The Elutriator Method

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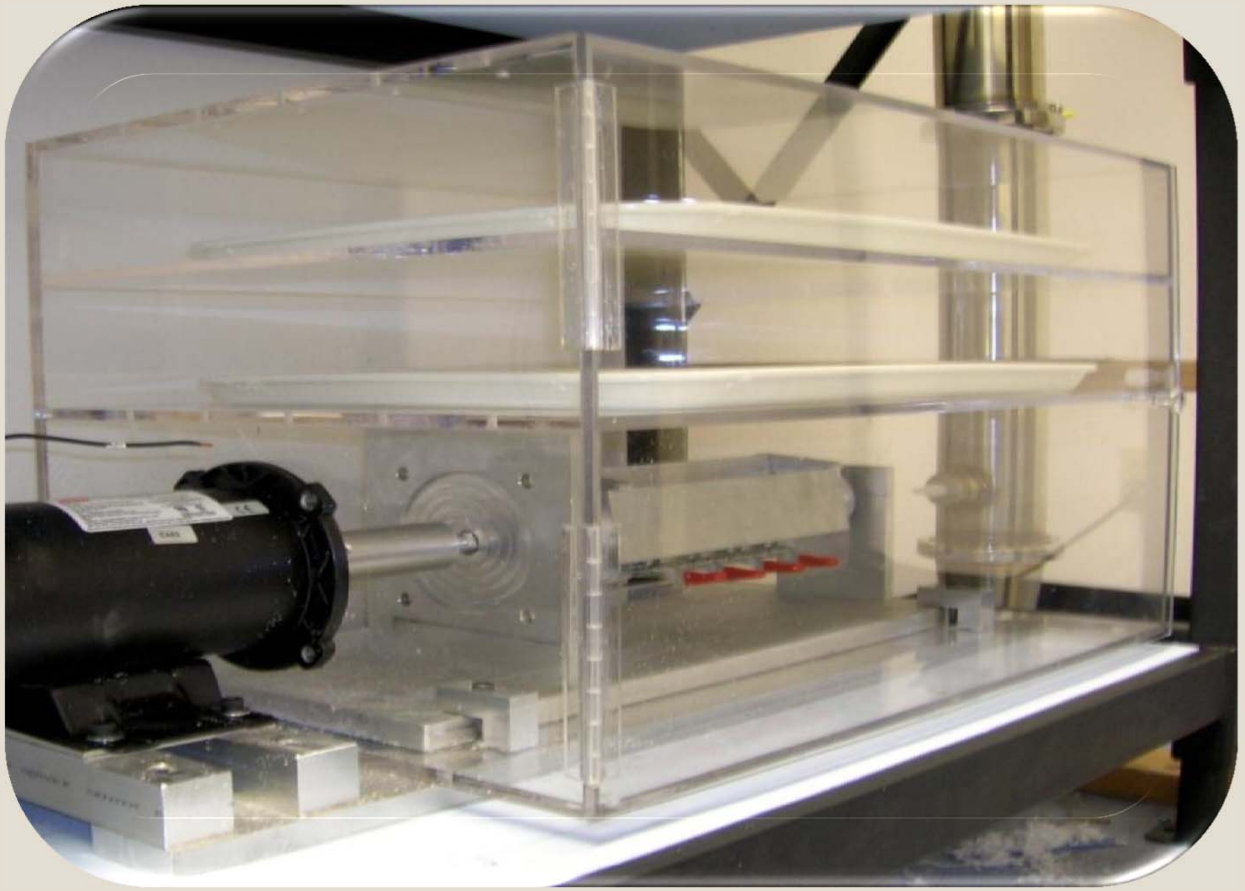
Tumbler inside enclosed humidity chamber



Risk Assessment Methods

The Elutriator Method

EMSL ANALYTICAL, INC.

Air Cassettes on top of the elutriator stack.

Isokinetic sampling to catch only the respirable fraction of fibers released from the soil.

Field Alternatives to the Elutriator

The EPA uses other techniques in the field that also collect and measure releasable fibers from soil.

- **Activity Based air Sampling**
- **Releasable Asbestos Field (RAF) Unit**
- **Fluidized Bed**

Activity Based Air Sampling

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Activity Based Air Sampling

Personnel (and sometimes area) monitoring is performed while samplers mimic likely activity for that location.

Photos courtesy of EPA

RAF Unit

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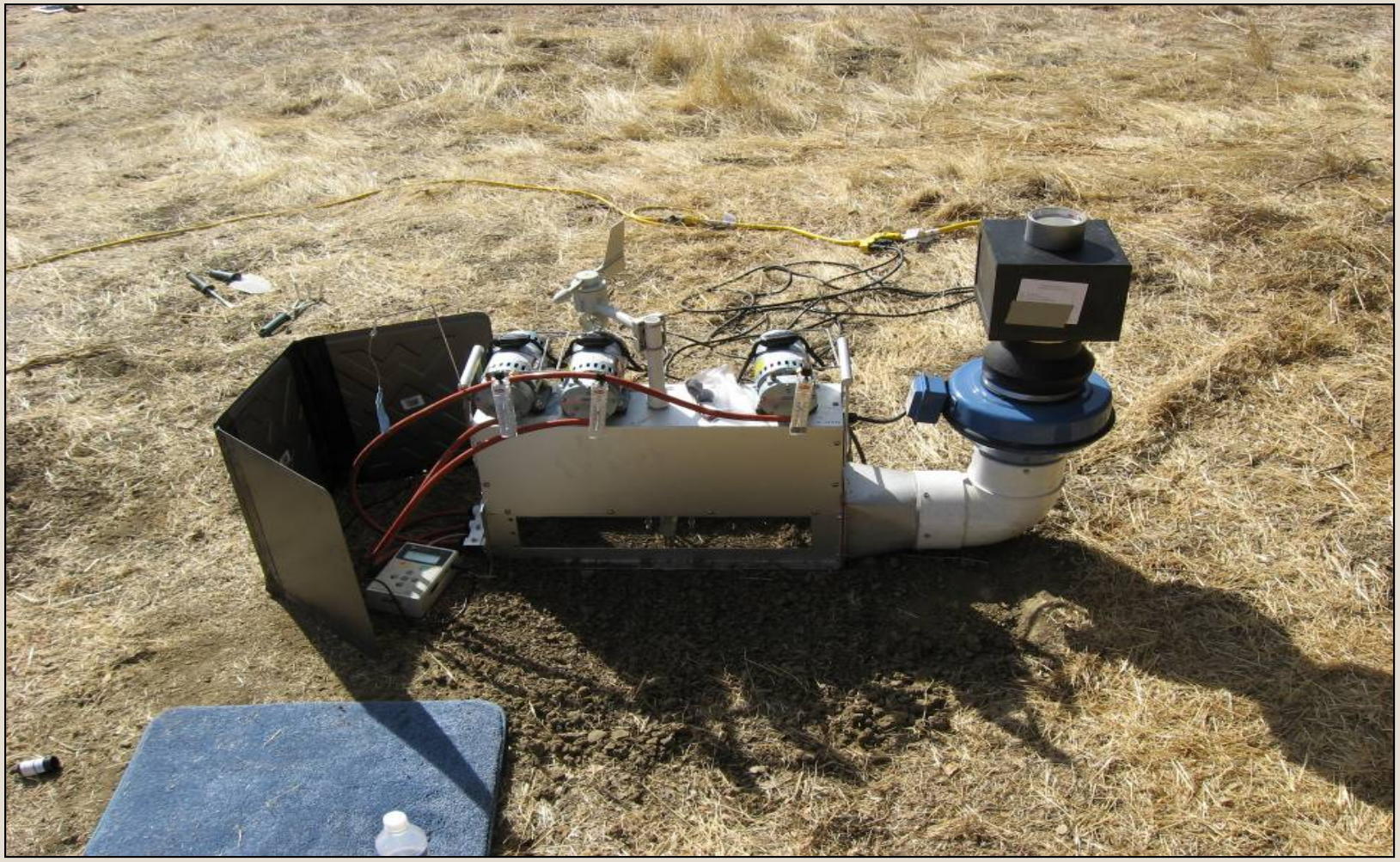

Photos courtesy of EPA

RAF Unit

EMSL ANALYTICAL, INC.

Photos courtesy of EPA

Fluidized Bed

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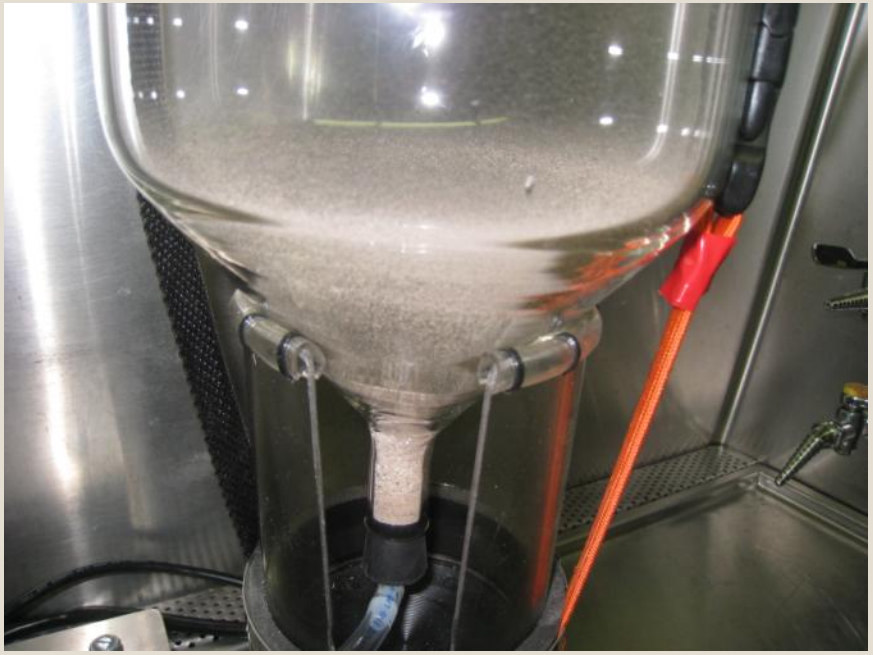
- Air is injected at a precise flow rate to get the soil sample behaving like a fluid.
- Then air samples are collected from above.



Fluidized Bed

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Fluidized Bed

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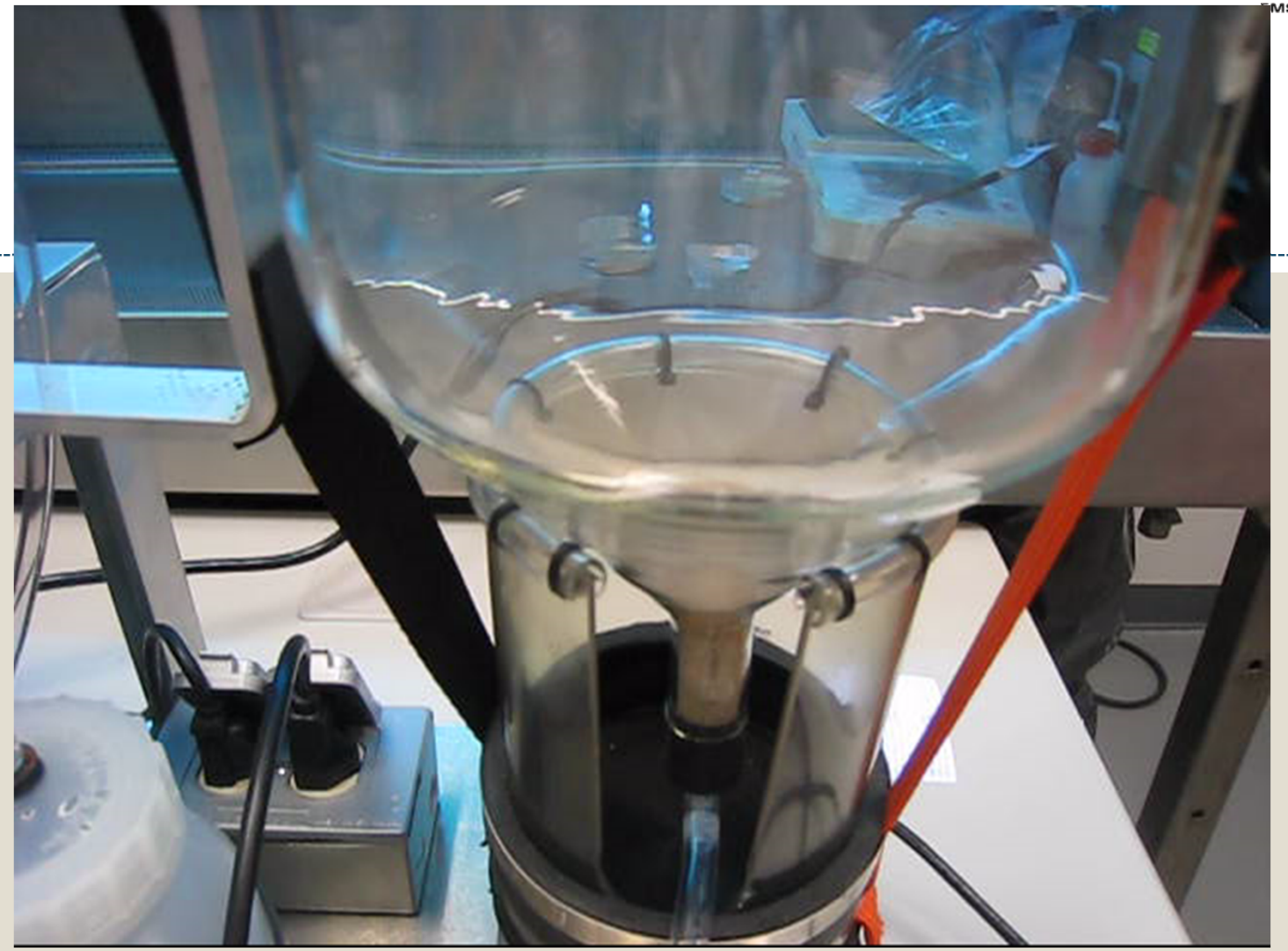

Fluidized Bed

Fluidized Bed

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Summing Up

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The right answer depends on the right question…

"I see building material debris in the soil. Does it have asbestos and if so how much? Do I need to dispose of it as hazardous waste?"

- ASTM Sieving Method to give % ACM in soil

"I don't necessarily see suspect asbestos but I think it might be there either from contamination (ex brake shops) or from NOA."

- PLM CARB 435 (down to 0.25% or 0.1%)
- TEM CARB 435 (EPA 600 Mass Analysis)
- ASTM Sieving Method

Does the Soil Contain Respirable Fibers?

- EPA 540-R-97-028 Superfund Method (Elutriator)
- Activity based air sampling

- **CARB 435 mentioned**
- **1% is not an appropriate action level**

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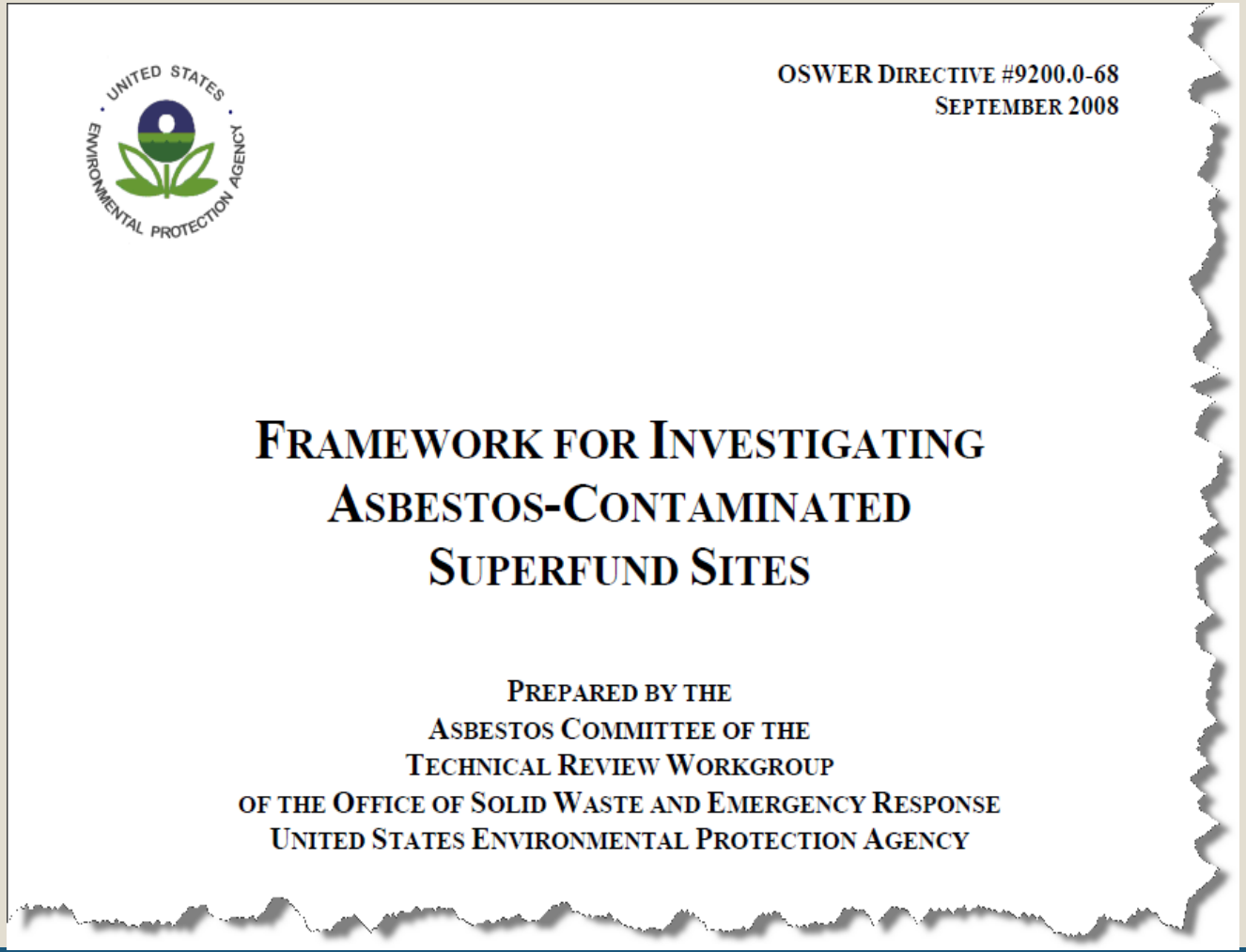

OSWER DIRECTIVE #9200.0-68
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FRAMEWORK FOR INVESTIGATING ASBESTOS-CONTAMINATED SUPERFUND SITES

PREPARED BY THE
ASBESTOS COMMITTEE OF THE
TECHNICAL REVIEW WORKGROUP
OF THE OFFICE OF SOLID WASTE AND EMERGENCY RESPONSE
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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