Oct 31, 2018- *subject to change/editing*
The Joint Institute of Food Safety and Applied Nutrition
(JIFSAN) symposium on "Asbestos in Talc"
November 28, 2018

invited presentation by
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My Assigned Topics

1. Overview of current asbestos testing methodology
2. Limitations of X-ray diffraction (XRD), polarized light microscopy (PLM), and phase contract microscopy (PCM)
3. Advantages of electron microscopy (EM) methods (SEM, TEM)
4. Methods of mineral identification

I was asked by JIFSAN to describe and explain in thirty minutes the testing methods currently used and proposed for asbestos in commercial talc ores and products. The anticipated audience is "diverse". There are government regulators who oversee the scientific and industrial community; professional organization administrators; biologists; mineralogists; and highly competent specialists- e.g., "talcologists" and "asbestologists". It became clear to me that the audience would have highly varying background knowledge of asbestos in talc, ranging from understanding of mining, product history, nomenclature and analytical methods.

So, I decided to make a presentation that focuses on the key issues affecting the techniques used for the materials being analyzed, and with an overarching constraint of analyte definition accuracy and consensus.

In the outline below, prepared as of October 31 and subject to some editing, I have provided listings of pros, cons and "issues" to summarize what I deem as key aspects of the assigned "limitations" and "advantages" (especially since those terms can be perceived as introducing a bias. Time constraints preclude an extensive discussion of sample submittal and preparation, but remember GIGO- garbage in, garbage out!

I will comment more on items marked with an asterisk and leave other topics for the breakout session dialogues.

I conclude with the proposals that consensus analyte definitions must precede whatever analytical method(s) become selected and that multiple methods are better than a single technique.

Mineral and "asbestos" ID differ!

Example -What is a single fiber?
"Answer"- It's "likely" to be asbestos on the basis of:
Aspect ratio
Width -Length
Parallel sides
Terminations
Unit cell
Chemistry
"Population"
Nomenclature
Litigation

ANALYTICAL METHODS

Eyesight observations
Advantages:
Rapid sorting of some samples

Disadvantages/
Limitations/Issues:
Magnification limits
only "sees" shapes

Light Microscopy- PLM & PCM
Phase Contrast Microscopy (PCM)
not discussed; mainly for air samples.

Polarized Light Microscopy (PLM)

PLM Advantages:
Codified by EPA *
Widespread usage *
Relatively inexpensive
Rapid turn-around
Standardized rules
Dispersion staining
Becke Line
Good for building materials
Good for "bulk materials"
"Sees" range of fiber sizes
Skill levels

PLM Disadvantages/
Limitations/Issues:

Magnification limit ~400x *
Smallest fibers can be masked by matrix
Non-friable materials opaque
Variations in mineral chemistry changes RI
Becke Line techniques "harder"
(pleochroism, extinction, RI, …)
Quantification

XRD for Asbestos, talc & "fibers"

XRD Advantages:
Rapid turn-around
Standardized rules
Reference standards
Good for gross phase ID
Identifies sample mineral assemblage
Semi-quantitative for amounts
improvable by concentration (sieving, elutriation)
More quantitative with standards (slow scan)
"Sees" almost all size fractions

XRD Disadvantages/
limitations/"issues":

Measure atomic spacings
Phase ID errors
Expensive
Need reference standards
Sample "mounts"
powder "packing"
grain orientation
Analysts expertise & skills
Radiation protocols
Instrument calibration
"Poor" shape information
Overlap 2 theta peaks *
Detection limits *
fast, slow scans

SEM for Asbestos, talc & "fibers"

Advantages:
Visual magnification of shape
Chemistry by EDS

Disadvantages/
Limitations/Issues:
Versus TEM, the "Gold" standard *
Expensive
Analyst expertise
Instrument calibration
No structural capability *
Can't discriminate some amphiboles *
Interpretation of-
"shapes"/morphologies
asbestos present and amount(s)

TEM for Asbestos, talc & "fibers"
Advantages:
Perceived as AHERA "Gold" standard *
Relatively widespread usage *
Shape via visual ID
Calcium amphiboles

TEM Disadvantages/
Limitations/Issues:
Aspect ratio %
Population and amounts *
Detected vs. Not-detected *
Confirmed vs. non-confirmed *
"Sees" only smaller size particulates
Phase ID errors (amphibole species)
Expensive
Need reference standards
Analyst expertise
Instrument calibration
Interpretation "shapes"/morphologies
Talc vs. anthophyllite - Twisted talc ribbons/fibers
"kinky" talc *

Talc-Tremolite-Anthophyllite
Chemistry and structure issues

Goal for Talcs: "prove" absence of
relevant
amphiboles and chrysotile

Need a full spectrum of analytical tools,
applied in context of
a common analyte definition,
to assert
problematical levels of concern!

Conclusions:

PLM will remain primary technique given its simplicity and widespread availability.
SEM & PCM useful supplements.
XRD especially useful to confirm presence of amphiboles.
TEM and EDX likely to be "ultimate" analytical tool

But ONLY IF we agree on definition of
"phase" names and relevant shapes!
&
Remember that AHERA TEM method allows for
"Ambiguous" & "Indeterminate"
or
We just don't know!