Career Day

I was asked to address my 1st grade daughter's recent Career Day. Now, I usually feel pretty confident about myself, but it was easy to feel intimidated when you have to follow the uniformed airline pilot, the local Police Officer, and other more 'sexy' professionals that seem to be more appealing to the young minds that were assembled that day.

So, there they sat looking up at me, thirty smiling faces waiting to hear how important and exciting my profession could be. I considered talking about the *excitement* of employing various microanalytical techniques in materials investigations. I measured the potential of sharing stories about the *thrill* of employing High Resolution Electron Microscopy or the *exhilaration* of using a spindle stage to study a mineral's unyielding properties…

Okay, I considered lying. It was obvious that the kids, after hearing about emergency maneuvers at 20,000 feet and about the possibility of using a weapon, wanted excitement! I told myself that I could do that: my weapon might be a page from 40CFR and my maneuver might have to do with defining cleavage fragments, but I would make them see the excitement of being a Laboratory Director of a large commercial environmental laboratory.

I failed miserably.

The Thrill of Changing Asbestos Definitions

Asking the 'man on the street' to *define asbestos* can be as interesting as a first grader's career day presentation. From a legal standpoint, the answer is quite simple. We have long associated the 'regulated six' in our definition of asbestos. The definition includes parameters of mineral length to width (fibrosity), flexibility and durability (tensile strength), and of some more clinical conventions like 'asbestiform'.

Many of us involved with the environmental testing industry are well versed in these familiar definitions. Yet the subtleties of these definitions, especially when it comes to debate between mineralogists, geologists, public health professionals, and industrial stakeholders is significant.

At the infancy of asbestos public health legislation and the parallel birth of regulations in the testing community, there was a feeling of compromise that worked well to shepherd through meaningful and timely rules, codes, and guidelines. These regulations made a positive difference in many arenas. Yet, for many involved in analytical circles there was always a feeling of incompleteness about the seemingly rigid definitions of the 'regulated six' asbestos minerals. This feeling often was associated with case by case or sample to sample observations of the minerals we were characterizing.

Of course, there was some comfort and convenience with the current definition, as it relieved us of any gray areas of interpretation. Said another way, the analytical methods for sample collection, preparation, analysis, and data production were usually inflexible. There was some consolation knowing that counting rules were black and white and that our job was really just filling in the blanks on an analytical data matrix – it was someone else who would interpret and make public health decisions based upon our data. An example… our training as mineralogists and/or microscopists helped us distinguish amphibole cleavage fragments from true asbestiform fibers, but we didn't have to worry about any overlaps or fuzzy areas of definitions since the counting rules specified a clear length to width aspect ratio – whew.

Asbestiform:
specific type of mineral fibrosity in which the fibres and fibrils possess high tensile strength and flexibility.

Asbestos:
term applied to a group of silicate minerals belonging to the serpentine and amphibole groups which have crystallized in the asbestiform habit, causing them to be easily separated into long, thin, flexible, strong fibres when crushed or processed.

After a generation of maturation, it is safe to say that the current definition for asbestos is not adequate.

Mineral Maneuvers

The definition for asbestos listed above simply states "term applied to a group…". This is from one of the recent ISO methods on asbestos analysis. The original AHERA and other pre-2000 USEPA documents always include the 'regulated six' minerals of chrysotile, anthophyllite, amosite (grunerite), crocidolite (riebeckite), tremolite, and actinolite. It is this specific "group" that has been rigidly defined by 40CFR and other early foundational documents at the infancy-stage of this knowledge base that were mentioned above. For better or worse, it has also been the foundation of various legal arguments. Stakeholders have invested countless hours and dollars behind these definitions and therefore there is a wealth of legal precedence regarding their 'acceptance'. However, acceptance does not mean validity, nor does it mean static intransigence. There can be growth and evolution of any recognized definition.

Though not as thrilling as discussing emergency maneuvers at 20,000 feet, I do know the excitement of witnessing heated dialogue between colleagues debating these definitions. The debate has raged on for well over twenty years. As the knowledge base widens, and especially as bio-physiological and epidemiological evidence mounts, the definitions are, by default, evolving. This maturation has been evident in the more open ISO definition above and in other inclusive parameters in associated guidelines (ex. USEPA Vermiculite Attic Insulation Method).

The conversation now involves other asbestiform minerals that exhibit the properties (and possible hazards) of the regulated six. That is, crystal growth habit that is asbestiform with high flexibility, tensile strength, fibrosity, and durability in the environment and, as research is concluding, in biological studies.

Roadmap to (H)EMP

Again, the issue of limitations of the definition of asbestos has been recognized by significant authorities (ASTDR, NIOSH, USGS, OSHA). The best and perhaps most recent example is the Center for Disease Control's work with the National Institute of Occupational Safety and Health. Engaged professionals should regard this issue and this topic as a requisite to their vocation and their role in public health. The CDC/NIOSH produced the following document: "Current Intelligence Bulletin: Asbestos Fibers and Other **Elongated Mineral Particles**: State of the Science and Roadmap for Research." This is also available at http://www.cdc.gov/niosh/review/peer/ISI/cibasbestos-pr.html.

The roadmap parallels other historical efforts at clarity. That is to say, the road took some twists and turns and the simple "how do we get from Point A to Point B?" morphed into something that, in an effort to be inclusive of multiple interest group concerns, looked like a map of the Boston Subway. The hope is that other EMPs will be recognized as asbestos, with all of the *rights and privileges* that entails, and with the bottom line of underscoring public health.

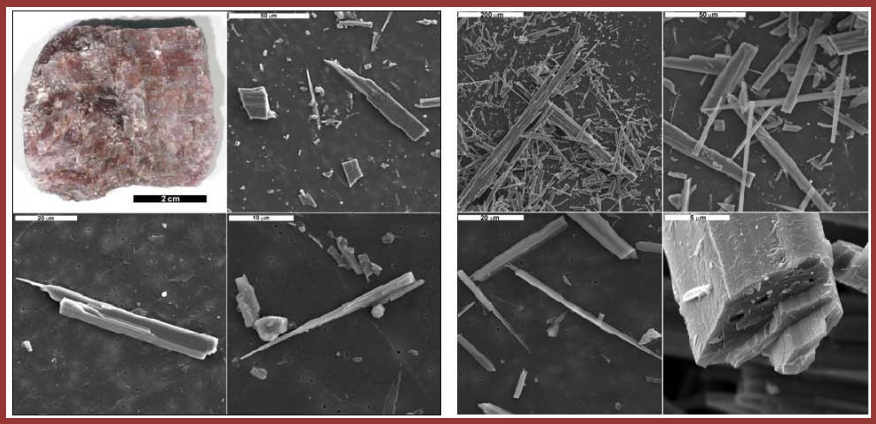

Figure 1. Massive tremolite (var. hexagonite) ground with a pestle in a mortar to produce cleavage fragments. Unground sample (upper left) and scanning electron micrographs at various magnifications are shown. Photograph courtesy of USGS.

Figure 2. National Institute of Standards and Technology (NIST) Standard Reference Material 1867a "Commercial Asbestos-Tremolite". Photograph courtesy of USGS.

[As a side note, let it be known that Dr. James Webber, research scientist of NYSDOH-ELAP and Chairman of ASTM's D22 Committee on Air Quality has contributed to the discussion by adding the memorable prefix "H". This stands for Hazardous. Thus, HEMP was born. This addition may pique the interest of the public and perhaps other interested parties (excuse the pun).]

For Instance…

Here's a brief list of some current mineral fibers of concern:

Vermiculite (winchite/richerite):

Much has been made of the disaster at Libby Montana and the amphibole mineral complex associated with vermiculite that originated there. Though the actinolite/tremolite series of amphiboles is commonly the mineral in question, the whole solid solution series of related hornblendes has contributed winchite and richerite to the dialogue.

Where do these two mineral types stand? Asbestiform growth habit? Fibrosity? Durability? Check. The biological damage was extensive enough that a new classification of "Libby Amphibole - LA" has been added to the metrics lexicon to incorporate these end-member minerals. Many laboratory professionals could differentiate these minerals from actinolite and tremolite by conventional means – but, often times an accurate characterization was outside the grasp of many commercial laboratories. These are officially not regulated asbestos and there are implications for mischaracterization.

With the recognition of the LA category, a comfort level was again established that allowed for laboratories to "call it like they see it" under the guidelines of counting rules and identification parameters. Once again, laboratories could do their best and let other professionals (risk assessors etc.) deal with the repercussions of their data.

Taconite:

Headlines in public and academic circles have proclaimed a connection between this iron-rich silicate rock and mesothelioma. Recent research (2007) focusing on at least one large formation of this rock type in the Great Lakes region has shown iron-rich regulated asbestos minerals in close geologic association with the taconite deposits. These include ferroactinolite, grunerite (amosite), and ferrous rich serpentine mineral.

Currently a $5M study through the University of Minnesota is being conducted with 2,000 participants to look at the issue. Could taconite be incorporated into a changing and more inclusive definition of asbestos? Or, are there mineral and geological issues ancillary to taconite that are the cause for concern?

Erionite:

Erionite has been linked to cases of mesothelioma in Cappadocia Turkey. Zeolites are microporous aluminosilicates of which there are 176 recognized types. Erionite is a fibrous zeolite, and the Turkish occurrence exhibits extreme fibrosity and can be considered asbestiform. Occupational exposures were prevalent and resulted in many pleural and pericardium diagnosed cases of cancer. Most of the zeolite used in the United States is in a very fine, granular, non-fibrous form. It is used extensively as a filtering and catalyst media. Fibrous

erionite, a residue from volcanic ash, have also been the cause for health investigations in North Dakota and Arizona. Might this fibrous silicate be added to an expanded definition of asbestos or does the Elongated Mineral Particle definition capture this case?

Fluoro-Edenite:

The recent World Asbestos Conference was held in Taormina Sicily in October of 2009. The location was just up the coast from Biancavilla, the village where off-the-chart rates of malignant pleural disease has been documented. These cases centered around the absence of industrial exposures to asbestos and the prevalence of volcanic quarry activity where the amphibole mineral was detected. Research continues to demonstrate the health significance of this fibrous mineral especially when compared to asbestos disease cohorts. Like Winchite and Richterite, will this amphibole be considered for any comprehensive list?

Fluoro-edenite. Biancavilla, Sicily 2009

Adventure

Like Indiana Jones, the career-day first grade class associated exotic places and travel with adventure. Would they be excited to hear that the concerns of these minerals are global? Though perhaps not ubiquitous, really anywhere with exposed outcroppings of fibrous silicates, especially volcanic dust, may have the potential for health consequences. International health and safety organizations continue to research and discover that the realm of asbestos disease has expanded to include more than the regulated six target minerals! The four examples above cover three continents. If only Dr. Jones would trade his leather whip for a TEM, or at least a chrysotile woven/braided whip?

IAQ / FAQ / NOA

As an interested industrial hygienist or an indoor air quality professional what should you know about these issues? First off, be aware that these elongated mineral particles might be found in many locations – quarries, foundries, road or excavation sites, and in existing building products. There are number of occupations that might have the potential for exposure – miners, construction workers, demolition contractors, etc.

Notice in the examples listed previously that there is a propensity for exterior exposure (mines, quarries, etc.). Perhaps this is where mention of the dreaded *natural occurrences of asbestos* or NOA should be mentioned? I caution you when carelessly employing this term (NOA) when in the company of a mineralogist. Or just to have fun at your next dinner party – invite a mineralogist and watch their

reaction when you throw out NOA with little thought to conventions employed by the Mineralogical Society of America. It seems that many asbestos professionals use NOA to mean naturally occurring asbestos. All minerals including asbestos are, of course, originating naturally in geologic formations – thus there is a redundancy with 'naturally occurring'. You can soothe the manic response of your party guests by simply underscoring that NOA for you means *natural occurrences* of asbestos. [This compromise did, surprisingly, contain Dr. Gunter at a recent conference.]

Finally, assume nothing. That is, definitions of asbestos may still be in place by regulators, but in order to provide the highest level of due diligence, a more open-minded approach might be followed when you sample for airborne contaminants, request laboratory analysis, and interpret data for exposure or risk assessments. "The laboratory data did not detect any asbestos, but wow, there are high concentrations of long thin silicate minerals." Please consider the consequences of such observations.

Final Note

Perhaps the next step is to both be aware (and educated) of the EMP dialogue that is on-going and become an advocate for expanded definitions of asbestos through local, national, and international organizations that promote public health. If anything, you'll be able to be proud the next time that you have to stand in front of a class of first graders and expound on the thrill of your profession.

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