ASBESTOS *SANS* MINERALOGY

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It would come as a shock to a mineralogist if you heard a judge say "the definition of asbestos is a legal matter" (stemming from debate on which species of amphiboles should be considered asbestos), or saw the phrase "naturally occurring asbestos" (used to denote asbestos occurring in its natural setting), or heard a federal agency in charge of worker safety propose the phrase "elongated mineral particle" to express a concern about the health effects of all minerals three times longer than they are wide, or, my favorite, read that a court recently defined asbestos as "a fibrous non-combustible compound that can be composed of several substances, typically including magnesium." Note that "mineral" was left out of the latter definition; thus, the meaning of my title, and the reality that in all of these examples there was no input from the mineralogical community.

I believe asbestos basically moved out of the minds of most mineralogists a decade or so ago. At that point, society had realized there were health issues in mining and milling asbestos in the pre–regulated workplace (i.e. before the 1970s). Then, concern moved from the workplace to the schoolhouse, with the 1990s seeing asbestos abatement in those settings. However, it was the mineralogy community that pointed out there are major differences in the health effects of chrysotile asbestos when compared to amphibole asbestos, the latter being more harmful. There are five regulated amphiboles, with only two of commercial importance: crocidolite, the asbestiform variety of riebeckite, and amosite, the asbestiform variety of grunerite. The other three regulated amphiboles are tremolite, actinolite, and anthophyllite when they occur in the asbestiform habit; this they rarely do, and instead are common rock-forming minerals occurring in many geological settings. In the late 1990s, asbestos concerns reemerged based mainly on two issues: the former vermiculite mine near Libby, Montana, which contained trace amounts of amphiboles in the ore, and the "discovery" of "naturally occurring asbestos" near El Dorado Hills, California.

Historically, the amphiboles associated with the vermiculite deposit in Libby had been referred to as tremolite. However, as attention turned toward the health effects of these amphiboles, it became apparent that the majority of the amphibole asbestos species at the mine were winchite and richterite, with less than 10% being tremolite. And because winchite and richterite were not regulated, a legal question emerged: was worker exposure to asbestiform varieties of these minerals a crime? Based upon Libby and the occurrence of other nonregulated asbestiform amphiboles (e.g. fluoro-edenite in Biancavilla, Sicily), now there are recommendations that all asbestiform amphiboles should be regulated. Although this seems like a logical conclusion, one that I have somewhat naively supported in the past, the real issue, then, becomes how one defines asbestiform and nonasbestiform amphiboles; but before we tackle that definition, it is worth noting why we care.

Although debated, there appears to be a difference in the disease potential between amphibole particles derived from asbestiform amphiboles and those derived from nonasbestiform ones, the latter being less harmful. The central issue is the difference in how asbestiform amphibole is defined by mineralogists and the regulatory agencies. A mineralogist would define "asbestiform" as a type of morphology characterized by a lengthwise splitting into fibers, and we, in turn, would define a fiber as being flexible, much like a human hair. The regulatory community "counts" a particle as a "fiber" based on its aspect ratio (length divided by width). A particle examined with a light microscope would be considered a fiber if its aspect ratio were greater than 3. This counting method had merit when used to count particles in air samples from places where commercial asbestos had been used, as in an asbestos mining or milling operation or in an asbestos abatement project. However, when these methods move into the natural world they fail, as most nonasbestiform amphiboles would meet this counting criterion, and thus many geological materials (e.g. mafic rocks, sediments derived from them, and amphibole-containing construction materials) would be subject to some type of regulation.

And now comes the issue of "naturally occurring asbestos (NOA)." This phrase was what originally prompted me to write this editorial. It appears that this term was first used in the *Sacramento Bee* (March 29, 1998) in reference to tremolite asbestos "unearthed" during a housing construction project. After the *Sacramento Bee* article, a California state geology report was issued also using the acronym NOA, but to their credit they defined it as "natural occurrences of asbestos." However, the definition coined in the *Sacramento Bee* seems to have won out. My issue, as a mineralogist and someone concerned with helping the public understand these issues, is when people see the phrase "naturally occurring asbestos," they would naturally think there must also be non-natural asbestos and not interpret the term as it was intended (i.e. to denote asbestos not occurring in an industrial setting). We must stop this imprecise use of scientific terminology. Yes, I also dislike the phrases "carbon footprint" and "organic food"!

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The current trend among regulatory and law-making groups, at least in the United States, seems to be to broaden the definition of asbestos to include all elongated mineral particles, which would, of course, include such common rock-forming minerals as quartz, feldspar, and calcite. And one such group is the United States Congress, where bills have been proposed to ban asbestos. Although many may agree that the use of asbestos in commercial products should be stopped, I think we would all disagree with how asbestos was defined in these bills, based on aspect ratio or, more generally, defined as elongated mineral particles. I believe it is critical for us to make our voices heard and bring our mineralogical expertise to bear on these asbestos issues, mainly to point out that under these nonmineralogical definitions of asbestos, most of our world would be naturally contaminated. If we stay uninvolved in this, and in other mineralogical issues important to society, we may find someone has defined a mineral as "a substance made of compounds."

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