THE UNIVERSITY OF MARYLAND
COLLEGE PARK CAMPUS
Department of Geology

November 7, 1986

Mr. Howard Wensley
Massachusetts Department of Public Health
150 Tremont Street
Boston, Massachusetts 02111

Dear Mr. Wensley:

I am sorry I can not be in Boston on November 17. I hope the following comments will be useful to you in the hearings that will take place on that day.

The term "asbestos" describes a particular mineral habit. Habit is a general term for the outward appearance of a mineral. It may also be defined as the way a mineral grows. The term "asbestos" does not specify chemical composition or the structure (atomic arrangement) of the minerals that can occur in the asbestiform habit. J.D. Dana, the originator of many of our mineralogical terms, states that minerals may "pass into fibrous varieties, the fibers of which are sometimes very long, fine, flexible, and separable by the fingers and look like flax. These kinds are called asbestos."(1)

Many minerals may occur as asbestos. Tremolite, actinolite, anthophyllite, riebeckite, grunerite, cummingtonite and serpentine are the most common but there are others(2,3). All of these most commonly occur as non-asbestos. Most examples of asbestos are composed of the amphibole minerals. Tremolite is an amphibole.

All of the epidemiology of human cancers linked to amphibole minerals and all animal studies showing that amphibole minerals can be carcinogenic involve asbestiform amphiboles with the properties described by Dana. All studies, involving both human epidemiology and animal inhalation and implantation, that have been done with the non-asbestiform varieties of amphibole including tremolite, are completely negative. In particular, there are three comprehensive epidemiological studies that show no association between amphibole cleavage fragments and cancer(4,5,6). The only location where any non-asbestiform mineral, that also occurs elsewhere as asbestos, has ever been accused of being a carcinogen is in the Guverneur District in New York State. However, these mineral deposits contain talc-asbestos. The absurdity of this situation is that if there is a problem with the material mined in this location (and this is currently the subject of a great controversy), it is certainly

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due to the asbestiform talc, not the ordinary rock-forming tremolite. Nonetheless, asbestiform talc remains unregulated.

What makes amphibole asbestos so different from amphibole cleavage fragments? The answer has several parts. First, amphibole asbestos has a "fibrillar" structure. Any fiber of amphibole asbestos that we can see with the eye is actually composed of millions of tiny fibers or fibrills that are intertwined but which are not chemically bonded one to the other. As Dana says, they can be easily separated by the fingers. You can see this fibrillar structure in Figure 2 in the article I have attached(3). It is these fibrills which can become airborne and enter the lungs. They are liberated when the bundle is disturbed. Their dimensions are variable among different samples of asbestos but their widths generally range from about 0.03 to 0.5 micrometers (300-5000 angstroms). Their lengths are also variable but in bulk samples, the mean aspect ratios are generally greater than 20:1. Many particles of asbestos have aspect ratios on the order of 100:1. Asbestos fibers are flexible. Asbestos can be woven into cloth. No non-asbestiform mineral could every be woven. Even minerals that occur naturally as long, thin crystals do not exhibit this flexibility unless they are composed of fibrills and are therefore asbestos. This unusual fibrillar structure produces many other unusual properties which allow a microscopist to identify amphibole asbestos and to tell it apart from amphibole cleavage fragment. These include: parallel extinction in monoclinic minerals, the lack of an interference figure, incomplete extinction, bundles of fibers exhibiting splayed ends, curvature, and mean aspect ratios in excess of 20:1.

We do not know what makes asbestos carcinogenic. Animal studies point to dimensions as being important in carcinogenicity. The most complete data set in this area was developed by Merle Stanton of the National Cancer Institute(7). He suggested that the most carcinogenic dimensions are lengths greater than 8μm and width less than 0.25μm. (This is an aspect ratio of 32:1.) He also found that when he took asbestos and reduced its fiber length and aspect ratio by grinding, its carcinogenic potential went to zero.

The 3:1 aspect ratio that is so often quoted as a definition of asbestos has no relevance to the dimensions of asbestos or to the carcinogenic potential of mineral fibers. It was originated as a counting criterion in England during the 1960's as part of a method for monitoring asbestos concentrations that was developed for manufacturing operations that used asbestos in their products(8). Many minerals form 3:1 particles when crushed. The most common mineral in the crust of the earth, feldspar, will form particles that have a mean aspect ratio of between 3:1 and 4:1 when crushed. I would estimate that as many as half of the minerals that are abundant in rocks including all amphiboles, all pyroxenes, all feldspar, and all aluminosilicates will form 3:1 particles on crushing. Clearly, this can not be a definition of asbestos. It could also not be a recipe for cancer or all our miners would be suffering from the terrible ravage now experienced by asbestos workers.

I would like to make one final point. The PLM method recommended by EPA and published by them, which most laboratories are relying on for the analysis of play sand, was written for analysis of bulk insulation materials found in buildings. It is inappropriate for the analysis of sand, crushed stone, or other mineral products. The reasons are many. Fundamental to this discussion, however, is the fact that if amphiboles are found in insulation they are most likely to be asbestos. Asbestos fibers have many unique properties which made them ideal for insulation. Cleavage fragments lack these properties. However, when amphiboles are found in crushed rock, they are not likely to be asbestos and criteria to discriminate between asbestos and non-asbestos must be applied, discriminators that are not usually necessary when dealing with insulation, and which are not included in the EPA's interim method.

Please let me know if I can be of any further assistance.

Sincerely yours,

Ann G. Wylie

Ann G. Wylie
Associate Professor

Attachments

cc: Kevin Ahern

REFERENCES

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