A Discussion on Definitions for Fibers, Asbestos, and Cleavage Fragments in Untangling Asbestos Exposure: Strategies, Protocols, Methods, and Statistics Roundtable 239

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Overview

- Definitions for bulk asbestos
- Definitions for airborne fibers
- “Federal” or “Government” fibers
- Cleavage fragments
- Countable fibers
- Recommendations
Definitions for Bulk Asbestos

- Definitions for “asbestos” (EPA/600/R-93-116)
  - A commercial term applied to the asbestiform varieties of six minerals
    - Serpentine
      - Chrysotile (asbestiform serpentine)
    - Amphibole
      - Amosite (asbestiform grunerite)
      - Crocidolite (asbestiform riebeckite)
      - Anthophyllite (asbestiform)
      - Tremolite (asbestiform)
      - Actinolite (asbestiform)
Definitions for Bulk Asbestos

• Definitions for “asbestiform” are usually based on bulk “hand-samples” from EPA/600/R-93-116
  – “Crystallized with the asbestiform habit”
    • Fibers with mean aspect ratios of 20:1 to 100:1 or higher for fibers longer than 5 µm
    • Very thin fibrils, usually less than 0.5 µm in width
    • And any two of the following:
      – Parallel fibers occurring in bundles
      – Fiber bundles displaying splayed ends
      – Matted masses of individual fibers and/or
      – Fibers showing curvature
Definitions for Bulk Asbestos

- 1982 Interim Method, Section 1.7.2.4, states:
  - ‘For the purpose of this method, “asbestos fibers” are defined as having an aspect ratio greater than 3:1 and being positively identified as one of the minerals in Table 1.1.’
Definitions for Bulk Asbestos

• 1993 Improved Method states:
  – These characteristics refer to the population of fibers observed in a bulk sample. It is unlikely that asbestos components will be dominated with fibers having aspect ratios less than 20:1
  – Number of fibers necessary to characterize the population is not defined here
Definitions for Bulk Asbestos

• USEPA/OSHA Regulations on asbestiform fibers vs. cleavage fragments:
  – Chrysotile and “… the asbestiform varieties of …” amphibole
  – Note that cleavage fragments of amphibole are not believed to be of concern
  – Analytical methods give general properties for asbestiform fibers and cleavage fragments
    • Asbestiform fibers: high aspect ratios
    • Cleavage fragments: low aspect ratios
Federal Fibers

- Where did the term “Federal” or “Government Fibers” originate?
Federal Fibre Mills
Federal Fibre Mills

- The Federal Fibre Mills building at 1101 South Peters Street, New Orleans, was built in 1907 and used then for the production of rope, largely for ships in port. In 1984 it was used as a pavilion for the World's Fair and now has been turned into condos by the Historic Restoration company.
Federal or Government Fibers

• “Federal” or “Government” fibers
  – Defined by regulation and not necessarily consistent with mineralogy

• Specific to analytical method
  • PCM – Any elongated particle with an aspect ratio of 3:1 or greater
  • EM – Any elongated particle with an aspect ratio of 3:1 or greater and displaying characteristic morphology, chemistry, and/or crystal structure
Definitions for Fibers of Airborne Asbestos

- **USEPA**
  - **AHERA TEM**
    - Six regulated asbestos materials displaying characteristic morphology, chemistry, and/or crystal structure
    - >0.5 µm in length
    - Minimally, 5:1 aspect ratio
Definitions for Fibers of Airborne Asbestos

• OSHA
  – NIOSH 7400 or ID 160 PCM
    • > 5 µm in length, 3:1 aspect ratio
    • NIOSH 7400 options:
      – Minimally, 3:1 aspect ratio – “A” rules
      – Minimally, 5:1 aspect ratio – “B” rules
Cleavage Fragments

- Asbestos fibers develop in single crystals
- Cleavage fragments are elongated fibrous particles generated by patterned breakage during the crushing or grinding of amphibole material
- Aspect ratios for cleavage fragments are generally lower than those of asbestos fibers
  - Mean aspect ratios of 20:1 to 100:1 for bulk asbestos materials
  - Aspect ratios less than 10:1 for cleavage fragments
Cleavage Fragments

- Tremolite cleavage fragments
- Asbestiform tremolite
- Photos from Bureau of Mines IC 8751 “Selected Silicate Minerals and Their Asbestiform Varieties”
Asbestiform Fibers vs. Cleavage Fragments

- Plot of fiber numbers vs. aspect ratio for bulk tremolite cleavage fragments and tremolite asbestos

**FIGURE 42.** Frequency polygons for the aspect ratios of tremolite and tremolite asbestos.
Asbestiform Fibers vs. Cleavage Fragments

- Plot of fiber numbers vs. aspect ratio for bulk anthophyllite cleavage fragments and anthophyllite asbestos

FIGURE 41. Frequency polygons for the aspect ratios of anthophyllite and anthophyllite asbestos.
Asbestiform Fibers vs. Cleavage Fragments

- Plot of fiber numbers of airborne and bulk chrysotile asbestos fibers vs. aspect ratio
  - US Bureau of Mines Report No. IC 8751
    “Selected Silicate Minerals and Their Asbestiform Varieties”

*FIGURE 44.* - Frequency polygons for the aspect ratios of commercial-grade chrysotile and chrysotile in ambient air.
What is needed?

• Clearly written, unambiguous definitions for:
  
  – Countable fiber
  – Asbestiform fiber
  – Asbestos
  – Cleavage fragment
Recommendations

• Countable fiber
  – Fiber: an elongated particle having an aspect ratio of 3:1 or greater
    • Large data base determined using 3:1
  – Length greater than 0.5 or 5 µm
  – Identifiable as asbestos by criteria given in the analytical method
  – Distinguished from cleavage fragments
    • Is a fiber with a 15:1 aspect ratio a short asbestos fiber or a long cleavage fragment?
Recommendations

• Asbestiform fiber: May need to consider specific definitions for serpentine and amphibole forms for bulk and airborne fibers
  – Some amphibole fibers may not show “curvature” found in serpentine chrysotile
  – General definitions subject to individual interpretation or misinterpretation
  – Should bulk and airborne asbestos fibers have different criteria?
Recommendations

• Asbestos: Government list of “named” fibers needs to be carefully reviewed
  – Winchite
  – Richterite
  – Others?

• Cleavage fragments:
  – Aspect ratio alone seems inadequate
    • How can we distinguish between long cleavage fragments and short asbestos fibers?
    • How many fibers must be counted to make such a distinction?
Recommendations

• *Fiber type, size, and number should be related to a health concern!*
Summary

- Fibers
- Cleavage Fragments
- Asbestos Fibers
- Particles
A Discussion on Definitions for Fibers, Asbestos, and Cleavage Fragments

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