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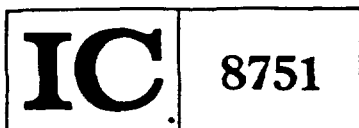
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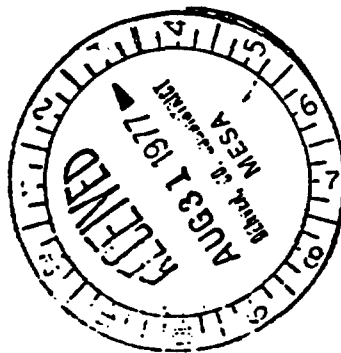
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**Selected Silicate Minerals
and Their Asbestiform Varieties**
**Mineralogical Definitions
and Identification-Characterization**



UNITED STATES DEPARTMENT OF THE INTERIOR

MTC 001249

Selected Silicate Minerals and Their Asbestiform Varieties

Mineralogical Definitions and Identification-Characterization

**By W. J. Campbell, R. L. Blake, L. L. Brown, E. E. Cather,
and J. J. Sjöberg**

This current report on asbestos has been prepared by the
Bureau of Mines, U.S. Department of the Interior to—

1. Provide precise nomenclature and information on
selected silicate minerals and their asbestiform
varieties.
2. Invite comment, revisions, or additional information
on the subject.

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**UNITED STATES DEPARTMENT OF THE INTERIOR
Cecil D. Andrus, Secretary
BUREAU OF MINES**

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SELECTED SILICATE MINERALS AND THEIR ASBESTIFORM VARIETIES

Mineralogical Definitions and Identification-Characterization

by

W. J. Campbell,¹ R. L. Blake,² L. L. Brown,³ E. E. Cather,⁴ and J. J. Sjöberg⁵

ABSTRACT

This report by the Federal Bureau of Mines Particulate Mineralogy Unit recommends mineralogical definitions and identification-characterization concepts for selected silicate minerals and their asbestiform varieties. Precise definitions acceptable to mineral analysts, regulatory personnel, and medical scientists are essential because of the present lack of conformity in terminology concerned with measuring and controlling asbestiform particulates and their related health effects. Because of the complexity and variability of crystal morphology in different mineral groups, the descriptive terms are generally explained by illustration rather than by numerical values. Applications and limitations of several analytical techniques for particulate identification and characterization are discussed.

INTRODUCTION

Concurrent with concerns within the Federal Government over future availability of minerals to meet our expanding needs is the requirement that minerals and mineral commodities be mined and processed with minimum environmental impact. Traditionally, matters related to "... inquiries and scientific and technologic investigations concerning mining, and the preparation, treatment, and utilization of mineral substances with a view to improving health conditions and increasing safety...." have been within the province of the Bureau of Mines as authorized in the amended Organic Act of 1913 (Public Law 62-386). Since its establishment by Congress, the Bureau of Mines has long been deeply involved in investigating the explosive characteristics of dusts in the mineral industries in its mining and metallurgy research centers, and has established analytical and mineralogical laboratories in seven metallurgy research centers. These laboratories are essential to solving the increasingly complex

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safety, health, and environmental problems posed by dusts within the mineral system.

Various legislative actions and public concerns within the past decade have had, and will continue to have, an impact upon the mineral industry. As a result, control of mineral particulates is becoming increasingly important, with much recent attention focused on asbestiform particulates in both air and water. Figure 1, from an Environmental Protection Agency report, shows the widespread occurrence of common amphibole and serpentine minerals that, according to existing regulatory definitions, may be classified as asbestiform minerals (16).⁶ With such possibly overwhelming implications to both mineral producer and mineral consumer, it is essential that existing ambiguities regarding silicate minerals and their asbestiform varieties be resolved. Until recently, adverse health effects associated with asbestos were focused on occupational exposure in asbestos-related industries. Now there is international concern regarding the effect on health from long-term low-level, or short-term high-level, exposure to mineral particulates by the general public (5, 28, 36). These particulates may include both the common and the asbestiform varieties of certain silicate minerals. In many instances, cleavage fragments of common amphibole minerals have been mistakenly identified as

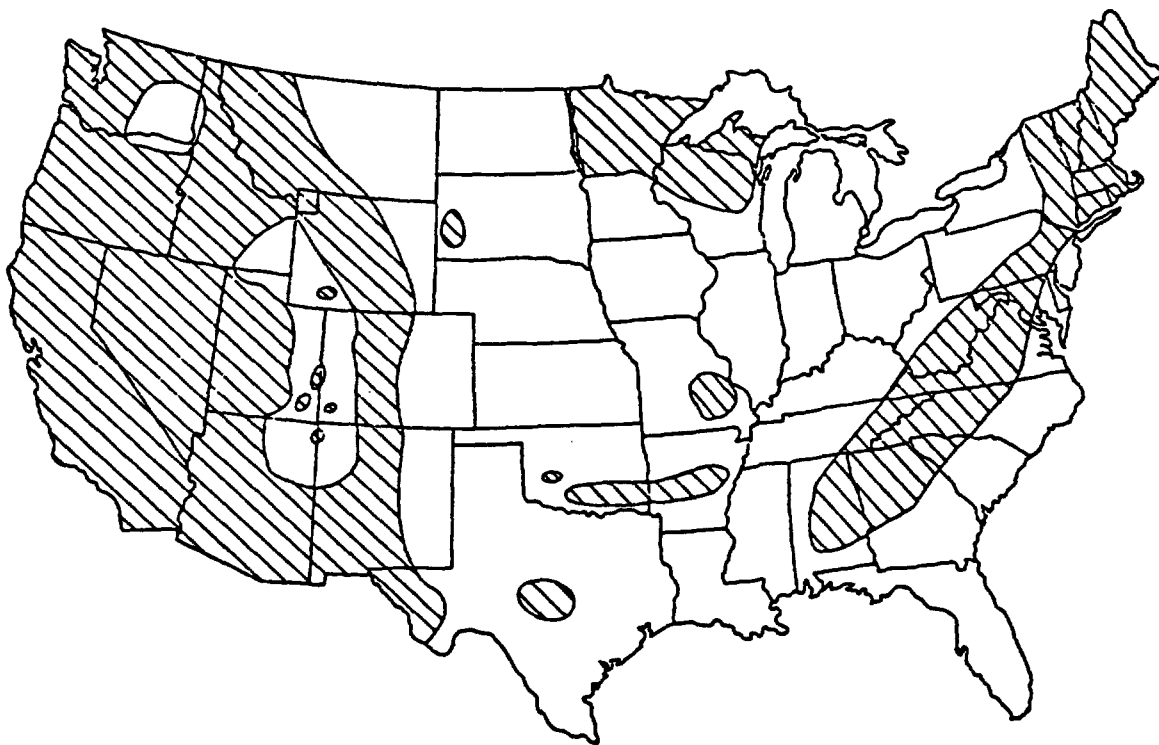


FIGURE 1. - Regions of the United States (shaded area) reported by the Environmental Protection Agency to contain asbestiform minerals in the bedrocks (16).

⁶Underlined numbers in parentheses refer to items in the list of references at the end of this report.

microscopic fibers of the related asbestiform variety. Such lack of precision in identifying these particulates is a handicap to scientific decisionmaking by regulatory agencies and medical researchers. The Particulate Mineralogy Unit was created to work on problems such as this.

The Particulate Mineralogy Unit

The Bureau of Mines established the Particulate Mineralogy Unit in September 1976. The College Park Metallurgy Research Center in College Park, Md.,⁷ is the focal point for this unit, but substantial support will be supplied by the other Bureau of Mines metallurgy and mining research centers, which are located throughout the United States. The unit is to assist local, State, and Federal agencies in establishing precise and workable mineral definitions and to improve or develop methods of particulate identification and quantitative measurement. The unit is also providing characterized serpentine and amphibole minerals for use by Federal health agencies in their asbestos-related research programs.

Scope of Report

This Bureau of Mines report is intended to clarify some of the terminology used in identification and characterization of asbestiform minerals, and to sharpen the distinction between common rock minerals and their asbestiform varieties. It defines certain mineral terms related to asbestiform minerals and discusses mineral-characterization techniques on a strictly mineralogical basis. The report then discusses the identification of silicate particulates and suggests how to apply this information to asbestos-related problems. Suggested areas for further research are summarized at the end of this report.

ACKNOWLEDGMENTS

The following College Park Metallurgy Research Center personnel are acknowledged for their invaluable contributions. Photographic assistance was provided by Garrett Hyde, research physicist, and Lawrence Johnson, geologist (mineralogy). Application data were provided by Raymond Brown, physical science technician; Charles W. Huggins, research chemist; and Eric Steel and Robert Virta, geologists (mineralogy).

⁷The research center is scheduled for relocation to Avondale, Md., in June 1978.

NOMENCLATURE OF SELECTED SILICATE MINERALS AND THEIR ASBESTIFORM VARIETIES^a

Background

In August 1976, a preliminary paper (1) was presented from which the Bureau of Mines hoped to elicit suggestions from the mineralogical community for critically defining silicate minerals and their asbestiform varieties. Significant terms such as "asbestos," "asbestiform," and "fibers" have different meanings to the various concerned groups--mineralogists, regulatory agencies, medical scientists, and industry. This has resulted in situations where erroneous conclusions have been drawn. Thus, precise definitions are required that will be uniformly accepted and applied by all personnel involved with silicate minerals that have asbestiform varieties (4, 11, 24-25, 31, 39).

Mineralogical nomenclature recognizes the historical origin of terms, and changes are made only when they are proven incorrect by new information (10, 32). The science of mineralogy is constantly being advanced with newly examined mineral occurrences and with new and improved instruments and techniques that provide more details on chemical composition, crystal structure, and morphology. To prevent constant revision, nomenclature has to have a certain flexibility, yet must be definite enough to be scientifically useful. The objective of this part of the report is to summarize mineralogically acceptable terms that relate to asbestos.

There is no "group" of asbestos minerals. "Asbestos" is a general term applied to certain minerals (that are themselves classified under crystal-structure-based groups) when these minerals crystallize as the asbestiform variety. Table 1 lists some common silicate minerals and their asbestiform varieties, together with their relationships and formulas. Although discussion in this report is limited to these minerals, appropriate terms and statements also apply to other silicate minerals that have rare fibrous varieties such as talc, some clay minerals such as attapulgite, and other amphiboles such as arfvedsonite, eckermannite, and richterite.

TABLE 1. - Selected silicate minerals and their asbestiform varieties

Mineral	Asbestiform variety
AMPHIBOLE GROUP	
Anthophyllite: $(\text{Mg}, \text{Fe}^{+2})_7 \text{Si}_8\text{O}_{22}(\text{OH}, \text{F})_2 \dots$	Anthophyllite asbestos.
Cummingtonite-grunerite: $(\text{Mg}, \text{Fe}^{+2})_7 \text{Si}_8\text{O}_{22}(\text{OH})_2$	Cummingtonite-grunerite asbestos.
Tremolite-actinolite: $\text{Ca}_2(\text{Mg}, \text{Fe}^{+2})_5 \text{Si}_8\text{O}_{22}(\text{OH}, \text{F})_2$	Tremolite-actinolite asbestos.
Riebeckite: $\text{Na}_2\text{Fe}_3^{+2} \text{Fe}_2^{+3} \text{Si}_8\text{O}_{22}(\text{OH}, \text{F})_2 \dots$	Crocidolite.
SERPENTINE GROUP	
Serpentine: $\text{Mg}_3\text{Si}_4\text{O}_{10}(\text{OH})_2 \dots$	Chrysotile.

^aTibor Zoltai, Professor, Department of Geology and Geophysics, University of Minnesota, made significant contributions to this section of the report.

Amphibole minerals and, to a lesser degree, serpentine minerals occur widely distributed in the earth's crust in many igneous or metamorphic rocks. In some rare instances, the mineralogical occurrences contain sufficient quantities of usable asbestiform minerals to be economically minable for commercial asbestos.⁹ The soft, silky fibers of asbestos (sometimes called mineral silk) are so flexible that they can be spun into threads from which cloth can be woven. The resulting material is fireproof, is a good thermal and electrical insulator, and has moderate to good resistance to acids. It has been used from Roman times, and is most familiar in daily use in brake linings for automobiles and as the "asbestos" siding used in residential construction.

Only a very small quantity of the amphibole and serpentine minerals under particular geologic circumstances occur as the asbestiform variety of the mineral. The asbestiform varieties occur in veins or small veinlets within rock containing or composed of the common (nonasbestiform) variety of the same mineral. Macrophotographs of the minerals of table 1, both asbestiform and nonasbestiform varieties, are shown in figures 2 through 7.

The serpentine group of minerals is limited to serpentine as the common variety and to chrysotile as the asbestiform variety. Antigorite and lizardite are not listed as separate varieties, but are understood to be included in the term "serpentine" because they represent 2 frequently named polytypes of about 10 recognized polytypes of serpentine (20). The polytypes differ only in minor structural stacking of components and are not sufficiently different to have a separate mineral status. Chrysotile generally occurs segregated as parallel fibers in veins or veinlets, although a recent study (6) has shown fine chrysotile intimately intergrown with the lizardite polytype.

The minerals and mineral series of the amphibole group in table 1 have variable compositions with extensive elemental substitutions and are found in forms ranging from massive to blocky to very fibrous. Crocidolite is the varietal name given to the fibrous habit of the mineral riebeckite (fig. 7), as shown by at least one study (35). It is retained here as a useful and correctly identified term.

Cummingtonite-grunerite asbestos is the mineralogically proper terminology for the commercial material commonly known as "amosite." Amosite, implied to be a mineral variety, is really an acronym--Asbestos Mines of South Africa--for a fibrous mixture of minerals; namely, cummingtonite-grunerite with variable tremolite-actinolite. Amosite has been discredited as a mineral species (22), and its use as a mineralogical term should be discontinued; however, it is still useful as a commercial term.

Mineral compositional series such as cummingtonite-grunerite involve replacing one cation for another in a crystal structure without significantly altering the structure. There may be a gradation in the structure in some series, and minor changes in physical characteristics may occur with elemental substitution. Usually a series involves two named compositional end members with intermediate substitutional compounds being separately named (if the members were recognized by early mineralogists), given a varietal name (for similar reasons), or just qualified by being referred to as members of the series. Members of the tremolite-actinolite-ferroactinolite series are hydroxylated calcium-magnesium, magnesium-iron, and iron silicates, respectively. Their series is named in table 1 for two of its members, and when its composition is known, it should be called by the specific name, such as

⁹Clifton, R. A. Asbestos. BuMines MCP-6, in preparation, 1977.

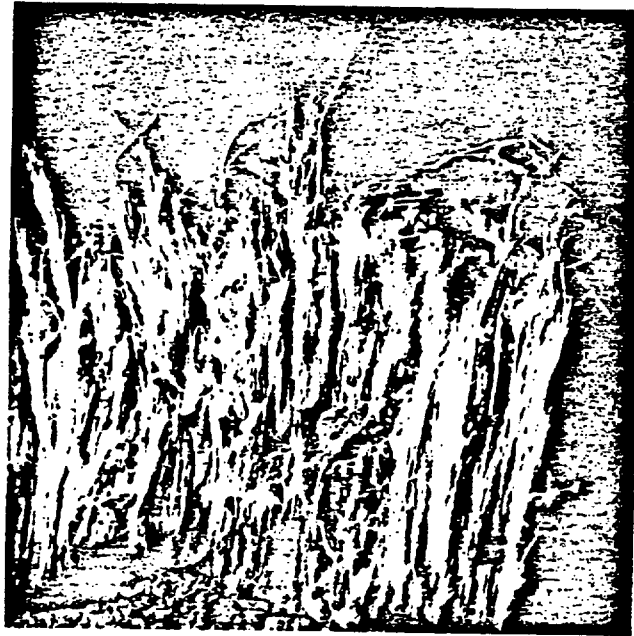


FIGURE 2. - Macrophotographs of serpentine (top, X 1) and chrysotile (bottom, X 3).



FIGURE 3: - Macrophotographs (X 3) of tremolite (top) and tremolite asbestos (bottom).

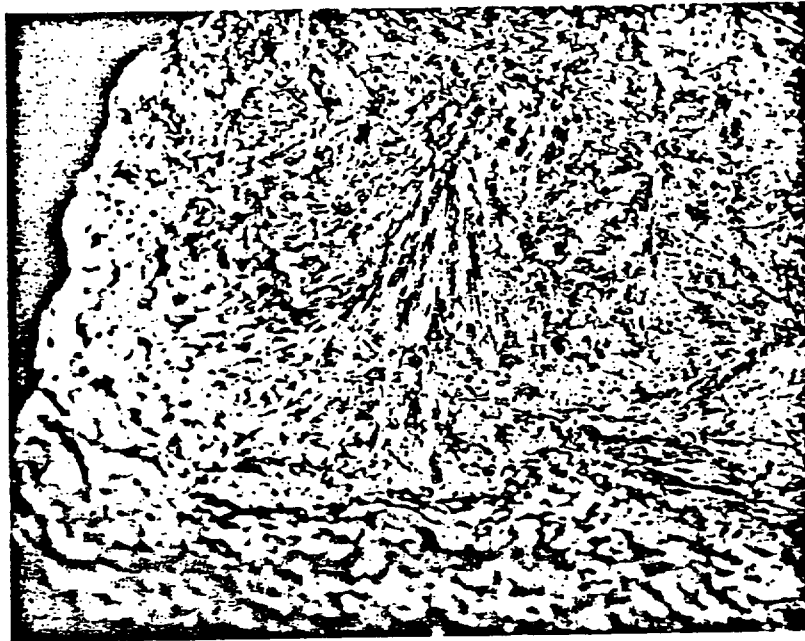


FIGURE 4: - Macrophotographs (X 3) of anthophyllite (top) and anthophyllite asbestos (bottom).

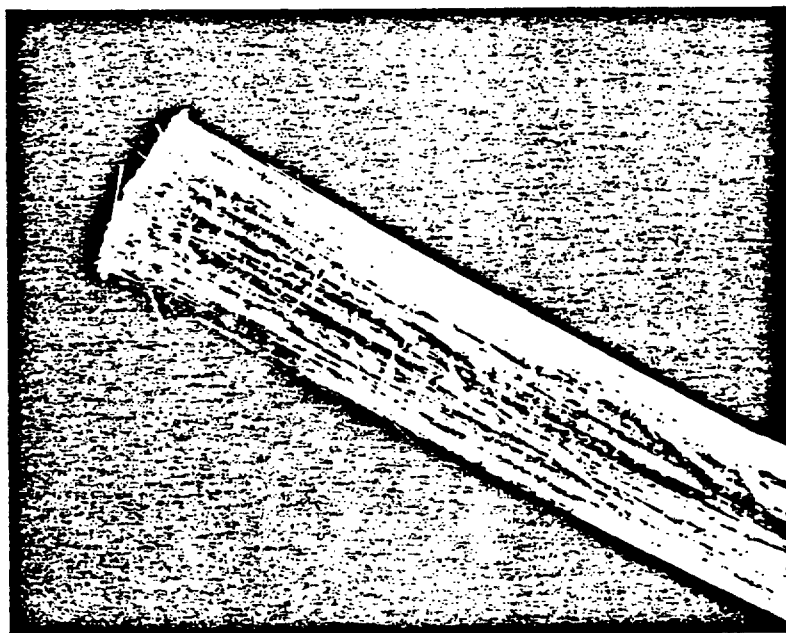
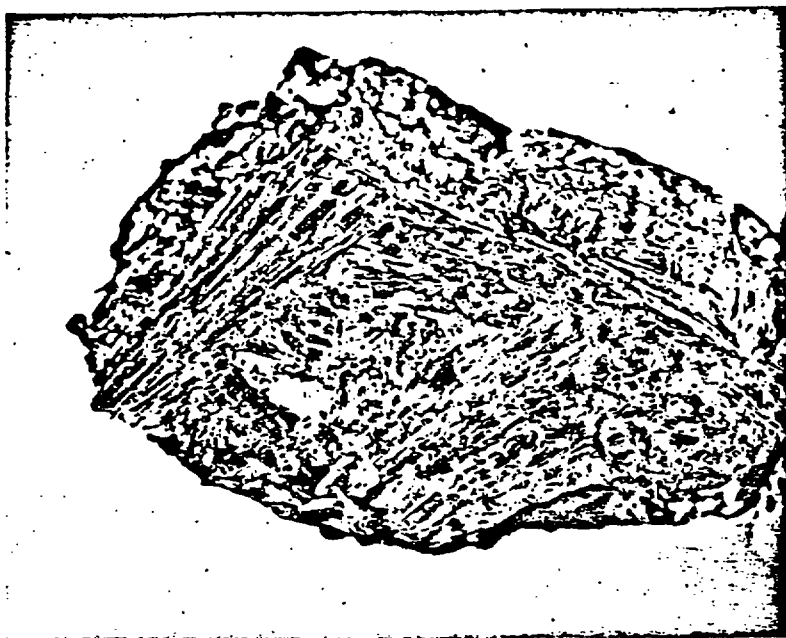


FIGURE 5: - Macrophotographs of actinolite (top, X 1) and actinolite asbestos (bottom, X 3).

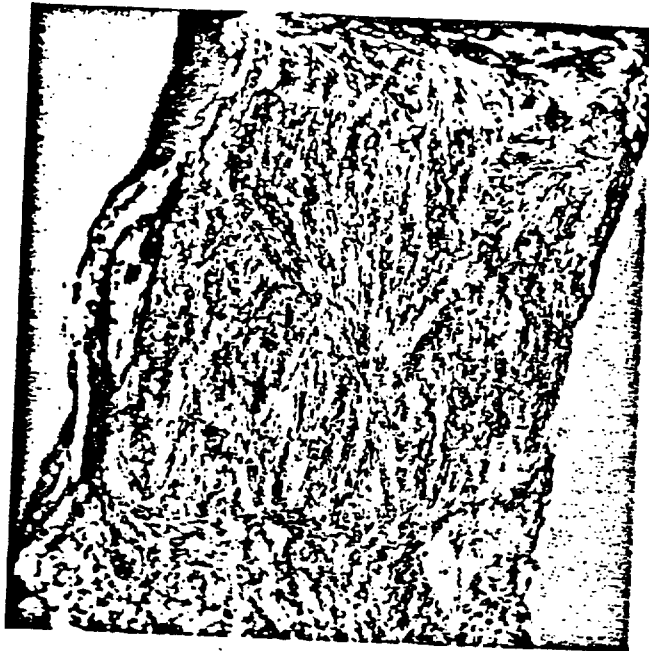


FIGURE 6: - Macrophotographs (X 3) of cumingtonite (top) and cumingtonite-grunerite asbestos (bottom).

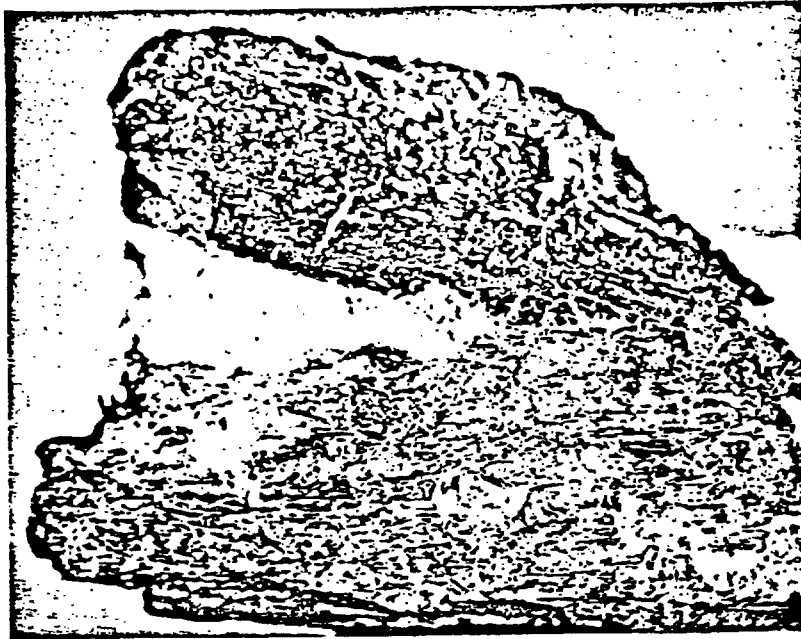


FIGURE 7. - Macrophotographs (X 3) of riebeckite (top) and crocidolite (bottom);

tremolite. The following nomenclature for this series (7) is based on the mole ratio (in parentheses) of $\frac{\text{Fe}}{\text{Fe} + \text{Mg}}$ in the formula $\text{Ca}_2(\text{Mg},\text{Fe})_5\text{Si}_8\text{O}_{22}(\text{OH})_2$: tremolite (0 to 0.2), actinolite (0.2 to 0.8), and ferroactinolite (0.8 to 1.0).

Definitions

Many mineralogical definitions apply to the entire mineral field, but the definitions in this report are restricted to those necessary to characterize the fibers and cleavage fragments related to asbestos identification-characterization. The terms to be defined are outlined in the following list:

Mineral terms:

- Mineral
- Mineral groups
- Mineral series
- Mineral varieties

Asbestos-related terms:

- Asbestos
- Fibrous
- Mineral fiber
- Fibril
- Fibril structure
- Asbestiform

Crystal terms:

- Crystal structure
- Crystalline
- Crystal
- Single crystal
- Twinned crystal
- Polycrystalline
- Polymorphs
- Polytypes
- Crystal form

Crystal morphology:

Single crystals:

- Equant
- Prismatic
- Acicular
- Fiber
- Fibril
- Filiform
- Bladed
- Platy
- Lamellar

Crystal aggregates:

- Asbestiform
- Columnar
- Fibrous
- Lamellar
- Massive
- Radiating
- Reticulated

Breaking of minerals:

Cleavage:

- Types:
 - Pinacoidal
 - Prismatic
 - Rhombohedral
 - Cubic
 - Octahedral

Quality:

- Perfect
- Good
- Fair

Imperfect

Cleavage fragment

Fracture: Types:

- Even
- Uneven
- Splintery
- Conchoidal
- Hackly
- Parting

Mineral Terms

Mineral.--A homogeneous, naturally occurring, usually inorganic and crystalline substance. Minerals with distinct crystal structure types (including lack of crystal structure) and limited variation in chemical composition are given individual names.

The early concept of a mineral as a natural-history species was gradually abandoned and changed into a chemical and structural definition around the middle of the 19th century, long before crystal structures were understood. The term "species" persisted for a long time with this newer definition, but is now seldom used in mineralogy.

Mineral Group.--Minerals that have essentially the same (or comparable) structures, but have different cations in secondary structural position (for example, pyrites, feldspars, and amphiboles).

In silicates, most of the mineral groups have the same linkage patterns of the silica tetrahedra, like the characteristic double chains of amphiboles. However, the secondary atomic sites may be occupied by a relatively wide variety of cations or some may even be vacant in the actual structures of the members. In some silicate-mineral groups, the identity of the silica-tetrahedral frame is less restricted and may be limited to the similarities of some basic characteristics. For example, the silica-tetrahedral frames of the zeolite minerals are variable, but they are all characterized by large open channels.

All mineral groups have names. In some instances, this name is the universal name of a common or important member of the group (for example, serpentine group).

Mineral Series.--Two or more members of a mineral group in which the cations in secondary structural position are similar in properties and can be present in variable, although frequently limited, ratios (for example, cummingtonite-grunerite). Also known as an isomorphic series.

Some mineral series such as the plagioclases have unique names, but most are identified by the combined names of the end-member minerals, such as tremolite-actinolite. The current trend is to simplify long series names by using the mineral name of only one (end or intermediate) member.

Individual minerals in the series are either identified by the names given to compositional ranges (for example, bytownite or oligoclase in the plagioclases), or by the name of the series followed by a symbol expressing the mineral's position in the series or the ratios of the variable cations ($\text{Ab}_x\text{An}_{100-x}\%$ for plagioclases, where Ab and An designate the two end members, albite and anorthite).

Mineral Variety.--Minerals that are conspicuously different from those considered normal or common in crystallization habits, polytypes, and other structural variants, or other physical properties such as color. Varieties are named by mineralogists, miners, gemologists, manufacturers of industrial products, and mineral collectors.

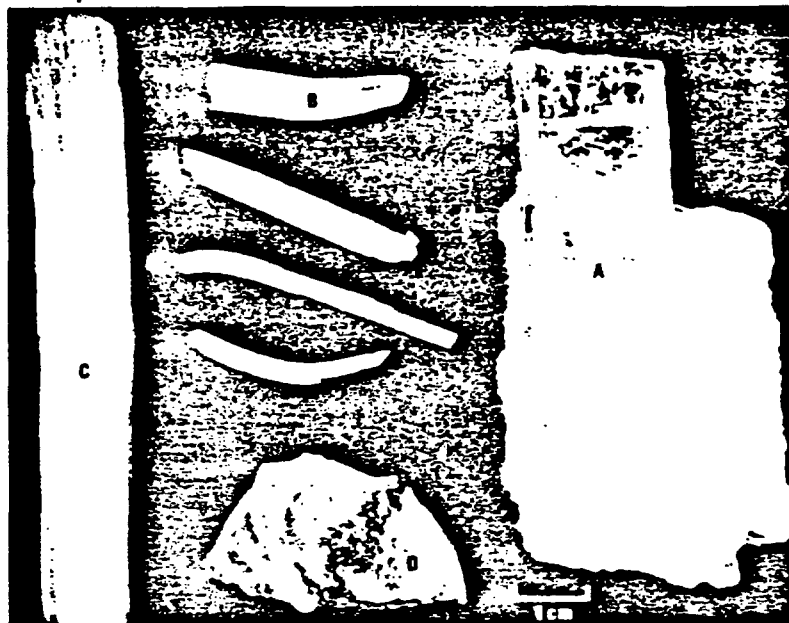


FIGURE 8. - Four varieties of gypsum: (A) Selenite; (B) satin spar, fine fibrous; (C) satin spar, coarse fibrous; and (D) alabaster.

Although mineral names are controlled by national and international mineralogical organizations, variety names are not. In practice, any variety name that becomes sufficiently popular is eventually recognized by these organizations as distinct enough to be used as a mineral-variety name. Typical of these are the various varieties of gypsum shown in figure 8. Figures 2 through 7 illustrate the massive and asbestiform varieties of serpentine and amphiboles.

Asbestos-Related Terms

In the following discussion, asbestiform refers only to asbestos. The other terms, "fibrous," "mineral fiber," "fibril," and "fibril structure," apply to both asbestiform and nonasbestiform varieties.

Asbestos.--(1) A collective mineralogical term encompassing the asbestiform varieties of various minerals; (2) an industrial product obtained by mining and processing primarily asbestiform minerals.

The quality of asbestos depends on the mineralogy of the asbestiform variety, the degree of asbestiform development of the fibers, the ratio of asbestiform fibers to acicular crystals or other impurities, and the length and flexibility of the fibers. The major asbestiform varieties of minerals used for asbestos are chrysotile, tremolite-actinolite asbestos, cummingtonite-grunerite asbestos, anthophyllite asbestos, and crocidolite. Asbestos may be marketed by its mineral name such as anthophyllite asbestos, its variety name such as chrysotile or crocidolite, or a trade name such as Amosite or Montasite. Two types of commercial asbestos are shown in figures 9 and 10.

The term "asbestos" was first introduced by Plinius Secundus in 77 A.D. The term "amiant" was previously used for the same mineral by Dioscorides in 50 A.D., and this term was the more common one until the middle of the 17th century. After that until the 20th century, "asbestos" was more common, and "amiant" was reserved for the more silky and flexible asbestos. In the 18th century, asbestos was classified into five different species. Currently, all



FIGURE 9: - Macrophotograph of tremolite asbestos (X 3).

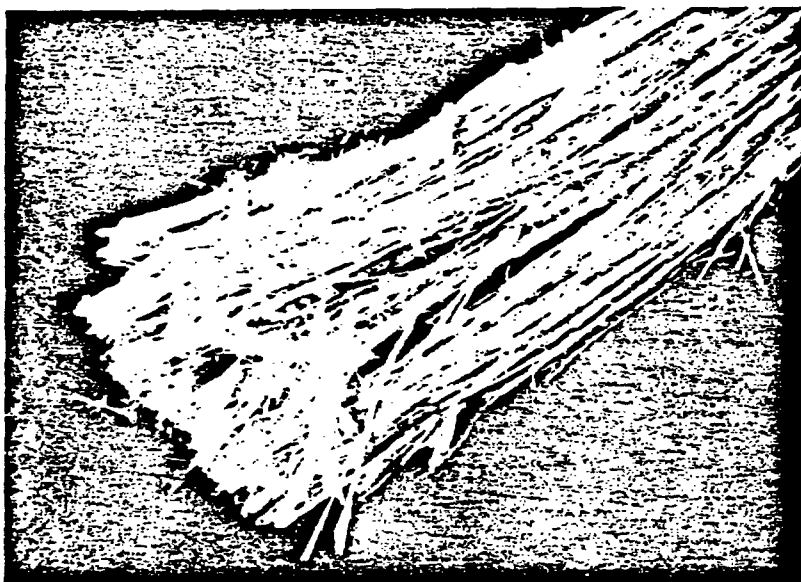


FIGURE 10: - Macrophotograph of anthophyllite asbestos (X 3).

asbestos is recognized as varieties of several individual minerals. Thus, in mineralogy, "asbestos" became a collective term, somewhat like "clays" or "gems." During the 20th century, asbestos developed into an important industrial material. Some asbestos products contain nonasbestiform minerals (for example, asbestos-cement and asbestos-magnesia); consequently, the mineralogical and the industrial definitions of asbestos do not always coincide.

Fibrous.--The occurrence of a mineral in bundles of fibers, resembling organic fibers in texture, from which the fibers can usually be separated (for example, satin-spar and chrysotile).

The term "fibrous" has been used during the last 200 years to describe all kinds of minerals that crystallized in habits resembling organic fibers, including asbestos minerals. However, the related

term "asbestiform" was never used for fibrous mineral habits other than asbestos. Accordingly, "fibrous" is the more general term, and asbestiform is a specific type of fibrosity. Figures 11, 12, and 13 show various types of fibrous mineral habits. Examples of fibrous minerals, both silicates, and non-silicates, that are not classified as asbestiform are shown in figure 13.

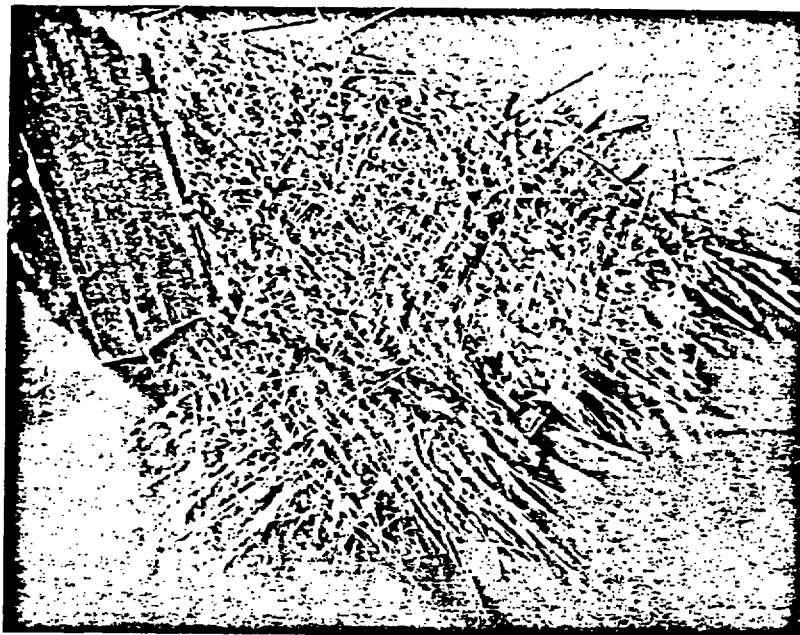


FIGURE 11. - Macrophotographs (X 3) of two fibrous amphiboles showing asbestiform habit: Byssolite (top) and richterite (bottom).

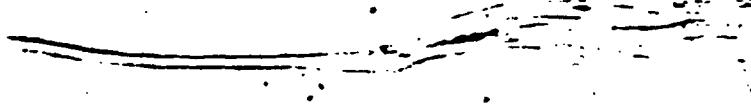


FIGURE 12. - Photomicrograph illustrating the separation of a crocidolite fiber bundle into fibers (X 600).

Mineral Fiber.--The smallest elongated crystalline unit that can be separated from a bundle or appears to have grown individually in that shape, and that exhibits a resemblance to organic fibers. (Examples: fiber bundles, chrysotile and crocidolite; individual fibers, epsomite and millerite.)

The term "fiber" is not limited to asbestos. However, it is distinct from "acicular" because it requires the resemblance to organic fibers. Figures 14 and 15 illustrate mineral fiber habits. Excellent photomicrographs of

organic fibers are illustrated in The Particle Atlas (18).

Fibril.--A single fiber, which cannot be separated into smaller components without losing its fibrous properties or appearances.

Most fibers are single structural entities, such as millerite and nickel sulfide, and some may be called fibrils. However, some fibers are composed of two or more fibrils that are less readily separable from each other than fibers are from bundles (for example, chrysotile and crocidolite). Figure 16 shows the high magnification necessary to resolve a fibril.

Fibril Structure.--A systematically deformed and/or defective crystal structure of a fibril. A defect structure would involve various types of dislocation. The fibril structure may be exhibited by a single crystal, a group of single crystals, or a twinned single crystal.

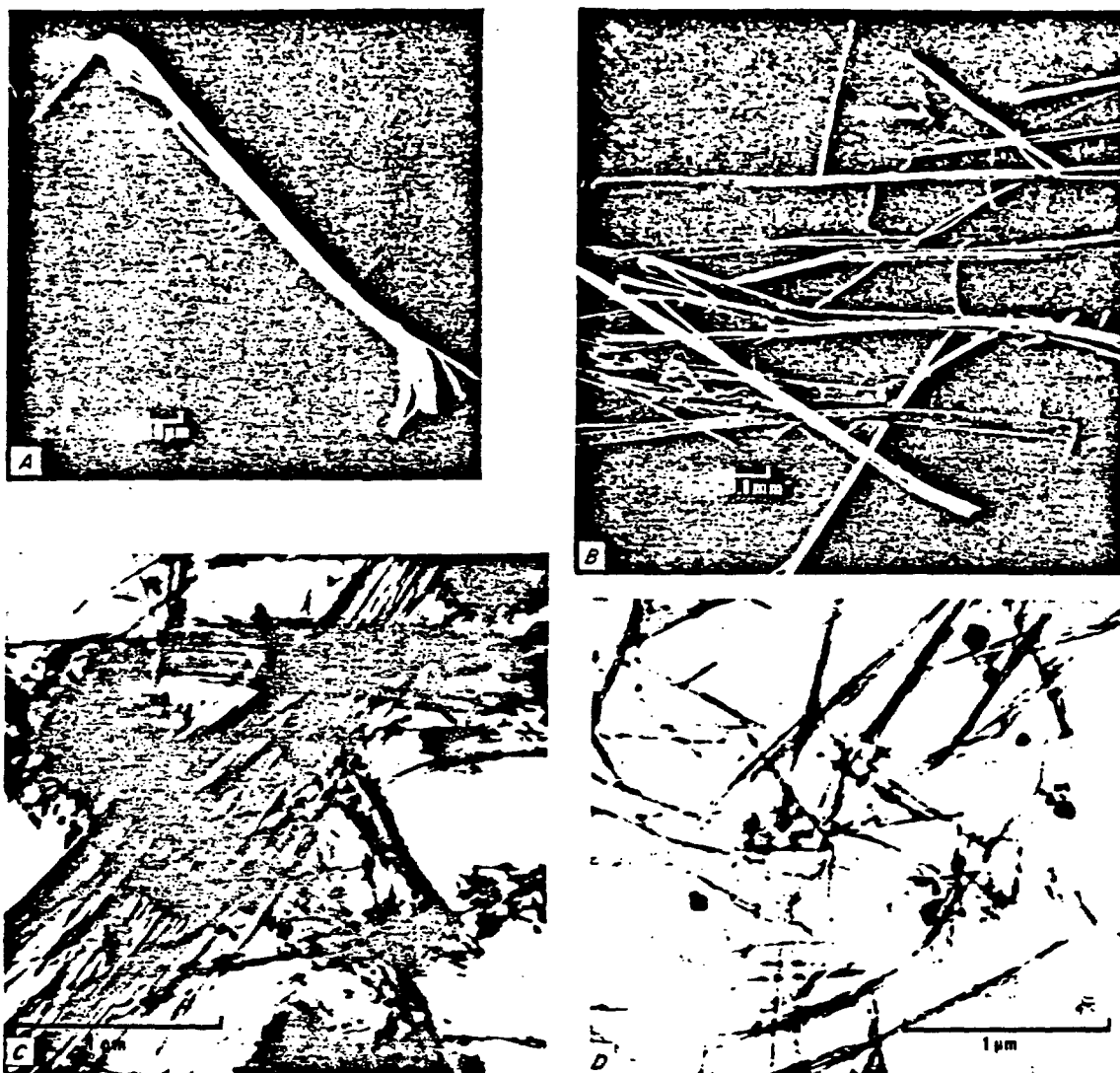


FIGURE 13. - Four fibrous nonasbestiform mineral varieties: A, Fibrous talc (X 500); B, fibrous brucite (X 50); C, palygorskite (X 30,000); and D, attapulgite (X 30,000).



FIGURE 14. - Light optical photomicrograph of fibers from tremolite asbestos (X 115). A few particles are seen to be bundles of fibers.

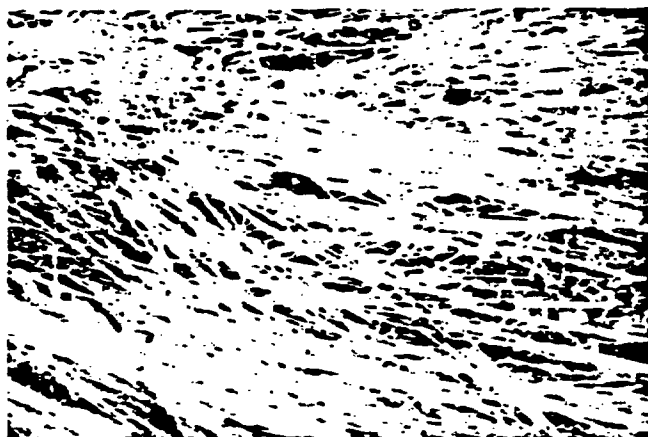


FIGURE 15. - Fibers of epsomite (magnesium sulfate hydrate) (X 13).

The scroll-like fibril structure of chrysotile (38), the twinned single-crystal fibrils of chrysotile (6), and the incompletely resolved fibril structure of an amphibole (9) are all examples illustrated in the literature.

Some acicular single crystals may have the appearance of fibers and fibrils, yet there is nothing unusual about their crystal structures. Other acicular single crystals may have significant structural deviations in addition to appearance that result in the display of certain properties usually found in fibers such as high tensile strength along the fiber axis. Thus, fibril structure is not limited to asbestiform structures, but may occur in a minor form in non-asbestiform structures.

Asbestiform.--A specific type of mineral fibrosity in which the fibers and fibrils possess high tensile strength and flexibility.

"Asbestiform" and "asbestos" are essentially synonymous in current usage. Some special properties of asbestiform varieties, including optical extinction and surface charge, are either not fully understood or are not uniformly applicable to

all asbestiform fibers; consequently, they cannot be considered fundamental characteristics at this time. The prototype of the expression "asbestiform" was introduced by Werner in 1774. He recognized three subspecies of actinolite and of tremolite. One of these subspecies had the prefix "asbestartiger." Thus, the restriction of "asbestiform" to certain mineral varieties appears to

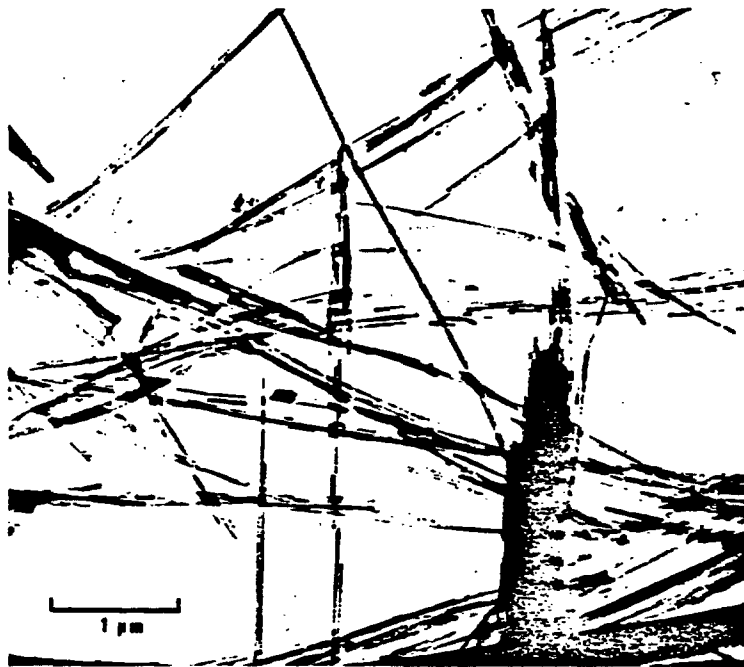


FIGURE 16. - Chrysotile, showing individual fibrils, at two magnifications: X 18,000 (top) and X 35,000 (bottom). The hollow-tube structure is visible at the higher magnification. (TEM microphotographs.)

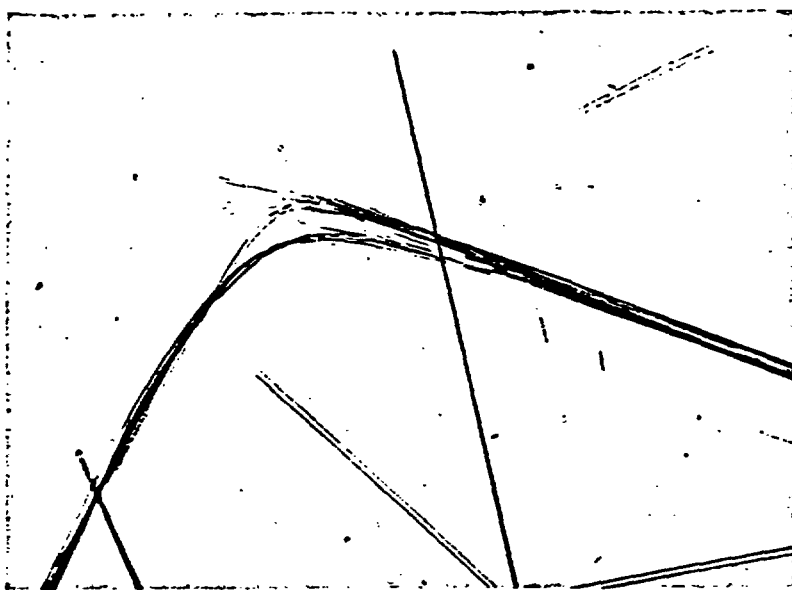


FIGURE 17. - Crocidolite, showing a fiber bundle and fibers (X 300).



FIGURE 18. - Chrysotile by polarized light (X 100).

two or more single crystals where adjacent crystals share a plane that is an integral part of both orientations of the crystal structure.

Polycrystalline.--A substance composed of two or more single crystals.

Polymorphs.--Two crystals with identical chemical composition but different crystal structures.

be justified on a historical as well as physical basis. Figures 17 to 20 show several asbestiform varieties of minerals.

Crystal Terms

Crystal Structure.--The pattern of the regular arrangement of atoms and ions in space. Usually refers to the basic (or average) structure of solids (and the ordered portions of liquids) without reference to minor, localized deviations.

Crystalline.--A substance possessing a reasonably well developed and long-range ordered crystal structure.

Crystal.--(1) Any single crystal; (2) a single crystal terminated by planar or nearly planar surfaces called crystal faces.

Single Crystal.--A crystal containing an uninterrupted crystal structure in a single orientation.

Twinned Crystal.--A crystal composed of

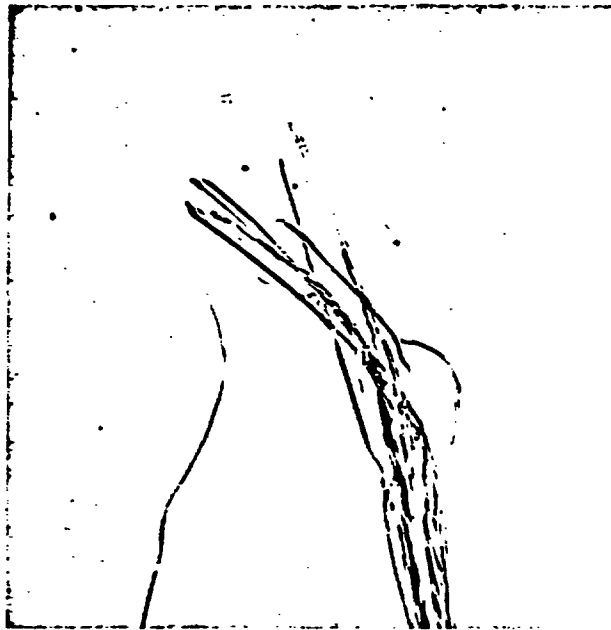


FIGURE 19. - Chrysotile (X 300).

Polytypes.--Polymorphs that contain essentially identical structural components, like layers, which are arranged in various patterns, like stacking of layers.

Crystal Form.--A set of symmetrically equivalent faces in a single crystal. A crystal may display several crystal forms.

Crystal Habit.--The actual shape assumed by a crystal or group of crystals as a result of the growth of dominant crystal forms (faces). Also known as crystal morphology.

Crystal Aggregate.--A cohesive mass of individual crystals or grains.

Single crystals exhibit growth shapes, while crystal aggregates exhibit growth patterns or arrangements (fig. 21). Some habits imply minor deviation of the crystal structure (deformation of the structure, presence of defects, inclusions, or impurities). Most habits are limited to the appearance of single crystals (crystal forms, irregular terminations, dimensional development, texture) or the pattern of aggregation of single crystals (dimension, orientation of the crystals, and cohesion between them). Under the following heading of "Single Crystals," the growth shapes are arranged first as equant, followed by other shapes that can be thought of as being derived from equant by suppressing or extending one or two of the three space dimensions, thus conveying the gradational nature of various defined crystal shapes.

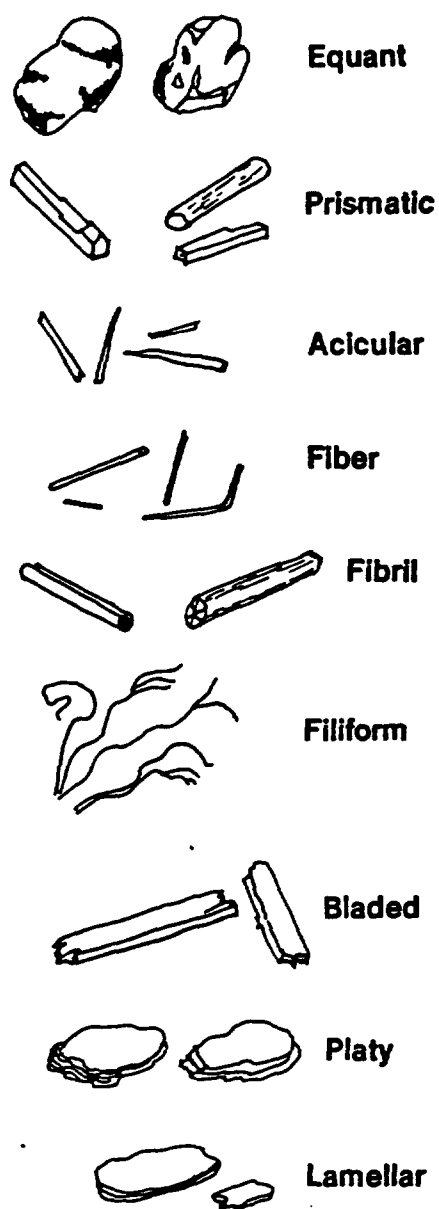
Single Crystals

Equant.--The shape of a single crystal or grain with three approximately equal space dimensions.



FIGURE 20. - Chrysotile at two magnifications: X 1,960 (top) and X 2,800 (bottom).

SINGLE-CRYSTAL SHAPES



CRYSTAL-AGGREGATE PATTERNS OR ARRANGEMENTS

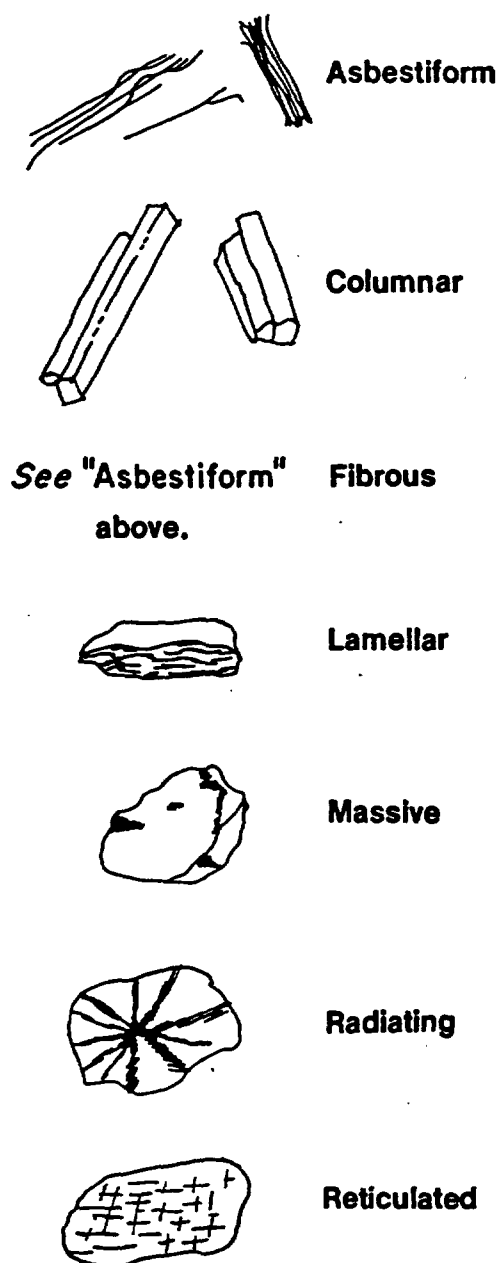


FIGURE 21. - Various shapes of single crystals, and patterns or arrangements of crystal aggregates.

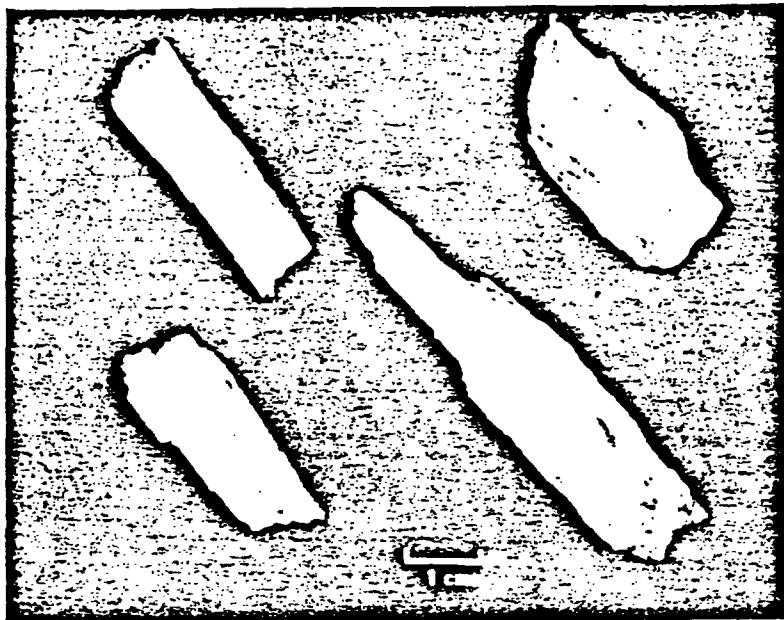


FIGURE 22. - Macrophotograph of spodumene ($\text{LiAlSi}_2\text{O}_6$) showing prismatic shape (X 1).



FIGURE 23. - Macrophotograph of tremolite showing prismatic and acicular crystal shapes (X 10).

Prismatic.--The shape of a single crystal with one elongated dimension and two shorter, approximately equal, dimensions.

Prismatic shapes of various single crystals are shown in figures 22 to 25.

Acicular.--The shape shown by an extremely slender crystal with small cross-sectional dimensions (a special case of prismatic form). Acicular crystals may be blunt-ended or pointed. The term "needlelike" refers to an acicular crystal with pointed termination at one or both ends.

Figures 23 and 26 show acicular crystals or crystal shapes.

Fiber.--See definition under "Asbestos-Related Terms."

Fibril.--See definition under "Asbestos-Related Terms."

Filiform.--The shape of threadlike mineral fibers.

Bladed.--The bladelike shape of a crystal with one longer dimension and two unequal, much shorter, dimensions.

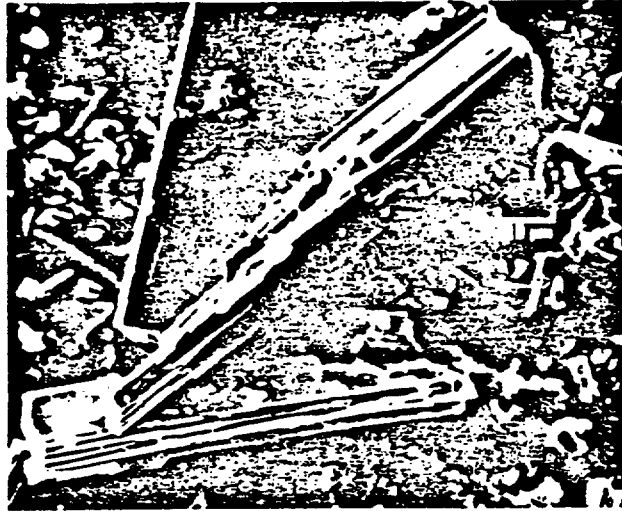


FIGURE 24. - Riebeckite, showing prismatic shape (SEM photomicrograph at X 800).



FIGURE 25. - Actinolite, showing prismatic shape (SEM photomicrograph at X 20,000).

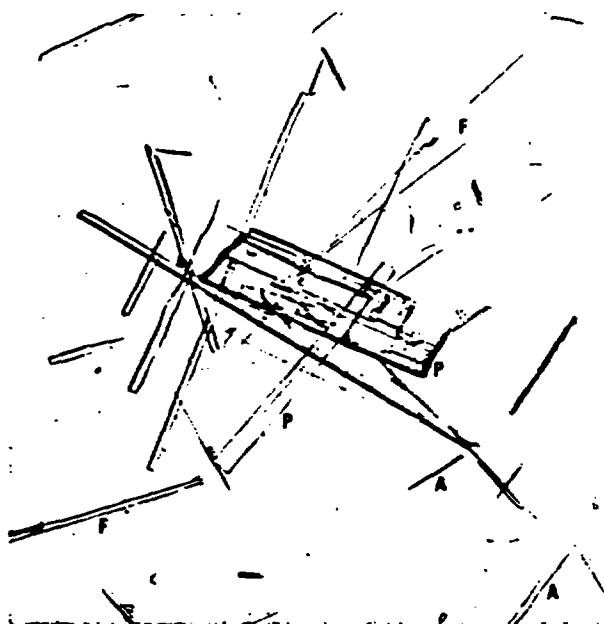


FIGURE 26. - Tremolite cleavage fragments (X 130), showing acicular (A), fibrous (F), and prismatic (P) shapes.

Figure 25 shows the bladed prismatic habit of actinolite.

Platy.--The shape of a crystal with one short dimension and two longer, approximately equal, dimensions. Chlorite, micas, and talc usually crystallize into platy shapes.

The serpentines, although possessing layered structure similar to micas and talc, rarely grow in platy shapes. Talc is of interest here because some talc deposits have associated asbestiform and nonasbestiform minerals. Platy talc, when seen in thin sections or as fragments in oil, may occur in various orientations. Plates lying flat look like plates but, if standing on edge, could appear fibrous.

Lamellar.--The shape of a very thin platy crystal.

Crystal Aggregates

Asbestiform.--See definition under "Asbestos-Related Terms."

Columnar.--The arrangement of a group of approximately parallel, prismatic, acicular, or bladed crystals.

Figure 27 shows columnar aggregates of coarse anthophyllite.

Fibrous.--See definition under "Asbestos-Related Terms."



FIGURE 27. - Macrophotograph of columnar aggregates of coarse anthophyllite (X 1).

Lamellar.--The pattern exhibited by aggregates of very thin platy minerals.

Massive.--Homogeneous structure without stratification, flow-banding, foliation, or schistosity. Also, crystals or crystalline grains that are tightly packed and scarcely distinguishable.

Figure 2 (top) is a good example of massive serpentine.

Radiating.--An arrangement of prismatic, acicular, or bladed crystals that appear to be diverging from a common center.

Figure 28 shows radiating aggregates of pyrophyllite.

Reticulated.--The pattern of a crisscross network of acicular, prismatic, or bladed crystals.

Breaking of Minerals

When a mineral crystal or grain is strained beyond its elastic and plastic limit, it will break in one of several characteristic modes described as cleavage, fracture, or parting.

Cleavage.--The tendency of a crystal to break in definite directions that are related to the crystal structure and are always parallel to possible crystal faces.

Cleavage Types

Pinacoidal Cleavage.--A crystal with only one cleavage plane that yields platy or lamellar fragments (for example, talc and the mica minerals). Also called platy, basal, or lamellar cleavage.

Prismatic Cleavage.--A crystal with two distinct cleavage planes that yield prismatic fragments (for example, the amphiboles and pyroxenes).

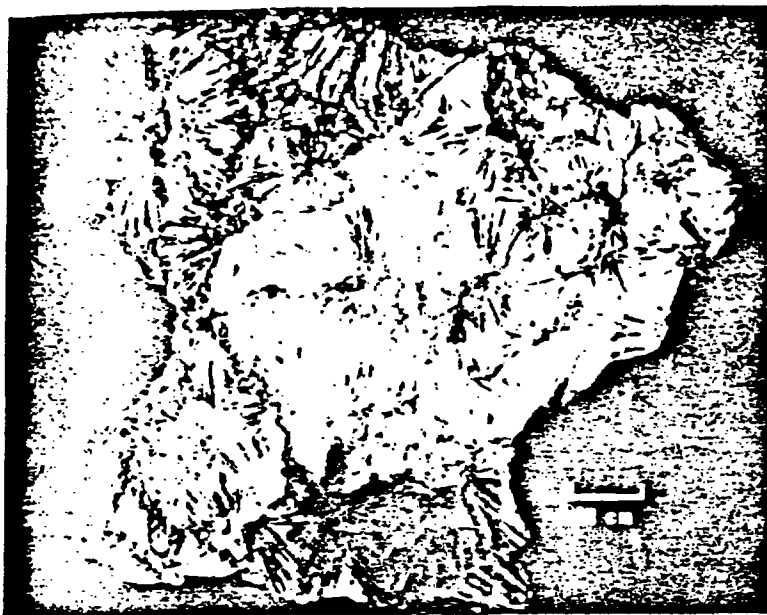


FIGURE 28. - Macrophotograph of radiating aggregates of acicular pyrophyllite (X 1).

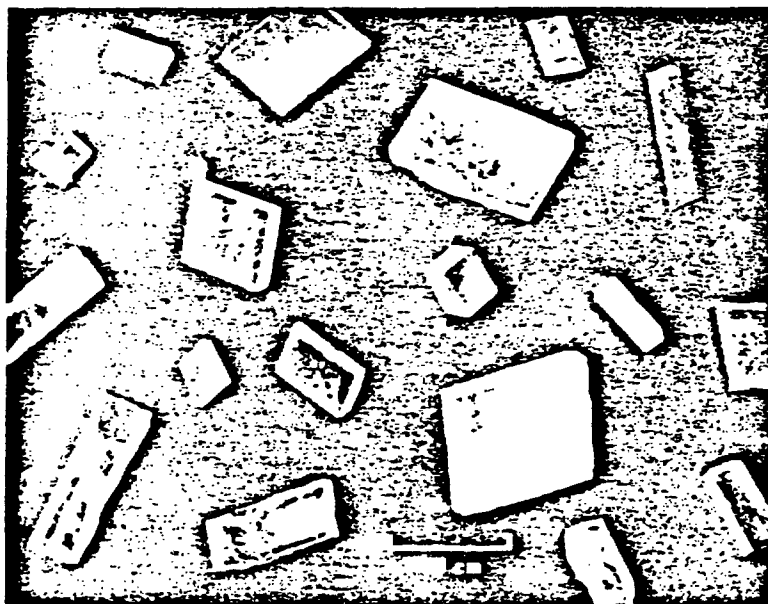


FIGURE 29. - Macrophotograph of calcite rhombohedral cleavage fragments (X 1.7).

Rhombohedral Cleavage.--A hexagonal crystal with three distinct cleavage planes that yield rhombohedral fragments (such as calcite).

Figure 29 shows the excellent rhombohedral cleavage of calcite.

Cubic Cleavage.--An isometric crystal with three distinct cleavage planes that yield cubic fragments (for example, halite).

Octrahedral Cleavage.--An isometric crystal with four distinct cleavage planes that yield octahedral cleavage fragments (for example, magnetite and fluorite).

Cleavage Quality

The quality or persistence of a cleavage is described as follows:

Perfect.--Difficult to break in any other direction; cleavage surfaces are extensive and smooth.

The cleavage of calcite in figure 29 is perfect.

Good.--Breaks readily along one direction, but can be broken in other directions; cleavage

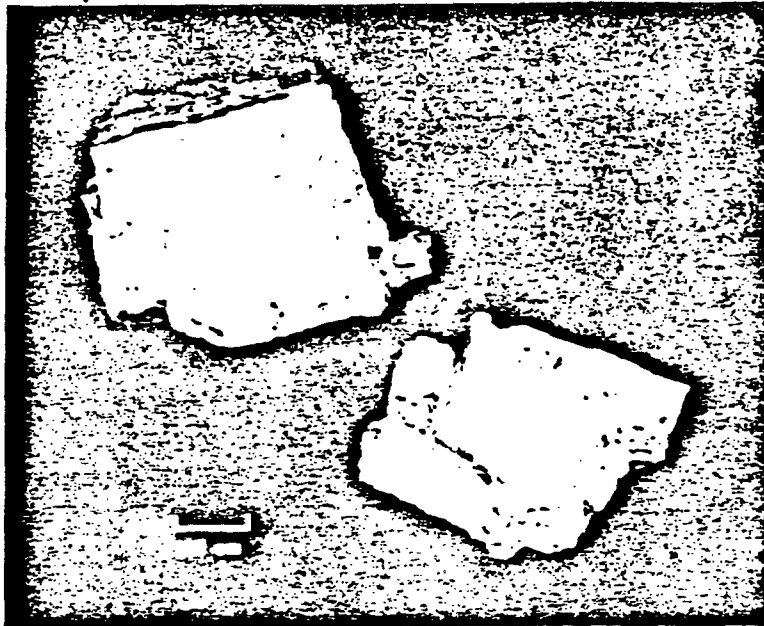


FIGURE 30. - Microphotograph of pyroxene showing good cleavage interrupted by uneven fracture (X 1).

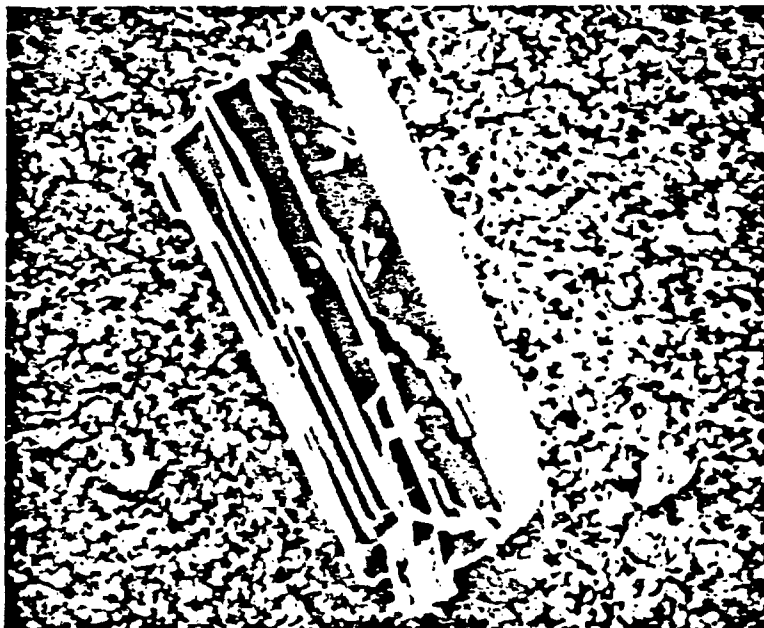


FIGURE 31. - Tremolite, showing good prismatic cleavage (SEM photomicrograph at X 560).

surfaces are smooth but interrupted by other fractures.

Figures 30 and 31 show good cleavage of pyroxene and tremolite.

Fair.--Breaks most readily along cleavage but also fractures easily in other directions; cleavage surfaces are seldom large.

Imperfect.--Breaks about as easily by fracture as by cleavage; cleavage surfaces tend to be small and frequently interrupted.

Cleavage Fragment

Cleavage Fragment.--A fragment produced by the breaking of crystals in directions that are related to the crystal structure and are always parallel to possible crystal faces.

Minerals with perfect cleavage can produce perfect regular fragments. Amphiboles with prismatic cleavage will produce prismatic fragments (fig. 31). These fragments can be elongated and on superficial observation may resemble fibers (figs. 26 and 32). However, because they did not grow as fibers, they cannot have the characteristics of fibers. Consequently,



FIGURE 32. - Cleavage fragments of riebeckite (X 500). Particle F has a fibrous appearance.

cleavage fragments cannot be called fibers. Minerals do not always break into the same shapes as their growth habits. For example, calcite has many growth habits, but usually breaks into rhombohedral cleavage fragments (fig. 29).

Fracture.--The tendency of a crystal or grain to break in an irregular manner apparently unrelated to crystallographic directions.

Fracture types are as follows:

Even.--Breaking along relatively smooth planes.

Uneven.--Breaking along irregular planes.

Splintery.--Breaking into irregular, elongated fragments.

Conchoidal.--Breaking along spherical or conical surfaces.

Hackly.--Breaking with a jagged irregular surface.

Parting.--The tendency of a crystal or grain to break along crystallographic planes weakened by inclusions or structural defects. Different specimens of the same mineral may or may not exhibit parting. Twinned crystals often part along composition planes, which are lattice planes and, therefore, potential crystal faces. Parting is similar to cleavage.

MINERAL IDENTIFICATION AND CHARACTERIZATION

Until recently, emphasis in the United States was placed on occupational exposure of employees manufacturing or using asbestos products for insulation and other applications (29, 33). Regulatory procedures were adopted from those used in Great Britain. The industrial-hygiene identification procedures were acceptable to industry, health, and regulatory organizations because the concern was restricted to several mineral products known collectively as asbestos. Although light optical microscopic procedures counted only the larger particles collected on the air filters, the procedure was adequate for

correlating health effects to the number of fibers observed. Exact definitions for asbestos-related mineralogical terms were not essential since all three groups (industry, health, and regulatory) clearly understood what was being counted and regulated.

The light optical microscopic procedures used by industrial hygienists were designed for control of asbestos-processing operations in which the chrysotile and asbestiform amphiboles are present as bundles of fibers as well as individual fibers (15). These bundles may have an average diameter of 0.75 to 1.5 μm for chrysotile and 1.5 to 4.0 μm for the amphibole asbestos (3). Particulates of these sizes can be readily observed at a magnification of X 450 to X 500. In contrast, samples from ambient air and personnel air monitors may consist of individual fibrils or small bundles of chrysotile 0.02 to 0.1 μm in diameter, and/or amphiboles 0.1 to 0.2 μm in diameter (3). Fibrils and small fibers in this size range are not visible using the conventional light optical microscopic procedures (13, 34). Therefore, the identification procedures currently used for regulating the U.S. mineral producing and consuming industries must be reexamined to insure that they are both mineralogically correct and applicable to the size range of the particles being regulated.

This discussion will be limited to the selected silicate minerals and their asbestiform varieties listed in table 1. The objective is to point out the particle size at which the minerals can be identified and characterized by various analytical techniques (17). Detailed descriptions of the various analytical and characterization techniques are available in numerous publications and textbooks and are therefore not included in this report.

A crystalline mineral is defined primarily by its crystal structure and by its definite composition or range of compositions. Therefore, any system of mineral identification should be based principally on crystal structure and chemical criteria. Additional characteristics have to be determined to distinguish varieties. These varieties have similar basic crystal structures and composition, but are usually differentiated macroscopically by the characteristic habits and/or other specific features of the varieties. The objective for this section of the report is to summarize the methodology for identifying the mineral first by mineral group (such as serpentine and amphibole), then by mineral (actinolite, anthophyllite, or chrysotile), and finally by mineral variety.

Macroscopic Samples

At the macroscopic level (easily visible by the unaided eye), the obvious feature of the asbestiform varieties is the presence of fibers that can be easily separated, while the nonasbestiform varieties have a massive, blocky, bladed, or columnar appearance (figs. 2-7). Although chrysotile does occur very rarely in a nonasbestiform habit, in general the distinction between chrysotile and serpentine can be based on the presence or absence of separable fibers. In some serpentine samples where an obvious asbestos texture is not displayed, the distinction between serpentine varieties may require more specialized techniques (6, 19). The distinction between serpentine and

amphibole minerals at the macroscopic level can be made by optical microscopy, elemental analysis, differential thermal analysis, and X-ray diffraction techniques. For essentially pure samples, these techniques should also be sufficient to identify the individual amphibole minerals based on the elemental composition corresponding to the various members of the solid solution series.

Many macroscopic samples of interest to the occupational and environmental health personnel may contain low percentages of asbestiform minerals (for example, chrysotile in serpentine and tremolite asbestos in talc). As a supplement to optical microscopy, the presence or absence of serpentine or amphibole minerals can be determined in 10- to 100-mg samples by instrumental techniques such as X-ray diffraction, differential thermal analysis, or infrared spectrophotometry. In general, the sensitivity of these instrumental methods is approximately 1.0 weight-percent. Sensitivity is significantly affected by the presence of other minerals that give a response at or near the response peak of the serpentine and amphibole minerals. It is important to note that these methods usually only distinguish between mineral groups; light optical or electron optical microscopy is required to obtain morphological characteristics necessary to identify varieties of the same material.

Chemical characterization is generally necessary to assign a specific mineral name to an amphibole whose structure is known. The amphiboles have been described (8) using the structural formula $W_{0-1}X_2Y_5Z_8O_{22}(OH,O,F)_2$. Generally, W = Na, K; X = Na, Ca, Mg, Fe^{+2} , Mn; Y = Al, Fe^{+3} , Ti; and Z = Si, Al. In addition to the variation implied by the structural formula, a chemical analysis must take into account inclusions of other minerals that may be present. In contrast to the more formidable task of amphibole chemical characterization, the serpentine minerals generally show little deviation from the formula $Mg_3Si_2O_5(OH)_4$. For either structural or chemical characterization of a macroscopic sample, sufficient time must be spent in sample preparation to insure that relatively pure minerals are being examined.

Microscopic Samples

The petrographic microscope provides a general method by which particles larger than 5 μm can be characterized. By observing the optical properties characteristic of the structure and chemistry of a mineral, an experienced microscopist can distinguish amphiboles from serpentines and, in some cases, distinguish individual minerals within these groups (7). The refractive indices are sufficiently different for the serpentine and amphibole groups to make a distinction between groups by using the appropriate index oil (table 2). There is significant overlap in the range of the three refractive indices among the amphiboles, but a specific index (for example, α , β , or γ) can be determined to aid in identifying the amphibole species. Optical relationships can be confused, however, if the particle consists of fiber bundles or is some other form of crystalline aggregate. The well-known parallel extinction of the commercial asbestos known as Amosite can be used to distinguish that variety from the nonasbestiform varieties of cummingtonite and actinolite. A method of using extinction angles and cleavage directions to distinguish specific asbestiform and nonasbestiform amphiboles has been described (37); however, this technique is limited to particles with diameters greater than about

5 μm and cannot be universally applied to all amphiboles. There are many other optical parameters such as pleochroism, sign of the elongation, and color that are easy to obtain. Other parameters such as optic axial angle, optical orientation, and optic sign are relatively more difficult to obtain.

TABLE 2. - Refractive indices for the serpentine group and selected amphibole minerals

	Refractive index	Range of values
Chrysotile.....	α	1.493-1.560
	β	1.504-1.550
	γ	1.517-1.562
Antigorite-lizardite.....	α	1.538-1.564
	γ	1.546-1.573
Anthophyllite.....	α	1.596-1.652
	β	1.605-1.662
	γ	1.615-1.676
Actinolite-tremolite.....	α	1.599-1.668
	β	1.612-1.680
	γ	1.622-1.688
Cummingtonite-grunerite.....	α	1.635-1.696
	β	1.644-1.709
	γ	1.655-1.729
Riebeckite.....	α	1.654-1.701
	β	1.662-1.711
	γ	1.668-1.717

Except for the asbestiform variety, serpentines are usually massive, while amphiboles range from fine-grained massive to columnar or radiating aggregates of prismatic or acicular crystals. Amphiboles in acicular habit may appear to grade into the asbestiform varieties. The characteristic features of this habit may still be seen by electron microscopy. Terms such as "acicular" or "prismatic" may still be applied when seen, but the term "asbestiform" begins to lose its usefulness. For example, how may flexibility be demonstrated in a 2- μm bundle of fibers? As particle size decreases, the inability to manipulate the mineral grains restricts the use of the term "asbestiform" without altering the original sense of the word. High magnification necessitates the use of strictly dimensional terms such as size and aspect ratios to accurately describe the morphology of the amphiboles and serpentines. The degree of morphologic characterization possibly will depend on the magnification being used. An asbestos particle being described as a single fiber at low magnification may be seen to be a bundle of fibers at some high magnification. Therefore, the magnification must be stated in the description. Morphologic characterization using light microscopy can be accomplished on particles as small as a few micrometers. Electron optics can

be used to characterize a wide range of sizes extending down to a few angstroms. Morphologic characterization alone will not identify a mineral without supplemental structural or chemical data.

Structural information on individual particulates can be obtained by use of a transmission electron microscope (TEM) in the selective area electron diffraction mode (SAED). The inclination of the single crystal fragments to the electron beam is very critical since a slight tilt of the crystal may change a relatively simple reciprocal lattice pattern into a very complex one. Consequently, a special goniometer or tilting stage is necessary to obtain easily interpretable diffraction patterns. For the identification of the mineral, a goniometer or tilting stage is even more essential since dependable conclusions cannot be made from measurements on one reciprocal lattice plane. The quality of the SAED pattern is a function of fiber diameter (fig. 33). The larger diameter fibers ($>0.5 \mu\text{m}$) strongly absorb the 60- to 100-kev electrons used in a conventional TEM, while the very small-diameter fibers ($<0.2 \mu\text{m}$) do not give sufficient electron-diffraction intensity. A second problem with small-diameter fibers is the degradation of the single-crystal pattern by diffraction lines from nearby particles. A higher energy TEM, with the resultant greater penetration of the electron beam, can be utilized for large-diameter particles. However, these costly instruments are not widely available.

Although the magnitude of the characteristic C, the distance between the conspicuous layer lines for chrysotile and the amphiboles, is similar in direct space ($d_{001} \sim 5.3\text{\AA}$), the chrysotile pattern has very prominent streaks on these layer lines compared with the spot pattern for the amphiboles (27). Researchers indicate the ability to distinguish between the fibrous and non-

fibrous variety of amphiboles by SAED is still to be resolved.

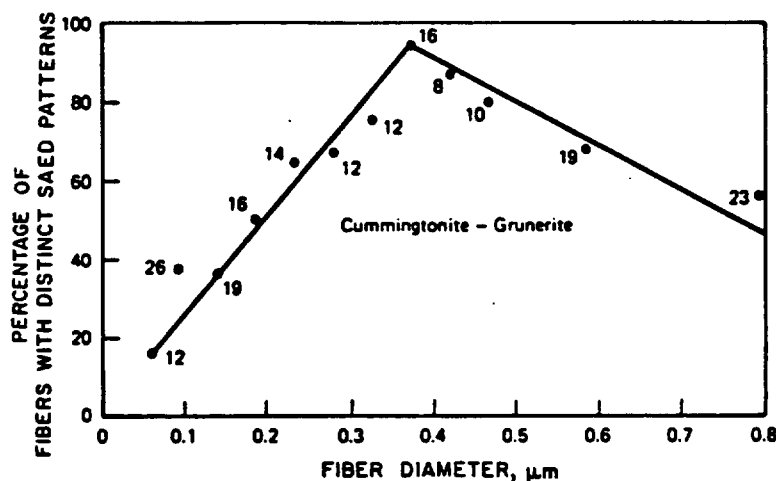


FIGURE 33. - Quality of SAED pattern as a function of amphibole fiber diameter. The values indicated on the graph are the number of fibers examined at each diameter. (Reprinted with permission of D. R. Beaman and D. M. File from Analytical Chemistry (2). Copyright by the American Chemical Society.)

At the very high magnification available with a TEM, chrysotile's hollow-tube (scroll-like) structure, approximately 50 Å in diameter, is visible (fig. 16). This hollow-tube structure, together with chemical and structural data regarding the sample, is sufficient to identify the mineral variety. However, the hollow-tube structure is only visible for individual fibrils; fibers (composed of

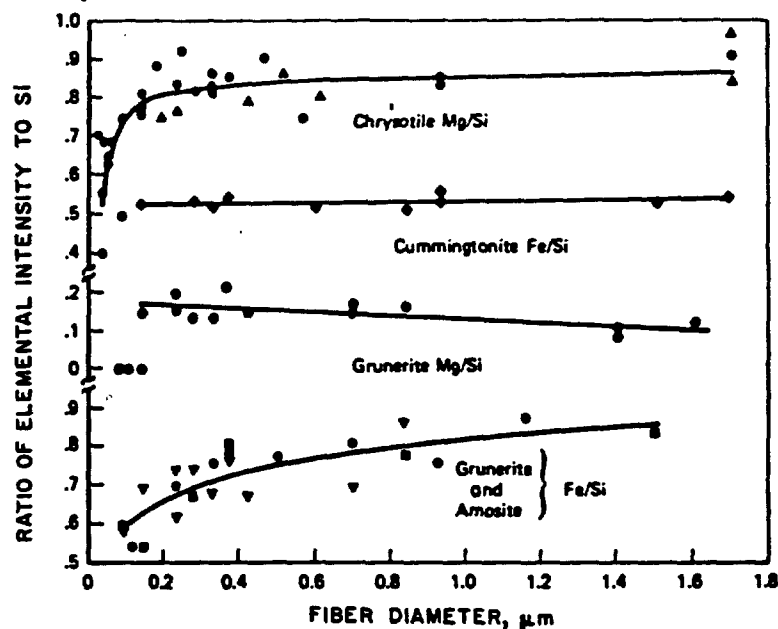


FIGURE 34. - Intensity ratio of FeK α , MgK α , or CaK α relative to SiK α as a function of fiber diameter. (Reprinted with permission of D. R. Beaman and D. M. File from Analytical Chemistry (2). Copyright by the American Chemical Society.)

particle diameter becomes a significant variable in the spectral intensity-composition relationship below 0.2 μm (fig. 34). Carbon contamination from diffusion pump oils must also be considered when analyzing small particles because the longer measuring times required to count sufficient numbers of X-ray photons allows time to build up a contamination layer. This carbon layer preferentially absorbs the lower energy X-ray photons.

Energy-dispersive X-ray spectral calibration data for each scanning or transmission electron microscope must be made using relatively pure standard minerals analyzed by accepted chemical-instrumental techniques. The analyst should be aware that other nearby grains may be contributing to the characteristic X-ray lines because of either penetration of the electron beam through the particles or secondary excitation of nearby particles from primary X-rays generated in the particle being measured. Modern electron optical instruments have electron beams diameters of approximately 0.1 μm ; however, the sphere of excitation can be several micrometers in diameter as a result of scattered electrons and primary X-rays generated in this particle (26). Conversion of intensity into concentration using accepted computer programs such as "MAGIC" is limited in accuracy because these programs are designed for use with grains or particles several micrometers in diameter or larger, whereas the average mineral fiber diameter is less than 0.5 μm for amphiboles and less than 0.1 μm for chrysotile. A good example is the diameter size distribution of

several fibrils) will not display this characteristic because of stacking of the fibrils.

The elemental composition of microscopic grains is determined by either wavelength or energy-dispersive X-ray spectrography in conjunction with scanning or transmission electron microscopy. Extreme care must be taken in the calculation of elemental concentrations from X-ray spectral intensities because the spectral line intensities (FeK α , MgK α , CaK α , relative to SiK α) are dependent on particle diameter for small fibers (2). The

chrysotile fibers in ambient air samples (table 3). The important point to note is that approximately 95 percent of these chrysotile fibers are 0.12 μm or less in diameter. Therefore, quantitative correction procedures applicable to large particles will be of limited value in mineral-fiber identification because the relative X-ray spectral intensities are dependent on fiber diameter below 0.2 μm .

TABLE 3. - Frequency distribution of the width of chrysotile fibers in ambient-air samples,¹ percent

Diameter of chrysotile fibers, μm	Sample					
	1	2	3	4	5	6
0.02-0.04	10	70	57	17	15	17
.04- .06	47	24	28	29	33	49
.06- .08	24	5	8	28	20	15
.08- .10	14	1	2	12	26	6
.10- .12	2	0	1	7	3	6
.12- .14	0	0	2	3	1	1
.14- .16	1	0	1	2	1	1
.16- .18	0	0	0	1	0	1
.18- .20	0	0	0	0	1	1
.20- .22	1	0	0	0	0	1
.22- .24	0	0	1	0	0	1
>.24	1	0	0	1	0	1

¹Samples were collected 1-2 miles from a serpentine rock quarry.

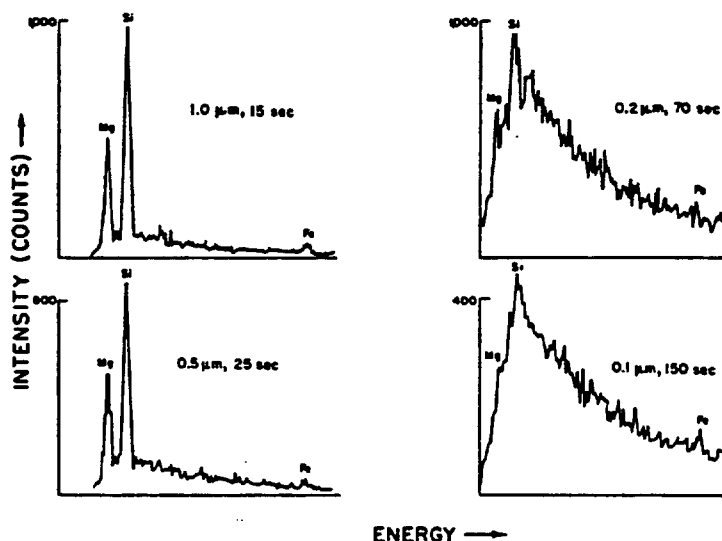


FIGURE 35. - Energy-dispersive X-ray spectra of chrysotile as a function of fiber diameter, BeO substrate (21).

Another problem with the elemental characterization of very small particles is the poor signal-to-background ratio. Longer counting times will help to improve the reliability of the measurement, but the best approach is to minimize the continuum background resulting from the interaction of the electron beam and the same substrate. Figures 35 and 36 show the energy-dispersive X-ray spectra from chrysotile fibers mounted on beryllium oxide (BeO) and beryllium (Be) substrates, respectively. The lower effective atomic number of Be compared with that of BeO results in a reduced continuum, therefore

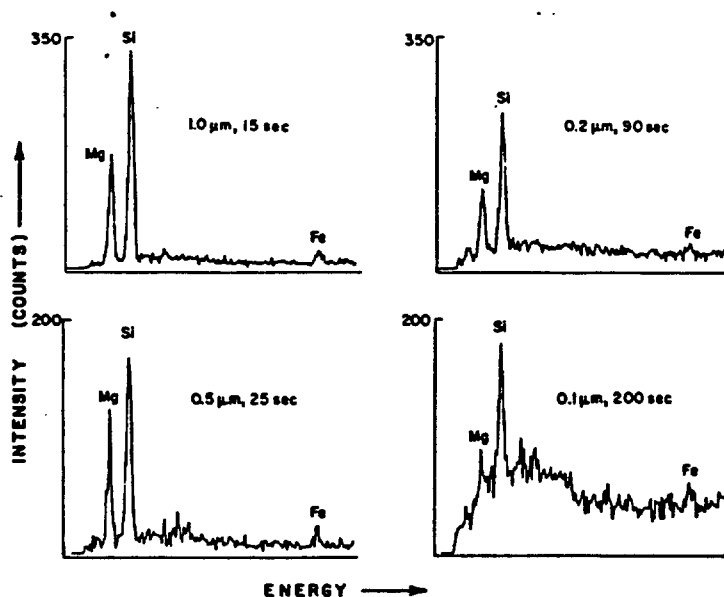


FIGURE 36: - Energy-dispersive X-ray spectra of chrysotile as a function of fiber diameter, Be substrate (21).

giving an improved signal-to-background ratio.

APPLYING MINERAL TERMINOLOGY TO THE IDENTIFICATION AND CHARACTERIZATION OF PARTICULATES

This section addresses the practical considerations and limitations encountered when applying nomenclature and identification-characterization procedures to regulatory and environmental samples.

Applying Morphological Terminology

One of the obvious features of minerals and their particulates is their morphology or shape. The need for precise definitions of terms such as "asbestiform,"

"fiber," "cleavage fragment," and "fibril" was explained earlier. These definitions were carefully structured to eliminate ambiguity and to be technically correct. Applying the definitions to samples requires careful thought as to what limits must be placed on interpretations resulting from the use of these terms and other mineralogical concepts. The underlying problem, recognized by both medical and regulatory personnel, is classifying the mineral particle as the asbestiform or nonasbestiform variety. The classification should withstand the test of mineralogical logic and proof. In a mineralogical sense, the source of the mineral particulates must be considered, as explained in the following discussion.

Particulates From a Known Asbestiform Serpentine or Amphibole Source

The definition of asbestiform minerals includes three aspects: morphology, structure, and chemistry. Morphologically, asbestiform mineral varieties separate into flexible fibers or flexible bundles of fibers. Flexible fibers bend readily and only break across the fibers into distinct pieces with some difficulty. Structurally, the asbestiform minerals are limited, in this report and in common practice, to the serpentine and amphibole mineral groups. Chemically, these minerals are all hydroxylated silicates; the term "hydroxylated" is preferred over "hydrated" because these minerals contain OH ions rather than water of crystallization. The serpentines contain approximately 13 weight-percent water; the amphiboles, approximately 2.5 weight-percent water.

For the purpose of this discussion, assume that a hand specimen meeting these requirements is correctly identified as an asbestiform mineral. If this sample is crushed and its fragments examined at various magnifications, its fibrous nature would be apparent, as in figures 14 and 17 to 19. These elongated fragments would be termed "fibers" and "bundles of fibers," and with the other available information would be called asbestiform. As these asbestiform particles are examined at increasing magnification, smaller particles become visible, while the image of large fibers and fiber bundles may exceed the field of the microscope. At increasingly smaller sizes, while fibers or bundles of fibers are still the predominant shape, a few of the fibers are observed to have broken into shorter and shorter segments. (Several short fiber segments are visible in figures 14 and 16.) These very short fiber segments are no longer described as fibers, but would be classified as fragments of fibers, or cleavage fragments if one or more cleavage planes govern their shape. Therefore, a known asbestiform sample would show an increase in the ratio of fiber fragments to fibers with a decrease in particle size.

Particulates From a Known Nonasbestiform Serpentine or Amphibole Source

If the hand specimen discussed previously does not separate into flexible fibers or bundles of fibers, the mineral would not be considered asbestiform. However, the specimen would be classified as serpentine or amphibole if the specific mineral is identified on the basis of optical properties, chemistry, and structure.

If crushed fragments of this known nonasbestiform mineral are examined at various magnifications, the particles would be primarily cleavage fragments, or irregularly broken fragments if cleavage does not govern breakage. However, a few elongated particles may resemble a fiber in appearance to the degree that they may be indistinguishable morphologically from fibers derived from an asbestiform mineral sample. Figures 26 and 32 for tremolite and riebeckite, respectively, show cleavage fragments with fibrous shapes that could be incorrectly identified as fibers.

What can be stated morphologically about particles derived from crushing a known nonasbestiform mineral is that most of the particles are cleavage fragments with nonasbestiform texture; a few are fibrous in appearance, particularly at low magnification; and all of the particles are known to be derived from a nonasbestiform source.

Comparison of Particulates From Known Serpentine and Amphibole Minerals and Their Asbestiform Varieties

The appearance of particles generated by milling known serpentine and amphibole minerals and their asbestiform varieties is shown in figures 37 to 40. The samples shown in figures 37 to 39 were photographed using light optical microscopy at three magnifications to show that, at decreasing size (depicted by increasing magnification), the original habit generally persists. For the nonasbestiform amphibole minerals, there were a few elongated particles from the riebeckite and tremolite. Elongated particles of this type

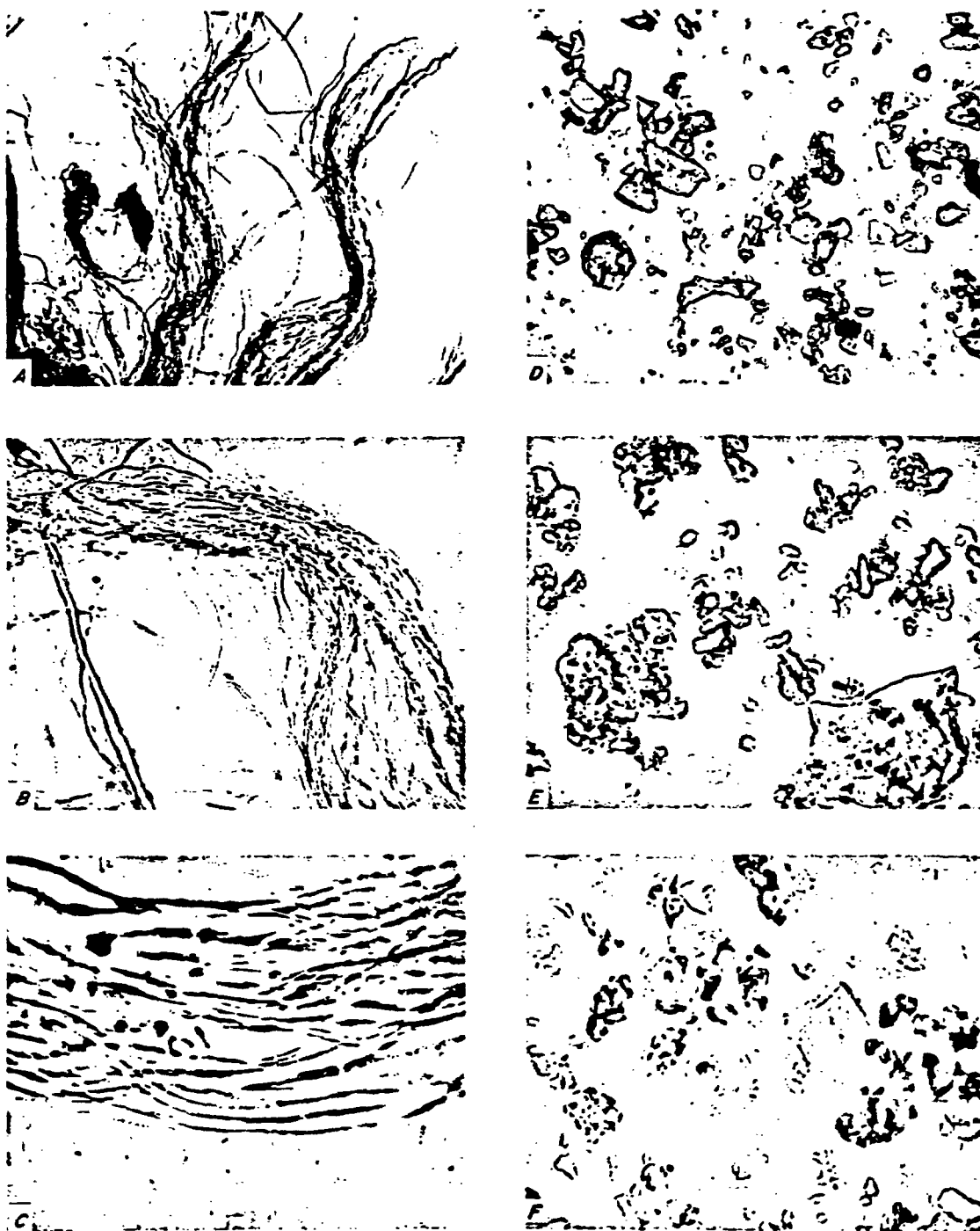


FIGURE 37. - Light optical photomicrographs of chrysotile and antigorite-lizardite at three magnifications. Chrysotile (left) at A, X 100; B, X 500; and C, X 950. Antigorite-lizardite (right) at D, X 100; E, X 500; and F, X 950.

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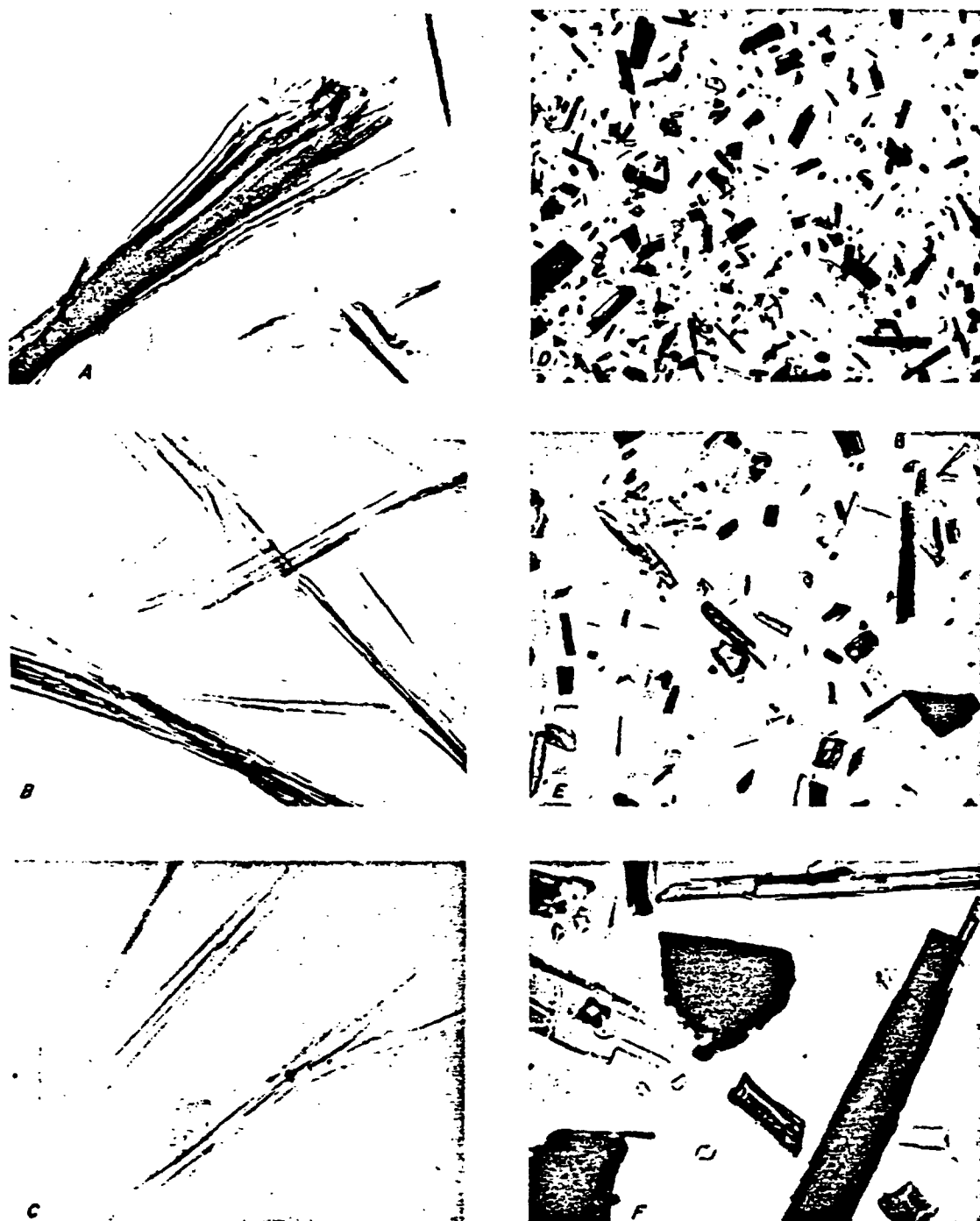


FIGURE 38. - Light optical photomicrographs of crocidolite and riebeckite at three magnifications; Crocidolite (left) at A, X 100; B, X 500; and C, X 950. Riebeckite (right) at D, X 100; E, X 500; and F, X 950.

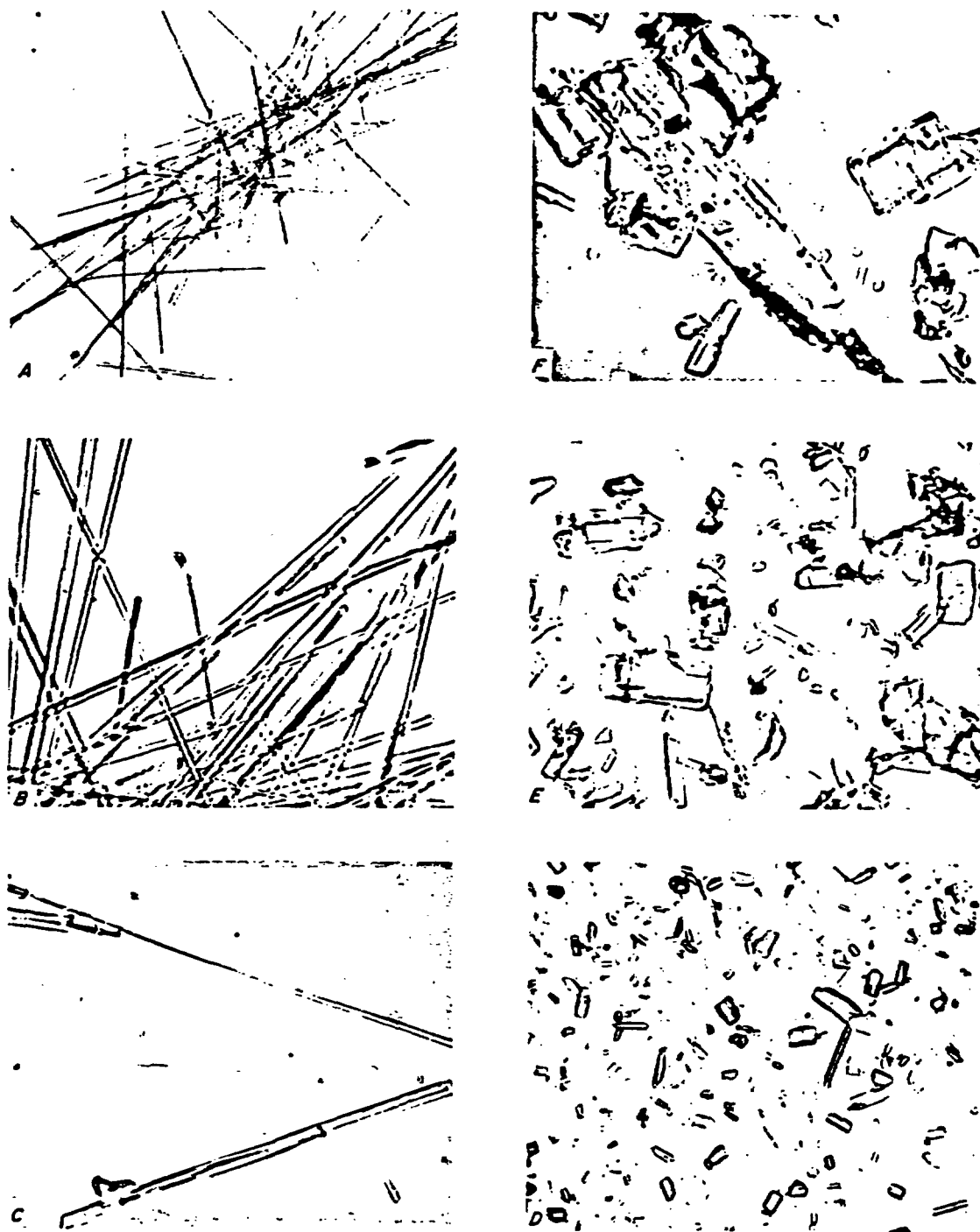


FIGURE 39. - Light optical photomicrographs of tremolite asbestos and tremolite at three magnifications. Tremolite asbestos (left) at A, X 100; B, X 500; and C, X 950. Tremolite (right) at D, X 100; E, X 500; and F, X 950.

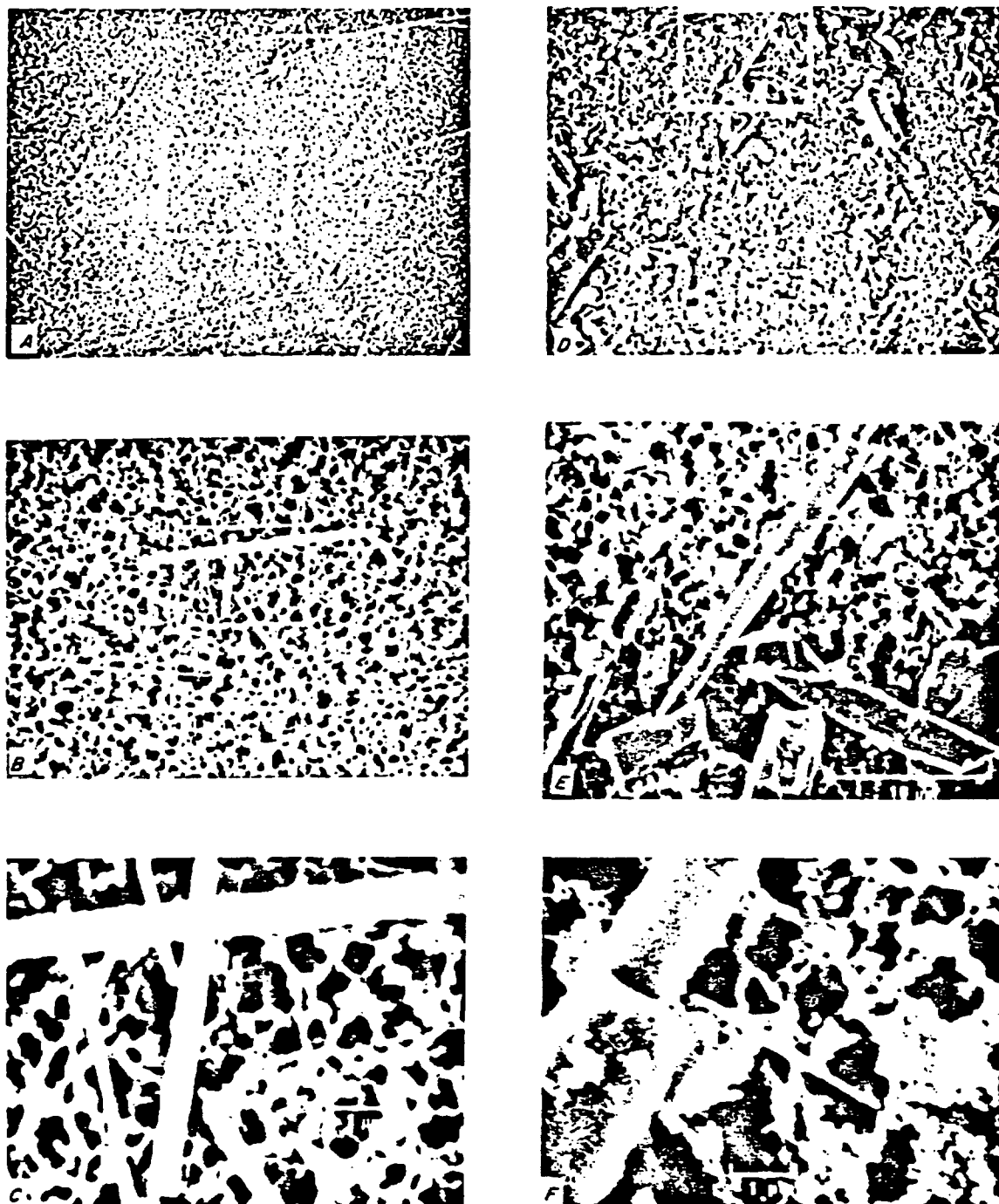


FIGURE 40. - SEM photomicrographs of crocidolite and riebeckite at three magnifications: Crocidolite (left) at A, X 500; B, X 2,500; and C, X 10,000. Riebeckite (right) at D, X 500; E, X 2,500; and F, X 10,000. Rectangles indicate the area shown at the next higher magnification.

are typical of the prismatic cleavage of amphiboles. To increase optical contrast, the serpentine group samples were dispersed in an immersion oil considerably below the refractive indices for the serpentine.

Riebeckite and crocidolite particles are compared at higher magnifications in figure 40. The outlined areas in the scanning electron micrographs indicate the area displayed at the next higher magnification. Again, note the presence of a few elongated cleavage fragments of riebeckite visible at the higher magnification. In contrast, the aspect ratio of the crocidolite will decrease with decreasing particle size because the individual fibers cannot cleave further along the fiber axis; they can only break into shorter segments.

Aspect Ratio

Existing regulatory standards are based on counting specific mineral particulates with aspect ratios of 3 to 1 or greater. This report emphasizes that the aspect ratio has little mineralogical significance for individual particulates but is applicable to a large number of particles. A few relatively long thin particles are produced as cleavage fragments from the crushing and grinding of many nonasbestiform minerals. Conversely, similar milling treatment will result in a few short segments of true fibers from the asbestiform varieties. However, statistically, the length-to-width characteristics of the milled amphiboles and serpentine and their asbestiform varieties are significantly distinct, as shown by the data in figures 41-44.

Figures 41, 42, and 43 show the frequency polygons of the aspect ratio distribution for milled samples of the normal nonasbestiform variety of three amphiboles--anthophyllite, tremolite, and hornblende, respectively. Note that in all three examples, approximately 70 percent of the particles have an

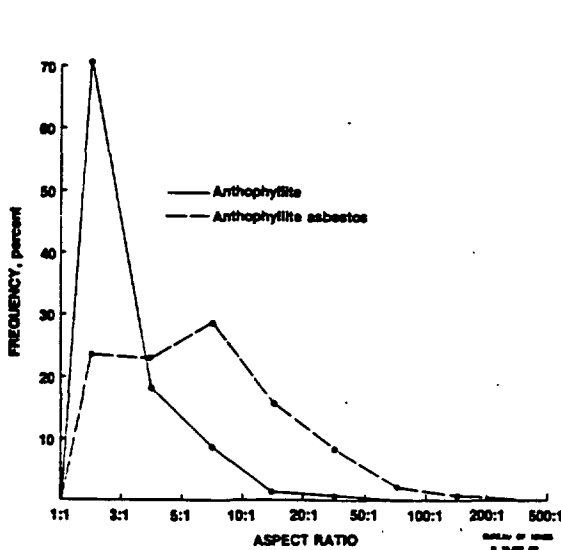


FIGURE 41. - Frequency polygons for the aspect ratios of anthophyllite and anthophyllite asbestos.

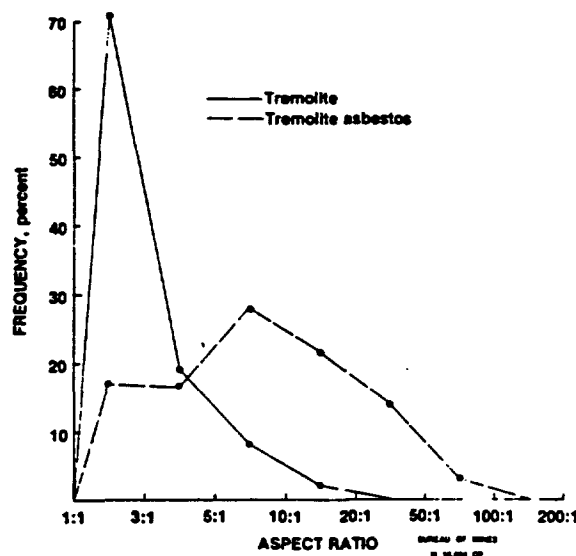


FIGURE 42. - Frequency polygons for the aspect ratios of tremolite and tremolite asbestos.

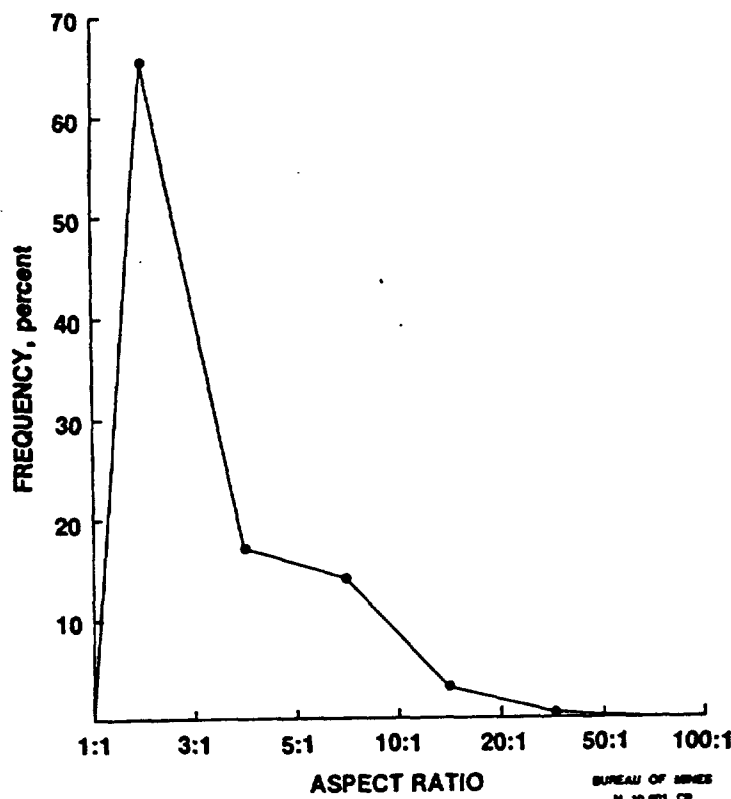


FIGURE 43. - Frequency polygons for the aspect ratio of hornblende.

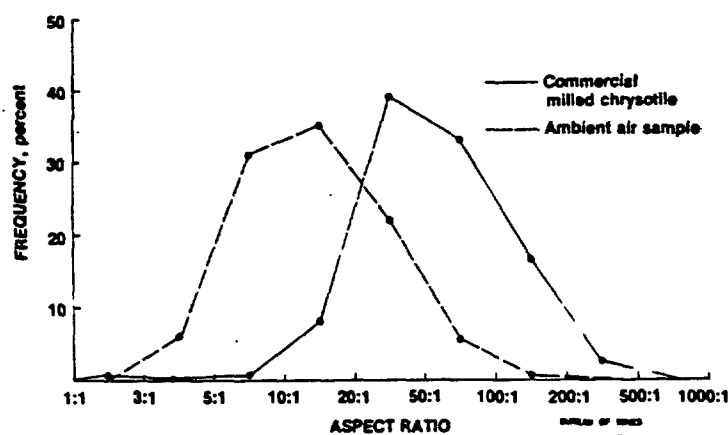


FIGURE 44. - Frequency polygons for the aspect ratios of commercial-grade chrysotile and chrysotile in ambient air.

aspect ratio of less than 3 to 1, and 95 percent of the particles have a length-to-width ratio of less than 10 to 1. The frequency distribution maximums of the aspect ratios for milled anthophyllite asbestos and tremolite asbestos are significantly higher than those for the normal, nonasbestiform variety. Thirty to forty percent of the asbestiform particulates are in the 10-to-1-or-longer class, with a significant number of particles having an aspect ratio greater than 20 to 1.

Figure 44 shows the distribution frequencies for a milled commercial grade of chrysotile asbestos and for chrysotile particulates collected on ambient air filters in the vicinity of a serpentine rock quarry. For the commercial-grade chrysotile, over 50 percent of the particles have an aspect ratio greater than 50 to 1, whereas the frequency distribution for the ambient air sample has a maximum between 10 to 1 and 20 to 1. These results are anticipated because the higher aspect ratios for the commercial-grade chrysotile are characteristic of the significantly longer starting material.

All of the aforementioned samples except the ambient air were milled, then dispersed in water for collection on a suitable substrate. The samples were then measured using electron microscopy at magnifications

of 5,000 to 10,000. The ambient air sample, collected near a serpentine rock quarry, was measured using a TEM with magnifications of X 5,000 to X 32,000.

Based on these data, one test for distinguishing the presence or absence of the asbestiform variety of a mineral could be an examination of the frequency distribution of the aspect ratio for that mineral. Assuming positive identification of the mineral type, then the designation of variety would be based both on particle morphology and the frequency maximum of the aspect ratio. Cleavage fragments will generally have a frequency maximum less than 3 to 1, whereas the asbestiform varieties will fall between 10 to 1 and 20 to 1 or higher, depending on the characteristics of the mineral and the history of the sample, particularly the type and degree of milling. If any shape or size limits are placed on characterizing mineral particulates, such limits should be based on medical evidence or on some limitation of the characterizing technique and so stated.

Particulates From Unknown Sources

Samples such as environmental airborne or waterborne mineral particulates collected at a considerable distance from a possible source are examples of particulates from an unknown source. The samples could have been collected at a location so distant from a known source that other mineral particulates originating from other sources compose most of the sample.

The source of the particulates in an environmental sample may be located by taking additional samples at selected intervals in the direction of, and closer to, the suspected source. However, several factors must be considered: The direction of air and water currents with respect to the suspected source, and the proximity to and direction of other sources with regard to the suspected source. One study found very low concentration of airborne chrysotile upwind from a source compared with a concentration two orders of magnitude greater downwind (14). Another important consideration is the level of natural or human disturbances of particulates; for example, strong versus weak winds, or heavy versus light vehicle traffic. In some instances, it may be possible to identify the source if the mineral particulates of interest have unique trace elements or combinations of elements that are specific to the probable mining or milling operation emitting the particulates. Detailed elemental analysis using the X-ray spectral capabilities of an SEM or TEM is required on both the suspected source and the particulates.

APPLICATIONS

The following examples illustrate the application of mineral terminology and identification-characterization procedures to three types of problems: (1) chrysotile determination in ambient-air samples collected near a serpentine rock quarry, (2) identification of asbestiform minerals in ceilings and walls of public buildings, and (3) characterization of a mineral product. These examples illustrate, in order, the need for higher magnification than available with the light optical microscope, the use of various characterization techniques to screen and identify asbestiform minerals, and the judgment of the analyst in distinguishing cleavage fragments and asbestiform particles.

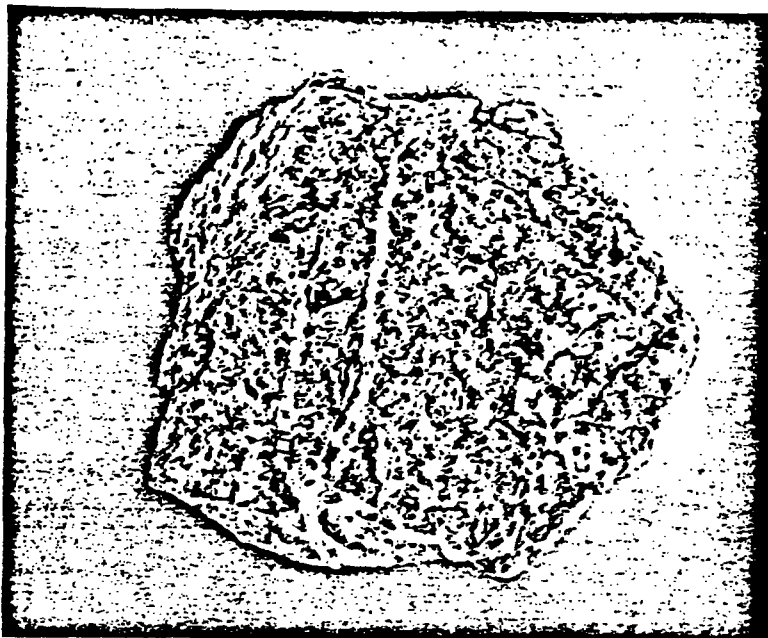


FIGURE 45: - Macrophotograph showing chrysotile veins in serpentine rock (X 1):



FIGURE 46: - Chrysotile bundle (SEM photomicrograph at X 5,000):

Ambient-Air Samples
Collected Near Ser-
pentine Rock
Quarry

The Bureau of Mines is working with State and Federal officials to measure mineral particulates in ambient-air samples collected in the vicinity of a serpentine rock quarry. Optical microscopic procedures at about X 500 are limited to the identification of mineral particulates longer than 5 μ m with an aspect ratio of 3 to 1 or larger (criteria set by the Mining Enforcement and Safety Administration and the Occupational Safety and Health Administration). The mineralogist can further identify the

particles as belonging to the serpentine, amphibole, or other mineral group with index oils (table 2).

The serpentine rock in the quarry is interlaced with small veins of chrysotile (fig. 45). Optical microscopic procedures used for industrial hygiene are adequate for the detection of large chrysotile fiber bundles. These fiber bundles of commercial-grade chrysotile can be several micrometers or larger in diameter (fig. 46). In contrast, the mining and crushing operations in the quarry plus transport of particulates over a distance breaks bundles of fibers down to fibers or fibrils with diameters of 250 to 1,000 $\text{\AA}$ (table 3).

Figure 47 is a series of SEM photomicrographs of a mixture of chrysotile and nonasbestiform serpentine handpicked from a small vein in the serpentine rock quarry. Note that at X 450 (corresponding to the optical microscope magnification), only one or two bundles of chrysotile are faintly visible; the predominant particles are the nonasbestiform serpentine. As the magnification is increased, the high concentration of chrysotile fibers becomes readily visible. The fiber diameter size data in table 3 indicate that more than 95 percent of the chrysotile fibers in these ambient air samples are below the limit of resolution of the optical microscope. Although many other scientists have pointed out the limitation of the optical procedures for chrysotile in ambient air, there is need for continuous emphasis that higher magnification techniques are necessary for environmental and regulatory samples.

Asbestos in Ceiling and Wall Materials

A possible environmental hazard is the release of asbestos from ceilings and walls in homes, churches, schools, and various other public and commercial buildings. Because of the very high number of potential samples to be examined by various State or Federal agencies, a rapid and reliable screening procedure is necessary to identify those samples that warrant further tests. Three complementary analytical methods for screening, identification, and semiquantitative estimate of the asbestiform mineral concentration are X-ray diffractometry, differential thermal analysis, and microscopy (light optical and scanning electron).

The screening identification procedures can be relatively simple because chrysotile is the principal asbestos mineral used for building insulation materials, with Amosite used to a much lesser extent. In 18 samples from a mid-western municipal health department, chrysotile was a major constituent (>50 weight-percent) in 2 samples, a minor constituent (1 to 10 weight-percent) in 12 samples, and not detected in 4 samples. Other minerals present in various concentrations in these samples were calcite, quartz, gypsum, and mica. Amosite was found as a major constituent in the ceiling of an older building located on a university campus.

The presence of either serpentine or amphibole minerals in the insulation materials can be used as a probable indication of asbestos. Therefore, screening tests are based on the presence or absence of characteristic differential thermal analysis or X-ray diffraction peaks of either serpentine or amphibole minerals. For the positive samples, confirmation of the presence of the asbestiform variety requires some type of microscopic examination because the thermal and X-ray diffraction methods do not identify the mineral variety.

Differential thermal analysis provides a detectable signal from chrysotile at 0.5 to 1.0 weight-percent, as indicated by the curves shown in figure 48. Note the increase in the endothermic (A) and exothermic peaks (B) upon addition of about 5 weight-percent chrysotile to a sample taken from a school ceiling. The sensitivity of differential thermal analysis for the amphibole minerals is significantly poorer because the H₂O content of amphiboles is approximately 2.5 percent compared with about 13 percent for chrysotile. The sensitivity of the X-ray diffraction method also ranges from 0.5 to

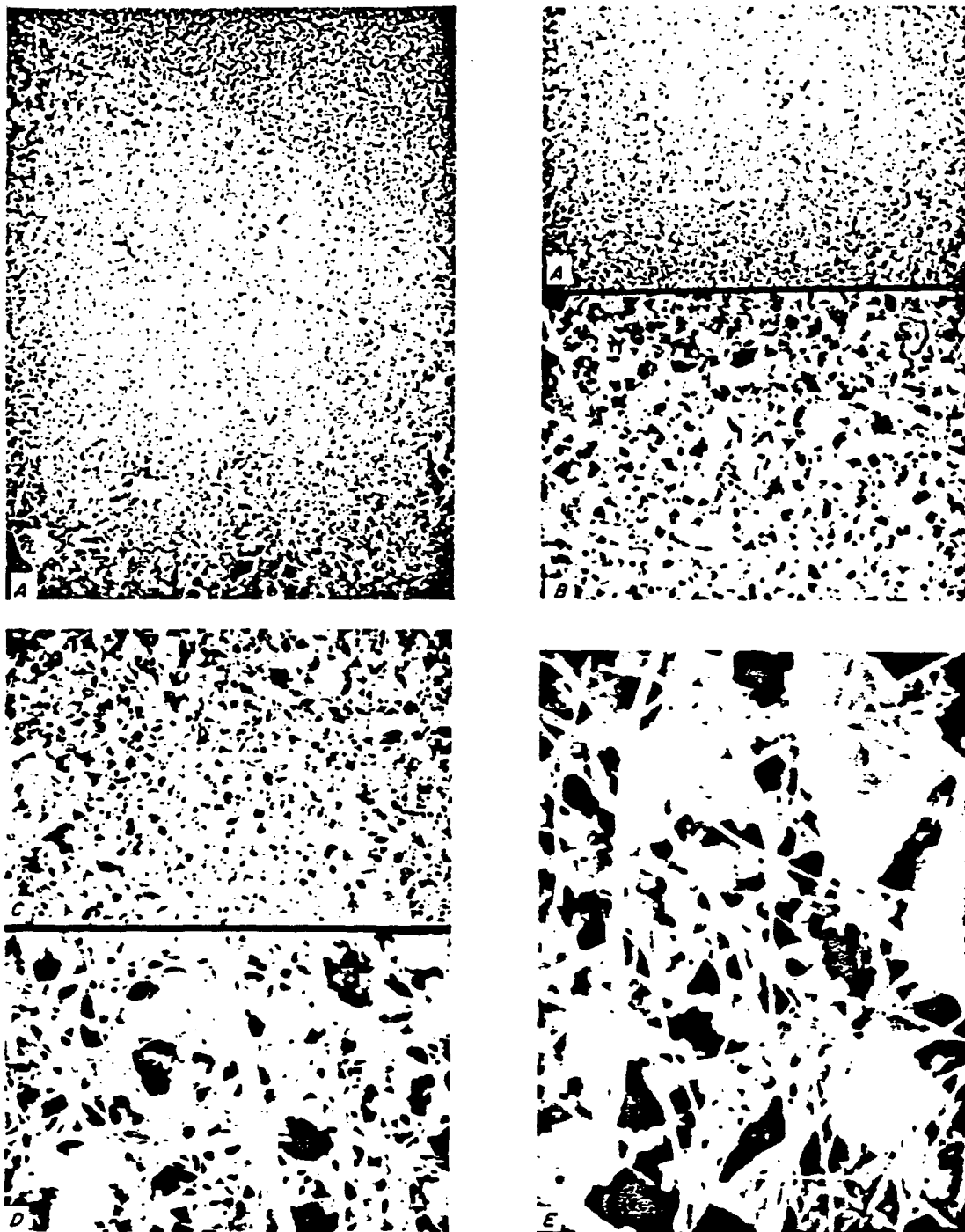


FIGURE 47. - Mixture of nonasbestiform serpentine and chrysotile at five magnifications: A, X 450; B, 2,250; C, X 9,000; D, 1,800; and E, X 18,000. Rectangles indicate the area shown in the next panel.

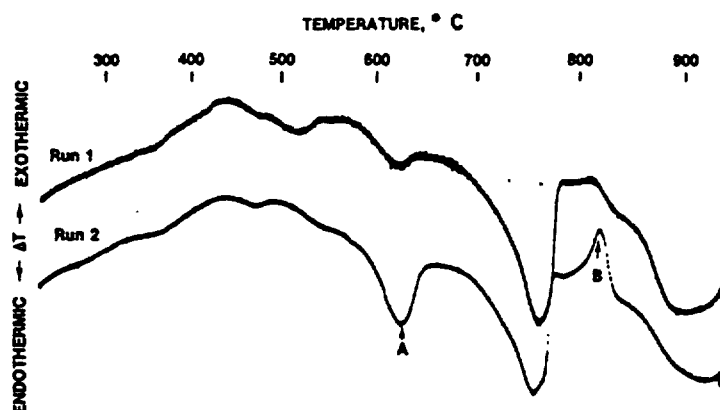


FIGURE 48. - Differential thermal analysis of sample from school ceiling, showing endothermic (A) and exothermic (B) peaks of serpentine. Run 1 is the sample as received; run 2 is a mixture of 95 pct of the as-received sample and 5 pct chrysotile.

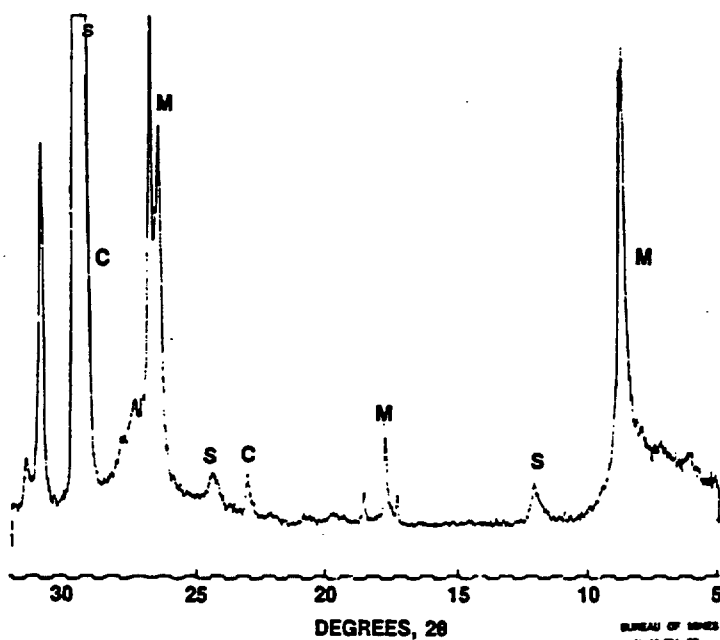


FIGURE 49. - X-ray diffractometer scan of sample from school ceiling, showing the presence of calcite (C), mica (M), and serpentine (S).

1.0 weight-percent. An X-ray diffractometer scan of the 2θ range for major serpentine peaks is shown in figure 49. The magnitude of the characteristic peaks for chrysotile are a function of several factors, including degree of fiber orientation and the type of milling or crushing used to process the sample. Also, the sensitivity of both methods is affected by the presence of other minerals that have characteristic thermal or diffraction peaks in the same region as those of the minerals of interest.

Some samples will be composed of a mixture of synthetic and natural fibers, such as the mixture of fiberglass and chrysotile shown in figure 50. Generally, it is not difficult to identify the synthetic fibers based on their larger diameter and the more uniform appearance.

Amphiboles and Talc

Asbestos-related health regulations are having a significant impact on the domestic talc industry from occupational exposure at the mines and mills and at various manufacturing plants that use talcs in their operations. Certification that the talc does or does not contain asbestiform minerals is important because the occupational health requirements are much more restrictive if the talc is designated as containing asbestiform serpentine or amphibole minerals.



FIGURE 50. - Sample from university building, showing a mixture of chrysotile and fiberglass (X 140).

Talc is both the name of a specific mineral, $Mg_3Si_4O_{10}(OH)_2$, and a commercial term for a mixture of minerals ranging from essentially 100 percent talc to blends where the mineral talc is a minor constituent (12, 23). Semiquantitative estimation of the serpentine and/or amphibole mineral concentration, if present, can be obtained by X-ray diffraction and differential thermal analysis. Several talc deposits contain a variable amount of tremolite. Therefore, the essential question faced by the analyst is whether or not the tremolite is fibrous. Figure 51 shows the typical platy morphology of talc; no tremolite (amphibole) was detected in this sample by X-ray diffraction. Figure 52 illustrates the type of particles obtained from a mixture of tremolite and platy talc. The cleavage fragments of tremolite are typical of the nonasbestiform variety. Better judgment is required of the analyst

with the type of sample illustrated in figure 53. This sample consists of platy talc, cleavage fragments of tremolite, and minor to trace amounts of fibrous tremolite. For this latter sample, the 3-to-1 aspect-ratio criteria would greatly overestimate the number of fibrous tremolite particles collected on air filters or other monitors.

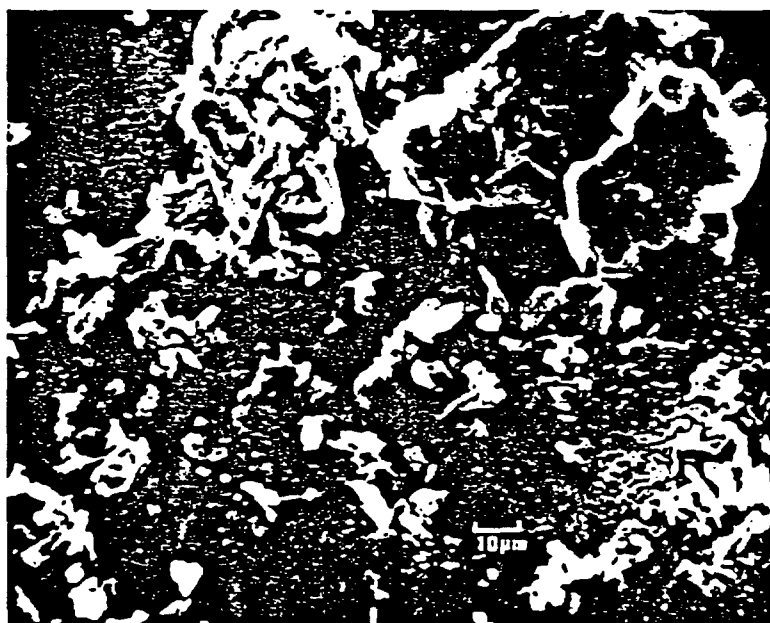


FIGURE 51. - Typical platy morphology of talc (X 600).

RESEARCH NEEDS

There are several areas in particulate identification-characterization where further research is warranted. Areas of research that are immediately applicable to asbestos are briefly summarized.

Commercially available electron optical instruments are generally limited to morphological characterization for mineral particles with diameters less than $0.2\text{ }\mu\text{m}$. As pointed out in the identification-characterization section, both the signal-to-background ratio for energy dispersive X-ray spectra and the SAED pattern are significantly degraded for elongated particles less than $0.2\text{ }\mu\text{m}$ in diameter. Field emission electron optical microscopes with their higher vacuums and smaller beam diameter may have some advantages over conventional SEM instruments. Also, other microprobe techniques, in particular ion microprobe mass spectrographs and laser Raman microprobes, should be evaluated for particulate characterization.

Although electron microscopic methods can generally positively identify chrysotile in air and water samples, the quantitative aspects of the measurements need substantial improvement. Sample treatment and measurement errors need to be isolated from sampling variance.

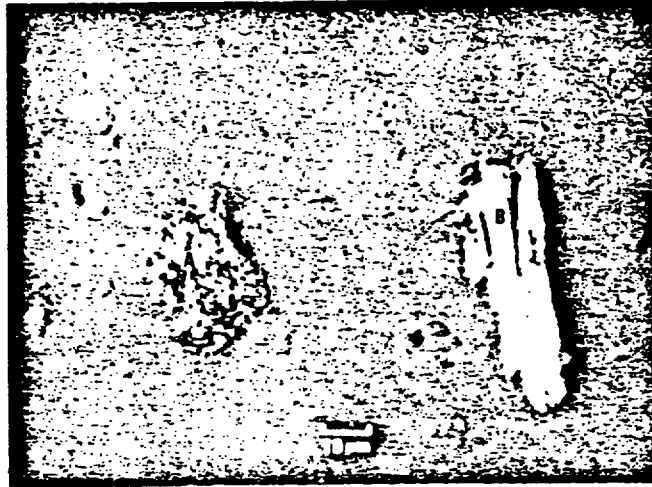


FIGURE 52. - Platy talc (A) and tremolite cleavage fragment (B) (X 640).



FIGURE 53. - Platy talc, tremolite cleavage fragments, and a fibrous tremolite particle (A) (X 400).

Because of the ambiguity of fiber counts, results should be reported both in mass equivalents and in fibers per unit volume.

Fundamental studies should be conducted to determine if there are unique chemical and physical characteristics of a mineral fiber as compared to elongated cleavage fragments. For example, the surface properties of chrysotile are similar to those of magnesium hydroxide, whereas the nonasbestiform varieties of serpentine have the surface characteristics of a silicate (30). Variations in surface properties, if any, between asbestiform particles and cleavage fragments of amphiboles should be investigated. Surface characterization techniques to be considered should include Auger electron spectrography and low-energy X-ray spectrography. Research at the University of Minnesota indicates that asbestos fibers have an extensive surface charge over the whole surface, whereas cleavage fragments have a significantly lower surface charge (40). Extinction angle measurements are another possible approach to distinguishing asbestiform from the nonasbestiform varieties of amphiboles (37).

There is a critical need to reexamine the 3-to-1 aspect ratio as a criterion for a mineral fiber. The aspect ratio for fibers from asbestiform minerals were as much as 200 to 1 or higher, whereas the ratio for cleavage fragments is about 3 to 1, as illustrated by the data in this report. The 3-to-1 aspect ratio may be valid for the industrial hygiene control of asbestos-processing plants; however, its applicability to existing nonasbestos mining and ore processing plants requires critical evaluation. There is also need to evaluate the restriction of the mineral particulate measurements to light optical microscopy because many particulates of interest, especially chrysotile fibrils, are not visible by this technique. Low-cost scanning electron microscopes are in the same price range as research-grade petrographic microscopes, and the skill requirements for the operator are comparable for both instruments.

Particulate measurements by microscopic procedures are time consuming and expensive. Two possible approaches to reducing the time and cost are (1) automation of the particulate identification-characterization measurements using computerized image analyzers and (2) development of chemical reagents that give a specific response with either chrysotile or the various asbestiform amphibole minerals. Using the chemical-reagent approach, mass-concentration values could be obtained by measurement of some response such as color, ultraviolet fluorescence, X-ray spectral intensity, etc.

Health studies related to inhalation and ingestion of fibers have been essentially limited to well-defined commercial types of asbestos. The fundamental question to be resolved is the biological effects of cleavage fragments compared with those of true mineral fibers. If shape and size are the critical parameters, the analyst could establish and measure suitable analytical parameters to monitor the particulates of interest. Likewise, if the health scientists find a correlation between health and the amount of trace metals, adsorbed organics, surface area, etc., the analyst can respond accordingly. Therefore, there is a primary need for an adequate quantity of well-characterized amphiboles and serpentine of both the normal and asbestiform varieties for use in health-related studies.

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July 21, 1924.

Dr. R. R. Sayers, Chief Surgeon,
U. S. Bureau of Mines,
Washington, D. C.

SUBJECT: Paper, "Air dustiness
determined with the sugar
tube, Palmer apparatus and
impinger, compared to deter-
minations with the konimeter.

Dear Dr. Sayers:

In accordance with our recent conversation, there is enclosed herewith two copies of the paper, title above. I would *be pleased to have* ~~like~~ your comments, and also the paper may be submitted to any others whom you desire, including members of the Public Health Service who asked that this matter be deleted from the bulletin on Comparative tests of instruments for determining atmospheric dusts. Should there be objections to the paper in its present form, will you please ask that the comments and criticisms be written.

I would like to present this matter at some future meeting of the American Society of Heating and Ventilating Engineers, and possibly elsewhere if it can be released for that purpose.

Very truly yours,

S. H. K.
S. H. Katz.

2 encls.

Emb
MTC 001311

DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

WASHINGTON

September 8, 1924.

Mr. S. H. Katz,
U. S. Bureau of Mines,
Pittsburgh, Pa.

Dear Mr. Katz:

Your paper on "Air dustiness determined with the sugar tube, Palmer apparatus and impinger, compared to determinations with the konimeter," has been submitted to the Public Health Service and then to the Editorial Division of the Bureau.

The Public Health Service say that it is impossible to submit it to Dr. Frost, as he is on leave and will be away from duty for several weeks. Of course, the Public Health Service have no objection to the Bureau of Mines publishing the paper, if it is thought best. However, the Public Health Service still feel that they do not care to publish the paper. The only possible criticism that Dr. Thompson had was that on page 11 some of the data given would detract from the bulletin now being published by the Public Health Service if this should appear at an earlier date. Other criticisms were that counts of the konimeter were not practicable in high concentration and, therefore, the derivation of a mathematical relation with any other determination was not justified. It is also believed that the double logarithmic scale is difficult to interpret, even by the average engineer.

There were other minor suggestions, but after talking with the Editorial Division and others, it was deemed inadvisable to have the article published. I am very sorry that this is true, because I know that you have worked hard on the article to get it in the shape that it is.

Yours sincerely,

R. R. SAYERS
Chief Surgeon, U.S.B. of M.
Surgeon, U.S.P.H.S.

*Do not practical for general
reactive analysis, the counts were
made in the comparison study and
this comparison shows the practicality in
these circumstances.*

*Furthermore the same
relations are true over
the so-called "practical"
range.*

081
*Paper as used is B of M standard paper.
Also derivation of equation is more easily
perceived with the paper as used.*
Published later.
*change to a
log scale paper.*

S. H. K.
CR

MTC 001312

March 13, 1926.

SHK/LD

CHIEF SURGEON.

Subject: Publication of Paper.

Dear Dr. Sayers:

Now that the Public Health Service Bulletin 144 has been issued, it seems advisable to publish the paper "Air Dustiness Determined with the Sugar Tube, Palmer Apparatus and Impinger Compared to Determinations with the Konimeter". You will remember that Dr. Thompson preferred that it be held until the issue of the Bulletin.

Mr. Smith, Mr. Myers and myself think that the paper has valuable information, which should be given to other workers. When you are in Pittsburgh again, I would like to consult you about it. I believe it is now arranged to accord with all criticisms and comments that have been received.

Yours very truly,



S. H. Katz,

47
MTC 001313

March 16, 1926.

SHK/LD

ASSISTANT DIRECTOR.

Subject: "Air Dustiness Determined
with the Sugar Tube, Palmer
Apparatus and Impinger, Com-
pared to Determinations with
the Konimeter."

Dear Dr. Lyon:

Enclosed herewith are the original and one
carbon copy of the above paper by Katz, Smith and Myers.

Will you please refer to Dr. Sayers, and if
agreeable, it may be sent to the Journal of Industrial
Hygiene for issuing. In event the Journal of Industrial
Hygiene does not publish the paper, please refer it to
the Journal of the American Society of Heating and Venti-
lating Engineers.

Very truly yours,

Alz

Encl.

A. C. Fieldner.

(1) H. H. Taylor
(2) Fil

SHK. Carded
3-27-26
SWT

MTC 001314

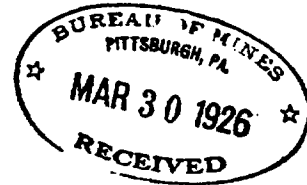
1. Mr. Kating ✓ SHX.
8 file
IN ANSWERING REFER TO No. _____

UNITED STATES
DEPARTMENT OF COMMERCE
BUREAU OF MINES

WASHINGTON

March 29, 1926.

Mr. A. C. Fieldner,
U. S. Bureau of Mines,
Pittsburgh, Pa.



Dear Mr. Fieldner:

This will acknowledge receipt of the original
and one copy of the paper on Air Dustiness Determined with
the Sugar Tube, Palmer Apparatus and Impinger, Compared to
Determinations with the Konimeter. This has been forwarded
through the regular channels for publication and as soon as
it has been passed upon you will be informed.

Yours very truly,

A handwritten signature in cursive script, reading "R. R. Sayers".

R. R. SAYERS
Chief Surgeon, U.S.B. of M.
Surgeon, U.S.P.H.S.

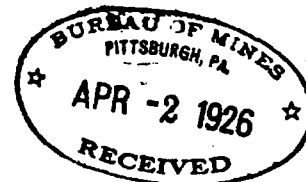
A handwritten signature or set of initials, possibly "C. L. S.", enclosed in a circular flourish.

MTC 001315

~~1 Mr. J. S. Taylor forward sub~~
~~2 Mr. Katz E. H. K. Mr. Fisher~~
3 file

March 31, 1926. RES/SJF

Dr. O. K. Drinker,
JOURNAL OF INDUSTRIAL HYGIENE,
240 Longwood Avenue,
Boston 17, Massachusetts.



Dear Dr. Drinker:

I am inclosing an article on "Air Dustiness
Determined with the Sugar Tube, Palmer Apparatus and
Impinger, compared to Determinations with the Konimeter,"
by Messrs. Katz, Smith, and Myers. This is submitted
for possible publication in the JOURNAL OF INDUSTRIAL
HYGIENE.

Yours sincerely,

R. R. SAYERS
Chief Surgeon, U.S.B. of M.
Surgeon, U.S.P.H.S.

Inclosure.

✓ cc - Mr. Fieldner

Barrett
3-27-26
sub

cc

RECEIVED

MTC 001316

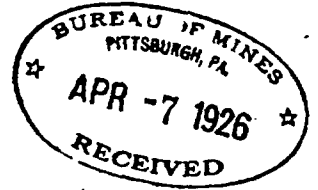
Philadelphia Archives
RG 70 Box 16

IN ANSWERING REFER TO No.

UNITED STATES
DEPARTMENT OF COMMERCE
BUREAU OF MINES

WASHINGTON

April 6, 1926.



Mr. S. H. Katz,
U. S. Bureau of Mines,
Pittsburgh, Pa.

(Thru Superintendent)

Dear Mr. Katz:

I have just received a letter from Dr. Drinker

in which he says that both himself and his brother Philip
think it an excellent piece of work. Apparently they
will publish it in the Journal of Industrial Hygiene in
the near future.

Yours very truly,

R. R. SAYERS
Chief Surgeon, U.S.B. of M.
Surgeon, U.S.P.H.S.

S.H.K.

MTC 001317

Philadelphia Archives

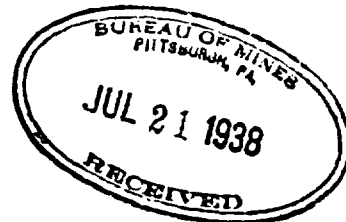
RG 70, Box 13

ADDRESS ALL COMMUNICATIONS TO
THE DIRECTOR, U. S. BUREAU OF MINES
WASHINGTON, D. C.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
WASHINGTON

July 20, 1938.

Mr. J. J. Forbes,
U. S. Bureau of Mines,
Pittsburgh, Pa.

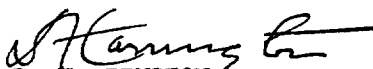


Dear Mr. Forbes:

Herewith a paper of mine on dust together with some discussions of it, the paper being merely a repetition of other papers on this subject. The main reason for transmitting the paper to you is for you to see the material in the discussions and I think you will find in them some rather interesting information.

A copy is being sent to several of the district engineers.

Yours truly,


D. HARRINGTON,
Chief, Health and Safety Branch.

Encl. - 1326993

*ack with thanks -
2 inc pamphlet box*

MTC 001318

METHODS FOR PROTECTION AGAINST DUST HAZARDS

AND WHEN THEY ARE JUSTIFIED 1/-----
By: D. Harrington 2/

While apparently the hysteria with regard to silicosis and other occupational diseases has largely subsided and this subject is being more carefully considered and soberly judged, it would be poor policy for any employer to maintain that the storm has ended and that he can relax and revert to conditions as they were 5, 10, or more years ago. The fact is that the plan of paying occupational-disease compensation is now in its infancy and can be expected to grow rapidly. At present, while all of the States of the Union, including the District of Columbia and excepting only Arkansas and Mississippi, have compensation acts, only the following make provision for occupational diseases to some extent or in one way or another: California, Delaware, Connecticut, District of Columbia, Illinois, Indiana, Kentucky, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Jersey, New York, North Carolina, North Dakota, Ohio, Pennsylvania, Rhode Island, Washington, West Virginia, and Wisconsin. Silicosis is compensable in one way or another in California, Connecticut, District of Columbia, Illinois, Kentucky, Massachusetts, Missouri, New York, North Carolina, North Dakota, Ohio, Pennsylvania, West Virginia, and Wisconsin, and possibly in other States. During the past few months, occupational-disease legislation (largely silicosis) has been considered in some form in Arkansas, California, Delaware, Idaho, Maryland, Kansas, Massachusetts, Michigan, Minnesota, Montana, Nebraska, New Jersey, Ohio, Pennsylvania, Tennessee, Utah and Washington. It will be surprising if comparatively comprehensive occupational-disease legislation is not on the statute books of nearly every State in the Union within the next 5 years.

With this situation confronting him, the farsighted industrialist who has the interest of his organization at heart, if he has not already done so will immediately start to "put his house in order" by studying possible occupational disease hazards to his employees and promptly applying known remedial measures or attempting to devise such measures if none exist. Unquestionably, one of the most important of the surveys to be made relates to dust occurrence, as State laws on occupational disease are almost certain to contain provisions on silicosis and, with almost equal certainty, the provisions of any State law are not likely to be particularly similar to those of other States.

1/ Presented at Mid Year Meeting of Directors of the National Slag Association, Washington, D. C. June 3rd, 1938.

2/ Chief, Health and Safety Branch, Bureau of Mines, Washington, D.C.
6128

MTC 001319

In studying possible dust harmfulness to those employed in industry, the investigator naturally will try to ascertain from the experience of others, as embodied in available literature, or from other sources the features of dust occurrence that may endanger the health of or otherwise harm workers; in doing so the investigator is likely to find such confused and conflicting data that, irrespective of his investigative or operating ability or his good intentions, he is likely to have considerable difficulty in ascertaining what it is all about and what is to be done about it.

While the State dust laws and regulations apply primarily to silica dust and resultant silicosis insofar as the health hazard is concerned, those most familiar with dust occurrence and its possible hazards recognize not only that the breathing of large quantities of dust of free silica (SiO_2) is probably the greatest hazard to health likely to be found where dust is involved, but that not even silica dust is harmful to health unless it occurs in very finely divided form and is breathed in relatively large quantities more or less continuously for a considerable length of time. Moreover, many thoughtful experts on dust harmfulness are now becoming convinced it is to be expected that health will be harmed when human beings are obliged to breathe high concentrations of any kind of dust more or less continuously. This conviction has been definitely expressed recently by so many of those who have made dust investigations their life study that it seems inevitable the law makers must soon take cognizance of it. Professor Philip Drinker, of Harvard, as chairman of the Preventive Engineering Committee of the Air Hygiene Foundation, Pittsburgh, now engaged intensively on studies of air harmfulness, very concisely and definitely expressed the considered opinion of a body of outstanding dust experts as follows:

There is no satisfactory medical answer at present to this question, but the engineer is making a bad mistake if he lets men breathe heavy dust concentrations of any material. If no other reason for dust control can be found, then one should read transcripts of some of the recent suits at common law in which fantastic damages for alleged silicosis were granted to men who breathed dust containing little or no silica. The courts and compensation boards are not impressed with subtle distinctions between dusts with 10- and 40-percent quartz, especially when medical experts are reluctant to make definite statements as to the comparative significance of such differences.

It would be well to realize that men working in dusty trades suffer far more from respiratory troubles of all kinds than do men who work in clean air. The evidence that excessive dustiness of any kind is harmful is beyond argument.

In connection with what is likely to confront the employer in compensation obligations in the future with regard to dust, it should be remembered that the inhaling of dust is by no means its only hazard in industrial work

MTC 001320

that may require compensation payment; and even here the harmful effect of breathing dust is not necessarily confined to the lungs, as some kinds of dust are known to have detrimental health effect on the nose, throat, and bronchial passages as well as (indirectly) on the heart, stomach, and possibly other internal organs. Externally, dust may cause injury to the eyes, ears, and skin; and some dusts, in contact with the perspiration, are absorbed, with definite harm to the health of the victim.

Moreover, heavy concentrations of dust in the air reduce visibility materially; in some cases, as in the storms in the Dust Bowl in the Central West, the dust in the air reduced visibility virtually to zero in midday with the sun shining brightly. Obviously, in industrial occupations in which but limited amounts of natural light are available or in which artificial light is used entirely, any decrease in visibility due to air-dustiness (and the decrease in visibility may, under some circumstances, amount to 75 percent or more) is likely to result in materially reducing efficiency and also in the more frequent occurrence of accidents accompanied by an increase in compensation commitments. Some dusts (coal, zinc, aluminum, and scores of others, mineral and non-mineral) are explosive and many are subject to spontaneous combustion with consequent hazards to health, safety, and property. Many dusts have detrimental effects of various kinds on property as distinguished from persons. Machinery, growing vegetation, animals, dwelling houses, and other types of property are damaged by dusts, and compensation of some kind often is obtained from industrial concerns through damage suits or otherwise.

In view of these facts, it would appear that the industrial executive who is trying to protect his employees from harm and his organization from undue avoidable expenditures because of the hazards of various kinds from dust, would disregard technicalities and concentrate on reduction of dust in the air in and around his plant instead of splitting hairs as to the size of dust or the kind of dust or the quantity of dust or any of the scores of other uncertainties as to dust, as to many of which no reliable information is yet available and in many cases probably never will be available.

Prevention of air dustiness where human beings must work and the elimination of dust or keeping it confined and under control most certainly should be an integral part of any industrial work of the future if those engaged in industry are to avoid heavy expenditures for compensation and other damages. Having arrived at this conclusion, the forward-looking industrial executive who is trying to protect his employees as well as his company wants to know immediately what constitutes a harmful amount of dust and how to eliminate or reduce it; and here, again, the answers are not easily given nor are they as specific as might be desired.

From the viewpoint of respiratory harmfulness, it is generally stated (though actually knowledge on this point is by no means certain) that the particle sizes of dust (such as that of free silica) that affect health adversely upon entering the lungs are those that are less than 10 microns in

size, different persons having different ideas as to what the maximum may be - 10 microns or 8 or 6 - and some say that the harm really is done by particles less than 2 microns in size. As against this, it is stated that fibers of asbestos dust as long as 200 microns have been found in the lungs of men, and that undoubtedly these long asbestos fibers exerted at least some detrimental effect. Since a micron is only about one twenty-five thousandth of an inch, or much smaller than the naked eye can see, it is usually assumed that the larger dust particles that can be seen floating in the air, and which settle out relatively fast are not harmful to health. Certainly, this is not so, as the larger particles that float in the air (some of them 100 or more microns in size), if present in considerable quantities, clog the air passages leading to the lungs, some of which have agencies that under ordinary conditions intercept dust particles before they can reach the lungs, and this clogging then allows the smaller and probably most dangerous dust to enter the lungs unimpeded. A common-sense opinion as to what constitutes an atmosphere so dusty that dust-prevention action should be taken is that any atmosphere in which dust can be seen by the naked eye is too dusty, not only for health but also, at least in many cases, for safety and efficiency. If the visible dust is eliminated, much of the invisible or probably most dangerous dust will unquestionably have been removed also and very likely the health as well as other hazards much minimized or even removed. After the visible dust has been removed, it may be necessary, under some conditions or with some types of dust, to make more intricate investigations as to the occurrence of invisible dust, using the impinger, konimeter, or other instruments; but unless litigation is in effect or threatened, these intricate studies are relatively unimportant if the visible dust is eliminated from the air of working places.

Manifestly, if dust is not produced, it can't get into the air or become harmful otherwise; and some relief from dust troubles in industry can be achieved by using construction, practices, processes, or equipment that tend to eliminate dust formation.

In designing and equipping the places in which employees must work, the forward-looking industrialist will be wise to prevent the making of dust or to control it if it must be made, by using machinery, methods, processes, construction, etc., with dust-eliminating characteristics rather than those that produce or spread dust, even though some additional expense in construction or operation may attach to the dust-prevention features. The emphasis now being placed on dust in its various phases and the expense which dust may cause make it almost imperative that in the future much more thought be given to dust prevention and handling than has been given in the past. For instance, processes or practices that produce excessive dust should be discarded for others that produce less dust, or they should be isolated somehow, such as by housing them tightly in a separate part of the plant or using them at times when the least number of persons would be exposed to them or when there is ample time to remove the dust from the atmosphere of the working places. Such installations or practices must be operated efficiently at all times, however. Common sense should be used

in handling a dust-control device or method; certainly it is foolish to use an elaborate exhaust system to take the dust out of part of an establishment and then exhaust the dust-laden air at such point or in such manner that it will be taken into the same or some other part of the establishment or into an adjacent one through doors, windows, etc.

If dust must be formed, as is the case in many industries, several effective methods are available to prevent the dissemination of dust into the air or into places where it may cause trouble.

In many industrial operations the air in the plants is also impregnated with considerable quantities of poisonous gases, such as carbon monoxide, oxides of nitrogen, hydrogen sulphide and other dangerous sulphurous fumes, in sufficient quantities and percentages under some circumstances as to asphyxiate persons who may breathe them or to cause serious illness, often of a more or less permanent character.

Many persons who have studied the incident of dust diseases are of the opinion that the breathing of even small quantities or percentages of extraneous or harmful gases such as carbon monoxide, oxides of nitrogen, hydrogen sulphide, etc., inflames or otherwise adversely affects the respiratory organs, especially the lungs, and makes them much more easily and readily susceptible to harm from the breathing of dust particles.

Ventilation is probably the most effective dust-control practice available for many industries, though it ranks second to wet methods in others. Where ventilation can be applied effectively, dust can be removed from the air or its concentration can be kept so diluted as to render it practically harmless to workers; ventilation can minimize dust hazards of almost all kinds.

Dust respirators of various types are now available for use in excessively dusty atmospheres, and while they are cumbersome and have numerous features that make them undesirable for constant wear throughout a working shift (though they can be worn readily for several minutes at a time), they do give adequate protection to wearers against dust but give essentially no protection against either poisonous or asphyxiating gases. Dust respirators should be regarded as being temporarily useful for emergencies only, whereas protection for workers against dust should be more substantial.

What might be designated "good housekeeping" has a definite place in dust prevention. Dusty materials should be stored in dust-tight containers or bins; dusty processes, including the handling of dusty material, should be carried on as far as feasible in dust-tight compartments or structures, the tightness of which should be maintained; ledges or surfaces on which dust may lodge and accumulate, to be thrown into the air by some shock or movement, should be changed to prevent opportunity for such accumulation, or, if this cannot be done, such surfaces should be cleaned periodically by vacuum process, by washing down, or by sweeping (the latter being a relatively poor method and should be employed only when as few of other

workers as possible are present); floors should be kept as free of dust as possible, preferably by washing them with water; and, certainly, air for the working places should not come from dusty sources.

Physical examinations should play an important part in the drive to minimize health harm from dust in industry, but so much controversy has been aroused because of them that their effectiveness has been largely nullified. Unquestionably, every person employed in an industry where considerable dust may be found in the air should be rigidly examined by a competent doctor previous to employment, and if the examination reveals the presence of respiratory trouble the person should not be employed; this is especially true if tuberculosis is indicated. At 6- or 12-month intervals every person in dusty industry should submit to a rigid physical examination; and if disease is shown to be developing the victim should be transferred to non dusty employment, if such is available. Handling physical examinations in a manner fair to the worker as well as to the employer should be worked out, and it must be admitted that to date this has not been done at all adequately.

Prevention of dust disease is chiefly an employer responsibility he should shoulder willingly, not only to safeguard the health of persons in his employ but also to relieve his firm of the heavy financial burden likely to be thrust upon it by compensation or legal authorities should employees become afflicted with dust disease; and when one takes into account how little is known as to the cause of the disease and how to relieve it if it is incurred, it would seem to be the acme of common sense to do anything practicable to reduce the dust content of the air of places where employees must work. This does not mean that the employee should not help himself. as it is manifestly as much to the interest of the employee to avoid dust or any other occupational disease as to avoid having accidents. However, information as to occupational disease (including dust disease) is not readily available to the worker in understandable form, and the employer should carry on an educational campaign to inform his safety and operating officials about occupational disease matters and to have them transmit the information to the workers so the latter can cooperate wholeheartedly in trying to eradicate these dread diseases from industry or at least control them to a far greater extent than has been done.

- - - - -

THE AMERICAN PUBLIC HEALTH ASSOCIATION

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PUBLIC HEALTH EDUCATION

RUTH HOULTON, R.N.
PUBLIC HEALTH NURSING

FILIP C. FORSBECK, M.D.
EPIDEMIOLOGY

Dr. H. H. Schrenk, Chief Chemist
Health Division
Pittsburgh Experiment Station
U. S. Bureau of Mines
Pittsburgh, Pennsylvania

Dear Dr. Schrenk:

The American Public Health Association is planning to hold its 68th annual meeting in Pittsburgh from October 17th to 20th this year, and as Secretary of the Industrial Hygiene Section, I am writing to invite you to prepare a paper on dusts for presentation before the second session of the program.

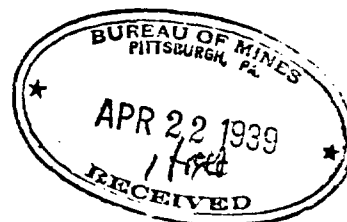
We have planned tentatively to have Mr. E. C. Barnes, Industrial Engineer of the Westinghouse Manufacturing Company, Pittsburgh, Pennsylvania, write a discussion of this paper, which will be read immediately following the reading of the paper. About 15 minutes will be allotted to each speaker for delivery of his paper.

Hoping that this is agreeable to you, and that you will find it convenient to be with us in Pittsburgh, I am

Sincerely yours,



W. J. McConnell, M.D.
Secretary, Industrial Hygiene Section

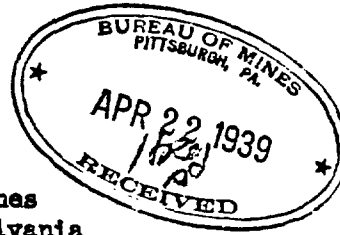


April 19, 1939

MTC 001325

Program of the Industrial Hygiene Section of the
American Public Health Association
1939

Second Session



1. Dusts.

Speaker: Dr. H. H. Schrenk
U. S. Bureau of Mines
Pittsburgh, Pennsylvania

Discussor: Mr. Barnes
Westinghouse Manufacturing Co.
Pittsburgh, Pennsylvania

Mr. E. J. Urban
Department of Health
Burlington, Vermont

2. Vapors.

Speaker: Professor P. Drinker

Discussor: Mr. G. W. Jones
U. S. Bureau of Mines
Pittsburgh, Pennsylvania

3. Gases.

Speaker: W. P. Yant
Mine Safety Appliances Co.
Pittsburgh, Pennsylvania

Discussor: Mr. B. Berger
U. S. Bureau of Mines
Pittsburgh, Pennsylvania

About 15 minutes will be allowed for
each paper

April 27, 1939.

HHS/kb

Dr. W. J. McConnell, Secretary,
Industrial Hygiene Section,
American Public Health Association,
Metropolitan Life Insurance Company,
1 Madison Avenue,
New York, New York.

SUBJECT: Paper for American Public
Health Association.

Dear Doctor McConnell:

Replying to your letter of April 19:

I shall be glad to give every assistance I can in the preparation of a program for the Industrial Hygiene Section of the American Public Health Association for its 1939 meeting at Pittsburgh.

If you desire, I shall be glad to speak on the subject of dust. However, I would appreciate having your ideas as to what information you would like presented--that is, do you wish a general talk on the subject which would naturally contain material that is available and be more in the nature of review, or do you prefer a report of some special research work? In asking these questions I have in mind that you may be planning your program as a whole and have certain rather definite ideas as to how the discussion on dust would fit in with the general program.

Sincerely yours,

H. H. Schrenk,
Chief Chemist,
Health Division.

MTC 001327

CC Mr Harrington

CS

[Handwritten signature]

THE AMERICAN PUBLIC HEALTH ASSOCIATION

ABEL WOLMAN, DR.ENG.
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EPIDEMIOLOGY

Dr. H. H. Schrenk, Chief Chemist
Health Division
Central Experiment Station
4800 Forbes Street
Pittsburgh, Pennsylvania

Dear Dr. Schrenk:

[Handwritten signature]

Thank you very much for your letter of April 27th. We are very glad that you find it agreeable to present a paper during the next annual meeting of the Association at one of our sessions.

We had in mind a symposium for the session on Field Methods for Rapid Determination of Air Contaminants, and I think that a paper more in the nature of a review would be preferable. However, if you have something new, of course, we shall be only too glad to have you present it.

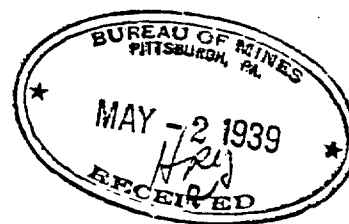
I am writing to Mr. Barnes of the Westinghouse Manufacturing Company to invite him to discuss your proposed paper.

Very truly yours,

[Handwritten signature: W. J. McConnell]

W. J. McConnell, M.D.
Secretary, Industrial Hygiene Section

April 28, 1939



MTC 001328

June 30, 1939.

IMS/kb

Dr. W. J. McConnell, Secretary,
Industrial Hygiene Section,
American Public Health Assoc.,
Metropolitan Life Ins. Co.,
1 Madison Avenue,
New York, New York.

SUBJECT: Meeting of the A. P.
H. A.

Dear Doctor McConnell:

I have accepted membership on a committee of the National Safety Council dealing with respiratory protective equipment. This committee is to meet at Atlantic City during the meeting of the National Safety Congress during the week of October 16 to 20, which, as you will note, conflicts with the meeting of the A. P. H. A. here in Pittsburgh.

I have suggested Monday as the date for this meeting since the A. P. H. A. does not start until Tuesday. There is a desire apparently to hold the meeting later in the week. Before making any definite commitments I would appreciate knowing, if the information is available, on what days the industrial hygiene sessions will be held during the Pittsburgh meeting. I would appreciate having this information at your earliest convenience so that plans can be made for the meeting of the committee referred to above.

Cordially yours,

H. H. Schrenk,
Chief Chemist,
Health Division.

P. S. As soon as I hear from Doctor McConnell, I shall let you know and also comment on the list of men whose names you included in your letter of March 6.

CC Mr. Keefer.
Mr. Harrington
Files
Mr. Keefer

CWS

JS

MTC 001329

THE AMERICAN PUBLIC HEALTH ASSOCIATION

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EPIDEMIOLOGY

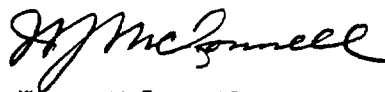
Dr. H. H. Schrenk, Chief Chemist
Health Division
Central Experiment Station
Bureau of Mines
4800 Forbes Street
Pittsburgh, Pennsylvania

Dear Dr. Schrenk:

Upon receipt of your letter of June 30th, regarding the time schedule for the sessions of the Industrial Hygiene Section during the annual meeting, I got in touch with the A.P.H.A. office and found out that you are to speak on Thursday, October 19th, at 9:15 A.M.

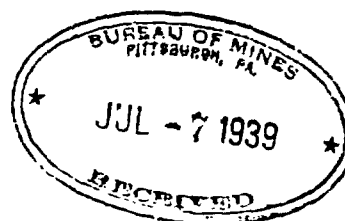
I hope that this will not conflict with the meetings you will attend during the National Safety Congress.

Very truly yours,



W. J. McConnell, M.D.
Secretary, Industrial Hygiene Section

July 6, 1939



MTC 001330

Philadelphia Archives

AG 70, Box 12

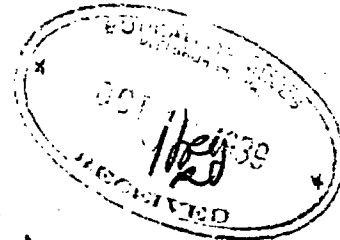
ADDRESS ALL COMMUNICATIONS TO
THE DIRECTOR, U. S. BUREAU OF MINES
WASHINGTON, D. C.

[Handwritten signature]

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
WASHINGTON

October 7, 1939.

Mr. H. H. Schrenk,
U. S. Bureau of Mines,
4800 Forbes Street,
Pittsburgh, Pa.



(Through D. Harrington)

Dear Mr. Schrenk:

Your manuscript entitled "Rapid Methods for the Estimation of Air Dustiness" has been approved for presentation at the Annual Meeting of the American Public Health Association, at Pittsburgh, October 16, 1939, and has been forwarded to the Editorial Section.

Very truly yours,

[Handwritten signature]
John A. Davis,
Chief Engineer,
Information Division.

MTC 001331

TESTING RESPIRATORY PROTECTIVE DEVICES

by

H. H. Schrenk and S. J. Pearce

Retyped Copy

MTC 001332

TESTING RESPIRATORY PROTECTIVE DEVICES

by

H. H. Schrenk and S. J. Pearce

ABSTRACT

The Bureau of Mines, through its approval system, serves as an impartial testing agency. Approval of a respiratory protective device is granted only after it has met the Bureau's published minimum performance requirements. The significance of approval depends on the suitability and thoroughness of the tests that are applied. This paper discusses the nature and severity of the approval requirements and points out their significance. The basic objective of the approval tests is to determine:

- (1) If the device gives adequate protection for a suitable period;
- (2) if it is reasonably comfortable and convenient to wear;
- and (3) if it is constructed of durable and suitable materials.

To attain these objectives the devices are subjected to a wide variety of tests which are described and explained in some detail. Individual parts of the devices are tested as well as the complete assembly. One of the most significant tests is that which pertains to actual wearing of the devices in the maximum concentration of contaminant for which the devices will be approved. This test is evidence of the confidence that the Bureau places in devices that it approves. A knowledge of the approval requirements and the prescribed field of use of the devices should enable the user to judge whether a device will afford satisfactory protection for a particular application.

(Contribution from the Central Experiment Station,
Bureau of Mines, Pittsburgh, Pa.)

TESTING RESPIRATORY PROTECTIVE DEVICES^{1/}

by

H. H. Schrank^{2/} and S. J. Pearce^{3/}

One phase of the Bureau of Mines work in the field of health and safety is the approval testing of a wide variety of equipment and explosives. This equipment includes such varied items as mine locomotives, and numerous other types of electrically operated mechanisms, flame safety lamps, and respiratory protective devices which are used widely in the mineral industries. The Bureau of Mines initiated its work on respiratory protective devices because of the need of such devices for protection against harmful atmospheres in the mineral industries.

Before any equipment can be tested for approval or permissibility under Bureau of Mines procedures, a schedule giving the conditions under which the equipment will be tested and the requirements to be met must be formulated and published.

In the preparation of a schedule for a respiratory protective device, available information on the field of use, application, and performance of the device in question is reviewed. This is

^{1/} Presented by permission of the Director, Bureau of Mines, U. S. Department of the Interior, at the 34th National Safety Congress, Chicago, Illinois, October 9, 1946.

^{2/} Chief, Health Division, Bureau of Mines, Pittsburgh, Pa.

^{3/} Chemist, Health Division, Bureau of Mines, Pittsburgh, Pa.

supplemented by research work in the laboratory. From the information obtained, a tentative schedule is prepared, based on the following requirements: (1) The device must give adequate protection for a suitable period; (2) it must be reasonably comfortable and convenient to wear; and (3) it must be constructed of durable and suitable materials. The tentative draft of the proposed approval schedule is usually sent to manufacturers, users, and others who have knowledge of the particular device for their comments, criticisms, and suggestions. A final draft for official publication is then prepared, taking into consideration the information obtained.

The schedule gives in detail the conditions under which the Bureau will accept a device for approval testing and the test conditions to which the device will be subjected and which it must pass in order to receive approval. The device is approved as a unit; the approval does not apply to individual parts. It is emphasized that the tests pertain chiefly to performance requirements and in general are not of the nature of specifications for constructing the device. Submittal of a device is voluntary on the part of the manufacturer.

RESPIRATORY PROTECTIVE DEVICES FOR WHICH SCHEDULES HAVE BEEN ISSUED

Numerous types of respiratory protective devices have been developed for various fields of use. These devices may be classified as follows:

- I. Contaminant-removing (air-purifying) respiratory protective devices.
 - A. Gas masks and chemical cartridge respirators.
 - B. Dispersoid respirators (dust, fume, and mist respirators).
- II. Atmosphere-supplying respiratory protective devices.
 - A. Self-contained type (oxygen or air breathing apparatus).
 - B. Hose type (supplied-air respirators—hose masks, air-line respirators, and abrasive blasting helmets, hoods, and masks).

The following schedules for approval testing of all the major types of respiratory protective devices have been issued:

<u>Schedule</u>	<u>Title</u>
13C	Procedure for Establishing a List of Permissible Self-Contained Breathing Apparatus.
14E	Procedure for Testing Gas Masks for Permissibility.
19A	Procedure for Testing Supplied-Air Respirators for Permissibility.
21	Procedure for Testing Filter-Type Dust, Fume, and Mist Respirators for Permissibility.
23	Procedure for Testing Nonemergency Gas Respirators (Chemical Cartridge Respirators) for Permissibility.

PRETEST REQUIREMENTS

Before the Bureau of Mines will undertake the active investigation of any respiratory protective device, the applicant must file an application that contains: (1) A description and complete drawings of the device; (2) a statement that the device is completely developed and of the design and materials which the applicant believes suitable for a finished marketable product; (3) a statement that the device has been subjected to inspections and tests of the nature

described in the schedule and that it has met these requirements when tested by the applicant or his testing agency; and (h) a statement describing the nature, adequacy, and continuity of control of the quality of the respiratory protective device. A reasonable fee is required for the tests.

The main purpose of the pretest requirements is to assure that the device is fully developed and that the manufacturer is equipped to test satisfactorily at all times the performance of his device.

INSPECTION AND PERFORMANCE REQUIREMENTS

Before the start of the Bureau performance tests, the device is inspected carefully for conformance to good mechanical and physiological principles and for its comfort, safety, durability, ease of inspection, repair and disinfection, and general practicability.

The pretest inspection not only permits checking the device for general conformance to the schedule, but also affords an opportunity for making suggestions that would make the device more comfortable or more efficient. The manufacturer can then make changes in the device before the laboratory and man tests are conducted by the Bureau of Mines.

The main test requirements for the various types of respiratory protective devices, except self-contained breathing apparatus, are given in the following sections. For complete details, the pertinent schedule should be consulted.

Gas Masks

A gas mask is an air-purifying respiratory protective device consisting of a facepiece, flexible breathing tube, carrying harness,

Dispersoid Respirators

A dispersoid respirator is an air-purifying respiratory protective device consisting of a half facepiece to which is attached one or more filter elements that remove dispersoids (dusts, fumes, or mists) from the inspired air of the wearer by physical trapping on the fibrous material of the filter. It offers no protection against gases or vapors or atmospheres deficient in oxygen.

The main items to be considered in the approval testing of a dispersoid respirator are efficiency and capacity of the filter, facepiece fit, and resistance to inhalation and exhalation. The tests made on the various types of dispersoid respirators determine their ability to remove the dispersoids efficiently for an adequate period before resistance to inhalation becomes excessive and the ability of the facepiece to fit a wide variety of facial shapes and sizes.

A controlled concentration of the test dispersoid is drawn through the respirator at a rate of 32 liters per minute. Any of the dispersoid that leaks through the filter is collected by means of an electric precipitator, and the amount is determined by weighing or by chemical analysis. The maximum allowable leakage is based on the safe or permissible limit for each test dispersoid; that is, the leakage shall not exceed the amount considered safe to breathe. For example, in testing a pneumoconiosis-producing or nuisance dust respirator, silica dust at a nominal concentration of 50 milligrams per cubic meter (representing a high dust concentration) is pulled through the respirator at a rate of 32 liters per minute for 90

minutes. The maximum leakage permitted is an average of 1 milligram per cubic meter of air. This value has been correlated with the accepted permissible limit for silica dust expressed as millions of particles per cubic foot for an 8-hour working day. In the second test a nominal dust concentration of 5 milligrams per cubic meter (representing a moderate dust concentration) is used, and the test is conducted until 10 cubic meters of air (volume breathed in an 8-hour working day) have been pulled through the respirator. The maximum leakage permitted is an average of 1 milligram per cubic meter of air. These tests give information on the efficacy of the respirator against high and low concentrations of dust for short and long periods. The amount of dust pulled through the respirator in each case is approximately 150 milligrams; with a dust load of this magnitude the resistance at a flow of 85 liters per minute must not exceed 2 inches of water. The resistance for these devices is lower than for gas masks because they are used routinely and for long periods of time whereas gas masks are usually used for emergency purposes or for short periods. In the tests against lead a nominal concentration of 15 milligrams per cubic meter is used, and the maximum leakage permitted is 0.15 milligram per cubic meter, which is the maximum allowable limit for lead usually accepted for an 8-hour working day. Similar tests are conducted to check efficiency against chromic acid and silica mists and against fume produced by burning lead.

The facepiece of the respirator is tried on many persons having a wide variety of facial shapes and sizes. If the respirator

seems to fit the test subjects, it is tested further by blowing air containing a high concentration of coal dust toward the respirator when worn by three subjects representing lean, average, and full types of faces. If it fits properly, there is a sharp line of demarcation at the point of contact of the facepiece with the face. Any leakage around the edge of the facepiece is indicated by dust streaks and a deposit of dust in the nostrils.

Hose-Type Supplied-Air Respirators

A hose-type supplied-air respirator is an atmosphere-supplying device that provides the wearer with respirable air from a source that is outside the contaminated region. These respirators include the devices commonly referred to as hose masks, air-line respirators, and abrasive blasting helmets and hoods.

Type A Supplied-Air Respirator (Hose Mask)

A Type A supplied-air respirator or hose mask consists of a tight-fitting full facepiece, breathing tube or tubes, a harness, a comparatively large diameter noncollapsible hose line, and a hand-operated blower. These devices are sturdily constructed as they are designed to be worn in atmospheres immediately dangerous to life and to afford protection against all types of atmospheric contaminants and atmospheres deficient in oxygen.

Hose. - The hose must not collapse or show permanent deformation when a force of 200 pounds is applied between two planes 3 inches wide on opposite sides of the hose. This test simulates a heavy man stepping on the hose. The hose and couplings must not show any separation or failure when tested with a pull of 250 pounds.

Philadelphia Archives
RG 70 Box 2

September 20, 1946 hhs/rd

Mr. D. Harrington, Chief
Health and Safety Branch
Washington 25, D. C.

SUBJECT: Manuscript

Dear Mr. Harrington:

I am attaching hereto two copies of the manuscript entitled "Testing Respiratory Protective Devices" which has been retyped to include the editorial changes made on this report.

Yours very truly,

H. H. SCHRENK



Encl.

cc ~~Files~~

September 20, 1946 hhs/rd

Mr. W. Dean Keefer, General Chairman
ASSE-Engineering Section
National Safety Council
20 North Wacker Drive
Chicago 6, Illinois

SUBJECT: Manuscript

Dear Mr. Keefer:

I am attaching hereto a copy of a manuscript which we plan to present at the National Safety Congress in Chicago on October 9. This manuscript gives the points which will be covered. However, in the actual presentation slides and movies will be used to cover the points rather than to give a simple description as is given in the manuscript.

Yours very truly,

MTC 001341

April 1, 1949 lbb/rd

Mr. J. J. Forbes, Chief
Health and Safety Division
Bureau of Mines
Washington 25, D. C.

081
Harmon

Dear Mr. Forbes:

I am enclosing herewith five copies of a paper prepared by Mr. Harmon on the subject of dust sampling and control for presentation before the New River District Safety Committee, Mount Hope, West Virginia, on April 13, 1949. As Mr. Harmon did not have sufficient notice of this assignment, the requested four weeks for approval cannot be observed in this case. It will be appreciated, therefore, if special attention can be given to Mr. Harmon's paper in order that it is approved prior to April 13.

I have read this paper and discussed it with Mr. Harmon, and consider it an excellent presentation of many practical facts regarding the dust problem, especially in consideration of the short time that was available to Mr. Harmon to prepare it.

It is suggested that notice of the approval be sent to Mr. Harmon at Mount Hope.

Yours very truly,

L. B. BERGER

Encl.

cc Mr. Berger
cc (1) Miss Stenger
cc (2) Files

L. B. B.

MTC 001342

Health Branch
Report No. 3276-B:641
Problem No. PB-119
April 1, 1949

DUST SAMPLING AND CONTROL

By

John P. Harmon

MTC 001343

DUST SAMPLING AND CONTROL.

By

John P. Hannon

Abstract of a talk to be given on April 13, 1949, to members of the New River District Safety Committee, Mount Hope, W. Va.

A historical background of pneumoconiosis is given which is followed by a description of how the tentative maximum allowable concentrations for various toxic substances have been established. Various dust sampling methods are demonstrated and effective, efficient control methods for use in coal mines are described. The effectiveness of wetting agent in wetting coal dust, with water, is demonstrated.

(Contribution from the Central Experiment Station,
Pittsburgh, Pennsylvania)

DUST SAMPLING AND CONTROL

By

John P. Harmon^{1/}

(A talk to be given on April 13, 1949, to members of the New River
District Safety Committee, Mount Hope, West Virginia.)

Gentlemen: I have been asked to speak to you today on the subject of dust. I plan to describe the early history of pneumoconiosis, which literally means dust on the lung. I will describe how certain tentative maximum allowable concentrations have been established and then describe a number of dust sampling methods. This is preliminary to the establishing of control measures.

Prehistoric man probably was the first to experience effects of breathing dust to the point that produced pulmonary trouble. Piles of flint chips have been found at camp sites of prehistoric Indians indicating that arrow heads and the like were manufactured at those points. In all probability, certain of those people were particularly skilled in their manufacture and spent most of their time producing them. Collis reports, as late as 1914, that flint knappers in England who still use tools similar in shape to deerhorn picks of their ancestors suffer a terrible mortality from phthisis induced by flint dust generated in their work.

^{1/} Mining Engineer, Health Branch, Bureau of Mines Central Experiment Station, Pittsburgh, Pa.

MTC 001345

One theory was that lung disease contracted above ground depended upon climatic conditions as influenced by the rays of the stars. Similarly, pulmonary disease of miners underground was caused by mineral rays. However, a Swiss alchemist philosophically reminded his readers that--

"We need metals and, therefore, we must risk life and health for them, since everywhere in nature good and evil lie together. As the crocodile distresses and kills men by his breath, likewise also the vapors (fine dust?) of such metals kill us. * * * The organism must be prevented from coming in contact with the metal emanations; for if the organism is once injured there is no cure".

Perna, in 1614, was the first to discuss in detail lung diseases of miners and the asthma of grain measurers. In 1649 Van Dinsbroek was reported to have made the first section of a stone-cutter's lung which, in a case of fatal asthma, revealed "lung vesicles completely clogged with fine dust"; as quoted by Lussanini, he found such heaps of sand that in running the knife through the pulmonary vesicles he thought he was cutting some sandy body.

From the above references you are aware that men in the mineral industry have for a long time understood that a hazard did exist due to breathing dust even though they did not quite understand it.

The first investigation of silicosis in the mineral industry in the United States was made in 1914-15 by the U. S. Bureau of Mines in cooperation with the U. S. Public Health Service in the Joplin, Missouri, mining district. Other work of similar nature was done during succeeding years at various metal mines. The U. S. Public Health Service investigated anthracite-silicosis among hard coal miners and published Public Health Service Bulletin 221 which describes their findings. The U. S. Public Health Service investigated soft coal miners health and working environment in 1941. Public Health Service Bulletin 270 describes their findings.

Control measures in metal mines were started about 1920 and are now generally accepted. Control in coal mines, however, started about 20 years later and is not so well understood and less progress toward control has been made.

A subhead of the Health and Safety Division of the Bureau of Mines is known as the Health Branch. The function of the Health Branch of the Bureau of Mines is to study health conditions in the mineral industry and recommend measures for abatement or control of unhygienic or unsafe conditions. A number of valuable publications have been made available dealing with the dust problem. Perhaps the most general publication on the subject is Bulletin 400 entitled "Review of Literature on Effects of Breathing Dust with Special Reference to Silicosis." Other publications are available, some of which are on my desk for your inspection later. The Health Branch is further subdivided into the Gas Analyses Section, where the gas samples that are

taken by the Coal Mine Inspection Branch are analyzed. The Respirator Testing Section tests and places the Bureau of Mines approval on respirators that pass stringent requirements. The Dust and Fume Control Section investigates the presence and concentration of these contaminants in the mineral industry and makes recommendations for their control when it is felt that a hazard to health is involved. The Mine Ventilation Section analyzes ventilation and air conditioning problems in mines for the benefit of the industry. Another section determines the chemical composition and characteristics of mine drainage.

Upon invitation a member of the dust control section will visit mining plants to make an analysis of the concentrations of the dust to which men might be exposed and will make recommendations for their control, where necessary.

Naturally, the operator should be interested in the concentration of dust to which his men may be exposed for an 8-hour exposure, day in and day out, without affecting their physical condition. After extensive work by physicians and engineers certain tentative standards for the maximum allowable concentration have been established for many toxic substances. In coal mines where the silica content is low, the latest information sets this tentative standard for maximum allowable concentrations for an 8-hour exposure at 20,000,000 particles of dust per cubic foot of air and at no time should the concentration exceed 40,000,000 particles per cubic foot of air. For highly siliceous material the average concentration should not exceed 5,000,000 particles

per cubic foot of air for an 8-hour exposure. We are further interested in the size of these particles and are only interested in those ranging in size from 1 to 10 microns. While these limits have not been definitely established, it is believed that the particles in this size range are the ones that can be inhaled and retained by the lungs. Larger particles are caught in the upper respiratory tract while the smaller sizes are exhaled. A micron, as you may imagine, is a small unit of measure and is equivalent to $1/25,000$ of an inch. Such particles are not visible to the naked eye.

The concentration values that have been outlined above seem large and it may occur to you that a sampling method for determining these concentrations might be very complex. Numerous sampling devices have been built and used for determining concentration of dust in the air. I have here a sampling device known as a Konimeter. This device is used extensively in South African mines and Canadian metal mines for sampling dust concentrations where the concentration is relatively low. A sample is taken by compressing a spring that actuates a plunger which, when released, draws a measured volume of air through this small orifice and the dust in the air impinges against and is collected on this plate, the bottom side of which is coated with an adhesive. Thirty samples can be collected on one plate. Later, the plate is examined under a microscope and the dust particles that have been collected are counted. From the number of particles collected on the plate and the volume of air sampled the concentration of dust per cubic foot of air may be determined.

In the United States this device, known as the midget impinger, is used for determining dust concentrations. As you will note, a 1-cylinder vacuum pump is operated by a hand crank. The instrument is so adjusted as to draw 1/10 of a cubic foot of air per minute through the orifice in this central tube and the dust and the air impinge on the bottom of the flask which is covered with alcohol in which the dust is entrapped. While the sample is being taken an accurate record of the elapsed time is made so that the volume of air that passes through the flask may be determined. In the early days of the development of the impinger when water was used in the impinger flask it was found that very small silica particles were dissolved when the sample was allowed to stand for several days or weeks. For that reason we now use alcohol rather than water because silica is not soluble in alcohol.

After the sample has been collected with the midget impinger, it is returned to the laboratory where it is examined under a microscope and the particles in a measured portion of the liquid are counted. From the dust that has been collected and the volume of air sampled the concentration may be determined.

Approximate determinations of the silica content of the air borne dust may be determined from the same impinger sample by examining the dust particles under a petrographic microscope. This procedure is tedious and is less accurate than other methods for the determination of silica content but it is the only method that we have available at the present time for use in coal mines.

The reasons that we use the impinger method rather than some other more portable device are that unfortunately various sampling methods cannot be correlated one with the other, and that because the Public Health Service has correlated their physiological findings with impinger samples, it seems desirable that we should continue collecting samples in this manner. Furthermore, the impinger is an efficient dust sampler.

The reasons for collecting dust samples are: (1) To determine the dust concentration, to see whether or not a health hazard exists. If a health hazard does exist control measures can then be recommended. (2) After control measures have been installed, their effectiveness can be evaluated and a check can be made on their efficiency.

Air borne dust is very difficult to control so it behooves us to prevent dust from becoming air borne wherever possible. Ventilation is effective in controlling dust at a working place but the particulate matter that is carried away by a ventilating current is spread to other working places where others are exposed or it may be deposited along the haulageways. Both of these are objectionable. Various control measures have been suggested; these include hoods, dust traps, and electric precipitators, to mention a few. All of these are effective when properly installed but it would seem to me that in many cases their application is impractical for underground operation. It has recently come to my attention that one metal mine is experimenting with an electrostatic precipitator for controlling dust underground. I doubt if the cost and potential gas-ignition hazard involved with an

Revised January, 1948)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

Place Pittsburgh, Pa.Date April 1, 1949
3276-13.641

MANUSCRIPT FOR APPROVAL

MEMORANDUM FROM: L. B. Berger Acting Chief, Health Branch
(Name) (Title)

TO: J. J. Forbes Chief, Health and Safety Division
(Name) (Title)

Title of Manuscript Dust sampling and control

Authors John P. Harmon

Problem Number PH-119

Suggested Form Talk to be given April 13, 1949, to members of the New River
District Safety Committee, Mount Hope, West Virginia.

Ms. Reviewed By _____
(Signature) (Date)

Ms. O. K. L. B. Berger April 1, 1949
(Signature of Branch Chief) L.B. Berger (Date)

Recommended for Publication _____ DIVISION CHIEF
Presentation _____ (Signature)
Date _____

TO OFFICE OF MINERALS REPORTS:

APPROVED FOR PUBLICATION _____ CHIEF, OFFICE OF
PRESENTATION _____ MINERALS REPORTS
(Signature)

Rec'd. Office of Minerals Reports _____
(Date)

To Editorial Section _____
(Date)

Edited by _____ Tr. to _____ for review _____
(Date)

Reviewed by _____ Ret'd to Editorial _____
(Date)

To _____ Published _____
(Place and Date) (Date, Series Title and No.)

(1) Miss Stanger (2) Files

MTC 001352

Philadelphia Archives
RB 70 Box 1 (incomplete)

Files

APR 11 1949

April 8, 1949.

JJF/HJS/ms

Mr. John P. Harmon,
Bureau of Mines,
P. O. Box 112,
Mt. Hope, West Virginia.

THROUGH: Mr. A. U. Miller.

Dear Mr. Harmon:

Attached is an approved copy of your papers, "Dust Sampling and Control" that you propose to present before the New River District Safety Committee at Mt. Hope, West Virginia on April 13, 1949.

If you prepare similar manuscripts in the future, it is necessary that you allow us more time for review and processing than you did in this instance.

Very truly yours,

J. J. FORBES

J. J. FORBES, Chief,
Health and Safety Division.

Encl.

cc - Mr. Forbes - 4512
Mr. Berger - Pittsburgh, Pa.
Mr. Sloman - 4326
Files

h. B. B.

081
Harmon

MTC 001353



MINERAL INDUSTRY SURVEYS

U. S. DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
WASHINGTON, D. C. 20240



Stewart L. Udall, Secretary

Earl T. Hayes, Acting Director

Asbestos, Annual

ASBESTOS IN 1967

Reduced construction activity in 1967 resulted in a decrease in asbestos production, according to the Bureau of Mines, U.S. Department of the Interior. Output dropped 2 percent from the record high of 1966. California continued as the leading producing State but output was 6 percent below the previous year. In Canada, the world leading producer, production registered a 3-percent decrease. Imports of amosite and crocidolite from the Republic of South Africa, the principal supplier, was less than half the 1966 receipts, whereas exports of asbestos manufactured products rose 8 percent.

Three producers in Arizona contributed to output which was 14 percent less than in 1966. Asbestos was produced by the Asbestos Manufacturing Co. at the Phillips mine; Jaquays Mining Corp. at the Chrysotile mine; and Metate Asbestos Corp. at the Lucky Seven mine, all in Gila County.

Chrysotile asbestos production in California fell 6 percent and came from Atlas Minerals Corp. Santa Cruz mine in Fresno County; Coalinga Asbestos Co. Coalinga mine in Fresno County; Pacific Asbestos Corp. Pacific Asbestos mine in Calaveras County; and Union Carbide Corp. Joe No. 5 mine in San Benito County.

Production of anthophyllite at the Burnsville mine in Yancy County, North Carolina, owned by Powhatan Mining Co., declined 5 percent. Vermont, where output came from the Lowell mine, near Hyde Park, was the only State to record increased production--6 percent greater than in 1966.

Prepared June 14, 1968, by Raymond C. May, Physical Scientist, 703-557-1570

TABLE 1.--Salient asbestos statistics

	1966	1967
United States:		
Production (sales)-----short tons--	125,928	123,189
Value-----thousands---	\$11,756	\$11,102
Exports and reexports (unmanufactured)		
short tons--	46,996	47,718
Value-----thousands---	\$5,763	\$6,025
Exports and reexports of asbestos products--		
(value) thousands---	\$21,963	\$23,767
Imports for consumption (unmanufactured)		
short tons--	726,459	645,112
Value-----thousands---	\$73,100	\$65,743
Consumption, apparent ^{1/} -----short tons--	895,391	720,583
World: Production-----do-----	3,359,000	NA

NA Not available

^{1/} Measured by quantity produced, plus imports, minus exports.

The U.S. Department of Agriculture invited U.S. firms to submit barter offers to deliver chrysotile asbestos, valued at approximately \$4.5 million, to India for the Agency for International Development. Successful offerors furnished asbestos to India and received payment in eligible agricultural commodities from Commodity Corporation stocks. The agricultural commodities will be exported to eligible barter destinations. Proceeds from the sale of the agricultural commodities abroad were used to pay for the asbestos while AID dollars were paid to CCC, thus helping to reduce the outflow of U.S. dollars.

General Services Administration disposed of 110.44 short tons of sub-specification chrysotile from the Defense Production Act inventory in 1967. In addition, 300 tons of amosite and 150 tons of crocidolite obtained under the barter program were sold.

Under Presidential action asbestos imports from Southern Rhodesia were barred after December 16, 1966. The decree also banned dealings abroad in these products by American and Rhodesian subsidiaries of U.S. firms.

The stockpile position for asbestos as of December 31, 1967, is shown in Table 2.

TABLE 2.--Stockpile objective and Government inventories as of December 31, 1967

(Short tons)						
	Stockpile objective	National	Supplemental	Commodity Credit Corporation	Defense Production Act	Total
Amosite-----	40,000	11,705	54,100	----	----	65,805
Chrysotile-----	13,700	6,073	4,383	----	----	10,456
Subspecification-----	None	152	3,193	----	----	5,228
Crocidolite-----	None	1,565	46,696	----	----	48,261

Apparent consumption of asbestos totaled 721,000 tons, 11 percent less than the record high of 1966. Chrysotile asbestos accounted for 96 percent of the total consumed, crocidolite 2 percent, and amosite 2 percent. U.S. mines supplied nearly 17 percent of total consumption. The principal markets for asbestos are in the building and construction industries; and the largest demand continued to be for use in the manufacture of asbestos cement products. Asbestos is also used in the manufacture of friction materials, gaskets, textiles, plastics, paints, roof coating, caulking, and numerous miscellaneous items.

Total imports for consumption of asbestos in 1967 was 11 percent less than in 1966. Imports of amosite and crocidolite from Republic of South Africa decreased 48 and 45 percent, respectively.

Exports of manufactured products in 1967 increased 8 percent over those of 1966. Canada accounted for 36 percent of the total.

TABLE 3.--U.S. imports for consumption of asbestos (unmanufactured),
by classes and countries

Year and country	Crude (in- cluding blue fiber		Textile fiber		All other		Total	
	Short tons	Value (thou- sands)	Short tons	Value (thou- sands)	Short tons	Value (thou- sands)	Short tons	Value (thou- sands)
1966:								
Australia-----	300	\$61	-----	-----	-----	-----	300	\$61
Bolivia-----	3	2	-----	-----	-----	-----	3	2
Canada-----	151	59	16,309	\$6,132	637,648	\$55,248	654,108	61,439
Finland-----	98	4	-----	-----	2,465	139	2,563	143
India-----	2	1	-----	-----	-----	-----	2	1
Italy-----	-----	-----	-----	-----	4	5	4	5
Mozambique-----	308	57	25	21	122	25	455	103
Portugal-----	-----	-----	-----	-----	10	1	10	1
Rhodesia-----	445	69	-----	-----	135	69	580	138
South Africa, Republic of 2/	56,929	9,844	530	131	5,111	801	62,570	10,776
U.S.S.R.-----	-----	-----	-----	-----	98	20	98	20
Yugoslavia-----	3,629	153	813	35	-----	-----	4,442	183
Zambia-----	1,324	224	-----	-----	-----	-----	1,324	224
Total-----	63,189	10,473	17,677	6,319	654,593	56,308	726,459	73,100
1967:								
Bolivia-----	-----	-----	-----	-----	3	3	3	3
Canada-----	6,966	1,246	15,063	5,745	579,953	52,174	601,982	59,165
Finland-----	662	26	-----	-----	2,585	166	3,247	192
France-----	15	2	-----	-----	-----	-----	15	2
Italy-----	1	1	-----	-----	6	7	7	8
Mozambique-----	250	32	-----	-----	-----	-----	250	32
Portugal-----	-----	-----	-----	-----	59	6	59	6
Rhodesia-----	420	68	75	26	4,956	775	5,431	869
South Africa, Republic of 2/	29,318	5,081	17	3	1,280	255	30,615	5,339
Yugoslavia-----	-----	-----	827	30	2,656	97	3,483	127
Total-----	37,632	6,456	15,982	5,804	591,498	53,483	645,112	65,743

1/ Less than 1/2 unit.

2/ Data reported by the Bureau of the Census have been adjusted
by the Bureau of Mines.

MTC 001357

TABLE 4.--U.S. Imports for consumption of asbestos, from specified countries, by grades

Grade	(Short tons)					
	1966			1967		
	Canada	Rhodesia	Republic of South Africa 1/	Canada	Rhodesia	Republic of South Africa 1/
Chrysotile:						
Crudes-----	151	445	6,000	6,966	420	1,843
Spinning and textile-----	16,309	---	530	15,063	75	17
All other-----	637,648	135	5,111	579,953	4,956	1,280
Crocidolite (blue)-----	---	---	26,995	---	---	14,917
Amosite-----	---	---	24,934	---	---	12,558
Total-----	654,108	580	62,570	601,982	5,451	30,615

1/ Data reported by the Bureau of the Census have been adjusted by the Bureau of Mines.

TABLE 5.--Exports and reexports of asbestos

Product	1966		1967	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Exports:				
Unmanufactured:				
Crude and spinning fibers short tons-----	1,631	\$355	1,116	\$290
Nonspinning fibers-----do-----	28,147	3,994	26,709	4,043
Waste and refuse-----do-----	17,218	1,414	19,893	1,692
Total unmanufactured-----	46,996	5,763	47,718	6,025

TABLE 6.--Quebec Production of asbestos
(Short tons)

Grade	1966	1967 ²
Quebec:		
Crude No. 1, 2, and other-----	(1)	(1)
Milled group:		
3 (spinning)-----	28,716	25,391
4 (shingle)-----	371,837	336,558
5 (paper)-----	190,275	155,450
6 (stucco)-----	299,426	244,021
7 (refuse)-----	512,030	490,027
8 (sand)-----	8,704	7,149
Newfoundland, Ontario, and British Columbia-----	138,288	154,345
Total all grades-----	1,479,281	1,443,011

^{1/} Included with group 3

Source: Dominion Bureau of Statistics.

TABLE 7.--World production of asbestos
(Short tons)

Country	1966	1967
North America:		
Canada (sales)-----	1,479,281	1,443,011
United States (sold or used by producers)-----	125,928	123,189
Europe:		
Finland-----	13,250	13,000
France-----	7,720	NA
Italy-----	90,464	110,900
U.S.S.R. ^{e/} -----	925,000	900,000
Asia:		
China ^{e/} -----	150,000	170,000
Cyprus-----	24,449	24,000
Japan-----	21,428	NA
Africa:		
Southern Rhodesia-----	175,000	NA
South Africa, Republic of-----	276,597	270,000
Swaziland-----	36,142	42,000
Oceania:		
Australia-----	13,467	509
Others-----	20,300	NA
World total (estimate)---	3,359,000	NA

^{p/} Preliminary. NA Not available.

Johns-Manville Corporation

Greenwood Plaza
Denver, Colorado 80217
(303) 770-1000

December 19, 1972

Director
Bureau of Mines
Washington, D. C. 20240

Gentlemen:

We are responding on behalf of Johns-Manville Corporation to the Department of the Interior's proposed Asbestos Dust Standard as published in the Federal Register on November 7, 1972 (hereinafter referred to as the "Proposal").

The Proposal indicates that interested parties may submit written comments, suggestions or objections to the Director regarding this Proposal. Various subsidiaries of Johns-Manville Corporation are substantially engaged in the mining, and milling of asbestos and the manufacture of numerous products containing asbestos and are, therefore, vitally interested in the final outcome of this Proposal. It is the purpose of this letter to present our comments and objections to the Proposal.

It is impossible for us to understand the justification for imposing a standard of exposure to asbestos dust in coal mining, on a time-weighted average basis, of two fibers per cubic centimeter of air, when such a standard is obviously not warranted on several grounds.

To the best of our knowledge, little use, if any, is made of asbestos in coal mining operations and, therefore, coal miners obviously have an insignificant, if any, exposure to asbestos dust. Coal industry sources have advised us that the only use of asbestos or products containing asbestos in the coal industry is the use of asbestos cloths for the lining of strip mining shovels during repair work. Only a limited number of maintenance personnel could be exposed to asbestos dust under these circumstances and then only on an intermittent basis.

As the Secretary of the Interior and the Secretary of Health, Education and Welfare must be aware, the Secretary of Labor, on June 7, 1972, promulgated a permanent standard for

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Heuric Schley
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MTC 001361

exposure to asbestos dust under the Occupational Safety and Health Act. That Act applies to virtually every work place in the country, although it does not apply to mining operations. A five-fiber standard has been promulgated under OSHA and covers operations throughout the country where employees are exposed to asbestos dust on a constant basis.

Section 101(d) of the Federal Coal Mine Health and Safety Act of 1969 states in part:

"The Secretary of Health, Education and Welfare shall, in accordance with the procedures set forth in this section, develop and revise, as may be appropriate, improved mandatory health standards for the protection of life and the prevention of occupational diseases of miners."
(Emphasis supplied).

If the Department of Labor did not determine that it was necessary to immediately adopt a two-fiber standard under OSHA for the "protection of life" and the "prevention of occupational diseases" in work situations where employees may be exposed to asbestos dust on a constant basis and in significantly greater quantities, than in coal mining, how then can it be justified in coal mining where the exposure to asbestos is minimal and certainly not constant?

Pursuant to Section 6(b) (5) of the Occupational, Safety and Health Act, the Secretary of Labor in promulgating a standard for exposure to asbestos dust is obligated to:

" set the standard which most adequately assures, to the extent feasible, on the basis of the best available evidence, that no employee will suffer material impairment of health or functional capacity even if such employee has regular exposure to the hazard dealt with by such standard for the period of his working life."

The statutory requirement with which the OSHA standard must comply is substantially more stringent than the statutory requirement governing the Secretary of Health, Education and Welfare in the instant case, yet the Secretary of Labor determined that an immediate five-fiber standard

would meet this more stringent statutory requirement. How then can a lower standard be justified in an industry where the exposure and hazard are substantially less?

Section 101(d) of the Federal Coal Mine Health and Safety Act of 1969 requires all mandatory health standards to "be based upon research, demonstrations, experiments and such other information as may be appropriate." We can only assume that the Secretary of Health, Education and Welfare is relying primarily, if not solely, on the NIOSH Criteria Package on asbestos, the recommendations of which were rejected by the Secretary of Labor. Section 101(d) further requires the Secretary of Health, Education and Welfare to consider experience gained under this and other health statutes. Therefore, the rejection of a two-fiber standard by the Secretary of Labor as an immediate standard and the record therein should be carefully reviewed in the instant case.

The Secretary of Labor was faced with a difficult task in view of the conflict in the medical evidence available. Scrutiny of the record of the OSHA hearings in March 1972 on this standard indicates that there was a head-on clash of medical expertise as to the most adequate standard for exposure to asbestos dust. However, there was substantial evidence in the record of those proceedings to support and justify a five-fiber standard.

A five-fiber standard was recommended in the testimony of Dr. Stephen Holmes, Asbestosis Research Council, England; Dr. George Wright, head of the Division of Medical Research in the Department of Medicine of St. Luke's Hospital, Cleveland, Ohio; Dr. H. Corbett McDonald, Chairman of the Department of Epidemiology and Health, McGill University, Montreal, Canada; and the statement submitted by Dr. Hans Weill, Professor of Medicine, Tulane University, School of Medicine, New Orleans, Louisiana. Copies of this testimony are attached to our comments for careful review by the Secretary of the Interior and Secretary of Health, Education and Welfare. On the basis of this testimony, it is clear that the Secretary of Labor was on firm ground in promulgating a five-fiber standard.

Although industry strongly urged the promulgation of a five-fiber standard, we were aware of the conflict in medical opinion as to the level below which no excess of disease will occur. However, the Secretary of Labor resolved this conflict in the favor of the health of employees by

promulgating a five-fiber standard until July 1, 1976. The conflict was certainly a difficult one to resolve since due to the long lapse of time from the onset of exposure to the manifestations of disease, we are now only first harvesting disease resulting from exposure to asbestos dust twenty to forty years ago. Although we have no accurate records of the levels of exposures in those days, we do know now that they were greatly in excess of current levels.

Medical authorities will agree that the health effects of asbestos inhalation are both dose and lapse - time related. It is very difficult to imagine that the relatively minute exposures by coal miners to asbestos can or will cause an excess incidence of disease. We are not aware of any evidence of excess disease occurring in the coal mining industry as a result of exposures to asbestos or even of the existence of any high or constant exposure to asbestos.

The Secretary of Labor did indicate that "so long as the ceiling limit is complied with, no harm is reasonably expected to result from exposures during the transitional period." The ceiling concentration limit promulgated by OSHA states:

"No employee shall be exposed at any time to airborne concentrations of asbestos fibers in excess of 10 fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section." 29 C.F.R. 1910.93a(b) (3).

There are many in the medical profession who believe that the high peak exposures to asbestos dust are of substantial concern and should be lowered to ten fibers/cc. However, the time-weighted average exposure of five fibers/cc is adequate, based on the attached testimony, to protect employees. As Dr. Holmes pointed out in his testimony, the evidence seems to indicate that more importance should be given to peak exposures in evaluating disease potential than to time-weighted averages.

In addition, any exposure to asbestos dust by coal miners in strip mining operations is quite different from the exposure of employees in manufacturing and fabricating operations covered by OSHA, where many exposures, over

the years, have occurred in confined spaces without adequate ventilation. Exposures to asbestos in strip coal mining must be minimized to a great extent by its dilution with the ambient air. One must recognize the obvious differences in the exposure and working conditions in strip coal mining as compared with manufacturing and fabricating industries.

Finally, it must be recognized that different industries, and the varying degrees of exposure to asbestos dust therein, may properly justify different standards of exposure. What is appropriate in one setting may not be appropriate in another. There is no logical reason to impose restrictions, which may be necessary in manufacturing and fabricating operations covered under OSHA, on the coal mining industry where, due to the greatly reduced exposure and minimal hazard, if any, such restrictions are totally unwarranted.

The asbestos industry, in general, and Johns-Manville in particular, have recognized for many years that there are occupational health hazards associated with excessive inhalation of asbestos dust.

As a company and as an industry, we recognize the necessity of protecting workers from exposure to potentially hazardous amounts of asbestos dust. In this respect, we support the intent of the Departments of Interior and Health, Education and Welfare in seeking to establish safe occupational health standards for asbestos. However, there appears to be no evidence demonstrating the necessity for an asbestos dust standard in coal mining, no less a standard below the present OSHA standard. Therefore, we must strongly disagree with the proposal for a two-fiber standard and urge the adoption of the current five-fiber OSHA time-weighted average standard and the OSHA ceiling concentration standard which were adopted after a very careful consideration of the available medical evidence. Since there is no scientifically credible evidence demonstrating the necessity of a two-fiber standard, or a lower ceiling concentration standard, it is socially irresponsible to adopt such standards.

It is expected that ongoing medical studies and future studies will provide more conclusive scientific evidence. At that time, asbestos standards can be re-evaluated as was indicated by the Secretary of Labor in the preface to the OSHA standard. But until such time, we must realize that there is presently no credible evidence demonstrating the necessity for a two-fiber standard or a ceiling

concentration standard below the OSHA standard in any industry, no less coal mining.

It is vital that we approach this problem with an open mind. Crucial decisions must not be made on the basis of incomplete or speculative evidence. Emotionalism or political pressure must not be allowed to interfere in the process of evaluation. The guiding philosophy of the Departments of Interior and Health, Education and Welfare in developing asbestos standards should be to adequately protect the worker to the extent that protection is necessary and to insure that the life-saving and other vital uses of asbestos will not be abandoned. Any other philosophy would be a mistake of the highest order.

Therefore, in accordance with Section 101(e) of the Federal Coal Mine Safety and Health Act of 1969, we respectfully request the Secretary of Health, Education and Welfare to modify the Proposal and promulgate an asbestos standard of five fibers per cubic centimeter of air as an eight hour time-weighted average and a ceiling concentration standard of ten fibers without any time limitation.

Very truly yours,

Richard Carter
Counsel

RC/mvd

bcc: W. L. Vanderbeek - 2W
F. J. Solon - 1W
E. M. Fenner - 4N
W. B. Reitze - 1S
Dr. George Wright

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X

HAIGHT, DICKSON, BROWN & BONESTEEL

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January 11, 1980

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(1959-1983)

OF COUNSEL
GEORGE CLARK LYON
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WILLIAM M. FITZHUGH

IN REPLY REFER TO:

Mr. Hoch
Los Angeles

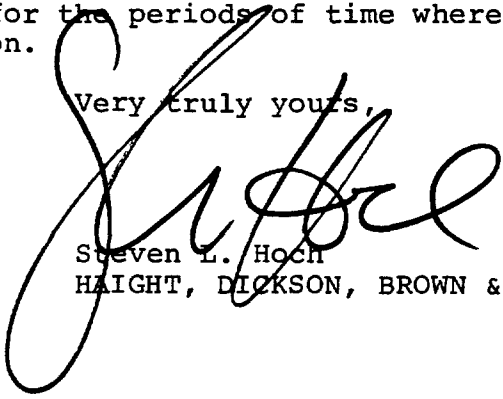
Mr. Jim Green
JOHNS-MANVILLE CORPORATION
Ken-Caryl Ranch
P. O. Box 5723
Denver, Colorado 80217

Re; ASBESTOS LITIGATION

Gentlemen:

Enclosed please find the summary of the material we have received from the U. S. Bureau of Mines through one of our co-counsel. The indexing is self-explanatory and for our shipyard cases it is interesting but of little consequence. Some of our co-defendants believe that this material shows that the United States government approved respirators for use when working with asbestos as early as 1935 and that these should have been available at shipyards from that point on. I believe when you read the material itself it specifically centers itself around the mining and quarrying and milling activities until the 1971 information. We are trying to fill in by a F.O.I.A. request for the periods of time wherein we do not have the information.

Very truly yours,


Steven L. Hoch
HAIGHT, DICKSON, BROWN & BONESTEEL

SLH:lkx

Enclosure

cc: Mr. Curtis M. Caton
Mr. Jack Saunders

MTC 001367

B

BUREAU OF MINES MATERIAL

LIST OF APPROVED RESPIRATORS, JANUARY 1941

This and all ensuing lists of approved respirators indicates that the Bureau of Mines has as one face of its work the "promotion of the use of safe, satisfactory and reliable respiratory protective devices". Their material indicates that under schedule 21 respirators were approved for dispersoids (dust, fumes, and mists). The listing under Type A is for pneumoconiosis and nuisance dusts. The earliest approval given to a schedule on Type A device appears to be 1935. There are also numerous listings for self-contained apparatus.

LIST OF APPROVED RESPIRATORS, 1943

Basically the same information as the 1941.

LIST OF APPROVED RESPIRATORS, 1948

Basically the same information as in the above.

LIST OF APPROVED RESPIRATORS, 1952

Basically the same information as listed above, however the Type A designation is no longer used. The schedule is broken down into various subparts and dust respirators approved for asbestos are approved with the introductory paragraph as follows "They are approved only for protection against the inhalation of dust that are not significantly more toxic than lead, such as arsenic, asbestos, cadmium, . . . and nuisance dusts."

LIST OF APPROVED RESPIRATORS, 1958

Repeats much of the information in all the above. Notes that Mr. S. J. Pearce wrote the section on dispersoid respirators. He is Assistant Chief, Branch of Health Research, Bureau of Mines, Pittsburgh, Pennsylvania. There is also a bibliography attached to this report which includes government and non-government publications which were used to develop the approvals.

NEW APPROVALS, SEPTEMBER 1959 and NOVEMBER 1959

No changes.

LIST OF APPROVED RESPIRATORS, FEBRUARY 1971

This is a new approval schedule which contains the information circular 8436 of October 1, 1963 (which we at this point do not have). There are no changes in this new approval schedule

for a respirator which can be used for asbestos since schedule 21 is broken down into categories and the only thing listed in this item is for dust with a TLV of less than 2.4 million particles per cubic foot.

NIOSH EQUIPMENT LIST, 1978

There are numerous notations for self-contained apparatus and under this dust section there is a separate category for respirators which are available for asbestos use. There are several dozen.

PROCEDURES FOR TESTING FILTERED TYPE DUST, FUME AND MIST
RESPIRATORS FOR PERMISSIBILITY, 1934

Asbestos dust would come under Type A criteria which is "mechanically generated dust resulting principally from the disintegration of a solid, such as the dust clouds produced in the various processes of mining, quarrying, and tunneling the various industrial operations of grinding, crushing and general processing of minerals."

Set forth a manner which tests should be done and the necessities of having several different mass of the same type to run combined tests on.

AMENDMENTS TO TESTING PROCEDURES, 1955

Basically that would not effect the above for this purpose.

AMENDMENTS TO TESTING PROCEDURES, 1965

Defines TLV as the "most recent threshold limit value adopted by the American Conference of Governmental Industrial Hygienists". Provides that certificates of approval will be issued for respirators in various categories, asbestos is listed in paragraph section 14.4(b)(1) as a respirator for dust with a TLV of not less than 2.4 million particles per cubic foot (asbestos specifically listed as follows: "including but not limited to aluminum, asbestos, coal, flour, iron ore and free silica, resulting principally from the disintegration of a solid, such as the dust clouds produced from various processes of mining, quarrying and tunneling, and in various industrial operations such as grinding, crushing and general processing of minerals and other materials".

RESPIRATORY PROTECTIVE DEVICES;
TESTS FOR PERMISSIBILITY, 1972

Dust respirators are found in subpart E. Definition sections the term "hazardous atmosphere" is used and it means any atmosphere containing a toxic or disease-producing gas, vapor, dust,

fume, mist or pesticide either immediately or not immediately dangerous to life or health.

There is a separate designation in Section 11.130(f) which states: "respirators, with replaceable filters, designed as respiratory protection against asbestos containing dust and mists". In the same section paragraph(h) there is a designation for single use dust respirators designed as "respiratory protection against pneumoconiosis and fibrosis producing dusts, or dusts and mists including but not limited to aluminum, asbestos, coal, flour, iron ore and free silica."

INFORMATION CIRCULAR, DEPARTMENT OF COMMERCE, BUREAU OF MINES

Physiological Facts in Mine Ventilation 1931 written by R. R. Sayers, Chief Surgeon, Health and Safety Branch, U. S. Bureau of Mines, U. S. Public Health Service.

The basic framework of this article is an attack on the failure of the United States to compensate men for silicosis. Citations are made on pages 8 through 13 to pulmonary asbestosis problems and findings in other countries. The case studies are noted including Cooke's in the Journal of State Medicine, London "Asbestos Dust and Asbestosis Bodies from the Lung of an Asbestos Worker", Volume 39, No. 9, September 1931 pages 244 through 248. The author believes there is some worthwhile investigation to be done in the area of iron-free asbestos which apparently showed no case studies of asbestosis.

Sayer's report goes on to cite an article appearing in the Lancelot, London "Woman's Death from Asbestosis", Volume 221, Nos. 5640 October 3, 1931 page 775 in which the parliament did an investigation of the asbestos industry due to the fact that the workers compensation scheme did not permit compensation for an asbestos worker once they left the employ of the asbestos manufacturer. The records indicate that out of 582 workers examined only 3 were found to have asbestosis with 77 yet pending completion of x-ray examination.

Sayers' report discusses findings in Germany; the first was in 1914 wherein a discovery of pneumoconiosis in an asbestos worker was observed; in 1931 there were 9 cases in two asbestos factories in Italy a report was done by Lovisetto "Pulmonary Asbestosis" "Record Internationale Conference" Johannesburg August 13 - 27, 1930, pages 506 to page 509. This survey started in 1902 and ended in 1912. The conclusions were that inhalation of asbestos dust in the long run causes pneumoconiosis and the required period for manifestation of a pathological state is at least five years. The results were a direct ratio between quantity of dust inhaled and pneumoconiosis, the higher the dust concentration the less time that is necessary for manifestation of fibrosis. It dealt with the functional injuries caused by inhalation of asbestos with some detail. The report cites the Gardner and Gardner (Journal of Industrial Hygiene Volume 13 No. 3 March, 1931, page 111). The report also cites to various articles written by both Sayers and Merriwether on the issue of silicosis.

BUREAU OF MINES MATERIAL

(VOLUME TWO)

BUREAU OF MINES APPROVED DEVICES FOR RESPIRATORY PROTECTION

Authored by W. P. Yant, supervising engineer, U. S. Bureau of Mines, Pennsylvania, as published in the Journal of Industrial Hygiene, Volume 15, 1933. It lists the reasons for the Bureau of Mines investigation into respirators as needed in "dangerous mine atmospheres".

PULMONARY ASBESTOSIS: ITS CLINICAL, RADIOLOGICAL AND PATHOLOGICAL FEATURES AND ASSOCIATED RISK OF TUBERCULOSIS INFECTION.

By Dr. Ellman as published in the Journal of Industrial Hygiene Volume 15, July 1933 #4. He is the physician in charge of the tuberculosis chest clinic, London, England. It discusses clinical, radiological and pathological findings of asbestosis. It deals with factory workers and especially one worker, who while employed in a factory, was not apparently employed in the direct manufacture of product but was rather a "cardroom superintendent".

CHRYSOTILE ASBESTOS DEPOSITS IN ARIZONA

Information circular 7706 by the U. S. Department of the Interior, Bureau of Mines, was written by L. A. Stewart. It describes most of the chrysotile asbestos deposits in Arizona and discusses briefly mining methods and asbestos milling. The manuscript was completed in June of 1954 and published in January, 1955. The author was quoted as follows: "Arizona asbestos mines are the only sources on the American continent of naturally iron-free chrysotile spinning fiber that is so urgently needed for electric cable coverings, especially on washers." The report indicates there are some 22 original sites owned by Johns-Manville now known as the "Western Chemical Company".

In December of 1952 the GSA acted for the Defense Minerals Procurement Agency authorized the establishment of an asbestos purchasing depot at Globe, Arizona for the procuring of strategic grades of fiber. This program was extended to 1958. The Western Chemical Company of Phoenix, Arizona purchased the 22 claims from Johns-Manville in December, 1951. The property became the largest producer of asbestos in the district and then developed into the largest asbestos mine in the United States.

THE ASBESTOS INDUSTRY

Bolton 552 Bureau of Mines. Written by Oliver Boals. Essentially this report answers anything you ever wanted to know about asbestos up to 1955. It lists principal mining companies for each state (pages 17 through 28) and gives world production maps showing U. S. production at about 2.3% of total. Published in 1955.

MTC 001371

The asbestos product manufacturing history is given. It notes that spinning and weaving of asbestos for textile manufacturers began in the 1890's. It cites the disastrous theatre fires which lead to the use of asbestos curtain in the advent of automobile requirements asbestos fabrics which include brake linings.

First insulating uses appear to have occurred in 1871. Asbestos papers was first manufactured in the United States in 1878.

MINING AND MILLING METHODS AND COSTS, VERMONT ASBESTOS MINES, THE RUBEROID COMPANY

Authored by Harry Burmeister in 1967.

Vermont is one of the two major producers in the United States. The article talks about safety and fire prevention (page 42), number of people employed by the company and dust control measures. It does not talk about health problems or personal protection.

MINERAL FACTS AND PROBLEMS

Bureau of Mines bulletin 667, 1975 edition. Updates U. S. production. There were only 380 people actually in the industry in the United States. The author notes that EPA was the first federal agency to recognize an asbestos problem. The history of the mines in the United States and notes that J-M Corp. is the largest asbestos producer in Canada and is considered to be the price leader. It further notes that the EPA says there is no acceptable way to measure asbestos in the ambient air despite OSHA requirements.

INFORMATION CIRCULAR UNITED STATES BUREAU OF MINES

Asbestos-domestic and foreign deposits by Oliver Bowl, June, 1934. Gives a good review of all mining in the U.S. up to 1934 (pages 2 - 7). Arizona and Vermont were the only major producers. Page 4 gives names of Vermont mining operations.

INSPECTED SILICATE MATERIAL AND THEIR ASBESTIFORM VARIETIES

Bureau of Mines information circular 8751. It tends to clarify some of the terminology used in identification and characterization of asbestiform in minerals.

VI-0

MTC 001373



**Johns-Manville
Sales Corporation**

Ken-Caryl Ranch
Denver, Colorado 80217
(303) 979-1000

June 20, 1980

Steven L. Hoch, Esq.
Haight, Dickson, Brown
& Bonesteel
2800 28th Street, 3rd Floor
Santa Monica, CA 90405

RE: ASBESTOS LITIGATION

Dear Mr. Hoch:

As I was going through stacks of papers, I came across a letter from you dated, October 25, 1979, addressed to Jim Green and copied to Curt Caton and Jack Saunders. In your letter you requested a copy of the Bureau of Mine Materials. I am enclosing a copy of the referenced material.

I feel terrible about this oversight and apologize for the inconvenience it must have caused you.

Sincerely,

Joie Peters
Litigation Assistant

JP
Encl.

cc: Mr. Curt Caton
Mr. Jack Saunders

PRIVILEGED
J-M 83

C

MTC 001374



Johns-Manville

Ken-Caryl Ranch
Denver, Colorado 80217
(303) 979-1000

Steven L. Hoch, Esq.
Haight, Dickson, Brown & Bonesteel
2800 Twenty-Eighth Street
Santa Monica, CA 90405

RE: Asbestos Litigation
Strategic National Stockpile

Dear Steve:

In our usual prompt fashion, I am writing concerning your letter to Rick Evans, dated July 1, 1980 (copy is enclosed), in which you seek further information regarding the Minerals Yearbook and stockpiling of asbestos by the government.

Before I attempt to follow up on your request, I thought it best to write and see if you still require this information or if you have already located any of the documents.

Please advise. If you have located any further information, would you be so kind as to forward same to me for our files.

Thanks, Steve.

Sincerely,

Anita L. Christen
Senior Litigation Assistant

alc
encl.

PRIVILEGED
J-M 83

MTC 001375

HAIGHT, DICKSON, BROWN & BONESTEEL

LAWYERS

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JOHN DOHERTY
WILLIAM S. HARRIS
REBECCA S. MOCCIARO
JERRY M. CURTIS
GREGORY A. BASTIAN
BARBARA G. NAPHTAL

July 1, 1980

RECEIVED

JUL 7 1980

LEGAL DEPARTMENT

815 MORAGA DRIVE
LOS ANGELES, CALIFORNIA 90049
(213) 475-6925

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SIDNEY A. MOSS
(1992-1993)

OF COUNSEL
GEORGE CLARK LYON
CHARLES B. SMITH
WILLIAM M. FITZHUGH

IN REPLY REFER TO:

Mr. Hoch
Los Angeles

Mr. Rick Evans
JOHNS-MANVILLE CORPORATION
Ken-Caryl Ranch
P. O. Box 5723
Denver, Colorado 80217

Re: ASBESTOS LITIGATION
STRATEGIC NATIONAL STOCKPILE

Gentlemen:

On June 20, 1980, Joie Peters of your office was kind enough to forward to me some material from a book entitled the "Mineral Yearbook". That book has references to asbestos stockpiling for World War II and later. According to a memo attached to the letter dated July 17, 1979, to Jim Green from C. P. Skelly, there is apparently a listing of asbestos stockpile cites with amounts and storage methods which are still available. This may prove to be interesting information to us and of assistance in the Federal suit and it may also place the government role of a supplier which could have some interesting side effects perhaps in the other litigation. I would appreciate it if you could have Mr. Skelly follow-up to obtain whatever information he can providing us with the name and source so that we may proceed via FOIA if necessary. Also, if you can locate a copy of the "Mineral Yearbook" for the years subsequent to 1951, that would be extremely helpful. We will try to do the same from our end as well.

Thank you.

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J-M 83

Very truly yours,

Steven L. Hoch

Steven L. Hoch
HAIGHT, DICKSON, BROWN & BONESTEEL

SLH:lkH

cc: Mr. Chuck Paul
Mr. J. Philip Martin
Ms. Joie Peters

MTC 001376

BARB-
COULD YOU
SEND HOCH
THIS THING?
THANKS.
R



Johns-Manville

12-4360
Internal Correspondence

To: J. Green 2-18

Date: July 17, 1979

From: C. P. Skelly CMS/WDC

RECEIVED

Copies: See Below

JUL 2 1979

Subject: U.S. DEPARTMENT OF INTERIOR LEGAL DEPARTMENT
BUREAU OF MINES

Bob Clifton of the Bureau of Mines was kind enough to furnish me with pages from the Mineral Year Book referencing asbestos stock pile for World War II and later.

He also told me that a listing of asbestos stock pile sites with amounts and storage methods is available. He indicated that some of the stock pile is in the same jute bags in the same bins as it was received 30 years ago. Should I pursue this further?

CPS:pdr

Attachment

cc L. D. Sorrentino 1-06
D. J. Stinson CMS/WDC
R. C. Manahan CMS/WDC
T. P. Williams 3-03
~~D. H. Markusson 2-18~~
J. S. Autry PAO/WDC
File/Chrono

PRIVILEGED
J-M 83

MTC 001377

Manville

Internal Correspondence

To: R. D. Batson

Date: 1-20-87

From: Lois Gaul *YG (148)*

Copies: D. H. Markusson, R. Meunier, **B. Diemer**
File/Chrono

Subject: ANNUAL REPORT, U.S. BUREAU OF MINES, 1935-1945

The annual report of the U.S. Bureau of Mines was first issued in 1911. All the reports are available in the Government Documents section of the Denver Public Library. This memo focuses on a review of the reports from 1935 to 1945, when they were part of the published annual reports of the Secretary of the Interior. Other memos will be prepared on the periods 1911-1924 and 1925-1934 as my notes are transcribed.

The attached pages contain excerpts from the reports, which can be summarized as follows:

1. The Health Division of the Bureau was "recessed" in July 1933 because of lack of funds, but a Congressional appropriation, largely for dust-disease investigations, permitted the program to resume in late 1935.
2. The Bureau's research on dust disease was primarily in the area of developing equipment and procedures for determining particle-size distribution in dust, for sampling and counting concentrations of dust in the air, and for ascertaining the specific composition of air-borne dust. There are references to more general studies of working conditions and to surveys of specific industries but these are either in coal-mining or in areas where exposure to silica is of concern.
3. The respirator approval program is described rather briefly in each report, usually listing the number of new approvals granted and that interest in it continues.
4. Asbestos was among the commodities routinely surveyed by the Bureau and there are several references to special surveys on asbestos supply and availability undertaken during the war.
5. In addition to advising the Army and Navy Munitions Board and the National Resources Planning Board, the Bureau of Mines conducted confidential studies (unspecified) for the Army and Navy with respect to military equipment and certain Navy operations, analyzed air samples for harmful gases and dusts for the armed forces and the Maritime Commission regarding respirators.

Annual Report of the Secretary of the Interior for the
Fiscal Year Ended June 30, 1935.

Highlights from the section on the Bureau of Mines (John W. Finch, Director), pp. 341-380, include: The Health Division of the Health and Safety Branch was "recessed due to lack of funds...some of the activities of the Health Division will be revived as funds permit" (p. 341).

"Routine questions on health were handled within the branch, although the Health Division has been recessed for 2 years" (p. 344).

"The Nonmetallic Minerals Experiment Station, Rutgers University, New Brunswick, N.J., conducts inquiries into the treatment and utilization of nonmetallic minerals and their products" (p. 357).

"Six respirators (type A) were approved for protection against pneumoconiosis-producing or nuisance dusts" (p. 359).

"In the fiscal year commodity studies were published on arsenic, asbestos, clay, minor mineral-fertilizer materials, sodium sulphate, titanium and vermiculite" (p. 366).

"The need for all major industrial nations for strategic and deficiency mineral raw materials, coupled with the fact that few countries are self-sufficient in their domestic reserves of such minerals, indicates the desirability of periodic studies of international flow of these commodities.... Recommendations have been made by the National Resources Board, the Science Advisory Board, the War Department, and the Navy Department that the Bureau of Mines make periodic presentation in chart form of the international flow of the principal minerals of commerce" (p. 370).

"Although the Health Division was recessed in July 1933 because of drastic curtailment of funds, hundreds of inquiries on health in connection with the mining industry have been received and answered annually, and in addition publications have been prepared for issuance both by the Bureau and the technical press on health subjects, particularly dust diseases. These publications have been so popular that the normal number of copies could not supply the demand" (p. 371).

Annual Report of the Secretary of the Interior for the
Fiscal Year Ended June 30, 1936.

Highlights from the section on the Bureau of Mines (John W. Finch, Director), pp. 347-385, include: "The most

important work of the reconstituted Health Division was an investigation of dust disease. This included field examination of health conditions at mines in several states and laboratory determinations of particle-size distribution and number concentration of dust" (p. 350).

"The present interest in occupational diseases, especially those associated with the mining industry, calls attention to the facilities possessed by the Bureau's Health and Safety Branch for studying them. Procedure and apparatus already devised by the Health Division could be utilized with a minimum of delay for the investigation of such a live subject as occurrence of dust disease in the entire mining industry if enabling funds were provided" (p. 353).

"A microprojector arrangement and procedure were developed for determining particle-size distribution and number concentration of dust in the air of mines and tunnels. The comparative efficiency of the various available procedures and apparatus for determining dust in the air breathed by workmen has been studied to obtain data that will serve as a basis for correlating the results obtained by the various methods now in use" (p. 365).

"To show the position of the United States with respect to strategic materials, flow charts depicting world trade in 50 commodities were completed" (p. 371).

"More comprehensive commodity studies were published as information circulars on alum and aluminum sulphate, asbestos, jade, lime, and the rare earths" (p. 371).

"The Congressional appropriation under which health work was resumed was given largely for dust-disease investigations; therefore most of the Health Division program, both in the field and in the laboratory, has been focused upon dust diseases. One engineer spent several months studying health conditions at mines in Ontario and Quebec, as well as in California, Arizona, and other states, and submitted several reports on ventilation, wash houses, dust prevention, sampling and air analysis" (p. 376).

"Four papers on dust disease or other respiratory affections were published by the Bureau and four others read before technical gatherings" (p. 376).

"The work of the Health Division, both in the field and in the laboratory, is so much in demand that allotments for it should be doubled; there is at present much hysteria concerning occupational diseases (especially dust disease) in mining, and the Bureau of Mines is by all odds the best-equipped organization to study this particular problem" (pp. 376-377).

Annual Report of the Secretary of the Interior for the
Fiscal Year Ending June 30, 1937.

Highlights from the section on the Bureau of Mines (John W. Finch, Director), pp. 114-150, include the publication of "a comprehensive bulletin describing all phases of the asbestos industry, with particular emphasis on foreign supplies and international trade" (p. 140).

"The activities of the Health Division were concerned largely with means of controlling occupational-disease hazards from dust or gas, and consisted of studies of factors governing the formation of atmospheric contaminants and development of simple devices and procedures for determining and preventing them. A midget impinger dust-sampling apparatus has been developed that is light, compact, and hand-operated and yields essentially the same results as the standard instrument.... Instructions were given to 57 persons in the technique of dust sampling and counting" (p. 144).

Annual Report of the Secretary of the Interior for the
Fiscal Year Ended June 30, 1938.

Highlights from the section on the Bureau of Mines (John W. Finch, Director), pp. 173-208, include the notation that "significant progress was made in developing and improving methods for calculating air dustiness. Six papers were published giving the results of this work, which especially emphasized application of the Bureau's midget impinger for dust sampling. The information thus made available should be of great practical importance in evaluating health hazards in dusty occupations. Considerable progress was made in developing procedures for determining the composition of air-borne dust. Studies were made of the applicability of petrographic, spectrographic, and x-ray procedures to this problem. This information is of fundamental importance in ascertaining the health hazards of various types of dust" (p. 200).

"Much interest was shown in the Bureau's approval of respiratory protective devices, as evidenced by the fact that 12 new approvals were granted and 6 additional approvals virtually completed. This work of the Bureau helps to assure safe, satisfactory, and reliable respiratory protective devices for use in nearly all kinds of atmospheric contaminants" (p. 200).

Annual Report of the Secretary of the Interior for the
Fiscal Year Ending June 30, 1939.

Highlights from the section on the Bureau of Mines (John W. Finch, Director), pp. 232-263, include: "In the

field of economics, much attention has been focused upon mineral self-sufficiency as a result of the present interest in national defense.... The values of maintaining cumulative historical data on production, consumption, sources, prices and stocks of strategic minerals seldom has been justified more completely than when the Army and Navy Munitions Board called upon the Bureau for detailed information of this nature covering metals and nonmetallic minerals on its 'critical' and 'essential' lists" (p. 232).

"The manufacture of mineral wool was studied and a report on this subject published" (p. 240).

"Cooperation with the Navy Department was extended further by training an assigned Navy metallurgist in the use of an explosion gallery for studying the possible ignition of gasoline vapors and of 'dope' solvents by abrasive sparks from various metals" (p. 241).

"Most of the reported deposits of diatomite in the State of Washington were sampled, and tests run on them to develop filter aids gave encouraging results" (p. 248).

"After making comprehensive preliminary reports on abrasives, asbestos, graphite, iodine, magnesite, phosphates, potash, quartz crystals, refractories, titanium, zirconium, and sundry other mineral commodities of potential military importance, specialists of the [Nonmetal Economics] division served as members of the Mineral Advisory Committee to the Army and Navy Munitions Board and assisted in the preparation of confidential reports on abrasive diamonds, graphite, and mica" (p. 254).

"Work has been continued on investigations of the characteristics of various methods used for determining concentration, composition, and size properties of dusts. Notable progress has been made in utilization of x-ray, spectrographic, and petrographic methods in determining the composition of air-borne dust. Data obtained during approval testing of respirators have been of value in understanding the fundamental characteristics of air-borne dust" (p. 256).

Annual Report of the Secretary of the Interior for the Fiscal Year Ending June 30, 1940.

Highlights from the section on the Bureau of Mines (R. Sayers, Director), pp. 1-38, include: "Statistical information supplied by the Bureau also aided the Army and Navy Munitions Board in its stock-piling program; other data were most valuable to the National Resources Planning Board.... Data were compiled for defense agencies on abrasive diamonds, asbestos, graphite, quartz, mica, iodine, and other nonmetallic commodities essential to a military program" (p. 1).

"Research on the properties and methods for utilizing Pacific Northwest diatomites was continued, and information on methods for treating Maryland diatomites was published. Reasonable assurance of the ultimate development of commercial production of high-grade diatomaceous earth from these eastern clay-diatomite deposits is indicated" (pp. 20-21).

"Stocks on hand, current and estimated future requirements, and other data necessary to perfect military procurement plans were ascertained in respect to industrial diamonds, asbestos, graphite, mica, and quartz crystals" (p. 28).

"The x-ray and spectrographic procedures for analyzing samples of dust from the air were improved further. An x-ray method for determining free silica was developed that has advantages over existing methods. More information was obtained on operating characteristics of the impinger and the electric precipitator, devices for collecting dust from the air" (p. 31).

"The national defense program necessitates rapid expansion of industrial activities, which will increase existing hazards and introduce many new ones in the mineral industries as well as in many other types of work. Safe, hygienic working conditions must be provided if inefficiency and delays are to be avoided.... The Health Division of the Bureau of Mines comprises 18 persons.... The personnel of this group should therefore be increased severalfold with the numerous problems certain to arise when the national defense program gets definitely under way" (p. 31).

Annual Report of the Secretary of the Interior for the Fiscal Year Ended June 30, 1941.

Highlights from the section on the Bureau of Mines (R. R. Sayers, Director), pp. 129-176, include: "Although well-supplied with most industrial minerals, the United States has depended largely on foreign sources for graphite, special varieties of mica, quartz crystals, industrial diamonds, asbestos, and certain other vitally essential materials" (p. 162).

Fully one-fourth of the time of the [Nonmetal Economics] division's commodity specialists was consumed in direct services to national defense agencies and British and Canadian specialists.... The chief of the division was appointed by the National Academy of Sciences and the National Research Council to the Advisory Committee on Metals and Minerals to serve as secretary to the Non-metallic Minerals Group" (p. 163).

"Assistance was given to manufacturers in the development of improved respirators, and information on the use, limitations, and maintenance of respirators was given to the users to enable them to obtain maximum protection" (p. 165).

"Improvements were made in x-ray and petrographic procedures for determining quartz and other minerals present in air-borne dusts that produce silicosis and pneumoconiosis" (p. 166).

Annual Report of the Secretary of the Interior, Condensed War Edition, Fiscal Year Ended June 30, 1942.

Highlights from the section on the Bureau of Mines (R. R. Sayers, Director), pp. 69-99, include: "A new unit composed of doctors, engineers and chemists was established to investigate occupational disease in the mineral industries and to perform other important duties in the Bureau's program of improving health in this field of employment" (p. 72).

"The Bureau issued more than a dozen publications on air contamination or contaminants" (p. 89).

"At the request of, and in cooperation with, the Army and the Navy, confidential studies were made with respect to health factors in some military equipment" (p. 89).

"In addition to the regular, periodic compilation of data on nonmetallic minerals...the Bureau made monthly canvasses of mica, graphite, asbestos, barium oxide, and natural sodium compounds; a semimonthly canvass of cement; and special canvasses of quartz crystal, mineral pigments, and industrial diamonds" (p. 91).

"The Bureau decided that some of the material published previously might be of aid and comfort to the enemy.... Other current reports dealing with demand, supply, and consumption of strategic and critical minerals also were placed on a confidential basis and their distribution was restricted to a limited list of Federal officials" (p. 93).

Annual Report of the Secretary of the Interior for the Fiscal Year Ended June 30, 1943.

Highlights of the section on the Bureau of Mines (R. R. Sayers, Director), pp. 1-31, include: "The Bureau received from the Congress approval for the most extensive exploratory program ever attempted -- a nation-wide search for coking coal, quartz crystals, copper, asbestos, zinc, mercury, tungsten, vanadium, beryllium and other pegmatite minerals, corundum, molybdenum, manganese, tin, iron,

chromium, bismuth, and nickel and other minerals for which a critical need may arise" (p. 5).

"Inspections were made of the hygienic aspects of working conditions in anthracite mines and zinc, manganese, and ordnance plants, and suggestions were made for eliminating or controlling hazards. Several investigations were made at the request of the Navy Department regarding health and safety aspects connected with certain of its operations" (p. 21).

"The protection of workers against noxious gases, fumes, and dust grew increasingly important as a wartime health measure, and demands for Bureau-approved respirators increased along with requests for suggestions regarding their correct use and care. Such requests came from various mines, labor organizations, ordnance plants, the Maritime Commission, and others concerned with war protection. Special tests also were made by the Bureau for the armed forces and the Maritime Commission to obtain certain information regarding respirators" (p. 22).

"The Bureau of Mines conducted 18 surveys in the nonmetallic industries during 1943, many of them undertaken at the specific request of officials in other agencies of the Government. Typical of these were facts regarding the availability of mica for airplane spark plugs, asbestos for fireproof wire coverings, magnesia for refractories...." (p. 24).

Annual Report of the Secretary of the Interior for the Fiscal Year Ended June 30, 1944, Post-War Frontiers Edition.

Highlights from the section on the Bureau of Mines (R. R. Sayers, Director), pp. 67-100, include: "Special research studies were made on air contaminants, and thousands of air samples containing harmful gases and dusts were analyzed for the Army, Navy, and industry" (p. 70).

"Other advancements of the fiscal year included the development of a new dust-sampling device, improvements in a microprojector to facilitate the collection and determination of the amount of harmful dust in the air, and progress in the application of the x-ray and petrographic methods in analyzing dusts and ores from a health standpoint" (p. 89).

Annual Report of the Secretary of the Interior, Fiscal Year Ended June 30, 1945, Victory Edition.

Highlights from the section on the Bureau of Mines (R. R. Sayers, Director), pp. 71-103, include: "To help meet

the needs for minerals from domestic sources, the Bureau conducted 150 exploratory projects and examined 850 additional ore deposits in 36 states and Alaska. The critical and essential minerals, such as tungsten, vanadium, chromium, zircon, coking coal, flourspar, mica, asbestos, optical calcite, and crystalline quartz received special attention" (p. 71).

"Field trips were made to areas where supply problems demanded attention with respect to such war minerals as asbestos, barite, graphite and magnesite" (p. 95).

MEALEY'S LITIGATION REPORTS

ASBESTOS

Questions from the bench regarding the state of medical knowledge on asbestos injury was prompted by Nightengale's argument that the court below--the Eastern District of Pennsylvania--entered its coverage theory without benefit of any medical testimony whatever. He said such a finding, without hearing evidence, was contrary to the Federal Rules of Civil Procedure. Nightengale argued that the policy intended manifestation to be the trigger for coverage, and said, "We define manifestation as a knowable condition. There must be loss, damage, distress..." on the part of victims.

Schlesinger said that there is no evidence that continuous injury occurs to victims during "exposure in residence" of asbestos.

EAGLE-PICHER WARNED BY GOVERNMENT OF ASBESTOS DANGERS IN 1932

The U.S. Bureau of Mines, following an inspection of Eagle-Picher Company's Rock Wool plant in Joplin Missouri, warned in 1932 that harmful conditions existed at the plant, and called asbestos dust "one of the most dangerous dusts to which man is exposed" (Text from Page 1,374).

The report, which was forwarded by the bureau as confidential information to Eagle-Picher on March 21, 1932, was found in government documents in Washington, DC, according to plaintiff attorney Gary Galiher of Honolulu. Galiher, who circulated the report to the plaintiff community earlier this month, says he cannot reveal the source of the document, which he hopes to introduce in two cancer death trials currently in their second week before Hawaii Federal Judge Harold M. Fong. He calls the report "the strongest piece of punitive damage evidence we have against Eagle-Picher."

The inspection was carried out in September, 1931 by Dr. F.V. Meriwether, surgeon in charge of the Commerce Department's Bureau of Mines Co-Operative Clinic, and involved dust analysis as well as a physical examination of four men at the plant, which produced Rock Wool from slag that was broken into fine, hairlike particles and combined with asbestos.

In his report, Meriwether said, "Based on the chemical analysis, quantity of dust, and evidence of such peribronchial thickening in the men who have been exposed, according to the histories, only a relatively short period of time to the dust, it is very likely that the dust is harmful if breathed over a relatively long period of time. This is particularly true in the mixing room where it is stated by the employees that rock wool is mixed with asbestos in various mixtures ranging from 10 to 75 per cent. This is a particularly dusty place, and it is now known definitely that asbestos dust is one of the most dangerous dusts to which man is exposed. With the combination of asbestos and a fused silica dust, known to be irritating to the lungs, it is reasonable to conclude that the men will get extensive fibrotic changes in a relatively short period of time. This is particularly true where the rock wool is mixed with asbestos. A study of the X-ray pictures of these men fails to reveal any silicosis at the present time, but to produce a decidedly more fibrosis than normal condition in the mines in the Picher field, the group shows an average working time --

MEALEY'S LITIGATION REPORTS

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Aetna argued that its coverage was triggered by manifestation of asbestos disease, while Travelers contended that its policies clearly specified that exposure triggered coverage to the insured. Attorneys for both insurers, however, emphatically denied that their clients owed any duty to defend the asbestos manufacturer after their policy limits were expended. "The concept of the court below that ACandS can pick one company for indemnity and one for defense is abhorrent," said Peter Schlesinger of Simpson, Thatcher & Bartlett, representing Travelers. "The insurer who has no obligation to indemnify cannot be saddled" with the duty to defend, Schlesinger said.

Aetna, contending that manifestation of asbestos disease triggered its coverage, argued that the duty to defend arises only with respect to liability limits, and that both were subject to limitations. Attorney Stephen Nightengale of Miller, Cassidy, Larroca & Lewin, representing the insurer, said when policy limits have been exhausted, leaving no obligation for insurers to pay a tort case, there was no obligation to defend.

ACandS, represented by Frank H. Griffin, III, of Dechert, Price & Rhoades, said there were two questions concerning triggers of his client's policies: what causes an insurance company to respond, and what constitutes an occurrence. He said the answer to the first was an injury during the policy period, and that an occurrence was an accident or continuous exposure to conditions which result in bodily injury. He said, "bodily injury, sickness or disease" triggered coverage—meaning that the trigger begins with exposure and continues through the period of manifestation. He said that under Pennsylvania law, the insurers also have a continuing duty to defend because the law says that each duty is treated separately. When asked by Judge Arlin M. Adams if he believed testimony should be heard by the lower court to determine the intent of the insurers and insureds regarding ambiguous policy language, Griffin said it was unnecessary. "It was form language," he said, common industry-wide.

Judge Adams also asked about scientific tests to determine when injury actually occurs from asbestos disease, and was told by Griffith that the various circuit courts to previously rule on the insurance coverage issue had reached their various conclusions on medical facts. Chief Judge Collins J. Seitz earlier in the hour-long hearing asked whether the court was not being asked to give a legal opinion based on medical opinions that lacked unanimity, and was told by Nightengale that was the case.

The court also questioned whether the lower court was briefed on the question of continuing duty to defend, or whether that duty was discussed in the opinion. Griffin said he did not recall if the issue was addressed in the pleadings to the lower court, but told the court that it was not discussed in the opinion. Rather, he said, the issue was raised in ACandS' motion for summary judgment.

Schlesinger argued that Armstrong, the one-time parent corporation of ACandS, is arguing in California litigation that upon exhaustion of primary policies, excess carriers have the duty to defend. He told the court, "That theory is a necessary, natural outgrowth of the exposure period. As indemnification eats into policy limits, it also eats into limits of a duty to defend," prompting insureds to face the decision of whether to purchase excess coverage.—

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of six years; in other words, apparently these men have contacted the same amount of fibrosis in 12 months or less that occurs in the mines of the Picher field in approximately six years. Assuming this to be correct, the evidence, while not complete, would lead to the conclusion that the dust encountered by these men is more dangerous and will produce lung involvement in a very much shorter period of time than the dust which is encountered in the Picher mines."

The report was sent to Erbon Mabon, safety engineer at Eagle-Picher by Scott Turner, apparently a director of the bureau. A transmittal letter said it was submitted "for your confidential information." Turner said he would appreciate any suggestions or comments, or his attention called to any errors or mistatements.

Meriwether made his inspection at the request of a safety engineer at Eagle-Picher, and airborne dust samples were analyzed in a laboratory, where W.A. Selvig reported that "as mineral wool is a slag and has been thoroughly fused it may be quite irritating if breathed into the throat and lungs in the form of dust."

Three out of four workers from the plant to undergo medical tests suffered fibrosis, with negative results on the fourth, a foreman, according to Meriwether's report. The men who suffered fibrosis had worked from nine to 18 months.

Meriwether recommended that dust control machines be introduced at the plant, and for mixing machines to be utilized for mixing, sacking and other possible steps in the process.

NEW INTERIM FUNDING ORDER ENTERED FOR RAYMARK

Cook County, Illinois Circuit Court Judge James C. Murray last week signed a new interim funding order for Raybestos-Manhattan setting down a complicated formula for various insurers to post indemnity and defense costs for the manufacturer as primary insurers exhaust their policy limits (Zurich Insurance Co. and Northbrook Excess and Surplus Insurance Co. v. Raybestos-Manhattan, Inc., et al., Text from Page 1,377. Also, See 9/28/84, Page 1,206).

The latest order revises a funding scheme outlined by Judge Murray last July 30, after he was notified that primary indemnity limits for Raymark were being exhausted by Federal Insurance Co., Globe Indemnity Co., Commercial Union Insurance Co., and Zurich. The order applies to all U.S. asbestos-related cases pending against Raymark, or commenced during the duration of the order.

Under the Oct. 16 order, the four primary insurers will continue to provide coverage provided under earlier direction by the court until they exhaust their primary liability limits. When primary coverage is exhausted, first-level excess insurers shall be responsible for further indemnity payments, with American Centennial Insurance Company paying 14 per cent; American Home Assurance Co. paying 34 per cent; First State Insurance Co. paying 2 per cent; Globe (as excess carrier) 10 per cent and Northbrook Excess and Surplus Insurance Co. 40 per cent. --

MEALEY'S LITIGATION REPORTS

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Defense costs incurred by Raymark in California through the last day of the month in which both CU and Globe--as a primary carrier--have given notice shall be paid by the two. After that, defense costs will be divided, with CU paying 36.4 per cent; Globe (as primary) 13.6 per cent; American Centennial 7.15 per cent; American Home 17.35 per cent; Northbrook 20.4 per cent; and Globe (as excess) 5.1 per cent. Defense costs incurred in all other cases will likewise be paid by Federal until the last day of the month in which it exhausts coverage, and thereafter, shared as follows: Federal 50 per cent; American Centennial 7.15 per cent; American Home 17.35 per cent; Northbrook 20.4 per cent and Globe (as excess) 5.1 per cent. Payments made by excess carriers for defense costs shall constitute payments under the Ultimate Net Loss provisions of the applicable policies.

CU and Globe (as primary) will be responsible under the order for the defense of Raymark in California, including decisions "as to the incurrence, commitment for and payment of defense and indemnity costs, except that any decision to expand for indemnity more than \$15,000 per claimant or \$100,000 per multiple claimant settlement, shall require the joint approval" of both CU (on behalf of itself and Globe) and Northbrook (on behalf of first-level excess insurers). If CU and Northbrook are unable to agree, representatives of Raymark shall make the decision.

For cases outside of California, Federal and Northbrook will decide when payments beyond the \$15,000 and \$100,000 ceilings are necessary.

CU and Globe (as primary) shall conduct the actual defense of Raymark in California, and Federal will have that same responsibility in the rest of the nation, invoicing other carriers under the outlines of the order.

Zurich, which the court says is no longer required for administration of the cases, will cooperate with other parties and will make claims records available on request.

Warehousing costs for documents, currently running \$35,000 per month, will be assigned 30 per cent to the California litigation and 70 per cent to cases in all other states.

When first-level excess carriers expend 80 per cent of their liability limits, they are to inform all other parties so that appropriate application for further relief may be made.

MEALEY'S LITIGATION REPORTS ASBESTOS

EAGLE-PICHER

long distance telephone, travel, transcripts, reproduction, postage and advances to committees of counsel.

(1) Any statement filed with the court after the twentieth calendar day of the month, will not be considered in the calculations awarding/permitting counsel fees unless good cause is shown why it should not be denied.

(j) Services rendered prior to the date of this Order by an attorney and/or law firm expecting an award for fees in this matter shall file on or before November 20, 1984, a statement in accordance with the preceding terms of this Order.

The statements shall be kept under seal by the Clerk of the Court.

BY THE COURT:

James M. Kelly
JAMES MCGINN KELLY, J.

National Archives and Records Service

To all to whom these presents shall come, Greeting:

By virtue of the authority vested in me by the Administrator of General Services, I certify on his behalf, under the seal of the National Archives of the United States, that the attached reproduction(s) is a true and correct copy of documents in his custody.

Signature <i>Janet L. Hargrett</i>	
Name Janet L. Hargrett	Date 10-3-84
Title Chief, General Branch	
Name and Address of Repository Civil Archives Division The National Archives Washington, D. C. 20540	

March 21, 1982. 1022/309

Mr. Erben Mabon, Safety Engineer,
Eagle Picher Company,
Fisher, Ohio.

Dear Mr. Mabon:

Enclosed is a report of a limited inspection of the rock wool plant of the Eagle Picher Mining and Smelting Company, Joplin, Mo., made by Dr. F. V. Herinether, of the U. S. Bureau of Mines.

This report is submitted for your confidential information. I shall appreciate any suggestions or comments you may have and shall be glad to have my attention called to any errors or misstatement of fact.

Yours faithfully,

SCOTT TURNER
SCOTT TURNER,
Director.

Enclosure No. 4513
cc - Dr. Herinether

MEALEY'S LITIGATION REPORTS ASBESTOS

SCHOOLS

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF PENNSYLVANIA

FILED OCT 19 1984

(d) The hours billed to other clients by the above mentioned attorney and legal assistant on non-class action matters during the time period.

IN RE: ASBESTOS SCHOOL LITIGATION

MASTER FILE NO. 83-0268

ENTERED: 10/22/84

THIS DOCUMENT RELATES TO:
ALL ACTIONS

CLERK OF COURT

PRETRIAL ORDER NO. 23

RE: AWARD OF COUNSEL FEES AND EXPENSES

AND NOW, this 19th day of October, 1984, it is hereby ORDERED that each attorney and/or law firm expecting an award for fees as the result of their efforts and time expended in this class action must file a statement under seal, during the first twenty (20) calendar days of each month concerning the prior month's activities, with the Clerk of this Court, attached with an affidavit attesting to the truthfulness and correctness of its contents setting forth the following information:

- (a) A narrative summary of the specific contributions made by the attorney for the benefit of the class as well as a summary of the work each attorney and legal assistant in the firm for whom compensation is requested.
- (b) The number of hours or fraction thereof and an explanation specifically describing the tasks performed by each attorney and legal assistant.
- (c) The hourly billable rate which the attorney/firm normally charges for each attorney and legal assistant for similar type of work/service.

(e) If the time or rate of any attorney who is not a partner or employee of the firm submitting the statement is included in the statement to the court, the submitting attorney must include a detailed statement prepared by the firm submitting the statement and such other attorney, setting forth in detail the arrangements between them for compensation during the litigation and the division or allocation of any fee or reimbursements awarded, together with a statement of the reasons why it was necessary to enter into such arrangements.

(f) The initial statement for each attorney or legal assistant shall include a resume of the background and qualifications of such person. This paragraph will not apply where the attorney or legal assistant contributes less than five (5) hours.

(g) This Order is not applicable to the award of counsel fees as a sanction for the filing of frivolous motions or for the failing to properly respond to discovery requests.

(h) Any and all expenses in connection with this litigation must be itemized by categories of the out-of-pocket disbursements, and shall be accompanied by copies of the original supporting documentation, including vouchers, disbursement memoranda, checks and similar records. The documents must be segregated into specific categories, such as

MEALEY'S LITIGATION REPORTS ASBESTOS

REPORT OF JUNE INVESTIGATION OF THE EAGLE PITCHER ROCK WOOL PLANT at JOPLIN, MISSOURI

In September, 1931, at the request of the Safety Engineer of the Eagle Pitcher Mining and Smelting Company, an inspection was made of the company's rock wool plant at Joplin, Missouri. This plant is operated in connection with a lead smelter and the product is made from by-products of lead smelting. Inasmuch as the rock wool plant is only operated when there is a demand for the product, considerable delay was encountered in assembling and collecting all data on the process. It was desired to obtain information on the dust, its chemical analysis, and to examine the older men employed at the plant in order to draw conclusions as to possible harmfulness of the dust.

Rock Wool. Rock Wool is made from slag which is heated to a molten liquid and is blown out of a small orifice at considerable pressure into the stream, breaking the molten liquid into very fine hairlike particles. This is blown into a large room and after collecting in quantities it is shoveled into containers for transferring to another building for fabricating. The material is made into sheets, bricks, and is combined with asbestos and used for the purpose of insulating buildings, furnaces, etc. In both the buildings in which the furnace and the fabricating rooms were located, large amounts of dust were detected in the air.

Dust Count. Atmospheric samples were taken in the sizing room, fabricating department, granulator and furnace rooms. The sample in the furnace room shows 25,000,000 particles under 10 microns; in the sizing room No. 2 sample shows 23,000,000 particles; No. 1 sample 10,000,000 particles; the fabricating room shows 1,000,000 particles; and the granulator 4,000,000 particles, all under 10 microns. Two of these samples were forwarded to Pittsburgh, Pennsylvania, for analysis (furnace room and sizing room No. 2) and the figures given above are the figures obtained at Pittsburgh. Our own figures show a much higher count. It is possible that some of the particles have gone into solution.

Chemical Analysis. Samples of the rock wool were sent to Pittsburgh to Mr. V. A. Selvig for chemical analysis and the analyses are as follows:

P1 PARTIAL ANALYSIS	
Lead, Pb	Per cent
Silica, SiO ₂	1.6
Aluminum oxide, Al ₂ O ₃	38.6
Ferric oxide, Fe ₂ O ₃	6.3
Calcium oxide, CaO	38.4
	13.3
P2	
Lead, Pb	0.5
Silica, SiO ₂	40.8
Aluminum oxide, Al ₂ O ₃	5.9
Ferric oxide, Fe ₂ O ₃	31.6
Calcium oxide, CaO	13.3
P3	
Lead, Pb	0.7
Silica, SiO ₂	42.0
Aluminum oxide, Al ₂ O ₃	6.0
Ferric oxide, Fe ₂ O ₃	29.2
Calcium oxide, CaO	12.0

MEALEY'S LITIGATION REPORTS

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conclude that the man will get extensive fibrotic changes in a relatively short period of time. This is particularly true where the rock wool is mixed with asbestos. A study of the X-ray pictures of these men fails to reveal any silicosis at the present time, but to produce a decidedly more fibrotic than normal condition in the mines in the Picher field, the group shows an average working time of six years; in other words, apparently these men have contracted the same amount of fibrosis in 12 months or less that occurs in the mines of the Picher field in approximately six years. Assuming this to be correct, the evidence, while not complete, would lead to the conclusion that the dust encountered by these men is more dangerous and will produce lung involvement in a very much shorter period of time than the dust which is encountered in the Picher mines.

Dust Control. Machines should be introduced to control the amount of dust produced at this plant. In the furnace room, where the wool is blown into the room, a method of sucking the dust out of the room or an upward system of ventilation should be installed. In the fabricating room, it should be as open as possible, and a definite dust-controlling system installed. In the mixing room, if it is suggested that a machine be installed to do this mixing, sucking, etc., similar to that used by cement industries, and it will not be necessary for the two men to be in the room. These machines are in common use and could be used here with economical results.

The concluding statement of Mr. Selvig's report is as follows: "As mineral wool is a slag and has been thoroughly fused it may be quite irritating if breathed into the throat and lungs in the form of dust."

Physical examinations. On January 6, 1932, four of the employees working at the plant were examined at the clinic to determine whether or not they show evidence of lung involvement. Three out of the four men examined show a decidedly more fibrosis than normal, and one of the three shows an old tubercle. The other man was negative. The histories of the men show that they have not been employed steadily in this plant, but they have been engaged in this work for periods ranging from 3 months to 1 1/2 years, probably at about half time. The men that show no thickening in the bronchial tubes is the foreman who is probably exposed to the minimum amount of dust.

Conclusions drawn. Based on the chemical analysis, quantity of dust, and evidence of such peribronchial thickening in the men who have been exposed, according to the histories, only a relatively short period of time to the dust, it is very likely that the dust is harmful if breathed over a relatively long period of time. This is particularly true in the mixing room where it is stated by the employees that rock wool is mixed with asbestos in various mixtures ranging from 10 to 75 per cent. This is a particularly dusty place, and it is now known definitely that asbestos dust is one of the most dangerous dusts to which man is exposed. With the combination of asbestos and a fused silica dust, known to be irritating to the lungs, it is reasonable to

MEALEY'S LITIGATION REPORTS ASBESTOS

RAYMARK FUNDING

IN THE CIRCUIT COURT OF COOK COUNTY, ILLINOIS
COUNTY DEPARTMENT - LAW DIVISION (#11296)

ZURICH INSURANCE COMPANY,
Plaintiff,
and
NORTHBROOK EXCESS AND SURPLUS
INSURANCE COMPANY,
Intervening Plaintiff,
v.
RAYBESTOS-MANHATTAN, INC., a
foreign corporation, COMMERCIAL
UNION INSURANCE COMPANY, FEDERAL
INSURANCE COMPANY, GLOBE
INDemnITY COMPANY, AMERICAN HOME
ASSURANCE COMPANY, FIRST STATE
INSURANCE COMPANY and AMERICAN
CENTENNIAL INSURANCE COMPANY,
Defendants.

NO. 78 L 8760

Judge James C. Murphy

UNITED STATES DEPARTMENT OF COMMERCE
BUREAU OF MINES CO-OPERATIVE CLINIC

PICKER, OKLAHOMA
March 11, 1932.

Dr. E. B. Sayers,
Chief Surgeon,
Bureau of Mines,
Washington, D. C.

Dear Mr. Sayers:

I am enclosing copies of the report on the
investigation of the Eagle Picher Company's Rock Wool
Plant in Joplin, which we discussed while you were here.

When this is finally approved, please forward
a copy to Mr. Erben Mabon, Safety Engineer, Eagle Picher
Company, Picher, Oklahoma, at the earliest possible date,
as they are very anxious to receive it.

Yours respectfully,

F. V. Meriwether
F. V. Meriwether,
Surgeon in Charge.

ORDER

Upon motion for interim funding of asbestos-related
claims against Raymark Industries, Inc. ("Raymark"), and based
on previous evidence and pleadings of the various parties to
this cause, the Court notes the following:

A. On September 29, 1983, this Court entered an Order
(the "September Order") which determined events which trigger
insurance coverage for asbestos-related claims under the
policies of comprehensive general liability insurance sold by
Commercial Union Insurance Company ("CU"), Federal Insurance
Company ("Federal"), Globe Indemnity Company ("Globe") and
Zurich Insurance Company ("Zurich") to Raymark Industries, Inc.
("Raymark").

PETERSON, ROSS, SCHLOERS & SEIDEL

MEALEY'S LITIGATION REPORTS

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1. This Order shall apply to all United States asbestos-related cases pending against Raymark or commenced during the duration of this Order.

Prior to Exhaustion of Primary Policy Limits

2. The terms of the February Funding Order shall remain in effect with respect to any Raymark cases in California until CU and Globe (as a primary) both give or have already given notice that their respective total committed indemnity limits have been exhausted by binding commitments to make settlements or payments of judgments. In the event either CU or Globe (as a primary) gives or has already given such notice prior to the other, the remaining insurer shall be responsible for any additional indemnity payments in California cases until the second notice is given.

3. The terms of the February Funding Order shall remain in effect with respect to any Raymark asbestos cases in states other than California until Federal gives or has already given notice that its indemnity limits have been exhausted by binding commitments to make settlements or payments of judgments. In this regard, by Stipulation between Raymark and Federal, dated December 23, 1983, on file with this Court, Federal's indemnity limits have been agreed to for the purposes of this litigation.

4. If CU and Globe (as a primary) both give or have already given notice pursuant to paragraph 2, but Federal has

E. On November 18, 1983, this Court entered an Interim Order (the "November Funding Order") which provided for interim funding of asbestos-related claims against Raymark.

C. On February 8, 1984, upon motion made by Federal, this Court entered an Interim Order (the "February Funding Order") which supplemented the November Funding Order and provided a method of funding asbestos-related claims filed against Raymark.

D. On June 15, 1984, this Court entered an Order (the "June Order") which determined various issues remaining in the case and which Order was final and appealable.

E. On July 26, 1984, this Court modified the June Order pursuant to Motion to Reconsider and modify filed by Zurich.

F. On July 30, 1984, this Court entered an Interim Order (the "July Funding Order") which provided for interim funding of asbestos-related claims against Raymark, given the fact that the primary insurers, Federal, Globe, Zurich and CU had or shortly will have exhausted the total of their primary indemnity limits.

This Court having considered the above and other evidence in the record and being fully advised in the premises, HEREBY ORDERS THAT:

Until such time as the action is ultimately resolved on appeal by a court of last resort, the following orders will be without prejudice to any party's legal position or rights:

Glover Exhibits

"ASBESTOS IN THE UNITED STATES--SUPPLY AND DEMAND"

Remarks by
Robert A. Clifton, U.S. Bureau of Mines

**before the Third International Conference on the
Physics and Chemistry of Asbestos**

Laval University, Quebec, Canada

August 17 - 21, 1975

MTC 001397

INTRODUCTION

It is easy to understand an asbestos-supply interest in the United States, which has, at least historically if not at the moment, led the world in asbestos consumption. Appraisal of the present and future ability of the United States to supply the demands of its industrial users of asbestos is the subject of this paper.

UNITED STATES DOMESTIC SUPPLY

The first recorded transaction dealing with asbestos in the United States took place more than 100 years ago when \$18 worth of asbestos was imported from somewhere in 1873. The United States has been importing asbestos ever since, and by far the majority of the asbestos supply needed to meet the U.S. demand has and will come from abroad. Since the turn of the century, for example, there have been only 2 years in which the imports have represented less than 90% of the apparent consumption.

production soon, and there is a chrysotile discovery on Tanana Indian land in the Eagle quadrant of Alaska. The Tanana and Cassiar situations seem to have complementary features. One possibly has a viable ore body, and the other has a fully equipped mine and mill at a nearly depleted ore body a few miles away. A U.S. Bureau of Mines study summarized in Bureau of Mines Information Circular 8672 indicates considerably higher mining costs in Alaska due, principally, to wages, but the continuing demand for asbestos may soon require that presently subeconomic resources be reevaluated.

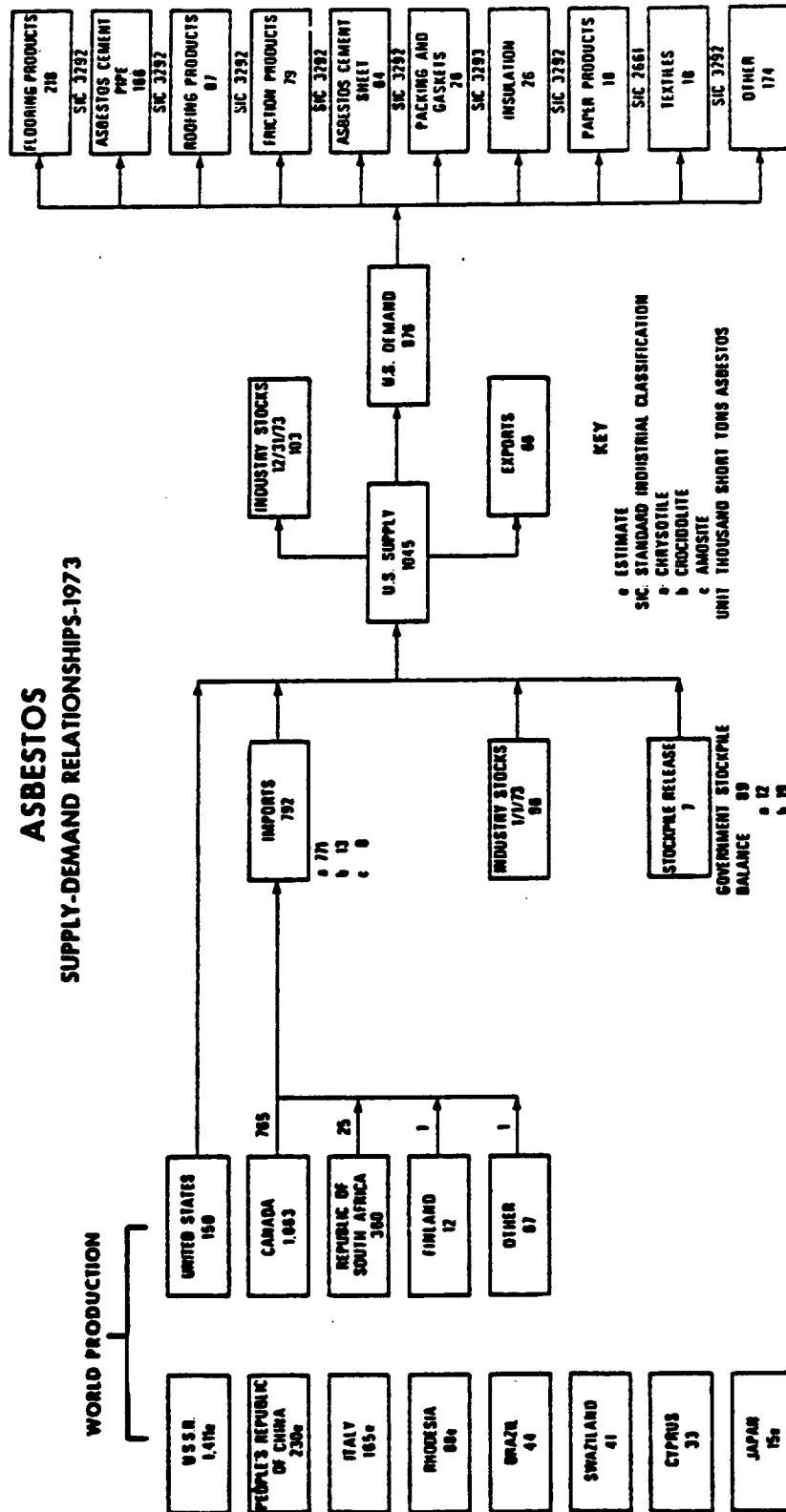
I have deliberately refrained, so far, from discussing the asbestos deposits of the Joaquin Ridge near Coalinga, Calif. Two companies are operating mines there now and a third closed last year. This deposit is so vast that one of the operators told me that he had 800 years of reserves at present production rates. That deposit just could hold a key to the future as the world's reserves of longer asbestos fiber become depleted. These admittedly short fibers are reported to have exceeded the critical length and have been able to reinforce every matrix in which tested. Asbestos is still the best substitute for asbestos, and perhaps this innovative industry will find means by which the short fibers can be made to act long.

I was gratified that a 2-year study by the National Academy of Sciences-National Research Council agreed with some of my hypotheses. This study, entitled "Mineral Resources and the Environment," was released in February of this year and a few quotes from the Chemical and Engineering News review of it seem appropriate: "The first true shortages are perhaps only a matter of a few years away." * * * "Asbestos. . . [is] among other mineral resources that may soon be in short supply, particularly in the U.S." * * * "The committee recommends that the government maintain stockpiles of threatened materials." * * * "Substitutes must be found for . . . asbestos. . ."

DEMAND

Figure 1 is taken from the asbestos chapter of the soon to be published 1975 edition of Mineral Facts and Problems. It should serve as a good bridge between the portions of this presentation covering supply and those covering demand. It shows how our major areas of supply feed the total demand and then breaks down to final major end-use areas, which we will cover later. Note that nearly 97% of the imports came from Canada and that a little over 97% of total imports was chrysotile.

ASBESTOS SUPPLY-DEMAND RELATIONSHIPS-1973



U.S. BUREAU OF MINES

FIGURE 1

MTC 001401

I wish that I could talk about demand in other than statistical terms. One definition describes a statistician as "a man who can draw a mathematically precise line from an unwarranted assumption to a foregone conclusion." Having said that, I will now have to admit that 5 years on this job have made a statistician of me and that some of their tools (particularly regression analysis and trend projection) are valuable means of describing sets of data.

My previous reports describing U.S. asbestos demand as "remarkably stable" were based on several 20 year analyses within the 1950-73 span, which showed very little change in the average annual growth rate and stayed well below 1%. As I became more of a statistician, though, I found that by careful selection of the span of historical data, I could influence the outcome. For example, for the 50-year span 1925-74, the average annual growth rate was 1.43%, which projected to the year 2000 would call for a demand of 1.9 million short tons. I think that the data shown in figure 2 (also from the forthcoming Mineral Facts and Problems) illustrate what I think the U.S. demand would be in the year 2000 in a buyer's market. Note that the growth rates of the 20 year trend and the 10 year trend both project large demand in the year 2000.

U.S. ASBESTOS DEMAND

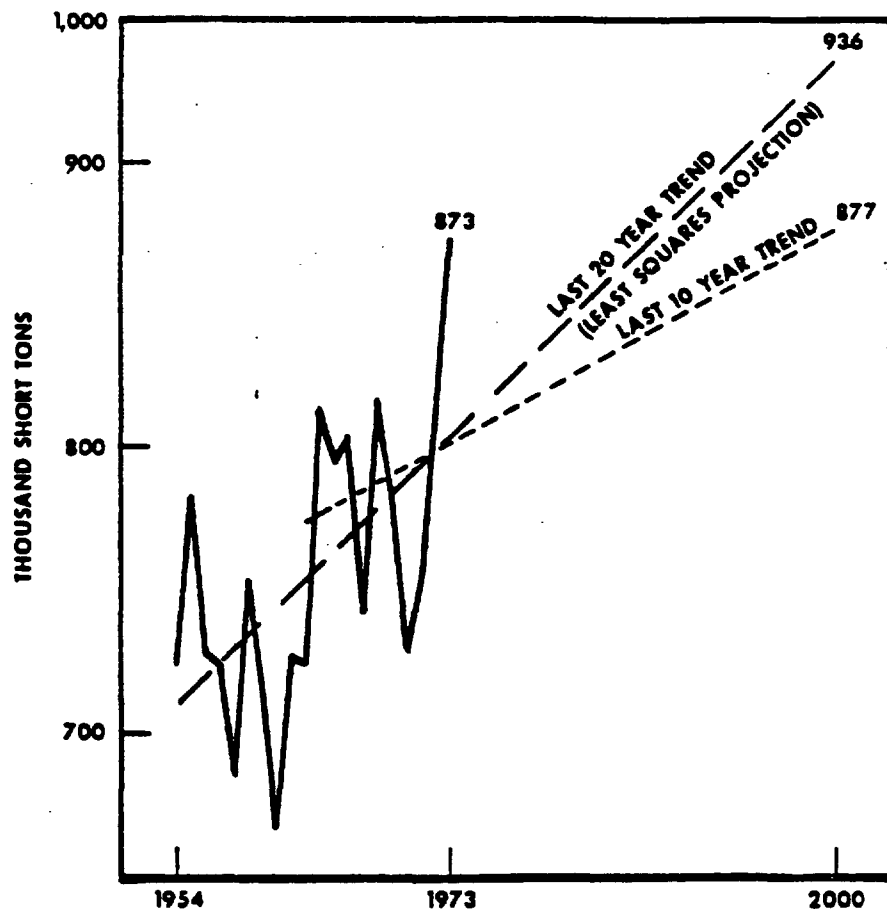


FIGURE 2

The world market and the United States' place in it are changing a great deal. In the early fifties, the United States consumed about 50% of the world production, and now, only about 20%. Figure 3 from the 1972 Minerals Yearbook illustrates this point rather well. If each of the major consuming countries kept a near-constant share of an expanding market, the result would be a straight line as shown by Canada. The U.S.S.R. and Japan typify those countries whose rate of consumption has grown faster than the world production rate. The United States and United Kingdom have gone the other way. Note that the U.S. and U.S.S.R. trend lines cross. This indicates that if the U.S.S.R. has not already done so, it soon will surpass the United States as the number one consumer of asbestos fiber.

There are some trends to be seen in asbestos end-use patterns. In the process of improving the data collection system, the continuity necessary to observe these trends has suffered. My mailing list of questionnaires has increased from about 40 to about 700, and the questionnaire itself has been drastically revised and needs further revision now. I think that the 1973 data as shown in table 1 are fairly valid. The chrysotile data have been adjusted to agree

MTC 001404

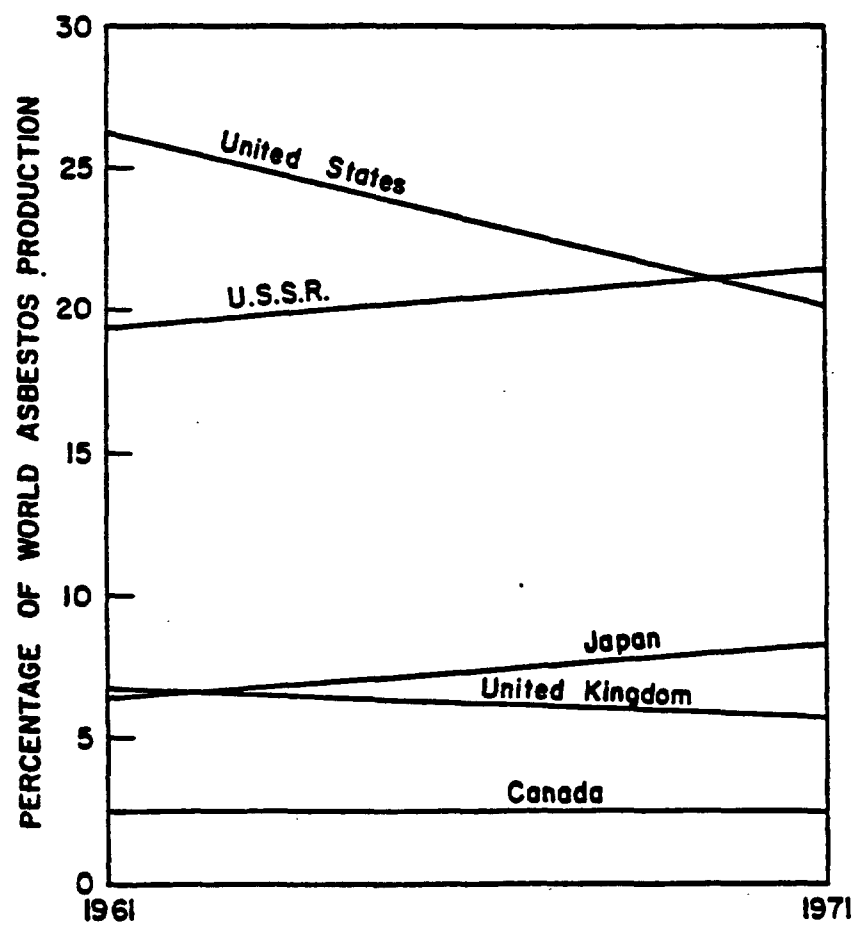


FIGURE 3

with the U.S. apparent consumption figure. These same data have been grouped into BM I (Quebec 1, 2, and 3), BM II (Quebec 4 and 5), and BM III (Quebec 6, 7, and 8). Note that by far the majority of end uses are tied to the construction industry. This fact accounts for both the record high year of 1973 and the decline in 1974.

In 1972 I predicted, from a position of much less knowledge, that the asbestos industry would find itself able to meet the regulatory agency criteria at about the same time it was found that the stringent criteria were not needed. This is turning out to be the case, but don't look for rule relaxation. It's much harder to get something off the books once on, and the highly vocal voices that equate asbestos and doom are still around. The regulations, so far, appear to have done little real damage to the manufacturing side of the asbestos industry but have inhibited the producing side.

The asbestos industry has been able to create new markets when other materials such as glass fiber made major onslaughts on the old. I think, however, that this creativeness must take new directions in the face of a

Table 1.--U.S. asbestos consumption in 1973
(short tons)

End uses	Chrysotile (adjusted)				Anchophyllite (reported)	Amosite (reported)	Crocidolite (reported)
	Mt I	Mt II	Mt III	Total			
Flooring products-----	---	---	218,000	218,000	---	---	---
Asbestos cement pipe----	---	64,000	95,000	159,000	139	198	6,646
Roofing products-----	---	16,600	70,100	86,700	---	310	---
Friction products-----	5,600	32,300	41,100	79,000	---	---	---
Asbestos cement sheet----	---	24,700	36,800	61,500	54	77	2,380
Packing and gaskets-----	1,200	12,900	11,900	26,000	---	---	56
Insulation-----	1,200	5,600	15,600	22,400	---	3,587	---
Paper-----	---	700	17,100	17,800	---	3	218
Textiles-----	---	---	---	18,000	---	---	29
Other-----	---	14,800	149,400	164,200	969	98	8,634
Total-----	26,000	171,600	655,000	852,600	1,162	4,273	17,966

MTC 001407

quite possible worldwide depletion of this valuable resource. The asbestos industry must answer such questions as the following: How can this end product be made with less asbestos to be as good as it now is? How can every last fiber be extracted from this ore? If no adequate substitute exists, can one be synthesized?

The outlook includes greatly expanded exploration efforts worldwide. Absolutely clean asbestos mills and manufacturing plants are also foreseeable, both for worker protection and for preservation of a valuable product. Every asbestos outcropping ever recorded will be reevaluated as will every abandoned mine. In these circumstances, fiber prices probably will continue to climb. Stockpiling asbestos may reach an unprecedented level, and substitute synthesis research is likely to be revived and carried much further into the applications field than ever before.

MTC 001408

May 22, 1987

II. EXHIBIT LIST

- 1985 - ① Letter from A.J. Lanza, M.D., to Dr. F.V. Meriwether, U.S. Bureau of Mines Clinic, February 12, 1932
- 1985- ② Letter from F.V. Meriwether to Dr. A.J. Lanza, February 16, 1932
- ③ Letter from F.V. Meriwether to Dr. H.H. Fellows, Metropolitan Life Insurance Co., February 16, 1932
- ④ Letter from H.H. Fellows, M.D., to Dr. F.V. Meriwether, February 18, 1932
- 1985- ⑤ Letter from R.R. Sayers, Surgeon, U.S. Public Health Service to the Surgeon General, U.S. Public Health Service, February 20, 1932
- 1985- ⑥ Letter from H.S. Cumings, U.S. Surgeon General to R.R. Sayers, February 24, 1932
- 1985- ⑦ Letter from S.A. Williams, Vice President, Johns-Manville Corp. to Dr. F.V. Meriwether, February 26, 1932
- 1985- ⑧ Letter from R.R. Sayers to Dr. F.V. Meriwether, February 27, 1932
- 1985- ⑨ Letter from F.V. Meriwether to Mr. S.A. Williams, March 1, 1932
- 1985- ⑩ Letter from F.V. Meriwether to Dr. R.R. Sayers, March 1, 1932
- ⑪ Letter from A.J. Lanza, Assistant Medical Director, Metropolitan Life Insurance Co. to Dr. F.V. Meriwether, March 24, 1932
- ⑫ March 25, 1932 letter from A. MacD. Hughes, Mgr., Personnel Department, Johns-Manville Corp. to Dr. F.V. Meriwether.
- ⑬ Letter from F.V. Meriwether to Dr. A.J. Lanza, April 1, 1932
- 1985- ⑭ Letter from F.V. Meriwether to Mr. A. MacD. Hughes, Johns-Manville, April 1, 1932
- 1985- ⑮ Letter from Vandiver Brown, Johns-Manville to Dr. A.J. Lanza, April 4, 1932

1985 = Manville received these documents on
microfilm from the USA in August, 1985

MTC 001409

1985- (16) Letter from A.J. Lanza, M.D., to Dr. R.R. Sayers.
April 6, 1932

1985- (17) Telegram from R.R. Sayers to Dr. F.V. Meriwether.
April 11, 1932

1985- (18) Letter from R.R. Sayers to Dr. F.V. Meriwether.
April 11, 1932

(19) Letter from F.V. Meriwether to Mr. A. MacD. Hughes,
April 19, 1932

(20) Letter from A. MacD. Hughes to Dr. F.V. Meriwether,
April 19, 1932

(21) Letter from F.V. Meriwether to Mr. A. MacD. Hughes,
April 22, 1932

(22) Letter from A. MacD. Hughes to Dr. F.V. Meriwether.
April 26, 1932

(23) Letter from F.V. Meriwether to Mr. A. MacD. Hughes,
May 2, 1932

provided to
Manville &
Castleman
deposition - April,
1987

(24) Letter from A. MacD. Hughes to Dr. F.V. Meriwether,
May 17, 1932

(25) Letter from A. MacD. Hughes to Dr. F.V. Meriwether,
May 23, 1932

(26) Letter from F.V. Meriwether to Mr. A. MacD. Hughes,
June 1, 1932

(27) X-ray results on third group of Johns-Manville Corp.
x-rays, June 7, 1932

[Duplicate]

Letter from A.J. Lanza, M.D., to Dr. F.V. Meriwether,
February 12, 1932

[Duplicate]

Letter from F.V. Meriwether to Mr. A. MacD. Hughes,
Manager, Personnel Dept., Johns-Manville Corp.,
April 19, 1932

[Duplicate]

Letter from F.V. Meriwether to Mr. A. MacD. Hughes,
June 1, 1932

Pretrial Brief of the United States, Johns-Manville
Corp. v. United States, U.S. Claims Court No. 465-83C .

COPY

GENERAL MOTORS CORPORATION
DETROIT, MICHIGAN

February 12, 1932.

Dr. F. F. Meriwether,
U.S. Bureau of Mines Clinic,
Picher, Okla.

Dear Dr. Meriwether:

The Johns-Manville Corporation have a plant at Manville, N. J. which employs about 1200 people. They are going to make a survey of their employees to determine the amount of asbestosis in the plant. To do this they are going to take one-half of their employees and have them fluoroscoped. They will then be examined and x-rayed. The physician who does the fluoroscopic work will have no connection with the x-ray work, the idea being to make the diagnosis with the x-ray and then determine to what extent the fluoroscope is correct.

Dr. Fellows is of the opinion that it will probably be difficult, if not impossible, to pick up asbestosis with a fluoroscope, although he thinks there would be no trouble in detecting silicosis by this method.

I have recommended to the Johns-Manville Corporation, as has Dr. Fellows, that they depend upon you for the interpretation of the x-ray films, 600 in number, and they will be glad to pay you a fee of \$200.00 for this work. They feel, as does Dr. Fellows, that they have no more right to ask this service from you without proper recompense than they would any other phase of the study.

If this is agreeable to you, will you please let me know so that I can communicate with Mr. Vandiver Brown, the General Counsel of the Johns-Manville Corporation. I hope that you can do this as this is really a very important experiment on this whole question of physical examination in industry and may have far reaching effects.

I am hoping to visit you with Dr. Sayers about March 1st but would like an answer to this letter as soon as possible.

With best regards, I am

Sincerely yours,

(Signed) A. J. Lanza.

P.S.

Dr. Fellows would like to know what type of film would be desired for this work, that is, a fairly brilliant film with a good deal of contrast, or a moderately light film which would show the earlier changes. He believes that a film strictly comparable with that used in the Metropolitan Office would probably be satisfactory.

I would appreciate if on receipt of this you would write directly to Dr. H. H. Fellows, Metropolitan Life Insurance Co., 1 Madison Avenue, New York City, and advise him as to the technique, remembering that these asbestosis cases do not show up as clearly as do the silicosis.

A. J. L.

MTC 001411

February 16, 1932.

Dr. H. H. Fellows,
Metropolitan Life Insurance Co.
1 Madison Avenue,
New York, N.Y.

Dear Dr. Fellows:

I have a letter from Dr. Lanza with reference to making some films for the Johns-Manville Corporation at Manville, N.J., and he desired that I notify you as to the type of film that would be suitable.

I would suggest a fairly hard film, with as much contrast as possible. I like this type of film much better in reading for any fibrotic changes than the softer film, as I believe that it gives fewer errors between the interpretations and clinical findings than in the softer film.

Yours respectfully,

F. V. Meriwether,
Surgeon in Charge.

MTC 001412

(COPY)

February 16, 1932

Dr. A. J. Lanza,
Room 15-159 General Motors Bldg.,
Detroit, Michigan.

Dear Dr. Lanza:

In reply to your letter in reference to interpreting X-ray pictures for the Johns-Manville Corporation, of employees working at the Corporation's plant at Manville, E. J.:

As you know, regulations against any of the Public Health men accepting any remuneration for work done without the permission of the Surgeon General exist. I am therefore sending Dr. Sayers a copy of your letter for his action. If it is agreeable with him, I would certainly be glad to receive the \$200.00, as I don't know of anything that would come in much handier at the present moment, as I have spent considerable in hospital expenses. However, if it is not permissible, you may notify the people to send the pictures down and I am sure that it would be agreeable to Dr. Sayers for me to read them without charge. I would certainly be glad to read the pictures for you in any event. I am writing Dr. Fellows as suggested in your letter with reference to the character of films desired.

I have been in the hospital with intestinal influenza (not my diagnosis) for a week or ten days. I am up today, but am leaving for Oklahoma City this afternoon to have some cardiographs run, as it seems to have affected my heart to some extent. However, the attending physicians tell me it is a temporary affair but I must say that it gives a very disagreeable sensation. I hope to be back on my feet and able to work within a short time.

With best wishes, I am

Yours respectfully,

F. V. Meriwether,
Surgeon in Charge.

MTC 001413

METROPOLITAN LIFE INSURANCE COMPANY

FREDERICK H. ECKER, PRESIDENT

NEW YORK CITY

HAYNES HAROLD FELLOWS, M.D.

Assistant Medical Director

February 18, 1932.

Dr. F. V. Meriwether,
Surgeon-in-Charge,
United States Department of Commerce,
Bureau of Mines Co-operative Clinic,
Picher, Oklahoma.

Dear Dr. Meriwether:

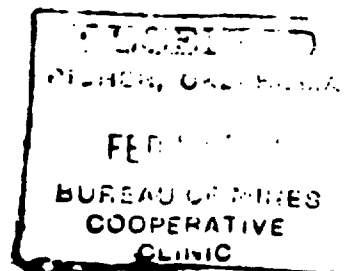
I have your letter of February 16
and am sending a copy direct to the Johns-Manville
Corporation. I believe that they will show this letter
to the X-ray technician and that the type of film will
be such as you suggest.

With very best personal regards, I

am,

Sincerely yours,

Fellows.
H. H. Fellows, M.D.



MTC 001414

February 20, 1942.RMB:cm

The Surgeon General,
U. S. Public Health Service,
Washington, D. C.

Sir:

I have the honor to inclose herewith copy of a
letter from Mr. A. J. Lanza to Mr. F. V. Norinether and Mr.
Norinether's reply.

In Mr. Norinether's reply he states he is sending
a copy of the letter to me for action. This is referred to
you for consideration in accordance with Paragraph 115 of
the Regulations.

Respectfully,

R. E. SATTER,
Surgeon, U.S.P.H.S.
Chief Surgeon, U.S.N. of M.

Inclosure No. 17485.

R

R R D

2/24
+

MTC 001415



U.S. PUBLIC HEALTH SERVICE
WASHINGTON, D. C.

TREASURY DEPARTMENT

BUREAU OF

THE PUBLIC HEALTH SERVICE

WASHINGTON

100 FEB-25-1938 10:47

February 24, 1938

Surgeon R. R. Sayers,
Bureau of Mines,
Department of Commerce,
Washington, D. C.

Sir:

*Formerly in residence
has just returned*
Receipt is acknowledged of your letter of
February 20th, enclosing copies of letters from
Dr. A. J. Laana and Dr. F. V. Meriwether, regarding
the interpretation of X-ray pictures for the Johns-
Manville Corporation of employees working at the
corporation's plant in New Jersey.

I do not approve of Dr. Meriwether's under-
taking the interpretation of films in this instance,
either with remuneration or without, since this work
appears to be only for the benefit of one company
and can not be considered as research work.

I believe, too, that the undertaking of such
work would be unfortunate from the standpoint of the
Public Health Service as the results obtained might
be introduced as evidence in court, or the officer
who made the interpretations might be subpoenaed
as a witness.

Respectfully,

H. S. Cumming

H. S. Cumming
Surgeon General

R.R.S.

MTC 001416

C O P Y

JOHNS-MANVILLE CORPORATION

292 Madison Ave.,
New York, N. Y.

February 26, 1932.

Dr. F. V. Meriwether,
Surgeon in Charge, Bureau of Mines,
Cooperative Clinic,
Picher, Oklahoma.

Dear Sir:

Dr. A. J. Lanza of the Metropolitan Life Insurance Company has advised us that he would seek the favor of your services in the reading and interpreting of X-ray films which will be made in connection with the physical examinations of the employees of Johns-Manville Corporation at its Manville, New Jersey Plant.

We have not heard further from Dr. Lanza, but have received a copy of your letter of February 16th to Dr. E.E. Fellowes in which you request that a fairly hard type of film be used in taking the X-rays and we assume, therefore, that you have seen fit to undertake this work.

We would be pleased, however, to have you communicate directly with us and advise us of your acceptance of the assignment, and we would like to be further advised if the fee of \$200.00 tentatively suggested by Dr. Lanza for making these readings will be satisfactory to you.

I do not know whether Dr. Lanza informed you of the facts, but we have had several suits brought against us by former employees alleging pulmonary disorders induced by dusty conditions at the factory. There is a possibility that other suits may be instituted by the same attorney who represents the plaintiffs in the pending suits. Such being the case, you will readily appreciate that we desire the results of your readings to be held in strictest confidence and that no unnecessary publicity be given to the fact that you are making these readings for us. We are making an honest effort to ascertain just what the conditions are among our employees and intend to use all reasonable efforts to improve the health of our employees and the conditions under which they work, but we wish, if possible, to prevent the results of our efforts being used against us either in the pending suits or in any suits which may be brought against us.

I am advised that the first set of plates will be sent you during the early days of March.

Yours very truly,
(Signed) S. A. WILLIAMS,
Vice-President.

MTC 001417

February 27, 1932. HEB/BJD

Dr. F. V. Harivether,
U. S. Bureau of Mines,
Picher, Okla.

Dear Dr. Harivether:

The Bureau of Mines has been requested to carry on a study at Paping, Wisconsin. I am asking Dr. Russell to do this and have requested him to visit the Picher Clinic and discuss the various phases of silicosis with you in order that any differences of opinion may be eliminated, should there be any. I very much doubt that there will be any difference of opinion between Dr. Russell and you regarding silicosis.

Dr. Russell will probably arrive a few days before Dr. Lanza and I am very sure that he will appreciate any suggestions that you may have. I would also suggest that you obtain such information as he may have available on the subject due to his experience in talc and granite. He will be very glad to learn what he can on the technique of operating an X-ray machine. It probably will be well to give him the privilege of making a few X-rays.

Yours sincerely,

R. E. SAYERS
Chief Surgeon, U.S.B. of M.
Surgeon, U.S.P.H.S.

VP

Dust Study

RRB

74866

437.1

MTC 001418

March 1, 1932.

Mr. S. A. Williams, Vice-Pres.,
Johns-Manville Corporation,
838 Madison Avenue,
New York, N. Y.

Dear Sir:

I have your letter of February 26 with reference to my sending the X-ray films made in connection with the physical examination of employees of the Johns-Manville Corporation at its Manville, New Jersey Plant. The letter which I received from Dr. Lanes on this matter was forwarded to the Chief Surgeon of the Bureau of Mines at Washington, D.C., (Dr. E.H. Syrett), for his approval, and if such approval is obtained I can undertake the work. I would, therefore, suggest that no films be sent to me until such consent is obtained.

I will notify Dr. Lanes upon receipt of Dr. Syrett's decision.

Yours respectfully,

F. V. Meriwether
F. V. Meriwether,
Surgeon in Charge.

MTC 001419

1
UNITED STATES DEPARTMENT OF COMMERCE

BUREAU OF MINES CO-OPERATIVE CLINIC

PICHER, OKLAHOMA

March 1, 1932.

BUREAU OF MINES
WASHINGTON, D. C.
1932 MAR - 3 - PM 12:05

Dr. R. E. Sayers,
Chief Surgeon,
Bureau of Mines,
Washington, D. C.

Dear Dr. Sayers:

I am enclosing copy of a letter from the
Johns-Manville Corporation and a copy of my reply to
it.

Yours respectfully,

F. V. Meriwether
F. V. Meriwether
Surgeon in Charge.

R

RRB

439

MTC 001420

Metropolitan Life Insurance Company

Frederick H. Edert, President

A. J. LANZA, M.D.
ASSISTANT MEDICAL DIRECTOR

New York City

March 24, 1932

Personal

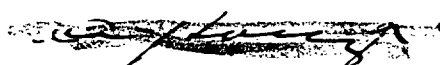
Dr. F. V. Merriweather,
United States Bureau of Mines Clinic
Picher, Oklahoma

Dear Doctor Merriweather:

On Tuesday Doctor Thompson, Doctor Sayers, and I had an interview with the Surgeon-General, and upon explaining the situation to him he was thoroughly agreeable to having you read the Johns Manville X-ray films. I so informed Mr. Vandiveer Brown, the General Counsel, yesterday and he is going to start shipping the films to you. To make the record straight, Mr. Brown will write a letter to the Surgeon-General, on receipt of which the Surgeon-General will write another letter to Doctor Sayers and everything will be in order.

With best regards,

Sincerely,


Assistant Medical Director

*Compassion is
not officially
best interest
and with
doubt can to
protect your
interests*

MTC 001421

March 24, 1946

Personal

Dr. F. V. Huntington
United States Bureau of Glass & Lenses
Pittsburgh, California

Dear Doctor Huntington:

On Tuesday, March 19, 1946, I had an interview with the Surgeon-General, and upon explaining the situation to him he was thoroughly sympathetic in having you read the Glass Research Society film. I so informed Dr. William H. Brown, the General Counsel, yesterday and he is going to start shipping the film to you. He will also send straight, Dr. Brown will write a letter to the Surgeon-General, in receipt of which the Surgeon-General will write another letter to Doctor Brown and everything will be in order.

With best regards

Sincerely,

Assistant National Director

001078

MTC 001422



Johns-Manville

MANVILLE, NEW JERSEY

March 25th, 1932.

Dr. F. V. Meriwether,
Surgeon in Charge, Bureau of Mines,
Cooperative Clinic,
Picher, Oklahoma.

Dear Sir:

There is being sent you via express prepaid a case containing 330 X-Ray films for reading and interpretation. These films have been sent you at the request of Dr. Lanza of the Metropolitan Life Insurance Company.

You will find attached to each film a card bearing a number corresponding to the number appearing on the film, and we would be pleased to have you write your findings on this card, and after this has been done, return the cards and films marked for the attention of the writer via express collect. Attached hereto, you will find a list of the numbers appearing on the X-Rays, which you may use in checking.

Facts in connection with these films are explained in letter of February 26th, 1932 written to you by our Mr. S. A. Williams, Vice President.

We expect to have approximately 600 films when examinations are completed, and the shipment just sent you is the first installment. Our program calls for the taking of about 100 films per week, and we will send you weekly installments until the survey is finished.

Would appreciate your kindly advising us when we may expect the return of these 330 films.

Yours very truly,

JOHNS-MANVILLE CORPORATION,
A. MacD. Hughes
A. MacD. Hughes, Mgr.,
Personnel Department.

AH:CIW
encl.

MTC 001423

X-RAY NUMBERS.

166	2110	4	334	293	700
110	1116	109	1646	192	701
328	636	551	484	213	708
760	1143	153	333	86	238
1331	1498	1234	107	201	2007
120	1474	1128	493	322	856
331	638	111	3	184	855
563	1325	1347	131	346	711
646	651	132	332	221	223
647	652	1134	1121	383	458
1236	1600	302	52	205	537
649	1666	1137	106	347	369
645	1133	309	41	235	1891
329	1346	33	316	374	630
49	1733	1087	178	352	779
320	29	562	114	216	658
321	1477	1232	134	241	1479
1709	1462	1229	335	1432	659
1739	398	1270	177	345	2062
1621	141	341	552	193	715
51	128	303	858	465	754
315	1439	162	775	409	6
330	1140	64	365	288	63
1507	496	1225	179	1280	16
2	792	34	2123	635	9
1054	80	112	50	15	0151
528	133	1887	695	815	11
1490	1119	1243	57	643	0137
5	1329	44	662	1310	1165
508	1727	1186	1290	642	224
1296	1110	79	1237	42	226
1467	1330	336	66	466	231
492	1298	105	531	1278	367
12	36	1889	43	202	1282
1301	1107	1879	103	1279	366
1802	499	308	116	1276	229
10	1240	1971	149	516	360
1101	639	175	45	203	1860
1103	650	324	117	525	67
22	1465	1	705	663	189
100	654	1297	801	351	1309
127	1517	653	249	595	1345
1294	668	1142	699	517	68
311	1492	756	544	1422	1299
1663	534	104	788	208	1100
113	19	13	782	555	
1342	524	1285	1428	353	
126	77	655	1433	222	
498	59	130	342	212	
735	122	17	1281	535	
180	56	124	379	354	
1501	145	757	519	217	
581	1302	726	233	215	
1697	108	304	597	2038	
39	1602	413	357	406	
244	155	660	868	234	
656	0148	176	242	713	

MTC 001424

APPROVED BY THE NATIONAL ARCHIVES

April 1, 1932:

Dr. A. J. Lanza,
General Motors Bldg.
Detroit, Michigan.

Dear Dr. Lanza:

During my absence at Amarillo, the 330 Johns-Manville pictures came in, as well as your letter saying that the Surgeon General had given his consent to my reading these pictures.

I am now reading these pictures, and as soon as I receive permission direct from the Surgeon General, I shall forward my report to the Johns-Manville Company. I am very interested in seeing how the X-ray readings will check with the fluoroscope readings.

With best regards, I am

Yours respectfully,

F. V. Meriwether,
Surgeon in Charge.

MTC 001425

(COPY)

April 1, 1932

Mr. A. Hughes,
C/o Johns-Manville,
Manville, N. J.

Dear Sir:

We are in receipt of a box of 330 X-ray films from your organization and also a communication from Dr. Lanza stating that permission from the Surgeon-General to read these films has been granted.

As soon as permission is received direct from the Surgeon-General I will read and return these films to you in accordance with your directions.

Yours respectfully,

~~P. V. MERRIWETHER~~
Surgeon in Charge

MTC 001426



Johns-Manville

292 MADISON AVENUE
NEW YORK CITY

egb.

April 4, 1932

Dr. A. J. Lanza, Medical Consultant,
General Motors Corporation,
Detroit, Michigan.

Dear Dr. Lanza:

I am enclosing herewith a copy of a letter which Mr. Hughes has received from Dr. Meriwether under date of April 1, 1932 and from which you will note on this date Dr. Meriwether had not yet received permission from the Surgeon-General to read the films.

The letter suggested by you was sent to the Surgeon-General on March 23rd over the signature of Mr. Voorhees. I suppose in a matter of this sort we must expect a certain amount of bureaucratic delay. We hope, however, that the notice to Dr. Meriwether that he may do this extra work will not be unduly delayed and it occurred to me that you might possibly be able to speed up the machinery by a letter addressed to one of your good friends in the Surgeon-General's Department.

I greatly enjoyed seeing you on your recent visit to the City and we are all very grateful to you for your very valuable assistance.

Sincerely yours,

Vandiver Brown

Vandiver Brown
Attorney

VB:T
Enclosure

MTC 001427

GENERAL MOTORS CORPORATION

DETROIT, MICHIGAN

April 6, 1938.

Ans / 4/11/32 / RRS

Dr. E. R. Sayers, Chief Surgeon,
U. S. Bureau of Mines,
Washington, D.C.

~~CHIEF SURGEON~~

Dear Doctor Sayers:

Attached is correspondence received today from
Mr. Brown of the Johns-Manville Corporation.
Can you help things along?

Sincerely,

A. J. Lanza

A. J. Lanza, M.D.
Medical Consultant.

RRS

MTC 001428

W

R. R. Sayers
Chief Surgeon
Washington, D. C.
April 11, 1932.

Dr. F. V. Norisether,
U. S. Bureau of Mines,
Pittsburgh, Pa.

SATISFACTORY TO PUBLIC HEALTH SERVICE YOU MAKE INTERPRETATION
XRAY NEGATIVES ACCORDING LAFRAN SUGGESTION

SAYERS :

R

RRS.

MTC 001429

April 11, 1932. H.S/S JL

Dr. F. V. Meriwether,
U. S. Bureau of Mines,
Picher, Okla.

Dear Dr. Meriwether:

Dr. Lanza, Dr. Thompson, and I called on the Surgeon General in regard to you reading the X-ray negatives for comparison with fluoroscopic interpretation of the same individuals. Dr. Lanza was to write a letter to the Surgeon General stating the conditions. As I understand it, this letter has been sent and received. The Surgeon General, Dr. Thompson, and I thought it would be entirely proper for you to read the negatives for the investigative purpose, it being understood that the interpretations made by you were for scientific purposes only, the negatives being identified by number and not by the individual.

Dr. Thompson advised me this morning that you should proceed to make the interpretations for the above purpose.

Yours very truly,

R. R. SAYERS
Chief Surgeon, U.S.B. of M.
Surgeon, U.S.C.P.H.S.

cc - Dr. Lanza.
Files ✓

R
mra

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h. h.

MTC 001430

April 19, 1932.

Mr. A. MacD. Hughes, Mgr.,
Personnel Department,
Johns-Manville Corp.,
Manville, New Jersey.

Dear Sir:

Upon receipt of orders from the Surgeon General, I completed the reading of 330 X-ray pictures sent me by your company on March 25. As requested by you, I wrote the findings on the small card attached to each film, and I am returning the films to you today as shipped.

In accordance with readings, I find that 212 of the pictures were essentially negative. A number of these men had far more thickening than normal with considerable mottling, but I did not regard this as being sufficient to diagnose as asbestosis. However, it is my opinion that in a number of instances these men will develop asbestosis in a relatively short time. This applies to all cards marked "decidedly more fibrosis than normal", of which there were 9, one of which had suspected tuberculosis. From a purely technical point of view these cases are essentially negative at the present time.

According to readings, 89 had first degree asbestosis, 11 had second stage asbestosis, and one had third stage asbestosis. There were three cases of asbestosis with suspected tuberculosis, two in first degree asbestosis and one in third degree asbestosis. There was one film that was questionable but suggested asbestosis 1 (picture was thin).

This was an especially good lot of films; the technic used was excellent. There were one or two cases, as noted on the cards attached to the films, that would be very interesting to follow up to see if they do not have some sporadic infection of the lungs. If it is convenient, I would appreciate learning the findings on these latter cases.

Upon receipt of the balance of the films, I will be in position to expedite the return of findings to you.

Yours respectfully,

F. V. Merivether,
Surgeon in Charge,
U. S. Bu. of Mines,
P.A. Surgeon, U.S.P.H.S.

CC - Dr. Lanza
Dr. Fellows

MTC 001431

UNITED STATES DEPARTMENT OF COMMERCE

BUREAU OF MINES CO-OPERATIVE CLINIC

PICHER, OKLAHOMA

April 19, 1932.

JOHN - MANSVILLE X-RAY DIAGNOSIS.

(Total x-rays 330.)

Decidedly more fibrosis than normal, bordering on Asbestosis 1-----	8	/
Decidedly more fibrosis than normal with suspected T.B.-----	1	/
Asbestosis 1(Beginning)-----	57	/
Asbestosis 1-----	25	/
Asbestosis 1 with suspected T. B.-----	2	/
Late Asbestosis 1-----	4	/
Late Asbestosis 1 with inflammatory process in left base-----	1	/
Some asbestosis with Tubercular or Apirilli Abscess-----	1	/
Late Asbestosis 1, bordering on Asbestosis 2.-----	2	/
Early Asbestosis 2.-----	9	/
Late Asbestosis 2.-----	4	/
Late Asbestosis 2 with probable basal pleurisy-----	1	/
Beginning Asbestosis 3-----	1	/
Beginning Asbestosis 3 with suspected T. B.-----	1	/
Questionable, but suggest Asbestosis 1-----	1	/

Total 118

5 boxes contained	40 x-ray pictures--	200
2 " "	43 " "	86
1 Box	44 " "	44
	Total--	330

118

212--Essentially negative x-rays.

MTC 001432



Johns-Manville

MANVILLE, NEW JERSEY

April 19th, 1933

Dr. F. V. Merivether,
Surgeon in Charge, Bureau of Mines,
Cooperative Clinic,
Ficher, Oklahoma.

Dear Sir:

Supplementing my letter to you of March 25th and your
reply of April 1st, I understand from Dr. Lanza that
you now have official permission to read the films,
which we shipped you.

We have approximately 400 more films ready for shipment,
and would appreciate an expression from you as to just
how you desire to have these films sent you in the future;
that is, the size of the allotments.

Yours very truly,

JOHNS-MANVILLE CORPORATION.

A. MacD. Hughes
A. MacD. Hughes, Mgr.,
Personnel Dept.

AH:CIW

MTC 001433

April 22, 1932.

Mr. A. MacD. Hughes, Mgr.,
Personnel Department,
Johns-Manville Corp.,
Manville, New Jersey.

Dear Sir:

In answer to your letter of April 19, wish to say that we returned the 330 films to you as shipped on April 19, together with a letter summarizing the findings of the X-ray readings.

You may ship the remainder of the films at your convenience in any size allotments suitable to you.

Yours respectfully,

F. V. Meriwether,
Surgeon in Charge,
U. S. Bureau of Mines,
P. A. Surgeon, USPHS.

MTC 001434



Johns-Manville

MANVILLE, NEW JERSEY

April 26th, 1932.

Dr. F. V. Meriwether,
Surgeon in Charge, Bureau of Mines,
Cooperative Clinic,
Picher, Oklahoma.

Dear Sir:

This will acknowledge receipt of your letter of April 19th, also box containing 330 films which were received yesterday. We note in your findings on positive cases, you use the term "Asbestosis". Unfortunately, we did not tell you the complete story as to the past history of the employees, whose pictures you interpreted. The greater majority of these cases have their past history complicated by other dust occupations, principally coal mining.

The box of films which we are sending you today by express prepaid, containing 464 films, has on the reverse side of each card the past history of the employee. If the past history is insignificant, there is no notation on the reverse side of the card. We hope that this additional information will help you in your interpretations, and possibly may aid you in trying to find some difference between Asbestosis and the other forms of Pneumoconiosis. We are attaching hereto a list of these 464 films being shipped today, which you may use for checking.

In our examinations at the plant of fluoroscopy, etc., Dr. Sabatelle has been calling cases with no significant past history "Asbestosis", and cases with a history of previous dust occupations have been called "Pneumoconiosis", because of the impossibility of deciding where the dust infection occurred. This has been done because passing an opinion of Asbestosis on a patient who previously worked in dust brings up a medical-legal problem before us. For this reason, we would like to have something similar to this in your opinions. Unfortunately, you have already completed the first 330 films. We feel that the same should be done with those. We can either return the cards alone, with the past history on the back, or if you wish and it is necessary, we can again return the films.

We also note on the X-Ray cards that you did not sign them. In order that these records may be of any value to us, it is felt the signature of the interpreter should be on the findings. Possibly, you did not sign these cards for a good reason, but we would appreciate an expression from you in this regard.

Very truly yours,

JOHNS-MANVILLE CORPORATION,

A. MacD. Hughes
A. MacD. Hughes, Personnel Mgr.

AR:CIW

MTC 001435

X-RAY NUMBERS.

423	1105	292	727	1363	722	1435
0299	1293	445	690	1681	720	785
820	1131	294	28	1688	1761	1410
361	1308	422	1253	35	1407	1691
125	549	154	767	164	1718	611
1348	553	1183	529	73	173	615
348	1141	1473	21	1077	172	1264
123	1230	18	692	191	84	1558
2006	1725	1638	773	169	952	1122
372	1672	1150	696	1349	431	1145
207	1161	1254	514	1483	1321	1328
671	682	1292	1470	230	305	459
750	1178	1138	40	1707	1262	2028
220	506	1149	48	1464	1500	1326
0314	683	289	1504	82	1273	1260
805	670	2022	1471	1994	392	1160
240	494	2033	572	1703	1153	790
243	684	291	142	1692	1324	1478
527	138	313	2039	1436	1565	774
1868	1108	298	1272	1594	1111	1486
1870	60	266	186	129	344	1472
2029	65	252	1303	1475	1332	948
246	310	1999	2083	1592	433	1736
1858	148	418	741	1460	400	738
253	1135	26	1320	1406	404	530
1863	306	339	796	1461	152	495
255	24	140	151	1402	1258	1705
277	1089	1256	428	1408	411	1481
143	58	0255	1306	547	1405	1853
1982	269	7	1257	1466	737	743
598	1896	1244	182	376	1593	1090
2000	857	32	419	1078	629	1219
368	2047	1252	1007	1083	1114	2097
395	810	337	168	1598	734	1512
385	432	541	338	1715	723	771
286	402	661	1610	1596	1120	1589
405	424	686	426	480	1207	1494
1981	282	761	797	1409	1641	1209
483	287	1080	325	1206	415	1449
526	156	1639	748	1552	758	1094
1228	160	688	604	625	724	786
1096	165	816	163	1204	421	482
0165	510	0141	14	957	762	1419
20	626	730	605	1979	1158	475
1231	512	783	777	1752	436	739
1615	136	765	170	1469	1170	1633
502	69	1093	697	1053	1590	1216
1734	71	78	718	1210	1208	1079
664	487	1288	674	1066	1539	1740
513	101	609	698	1726	1159	507
665	2048	1203	27	485	619	1680
1129	2044	1760	1311	1217	1213	2040
667	2037	1220	327	1476	451	2015
673	2003	603	190	456	1167	1275
1468	285	1173	181	1606	1484	976

X-RAY NUMBERS.

1649	1336
1212	575
751	1485
1261	1599
1701	1766
1327	522
1215	1587
1268	1571
1295	623
1139	764
491	766
1263	472
1154	745
956	1669
460	1403
1291	600
1567	1620
1854	1502
1102	276
486	317
1404	87
1127	1493
1335	
1855	
1337	
1274	
1667	
1416	
503	
1245	
1482	
1414	
1034	
913	
1010	
1619	
1266	
1446	
1569	
1584	
1444	
511	
538	
631	
1265	
617	
1716	
455	
1487	
1583	
622	
1613	
1003	
1765	
461	
1353	

May 2, 1932.

Mr. A. MacD. Hughes,
Personnel Manager,
Johns-Manville Corp.,
Manville, New Jersey.

Dear Sir:

In reply to your letter of April 26, the term "Asbestosis" was used as indicating fibrosis, and does not refer to the type of fibrosis or pneumoconiosis present. In reading these pictures, it was thought that some should have been termed definite silicosis with some asbestosis, and some were regarded possibly as anthracosis or bituminosis. I recall one case which I pointed out to the younger officers as a typical coal picture, but inasmuch as it was included in this study of an asbestosis condition, it was regarded as asbestosis.

If I had known at the time I was reading the pictures that you desired some information on the character of the dust or fibrosis, I would have been glad to have made a notation of this on the cards. If you care to return the films, I will undertake to read them without the histories, and will suggest the type of dust involved, and you can check them against the histories. I would much prefer in making these readings that the pictures themselves be returned, as some of them undoubtedly showed the effect of both dusts, and my opinion would depend upon the dominating changes noted. In regard to the additional pictures you are sending, I will try to conform to the readings of Dr. Sabatelli.

In a number of instances in reading these pictures, I noted that there were inflammatory changes that were not regarded as associated with dust. One case was particularly interesting. It is my opinion that these cases were the result of infection, probably associated with dust, but not directly caused by it. For some time we have been carrying on an investigation into this subject, and for this reason I feel that the history of the physical examination would be of considerable value in arriving at a true diagnosis, particularly if there has been a Wassermann test made. If you have not been making a Wassermann test, I would certainly suggest that this be done in the balance of the examinations. A sputum test should be made whenever obtainable, not only for tuberculosis, but I believe to be absent in most of the cases, but particularly for spirilli and spirochetes.

MTC 001438

Mr. A. MacD. Hughes,
Johns-Manville Corp.

-2-

5-2-32

I noted a place for signing the cards, but inasmuch as I understood the records were for readings only, and the interpretations were not to be used in any other manner, I decided it would probably be better not to sign them.

Yours respectfully,

E. V. Meriwether,
Surgeon in Charge,
U. S. Bu. of Mines,
P. A. Surgeon, U.S.P.H.S.

MTC 001439

UNITED STATES DEPARTMENT OF COMMERCE

BUREAU OF MINES CO-OPERATIVE CLINIC

PICHER, OKLAHOMA

June 7, 1932.

--- Third Group ---

John-Mansville Co. X-rays

(8 boxes) Total pictures-346.

Negative-----	125
More fibrosis than normal-----	45
Decidedly more fibrosis than normal-----	90
Slightly more fibrosis than normal-----	13
Decidedly more fibrosis than normal, bordering on Asbestosis 1-----	3
Decidedly more fibrosis than normal, bordering on Pneumoconiosis 1 --	6
Beginning Silicosis 1-----	2
Silicosis 1-----	1
Late Silicosis 1 becoming Silicosis 2-----	1
Beginning Pneumoconiosis 1 -----	8
Pneumoconiosis 1 -----	16
Late Pneumoconiosis 1 -----	5
Beginning Pneumoconiosis 2 -----	2
Pneumoconiosis 2 -----	2
Beginning Pneumoconiosis 3 -----	2
Beginning Asbestosis 1 -----	8
Asbestosis 1 -----	5
Late Asbestosis 1 -----	0
Suspected T.B. -----	3
Early Suspected T.B. -----	1
Old Healed T.B. -----	2
Pneumoconiosis 2 with suspected T.B. -----	1
Pneumoconiosis 1 with suspected T.B: -----	1
Acute inflammatory condition -----	1
Miliary Calcicosis -----	2
Believed to be fibrotic T.B. -diag. should be made from Phy. exam. and Laboratory find. 1	1
	346

PRODUCED AT THE NATIONAL ARCHIVES

MTC 001440

Symposium Held May 8th, 1973
Department of the Interior
Bureau of Mines
Washington, D.C.

The welcoming speech was made by Mr. Schlick, deputy director of the Bureau of Mines, who opened the remarks by stating that their goal was to establish a T.L.V. for tremolitic talc. He indicated that the symposium would be open to submission of written statements until June the 1st., 1973.

Mr. Arthur Nelson then spoke indicating that the Association of American Hygienists standards were not good and that new standards must be established for the talc mining and milling industry. The meeting was then turned over to Dr. Goodman who is the head of the medical staff on environmental safety to the Bureau of Mines who introduced Dr. Kleinfeld.

Dr. Kleinfelds' remarks were a review of his report on pneumonocosis which he had originally reported on from the 1942-1960. His updated report was on two hundred and sixty workers for the periods 1942-1973. He indicated that there were one hundred and eight deaths involved with two hundred and sixty workers, five of them had died from lung cancer at an average age of 60.3 years after a mean exposure of 24.1 years to the talc of New York. This would be four times the expected mortality rate from lung cancer. However, extrapolating the years from 1960 to 1973 with the associate lower T.L.V. and a mean exposure of 30.9 years there were twenty-nine deaths from various causes, but that the mortality rate due to lung cancer was now at/or very close to the norm for nonexposed groups. As an aside he also indicated that the cardiac mortality

in talc workers is lower than would be normally expected in the mortality tables.

The next speaker was Mr. Richard Lamar, research manager of the Celite Division of Johns Mansville. He spoke on the analytical technique for determining trace minerals in talc. The results of his research indicated that for petrographic analysis the electron probe by xray defraction was considered to be the superior method. He felt that chemical analysis did not yeild any good results. He felt that partical shapes would be best analyzed by scanning electron microscopy and that particals size could best be determined by the Andreasen pipette sedimentation method.

The next speaker was Mr. Joseph Mulryan, president of the United Sierra Division, who spoke on the talcs of New York state, California, and Montana. His point was that some of the talcs of California and that the New York state talcs were highly tremolitic but the Montana talc was free of any asbestos form minerals. He also reported on seven workers with more than twenty-five years in the talc mining and milling industry who were currently employed by United Sierra and that all were now free of any signs of carcinomas.

The next speaker was Dr. Humphrey of the R.T. Vanderbilt Company who spoke on the chrystalography of talo and tremolite and made the point that a three to one aspect ratio for crystal structure to define a fibrous partical was a wrong approach and that elongated particals per say are not necessarily fibrous. He had slides which indicated that the tremolitic type of partical

was crystalline in nature and in no way fibrous.

The next speaker was Dr. Smith. He reported on his animal studies by artificial insemination of chrysotile asbestos and tremolitic talc in hamsters. The final conclusions he drew were that low levels of chrysotile asbestos exposure were not carcinogenic and that even high levels, or massive dosages, of tremolitic talc did not produce carcinomas in animals.

The next speaker was Dr. Schepers who reported on extensive pathological studies he conducted on animals by the insemination of talc and also chrysotile asbestos and showed many slides indicating that while chrysotile asbestos was adsorbed into the lung tissue of the animals, in no case was tremolitic talc adsorbed into the lungs. His conclusion was that talc in the lungs has little or no physiological effect upon the animals but that chrysotile asbestos, because of its ferruginous and fibrous nature is highly carcinogenic. He therefore concludes that there is a storage effect of talc which is not injurious but that this is not the case with forms of fibrous asbestos. He further stated that talc dust in the lungs accounted for only approximately 5% reduction in lung capacity and in the case of chrysotile asbestos there was any where from 60% to 100% reduction of lung capacity. It was his opinion that in view of the fact that the lung can function with reasonable normality with only 40% capacity, talc would have little or no effect as a lung inhibitor.

The next speaker was Mr. Harold D. Stanley of Phizer, Inc. who spoke on the identification of talc and asbestos. It was his

conclusions that xray defraction together with transmission electron microscopy would be the best methods to identify contaminates in pure talc.

The next speakers were Mr. Arthur Langer and Mr. William J. Nickerson of the Mt. Sinai School of Medicine in New York, who reported on the earlier reports of Dr. Kleinfeld and also on some studies which were done on other workers who had been exposed for long periods of time to talc dust. Their conclusions were that the present restrictions on the T.L.V.'s of talc of the New York state region were a minimum and should not be changed at this time. They concluded from the data now available all asbestos is bad and none is better than others. This would include the so called tremolitic varieties. They indicated that animal studies, while useful as a research technique, were not completely reliable and that its effects on man were largely unknown at this time because of lack of long histories of medical records on workers exposed to talc dust. They felt that the count of fibers by an inspector could not be readily done differenciating between various types of fibers and that the mean norm of a lenth to width of three to one would be sufficient evidence of fibers in talc.

The last speaker of the afternoon was Dr. Sykes of the Ralph Nader Associates who spoke of his Y.D.A. orientation in as far as talc use in cosmetics and therefore only raising questions and did not have any real answers. However he felt that as the exposure rate to average humans is not known to date and that some talc apparantly is the cause of pneumoconiosis, it would therefore

be advisable for the industry to do much research work in this area to prove its relative safety for use by human beings both in manufacturing and consumer areas. He quoted various isolated cases of extreme exposure to talc dust and also the report of one ovarian tumor in which a talc partical was found at the center, as evidence of possible correlation between talc and cancer in man. While he freely admitted that the test to date were inconclusive he felt that the various agencies of the government should err on the side of caution rather than on the side of the talc producers. He indicated that he had in his possession a "read out" from the Oakridge, Tennessee Computer Bank of all of the complaints registered by various consumers and other medical records concerning the adverse effects of the use of the use of talc by human beings. He expected to have this report ready for filing with the F.D.A. in the near future.

Conclusions: I believe that the major thrust of the arguments for and against the use of talcs was primarily geared toward the use of tremolitic talcs as found in the New York state regions and that is primarily the Bureau of Mines intention of trying to establish a T.L.V. for this area and that as far as talc uses in other industries from other sources, there were not commenting at this time. The remarks of Mr. Mulyan, and several others during the questions and answer periods, seemed to indicate that most of the talc producers wish to disassociate themselves with the New York state tremolite problem and that they wish to have talc specified as to whether or not it was free of any asbestiform minerals including those of the tremolite variety.

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AIRBORNE ASBESTOS FIBER CONCENTRATIONS IN
ASBESTOS MINES AND MILLS IN THE UNITED STATES

BUREAU OF MINES

JULY 1973

DISTRIBUTED BY:

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Health and Safety Program

PB 222 611

BUREAU OF MINES TECHNICAL PROGRESS REPORT

**AIRBORNE ASBESTOS FIBER
CONCENTRATIONS IN ASBESTOS MINES
AND MILLS IN THE UNITED STATES**

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Bullines TPR 72

**AIRBORNE ASBESTOS FIBER CONCENTRATIONS IN ASBESTOS
MINES AND MILLS IN THE UNITED STATES**

by

L. A. Schutz, Walter Bank, and George Weems

**Denver Technical Support Center,
Denver, Colo.**

Bureau of Mines Health and Safety Program

Technical Progress Report 72

June 1973

U.S. DEPARTMENT OF THE INTERIOR

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MTC 001450

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0058699

MTC 001451

AIRBORNE ASBESTOS FIBER CONCENTRATIONS IN ASBESTOS
MINES AND MILLS IN THE UNITED STATES

by

L. A. Schutz,¹ Walter Bank,¹ and George Weems²

ABSTRACT

Personnel of the Bureau of Mines have conducted investigations in the principal asbestos mines and mills in the United States, to determine the concentration of airborne asbestos fibers in the workplace, and to establish the exposure of workers to such fibers. The surveys were conducted using the sampling and evaluation method recommended by the National Institute for Occupational Safety and Health. The method consists of collecting the airborne sample on filters and, after appropriate sample preparation, counting the fibers utilizing phase contrast microscopy. The results of the investigation show that fiber concentrations are low in the asbestos mines but high in the asbestos mills, ranging well above 5 fibers/ml of air based on a count of fibers greater than 5 μ m in length.

INTRODUCTION

Asbestos is a generic term that applies to a number of naturally occurring, hydrated mineral silicates incombustible in air and separable into filaments. The most widely used in industry in the United States is chrysotile ($3\text{MgO} \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$), a fibrous form of serpentine. The other principal mineralogic type, amphibole, includes amosite [$(\text{FeMg})\text{SiO}_3$]; crocidolite [$\text{NaFe}(\text{SiO}_3)_2 \cdot \text{FeSiO}_3 \cdot \text{H}_2\text{O}$]; tremolite [$\text{Ca}_2\text{Mg}_5\text{Si}_8\text{O}_{22}(\text{OH})_2$]; anthophyllite [$(\text{MgFe})_7\text{Si}_8\text{O}_{22}(\text{OH})_2$]; and actinolite [$\text{CaO} \cdot 3(\text{MgFe})\text{O} \cdot 4\text{SiO}_2$].

Chrysotile asbestos occurs chiefly in serpentized peridotite and is distributed in the United States in two principal belts; the eastern belt extends from Maine to Alabama, and the western belt extends from Washington to California, where numerous masses of ultramafic rocks were intruded in Paleozoic and Mesozoic time, respectively. The principal mine in the United States is located at Belvidere Mountain in Vermont. Minor amounts of asbestos have been produced from other deposits in these belts and from scattered occurrences of chrysotile elsewhere. Recently, increased activity toward development for short-fiber chrysotile has occurred in California.

¹Mining engineer.²Supervisory chemist.

0058700

MTC 001452

Chrysotile also occurs in bedded limestone, metamorphosed close to intrusions of diabase. The principal occurrences of this type are in Arizona, where small quantities of long-fiber, low-iron chrysotile have been mined from numerous small deposits.

Several species of amphibole occur in fibrous forms; in the United States only anthophyllite and tremolite are known to have commercial importance. As both the anthophyllite and tremolite occur in ultramafic rocks, associated greenstone, and amphibolite, the overall distribution of amphibole asbestos in the United States is like that of chrysotile. The deposits are generally small and erratic in distribution; a list of States identifying known asbestos deposits with associated basic rock formations is presented in appendix A. The occurrence of asbestos and/or asbestiform fibers is relatively widespread throughout the United States and, while the asbestos is not recovered for commercial purposes, the fibers can be present in the mine or mill atmosphere and may constitute a potential health hazard to miners and mill workmen.

The fact that asbestos or asbestiform fibers may be associated with the mining of other minerals complicates the problem of evaluating the health hazard of dusts.

Almost 1 million tons of asbestos is used in the United States each year. Analysis of production data indicates that approximately 74 percent of the asbestos produced (532,300 tons) was used in the construction industry, while 26 percent (187,400 tons) was used in the nonconstruction industries. Approximately 92 percent of the 532,300 tons used in the construction industry is firmly bonded, in such products as floor tiles, asbestos cements, roofing felts, and shingles; the remaining 8 percent is friable or in powder form present in insulation materials, asbestos cement powders, and acoustical products.³ The 187,400 tons of asbestos used in nonconstruction industries in 1965 was utilized in such products as textiles, friction material including brake linings and clutch facings, paper, paints, plastics, roof coatings, floor tiles, and other miscellaneous products. Mining and milling of asbestos in the United States is a small industry, employing fewer than 1,000 workers, and produces 125,300 short tons of asbestos, or approximately 17 percent of the total asbestos used in the United States.

Based on the results of asbestos surveys completed, the principal health hazards occur in the milling process with only minor problems existing in the mines.

The National Institute for Occupational Safety and Health (NIOSH) has developed criteria for a recommended standard for occupational exposure to asbestos. The criteria include consideration of the following factors: environmental, medical, labeling, personal protective equipment and clothing, appraisal of employees of hazards from asbestos work practices, and monitoring and recordkeeping requirements.

³ Hendry, N. W. The Geology, Occurrences, and Major Uses of Asbestos. Ann. N.Y. Acad. Sci., v. 132, Art. 1, 1965, pp. 1-766.

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The occupational safety and health aspects of the mining and milling of asbestos ores are covered by provisions of the Federal Metal and Nonmetallic Mine Safety Act (30 U.S.C. 725 et seq.), under which provisions the Bureau of Mines has promulgated applicable regulations.

In 1967, the published Threshold Limit Value⁴ was 5 million particles per cubic foot (mppcf) for dusts containing asbestos when collected conventionally with the impinger or midget impinger and counted with the standard light-field counting method. The number concentration represented the visible fragments (small) of asbestos fibers, plus the many associated mineral dust particles.

In 1968, the published "Notice of Intended Changes" proposed that (1) the mppcf be reduced to 2 mppcf and (2) an alternative figure of 12 fibers per milliliter of air (fibers/ml) based on a count of fibers greater than 5 (micrometers) in length be adopted. This figure was based on the membrane filter method at 430X magnification phase contrast illumination.

The aforementioned intended changes were retained in 1969; in 1970, the published proposed changes (1) eliminated entirely the midget impinger sampling method and its number concentration figure and (2) recommended that the alternative value be changed from 12 fibers/ml greater than 5 microns in length to 5 fibers/ml greater than 5 microns in length.

In 1971 and 1972, the "Notice of Intended Changes" retained the 1970 proposal and specified the membrane filter method with 400-450X magnification phase contrast illumination.

To evaluate the degree of the health hazard, the sample results included in this report were compared with the value of 5 fibers per milliliter (fibers/ml) as defined by NIOSH in the document "Criteria for a Recommended Standard . . . Occupational Exposure to Asbestos."

It appears that control practices in current mining and milling operations can be modified to meet the "5 fibers/ml greater than 5 μ m in length" standard. However, in order to meet a standard of "2 fibers/ml greater than 5 μ m in length," the asbestos industry will probably have to develop new processes, or drastically modify present dust control measures. Meeting the latter standard will be more difficult for mills and processing plants than for mines.

DESCRIPTION OF SURVEY

During the latter part of 1971, a program was instituted to conduct investigations in all the active asbestos mines and mills in the United States. Three of the four known active mills and two of the six open-pit mines in California were surveyed. Total employment at the four active mills and the six open-pit mines was reported to be 294.

⁴American Conference of Governmental Industrial Hygienists. Threshold Limit Values for 1967, Recommended and Intended Changes. 1967.

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In Arizona, two of the three known active underground mines and one of the three active mills were surveyed. Total employment at the three mines and three mills was reported to be 25.

The single active open-pit mine and mill in Vermont was surveyed. Total employment in the asbestos mine and mill was 201.

The only known active asbestos open pit in North Carolina was surveyed. Total employment was four.

In Maryland, the one known asbestos mill was surveyed. Total employment was eight.

Total employment for all known active asbestos mines and mills was 541. Of this total, 488 were employed at the mines and mills surveyed. A total of 656 samples was collected and evaluated in these surveys. Table 1 lists asbestos mines and mills surveyed in the United States, their location by city and State, employees at each, and samples collected during the survey at each location. Table 2 lists the average asbestos fiber exposures for the job classifications that were found at the mines and mills.

TABLE 1. - Asbestos mines and mills surveyed, with listing of employment and sampling data

Location	Number of mines		Number of mills	Employees	Number of samples collected		
	Open pit	Under-ground			Breathing zone	General atmosphere	Total
Mines:							
Burnsville, N.C.....	1	-	-	4	17	0	17
Hyde Park, Vt..	1	-	-	58	10	-	10
Coalinga, Calif.....	1	-	-	7	41	0	41
Copperopolis, Calif.....	1	-	-	36	55	0	55
Total, open pits.....	4	-	-	105	123	0	123
Globe, Ariz....	-	1	-	11	15	0	15
Do.....	-	1	-	2	2	0	2
Total, underground	-	2	-	13	17	0	17
Total, mines	4	2	-	118	140	0	140
Mills:							
Baltimore, Md..	-	-	1	8	59	1	60
Hyde Park, Vt..	-	-	1	143	55	2	57
King City, Calif.....	-	-	1	50	50	9	59
Coalinga, Calif.....	-	-	1	31	47	10	57
Copperopolis, Calif.....	-	-	1	135	205	57	262
Globe, Ariz....	-	-	1	3	20	1	21
Total, mills	-	-	6	370	436	80	516
Grand total, mines and mills.	4	2	6	488	576	80	656

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TABLE 2. - Average of asbestos fiber exposures
(daily weighted averages)
in mills and mines

Occupation	Total samples	Asbestos fibers/ml (>5 μ m in length)		
		Highest exposure	Lowest exposure	Average exposure
Mill:				
Blender, bagger, and packer...	132	24.8	2.7	11.3
Palletizer and car loader....	31	18.1	1.2	10.0
Crusher and dryer operator....	32	20.3	7.1	11.0
Foreman.....	32	15.8	4.3	8.3
Laboratory technician.....	33	17.4	4.5	8.8
Laborer.....	37	17.3	8.2	12.1
Maintenance man.....	50	16.9	3.8	8.4
Mill operator.....	50	17.9	4.7	11.5
Other.....	39	10.5	2.3	6.0
Mine:				
Driller.....	31	7.8	1.0	2.8
Explosives man.....	6	.6	.1	.3
Heavy equipment operator.....	55	1.7	.5	1.1
Maintenance man.....	7	.5	.1	.3
Truck driver.....	20	.8	.2	.5
Other.....	21	.8	.04	.5

Sampling methods and evaluation procedures employed in the surveys of asbestos mines and mills are described in appendix B.

DISCUSSION OF SURVEY RESULTS

A summary of the surveys of asbestos mines and mills is presented in figures 1 and 2. Only daily weighted average exposures are listed in these tables. An analysis of figure 1 indicates the "Laborer" occupation has the highest average exposure with 12.1 fibers/ml. (This is due in part to the cleanup work being done by sweeping.)

Following closely in order are mill operators at 11.5 fibers/ml, blenders, baggers, and packers at 11.3 fibers/ml, crusher and dryer operators with 11.0 fibers/ml, palletizers and car loaders with 10.0 fibers/ml, laboratory technicians with 8.8 fibers/ml, maintenance men with 8.4 fibers/ml, foremen with 8.3 fibers/ml, and the lowest average exposure of 6.0 fibers/ml, including the miscellaneous category. Averages for all the occupational classifications were above 5 fibers/ml.

Figure 2 lists exposures of the various occupations in open-pit and underground mines. None of the averages were above 5 fibers/ml.

While a few of the individual samples in some mills were extremely high (to more than 550 fibers/ml), the average of the highest were recorded at the blending, bagging, and packing operations where controls were not well

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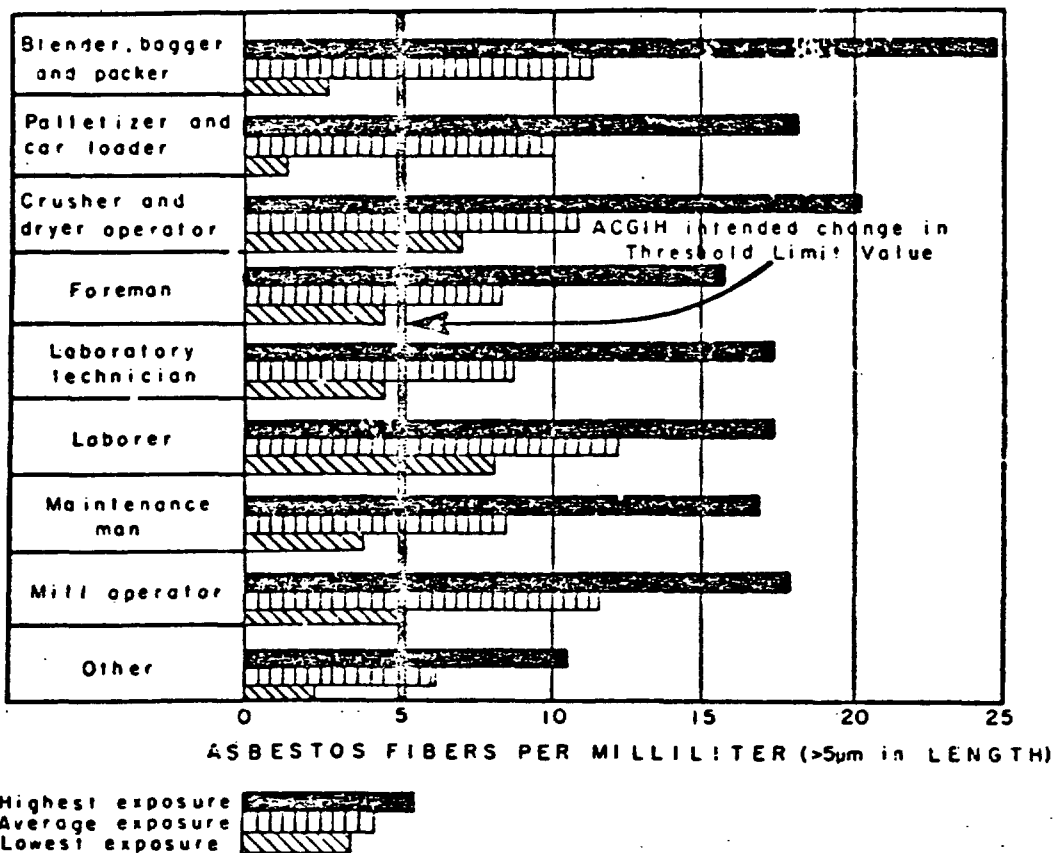


FIGURE 1. - Asbestos fiber exposures (daily weighted averages) in mills.

designed and maintained. Crushing and drying operations were second, with palletizer and car loader operations running third; mill operators, fourth; laboratory technicians, fifth; laborers, sixth; maintenance workers, seventh; foremen, eighth; and miscellaneous operations, ninth. All were well above the value of 5 fibers/ml. In the mines, dry-drilling, without dust collection, resulted in one high average exposure of 7.8 fibers/ml.

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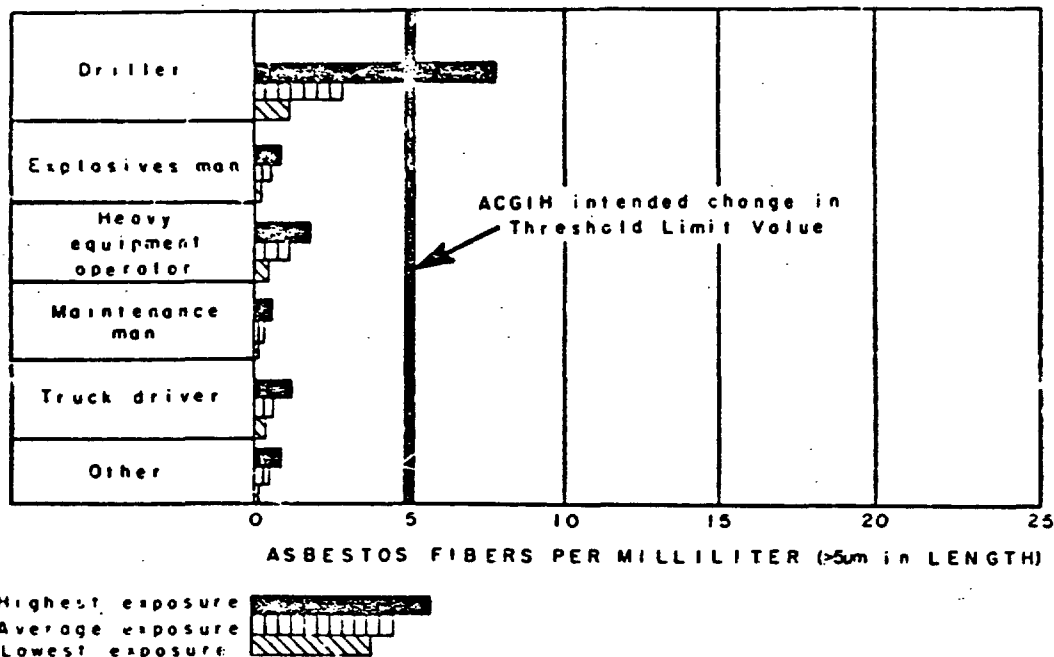


FIGURE 2. - Asbestos fiber exposures (daily weighted averages) in mines.

CONCLUSIONS

1. Some operators are adequately controlling the amount of asbestos fibers in the breathing zone of workmen; however, many are using inadequate control measures and practices which result in workmen being exposed to asbestos fiber concentrations above 5 fibers/ml.

2. The fact that asbestos or asbestiform fibers may be associated with the mining of other minerals complicates the problem of evaluating the health hazards of dusts in mines and mills throughout the United States. (Dust surveys are now routinely including sampling procedures to determine whether this hazard exists.)

3. It is believed that operators of most mills and mines should be able to meet a "5 fibers/ml of fibers greater than 5 μ m in length" standard by following practices such as, but not limited to, those listed below:

a. Installing and using effective and efficient control systems and collectors to prevent dust from becoming airborne.

b. Establishing a rigid maintenance program for process and dust control equipment.

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- c. Packaging the finished product in airtight containers.
 - d. Modifying processing machinery or replacing it with equipment designed to achieve adequate dust control.
 - e. Enclosing all conveyor belts, screens, crushers, and other operations, and using exhaust ventilation and collectors to minimize airborne dust.
 - f. Using vacuum cleaning systems for cleanup work to eliminate airborne dust from sweeping.
 - g. Following established recommended practices for the use of respiratory protective equipment.
 - h. Using accepted permissible methods for controlling dust when drilling in pits and mines.
 - i. Implementing methods for keeping dust at stockpiles, roads, mill-yards, and plant areas from becoming airborne.
 - j. Providing enclosed cabs with filtered air systems for operators of mobile equipment used in mill and mine surface areas.
4. New techniques such as the wet-milling process presently being investigated by some operators should be evaluated as a possible aid in complying with lower standards being considered.

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APPENDIX A.--OCCURRENCE OF ASBESTOS WITH ASSOCIATED BASIC ROCK FORMATIONS IN THE UNITED STATES

The following listing of States indicates known asbestos deposits, with associated basic rock formations:¹

Alabama.--Short-fiber amphibole asbestos; associated basic intrusive rocks.

Arizona.--Chrysotile in serpentine.

California.--Chrysotile in serpentine and in peridotite; tremolite and amphibole and anthophyllite asbestos in serpentine, greenstone, and schist. Some short-fiber and unknown varieties of asbestos in serpentine. Cross-fiber chrysotile in ultrabasic intrusion, in serpentinized saxonite, serpentinized limestone, and chloritized shale. Slip-fiber tremolite and amphibole and actinolite in quartz schists, in serpentine, and in limestone and dolomite.

Connecticut.--Slip- and cross-fiber chrysotile and some pyrophyllite asbestos associated with serpentine.

Georgia.--Long-fiber anthophyllite asbestos associated with peridotite, with talcose and chloritic schist, with pyroxenite, and with biotite-granite gneiss. Cross-, slip-, and mass-fiber amphibole asbestos with biotite granite and hornblende gneiss, and talcose rock associated with granite. Anthophyllite asbestos associated with harzburgite.

Idaho.--Slip-fiber and brittle mass-fiber anthophyllite asbestos in altered harzburgite and in altered dunite.

Maine.--Slip- and cross-fiber chrysotile in serpentine.

Maryland.--Slip-fiber tremolite associated with basic igneous rocks; also anthophyllite and low-quality amphibole asbestos.

Massachusetts.--Chrysotile asbestos in ultramafic rock; amphibole asbestos; fibrous anthophyllite in blocks of saxonite, enclosed in granite; also amphibole asbestos.

Montana.--Brittle tremolite asbestos associated with vermiculite in dike-like masses of pyroxenite; woodlike-fiber anthophyllite in altered peridotite dikes in Precambrian schist and gneiss; chrysotile asbestos in limestone similar to Arizona deposits.

New York.--Chrysotile asbestos veins in serpentinized zones in dolomite; slip- and cross-fiber chrysotile in serpentine.

¹Chidester, A. H., and A. F. Shride. Asbestos in the United States (Exclusive of Alaska and Hawaii). U.S. Geol. Survey, 1962, 11 pp., with accompanying map MR-17.

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North Carolina.--Chrysotile asbestos associated with ultramafic igneous rocks and with dunite and with a large mass of enstatite and in peridotite; anthophyllite asbestos and mass-fiber anthophyllite asbestos associated with altered dunite, with serpentized dunite, and with chlorite in an amphibolite.

Oregon.--Chrysotile asbestos veins in serpentine; short cross-fiber chrysotile asbestos in serpentine; anthophyllite and weak slip- and cross-fiber anthophyllite asbestos along shear zones in schists and greenstones; slip-fiber and iron-free tremolite asbestos in dunite.

Pennsylvania.--Unknown variety of asbestos associated with ultramafic igneous rocks.

Rhode Island.--Crocidolite asbestos.

South Carolina.--Asbestos of unknown variety associated with dikes of pyroxenite altered to amphibolite, in magnesian rocks, in basic igneous rocks, in partly metamorphosed amphibolite, in aphanitic hornblende slates.

Texas.--Tremolite and long brittle tremolite asbestos fibers in the shear zone between hornblendite and mica-quartz schist, in serpentine; small veinlets of chrysotile and small deposits of amphibole asbestos.

Vermont.--Cross- and slip-fiber chrysotile asbestos in serpentine and in unserpentized dunite and peridotite.

Virginia.--Asbestos of unknown variety associated with ultramafic rocks; asbestiform anthophyllite occurring with tremolite; amphibole asbestos and slip-fiber amphibole asbestos; slip-fiber anthophyllite asbestos associated with hornblende and olivine.

Washington.--Cross-fiber chrysotile asbestos in serpentine and in diopside and serpentine; cross-fiber and slip-fiber asbestos of unknown variety in serpentine and in peridotite; silky fibers of amphibole asbestos, fibrous soapstone with amphibole asbestos in shear zones cutting greenstone, short fibers of amphibole asbestos; talcose asbestos in serpentine dike; anthophyllite asbestos in biotite gneiss; tremolite asbestos in dolomite.

Wisconsin.--Cross-fiber chrysotile asbestos veins in peridotite.

Wyoming.--Slip-fiber chrysotile and amphibole asbestos in veins associated with serpentine cut by metadiabase dikes and surrounded by granite gneiss; brittle-fiber amphibole asbestos and talc in a sequence of metamorphic rocks and amphibole asbestos in serpentine.

APPENDIX B.--SAMPLING METHODS AND EVALUATION PROCEDURES¹Air Sampling Methods

In the study of asbestosis conducted by Dreessen, midget impinger count data were used as an estimate of dust exposure. All of the dust particles seen, both grains and fibers, were counted since too few fibers were seen to give an accurate measurement. The resulting count concentration was a measure of overall dust levels rather than a specific measurement of the asbestos concentration. This method was satisfactory at that time since exposures were massive and the control measures installed to reduce overall dust levels also reduced the asbestos dust levels.

As dust levels were reduced, it became necessary to measure the biologically appropriate attribute of the dust cloud. At equal levels of overall dustiness, the concentration of asbestos could vary considerably from textile manufacture (75-85 percent) to insulation (5-15 percent). Furthermore, if the limit were lowered below the 5 mppcf used previously and dust counts were taken by the impinger technique, it would be necessary to consider the effect of background dust, which could be as high as 1 mppcf.

A number of methods for measurement of asbestos dust concentrations have been used in the NIOSH epidemiological study of the asbestos product industry. Based on these data, the preferred index of asbestos exposure is the concentration of fibers longer than 5 μ m counted on membrane filters at 430X magnification with phase contrast illumination. This index is utilized in the method adopted as the standard field sampling method by the Public Health Service. Fibers longer than 5 μ m are counted in preference to counting all fibers seen in order to minimize observer and/or microscope resolving power variability. Furthermore, the British define a "fibre" as a particle, "of length between 5 μ m and 100 μ m and having a length-to-breadth ratio of at least 3:1, observed by transmitted light by means of a microscope at a magnification of approximately 500X."

Although the British have refrained from standardizing on a single method of measurement, recent measurements have been performed by a method essentially identical to the fiber-count method described in detail below, and the British hygiene standards for use with their asbestos regulations are stated in these terms.

Principles of Sampling

A dust sampling procedure must be designed so that samples of actual dust concentrations are collected accurately and consistently. The results of the analysis of these samples will reflect, realistically, the concentrations of dust at the place and time of sampling.

¹U.S. Department of Health, Education, and Welfare. Criteria for Recommended Standard, Occupational Exposure to Asbestos. Publication HSM 72-10267, sec. VIII, appendix I, 1972, pp. VIII-1 through VIII-8.

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To collect a sample representative of airborne dust that is likely to enter the subject's respiratory system, it is necessary to position a collection apparatus near the nose and mouth of the subject or in his "breathing zone."

The concentration of dust in the air to which a worker is exposed will vary, depending upon the nature of the operation and upon the type of work performed by the operator and the position of the operator relative to the source of the dust. The amount of dust inhaled by a worker can vary daily, seasonally, and with the weather. To obtain representative samples of workers' exposures, it is necessary to collect samples under varying conditions of weather, on different days, and at different times during a shift.

The percentage of working time spent on different tasks will affect the concentration of dust the worker inhales since the different tasks usually result in exposure to different concentrations. The percentage can be determined from work schedules and by observation of work routines.

The daily average weighted exposure can be determined by using the following formula:

$$\frac{(\text{Hours} \times \text{conc. task A}) + (\text{Hours} \times \text{conc. task B}) + \text{etc.}}{8 \text{ hours (or actual hours worked)}}$$

The concentration of any air contaminant resulting from an industrial operation also varies with time. Therefore, a longer sampling time will better approximate the actual average.

With the following recommended sampling procedure, it is possible to collect samples at the workers' breathing zones for periods from 4 to 8 hours, thus permitting the evaluation of average exposures for a half or full 8-hour shift--a desirable and recommended procedure. Furthermore, dust exposures of a more normal work pattern result from the use of personal samplers. In evaluating daily exposures, samples should be collected as near as possible to workers' breathing zones.

Collecting Sample

The method recommended in this report for taking samples and counting fibers is based on a modification of the membrane filter method described by Edwards and Lynch. The sample should be collected on a 37-mm Millipore type AA² filter mounted in an open-face filter holder. The holder should be fastened to the worker's lapel.

Air is drawn through the filter by means of a battery-powered personal sampler pump similar to those approved by NIOSH under the provisions of 30 CFR 74. The filters are contained in plastic filter holders and are

²Mention of commercial products does not constitute endorsement by the Public Health Service, the U.S. Department of Health, Education, and Welfare, or the Bureau of Mines.

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supported on pads which also aid in controlling the distribution of air through the filter. To yield a more uniform sample deposit, the filter-holder face caps should be removed. Sampling flow rates from 1.0 liter per minute (lpm) up to the maximum flow rate of the personal sampler pump (usually not over 2.5 lpm) and sampling times from 15 minutes to 8 hours are acceptable provided the following restraints are considered:

1. In order to obtain an accurate estimate of the number of fibers, the statistical error resulting from the random distribution of the fibers must be kept to an acceptably low level. Since fiber counts follow a Poisson distribution, a count of 100 fibers in a sample would have a standard deviation of $\sqrt{100}$, or 10 fibers, or ± 10 percent. Thus, the 95-percent confidence limits would be approximately 2 standard deviations, or ± 20 percent. Since the 37-mm filter has an effective collecting area of 855 mm² and the projected field area of the Porton reticle is 0.005 mm², each field represents 1/171000 of the sample. Based on this ratio, the following number of fields must be counted to measure the various limits in various sampling times:

Sampling time, minutes	Flow rate, lpm	Number of fields for 100 fibers		
		0.2 fiber/ml	2.0 fibers/ml	10 fibers/ml
10	2	4,350	435	91
15	2	2,860	286	<u>58</u>
30	2	1,430	143	<u>29</u>
90	1	1,000	100	20
90	2	500	<u>50</u>	10
240	1	260	<u>26</u>	<u>7</u>
240	2	180	<u>18</u>	4
480	1	180	<u>18</u>	4

2. Do not count a field containing over 20 fibers because, in addition to the fibers being counted, there are also present a number of grains, which interfere with the accuracy of the count.

Based on these restraints--that is, number of fields to be counted and maximum number of fibers per field--acceptable sampling parameters for the various limits are underlined in the above table.

The following conclusions may be drawn from this analysis:

1. The short-term limit should be for a period of at least 15 minutes and preferably 30 minutes.

2. The 2.0-fiber/ml limit may be evaluated over periods of from 90 to 480 minutes.

As many fields as required to yield at least 100 fibers should be counted. In general, the minimum number of fields should be 20 and the maximum 100.

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Mounting Sample

The mounting medium used in this method is prepared by dissolving 0.05 g of membrane filter per ml of 1:1 solution of dimethyl phthalate and diethyl oxalate. The index of refraction of the medium thus prepared is $ND = 1.47$.

To prepare a sample for microscopic examination, a drop of the mounting medium is placed on a freshly cleaned, standard (25 mm x 75 mm) microscopic slide. A wedge-shaped piece with arc length of about 1 cm is excised from the filter with a scalpel and forceps and placed dust-side-up on the drop of mounting solution. A No. 1-1/2 coverslip, carefully cleaned with lens tissue, is placed over the filter wedge. Slight pressure on the coverslip achieves contact between it and the mounting medium. The sample may be examined as soon as the mount is transparent. The optical homogeneity of the resulting mount is nearly perfect, with only a slight background granularity under phase contrast, which disappears within 1 day. The sample should be counted within 2 days after mounting.

Evaluation

The filter samples mounted in the manner previously described are evaluated in terms of the concentration of asbestos fibers greater than 5 μm in length. A microscope equipped with phase-contrast optics and a 4-mm "high-dry" achromatic objective is suitable for this determination. 10X eyepieces, one of which contains a Porton or other suitable reticle at the level of the field-limiting diaphragm, should be used. The left half of the Porton reticle field serves to define the counting area of the field. Twenty fields located at random on the sample are counted, and total asbestos fibers longer than 5 μm are recorded. Any particle having an aspect ratio of three or greater is considered a fiber.

The following formulae are used to determine the number of fibers per milliliter:

$$\frac{\text{Filter area (mm}^2\text{)}}{\text{Field area (mm}^2\text{)}} = K \quad (1)$$

$$\frac{\text{Average net count} \times K}{(\text{flow rate ml/min}) (\text{min sampled})} = \text{fibers/ml} \quad (2)$$

For example, assume the following: Area of the filter used was 855 mm^2 , counting area of one field under the Porton reticle was 0.005 mm^2 , average net count per field of 20 fields was 10 fibers, and sample was collected at 2 liters per minute for 90 minutes. Then,

$$\frac{855 \text{ mm}^2}{0.005 \text{ mm}^2} = 171,000 \quad (1)$$

$$\frac{10 \text{ fibers} \times 171,000}{2,000 \text{ ml/min} \times 90 \text{ min}} = 9.5 \text{ fibers/ml} \quad (2)$$

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Calibration of Personal Sampler

The accuracy of an analysis can be no greater than the accuracy of the volume of air which is measured. Therefore, the accurate calibration of a sampling device is essential to the correct interpretation of an instrument's indication. The frequency of calibration is somewhat dependent on the use, care, and handling to which the pump is subjected. Pumps should be calibrated if they have been subjected to misuse or if they have just been repaired or received from a manufacturer. If hard usage is given the instrument, more frequent calibration may be necessary.

Ordinarily, pumps should be calibrated in the laboratory both before they are used in the field and after they have been used to collect a large number of field samples. The accuracy of calibration is dependent on the type of instrument used as a reference. The choice of calibration instrument will depend largely upon where the calibration is to be performed. For laboratory testing, a 1-liter burette or wet-test meter should be used. In the field, a rotameter is the most convenient instrument used. The actual setup will be the same for all of these instruments. The calibration instrument will be connected in sequence to the filter unit which will be followed by the personal sampler pump. In this way, the calibration instrument will be at atmospheric pressure. Connections between units can be made using the same type of tubing used in the personal sampling unit. Each pump must be calibrated separately for each type of filter used, if, for example, it has been decided to use a filter with a different pore size. The burette should be set up so that the flow is toward the narrow end of the unit.

Care must be exercised in the assembly procedure to insure adequate seals at the joints and that the length of connecting tubing be kept at a minimum. Calibration should be done under the same conditions of pressure, temperature, and density as will be encountered. The rotameter should be used only in the field as a check if the diaphragm or piston pumps are not equipped with pulsation dampeners. The pulsating flow resulting from these type pumps causes the rotameter to give results which are not as accurate as that obtained with a burette or wet-test meter. Calibration can be accomplished with any of the other standard calibrating instruments, such as spirometer, Marriott's bottle, or dry-gas meter. The burette and wet-test meter were selected because of their accuracy, availability, and ease of operation.

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