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CHARACTERISTICS OF TALC DUSTS[1]

by

R. S. Lamar[2]

The Nature of Commercial Talcs

It is important to make a clear distinction between commercial talc and talc mineral. Pure talc mineral is a hydrous magnesium silicate having the composition $Mg_6(Si_8O_{20})(OH)_4$.[3] Limited isomorphous substitutions can occur within this structure.[4] Crystal form is generally monoclinic. Individual particles of pure, finely milled talc appear platy or micaceous under the microscope.

Commercial talcs may or may not be pure talc mineral. These products are commonly mixtures of talc mineral with other related minerals that were involved in the paragenesis of the talc mineral.

These associated minerals are in many cases calcite, dolomite, quartz, serpentine, magnetite, magnesite, chlorite, tremolite, anthophyllite, and in some cases chrysotile.[5] These may occur in various amounts and proportions in commercial talcs from different sources or mines. Not all of these associated minerals occur in all commercial talcs. Some products are entirely free from asbestiform minerals, and this distinction is also important.[6]

The so-called "fibrous talcs" appear fibrous because of the presence of asbestiform minerals. Pure talc mineral rarely appears fibrous in crystal habit and is much more commonly platy, lamillar, or micaceous. Specifically, we disagree with the definition of talc (fibrous)--tremolite as it appears in the documentation of the Threshold Limit Values for Substances in Workroom Air," published by the American Conference of Governmental Industrial Hygienists, 1971 edition, 1971, p. 243. It is our opinion that this documentation for talc (fibrous" should be rewritten to eliminate any reference to "fibrous talc" but should refer to the fact that the talc ores can contain fibrous contaminants which are asbestiform minerals. This is important in view of the fact that

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[1] John Wiley & Sons, Inc. Encyclopedia of Chemical Technology. Talc. V. 19, 2d ed., 1969, p. 608.

[2] Research Manager, Celite Division. Johns-Manville Corporation.

[3] Deer, W. A., R. A. Howie, and J. Zussman. Rock-Forming Minerals. V. 3, Sheet Silicates. Longmans, Green and Co., Ltd., London, 1962, p. 121.

[4] See page 124 of work cited in footnote 3.

[5] See pages 126-129 of work cited in footnote 3.

[6] Wilkie, Ben M. Talc Deposits of Steatite Grade, Inyo County, California. Div. of Mines, State of California, Special Rept. 8, August 1951.
Wright, Lauren A. Geology of the Silver Lake Talc Deposits, San Bernardino, California. Div. of Mines, State of California, Special Rept. 38, July 1954.

the definition of the American Conference of Governmental Industrial Hygienists is part of the Federal Mandatory Standard under the Metal and Nonmetallic Mine Safety and Health Act.

In addition to these mineralogical differences, commercial talcs are also supplied in a wide range of particle sizes from 200 mesh, or finer, to less than 5-micron maximum particle size. The end use for the product generally determines the particle size required.[7]

Characterization of Talc Dusts

Talc dusts may be characterized according to mineral composition, chemical composition, particle shape, and particle size. Each of these will be described separately.

Characterization of Mineral Composition

This may be done according to a variety of commonly used and accepted methods.

Petrographic Examination

A highly skilled petrographer, working with a petrographic microscope, can, in many cases, determine various mineral species by measuring such optical properties as index of refraction, extinction angle, birefringence, and crystal habit.[8] As the particle size of a mineral dust is reduced to much below 5 microns these measurements become increasingly difficult and less reliable. Most commercial talcs contain a high proportion of particles smaller than 5 microns and other methods are therefore more reliable.

Electron Probe

The basic principle underlying the identification of materials by X-ray or by electron diffraction is that each crystalline substance has its own characteristic atomic structure which diffracts X-rays or electrons in a particular pattern. The recognition of the pattern establishes uniquely the diffracting substance. Newly developed electron probes, operating through an electron microscope, make possible the identification of individual particles as small as 1 micron by this method. The equipment is very costly and not readily adopted to routine measurements.

X-Ray Diffraction

This is probably the most powerful and useful tool available for the mineral characterization of talc dusts.[9] Using equipment and techniques commonly

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[7] Industrial Minerals. Talc: Micronized Grades Lead the Way. January 1971 p. 9.

[8] Brindley, G. W. Experimental Methods. Ch. 1 in The X-Ray Identification and Crystal Structures of Clay Minerals, ed. by G. Brown. 1961, pp. 35-36.

[9] Page 1 of work cited in footnote 8.

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ployed in the talc industry, it is possible to identify as little as 1 per-
ent of tremolite in otherwise pure talc mineral. There is evidence that dif-
ferent tremolites respond differently and may show different lower limits of
tectability depending on crystal size and perfection.

ferential Thermal Analysis (DTA)

This procedure is useful but not as definitive as X-ray diffraction.
e, chlorite, serpentine, and the carbonate minerals show characteristic
.A. curves but many of the peaks overlap and are not clearly defined in
eral mixtures. Tremolite shows a relatively weak D.T.A. reaction because
its low content of chemically combined water.[10] While D.T.A. is a useful
l for qualitative analysis, it is of limited value for quantitative deter-
ations. Particle size, sample composition, and experimental and instru-
ental variables are complicating factors.

racterization by Chemical Composition

Complete chemical analyses are useful in identifying talc dusts but are
no means definitive. Quantitative analyses by conventional wet methods or
X-ray fluorescent methods only help but do not yield the type of positive
eral identification obtainable by X-ray diffraction.

rticle Shape

Partial morphology, shape, and structure are powerful tools for identifi-
tion of mineral dusts. Measurements made with an ordinary light-microscope
be misleading. For example, a talc platelet observed on edge, or on an
le, may appear to be a fiber. Scanning electron micrographs are far more
lable and revealing because of greater possible magnification and depth of
ld. When observed in this manner, some talc platelets appear to roll up
a tubular shape not unlike kaolin-halloysite or serpentine-chrysotile.
ver, in the case of talc, this tubular structure is far more rare and is
m complete.

rticle Size

Particle size may be determined by direct microscopic measurement using a
r micrometer eyepiece or by measurement of particles in an electron micro-
graph.[11] Television scanning techniques and equipment are also available.
er procedures involve settling rate determinations in water or other
uids. The Andreasen pipette is commonly used for this purpose.[12]

Mackenzie, Robert C. (ed.). The Differential Thermal Investigation of Clays. Mineral. Soc., Clay Minerals Group, London, 1957.

Allen, Terence. Particle Size Measurement. Chapman and Hall Ltd., London, 1968, pp. 45-61.

rr, Clyde, Jr., and J. M. DallaValle. Fine Particle Measurement. The Macmillan Company, New York, 1959, pp. 43-78.

Conclusions

We have attempted to show in the above presentation that the characterization of talc dusts is not simple. No one procedure or method is completely definitive. We believe that mineral composition can best be determined by X-ray diffraction. Particle morphology is best defined by means of scanning electron micrographs and particle size determined by sedimentation involving the Andreasen pipette.

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CHARACTERIZATION AND OCCURRENCE OF TALC

by

H. T. Mulryan[1]

My name is H. T. Mulryan. I am president of Cyprus Mines Corporation's United Sierra Division. The division is the world's largest producer of talc in terms of product value.

It operates talc mines in the States of Montana, Nevada, California, and Texas and talc processing units in the States of Montana, California, and Nebraska, Belgium, and through an affiliate, Mexico.

The division employs about 180 persons at its talc production units. Approximately half of them work in our Montana mines and mills, the remainder are scatterd among the other eight talc locations. The Montana product approaches the purity of pure talc mineral and its habit is platy or granular, depending on the material source and fineness of grind. Figures 1 and 2 illustrate the nature of the particles by transmission and scanning electron microscope, respectively.

On the other hand, mixtures of minerals from other sources may contain little or no talc mineral and still be correctly known commercially as "talc." Figures 3 and 4 show the particle shapes of "talcs" from the Gouverneur district of New York State. The needles or fibers are mainly tremolite with anthophyllite also commonly present.

This type of commercial talc is not confined to New York State, being extensively mined and processed in California. Table 1 compares the mineral content of talc from New York, California, and Montana. The Silver Lake, Calif., tremolitic talc is similar to a typical New York State talc except for the missing anthophyllite and quartz impurities.

TABLE 1. - Comparison of mineral content of talc from New York, California, and Montana, in percent

Talc type	Talc	Carbonate	Tremolite	Anthophyllite	Quartz	Other
New York.....	62	-	30	5	3	-
Silver Lake, Calif...	54	3	43	-	-	-
Panamint, Calif.....	82	12	-	-	Trace	2 Mont. 4 Mica.
Yellowstone, Mont....	99	1	-	-	<0.5	-
Beaverhead, Mont.....	98	1	-	-	-	1 Chlorite

[1]President, Cyprus Mines Corporation's United Sierra Division.

FIGURE 1. - Nature of particles by transmission and scanning electron microscope (X 6,000).

FIGURE 2. - Nature of particles by transmission and scanning electron microscope (X 4,400).

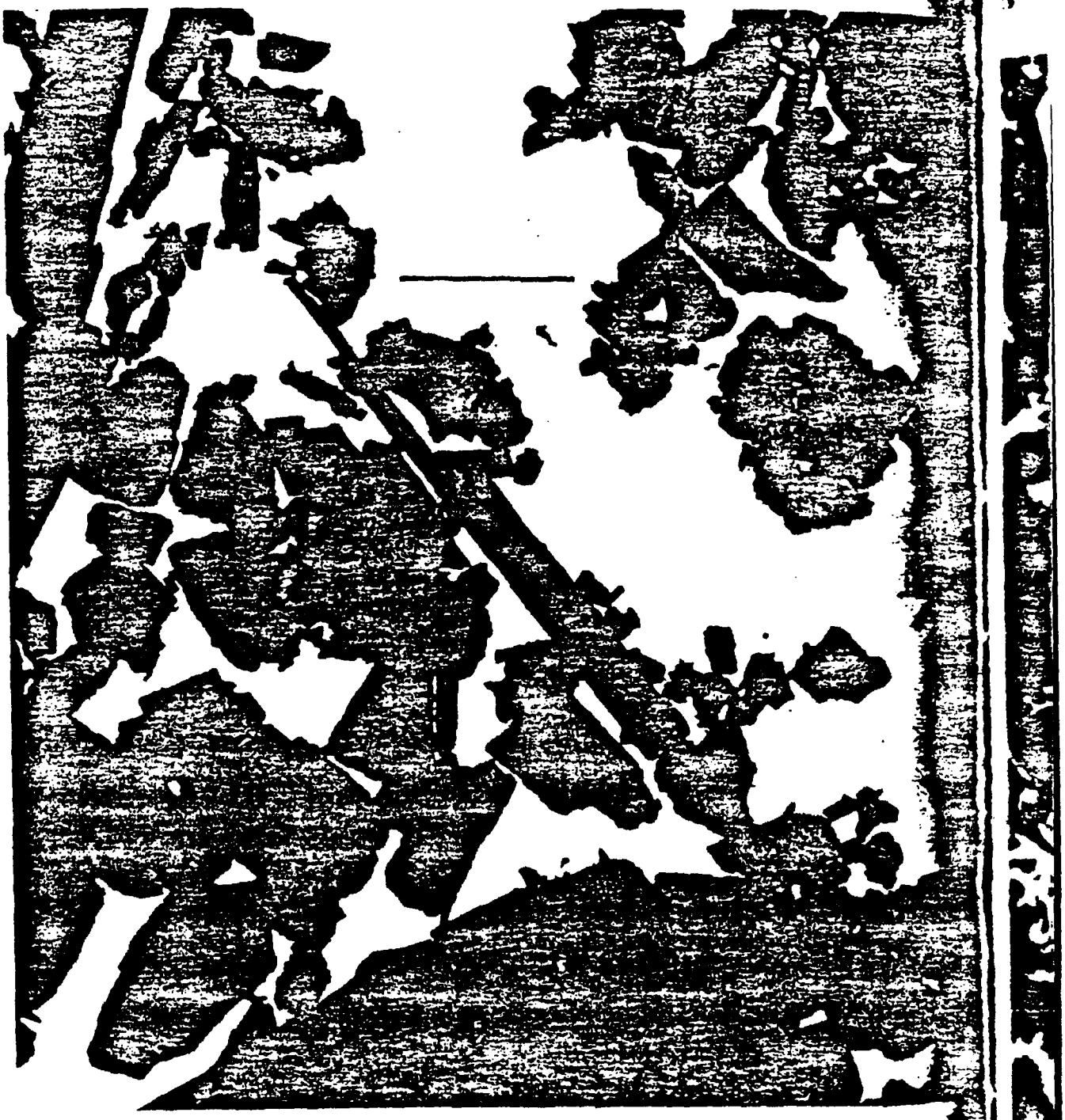

FIGURE 3. - Particle shapes of "talcs" from the Gouverneur District of New York State (X 6,000).

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FIGURE 4. • Particle shapes of "talcs" from the Gouverneur District of New York State (X 880).

Another California talc, the Panamint, contains calcite and mica as principal impurities with no asbestos minerals present. The two Montana talcs, Yellowstone and Beaverhead, are high purity and also free of asbestos mineral

It has been the policy of the Cyprus Mines Corporation to X-ray the production workers at all of our operations annually. This policy has been in effect for 5 years and these examinations have not turned up any lung or pleural cancer among our talc workers, nor have they revealed chronic respiratory disease of any kind.

Seven of the employees were first exposed to talc dust 25 to 44 years ago. All the long service group were California workers who had been exposed to tremolitic talcs as well as tremolite-free materials.

When the threshold limit values for tremolitic talcs were first made public, we became concerned about the possibility that our people had been inadvertently exposed to a health hazard and we took two steps.

First, the division ceased production of all talcs containing detectable amounts of tremolite and established an X-ray diffraction facility at our California mines to assure control.

Second, the seven long-service employees together with four retirees and ex-employees were subjected to exhaustive physical examinations with emphasis on the respiratory system, chest, and abdomen. This group's first exposure to talc dust ranged from 25 to 49 years ago. There are no records to tell us what conditions were like in the talc mines and mills of the 1920's and 1930's, but neither were mining nor milling techniques designed with dust control as a major objective. The oldtime worker was, therefore, exposed to vastly greater amounts of dust than his modern counterpart.

Nevertheless, these exhaustive examinations failed to detect any sign of cancer among any of the long-service group. One of the retirees did reveal signs of possible pneumoconiosis.

Cyprus Mines Corporation's interest in this proceeding is one of concern for the welfare of its workers and for the truth. Although the medical data presented are admittedly limited, they contain no indication that talcs of either the pure Montana type or less pure California varieties are carcinogenic.

We should emphasize that Cyprus' talc operations are in compliance with threshold limit values both as relates to dust from nonasbestiform talc and fiber count. We realized that any dust in excessive amounts cannot be a positive health factor and are making every effort to minimize employee exposure.