IMERYS288673

Metadata

Applic	Microsoft Word Document	ORIGINAL
Author	Worth	ORIGINAL
BegAttach	IMERYS 288673	ORIGINAL
Confidentiality	No	ORIGINAL
Custodian	Zazenski, Rich;	ORIGINAL
DATA_Prod_Vol	IMERYS013;	ORIGINAL
DateCreated	04/13/2004 6:42 PM	ORIGINAL
DateMod	04/13/2004 6:42 PM	ORIGINAL
DocExt	doc	ORIGINAL
DocumentType	Electronic File	ORIGINAL
EndAttach	IMERYS 288680	ORIGINAL
Filename	Comments - Position Paper April 2004.doc	ORIGINAL
FileSize	82944.00	ORIGINAL
HashValue	b0d95b8300abbb84d458e8a42ee351e9	ORIGINAL
OtherCustodians	Zazenski, Rich;	ORIGINAL
PgCount	8	ORIGINAL
ProdVol	IMERYS013;	ORIGINAL
Relative FilePath Append	Imerys - Talc Document Repository\Ovarian Cancer\Rio Tinto Data\RIO_CTRL001	ORIGINAL
Text Path	\IMERYS013\TEXT\0005\IMERYS 288673.txt	ORIGINAL
Title	Position paper refuting the recent allegation that talcs used	ORIGINAL
Trial_Ex_Number	Pltf_IMERYS_00072591	ORIGINAL

TALC / ASBESTOS POSITION PAPER

- Confidential -

April 2004
[For internal distribution only]

KEY MESSAGES

To be classified under the term "asbestos", *a mineral has to be one of the six minerals defined as asbestos*. This means having a specific chemical composition and specific asbestiform morphology. The grinding of a non-asbestiform mineral will never produce an asbestos fibre. Talc can occur in a fibrous habit, i.e. having an elongated form with an aspect ratio ranging from 3:1 to 5:1, but asbestiform talc does not exist.

At the NTP meeting of the Board of Scientific Counsellors Subcommittee (December, 2000), Ann Wylie (University of Maryland) submitted written comments that stated:

> "Fibrous talc may be asbestiform, in that it can form in bundles of parallel fibers of narrow diameter and high aspect ratio, or it may be acicular."
> [http://dir.niehs.nih.gov/dirtob/rocpubcom/10throc/2000nominations/talcasbestiform-nonasbestiform/wylie-11-27-00.pdf]

Addison and Langer (on behalf of EUROTALC) submitted written comments stating:

> "If 'asbestiform' means 'resembling asbestos' or 'having the morphology of asbestos' (following the ASTM definition), then asbestiform talc does exist as an extremely rare mineralogical curiosity. In contrast, if asbestiform means having all the properties of asbestos (as in the NTP Report definition), then asbestiform talc does not exist.
> http://dir.niehs.nih.gov/dirtob/rocpubcom/10throc/2000nominations/talcasbestiform-nonasbestiform/jaddison-11-30-00.pdf

While recognized experts such as Wylie and Addison may differ as to the occurrence of fibrous talc (as they did light-heartedly at the meeting), as mineralogists they would acknowledge that 'asbestiform' talc does exist – with asbestiform simply being used as an adjective to describe an 'asbestos-like' physical occurrence.

INTRODUCTION

A number of publications, media reports and rumours have linked talc with asbestos. This association stems from confusion surrounding the morphological features and chemical composition of asbestos and other minerals, including talc. The purpose of this paper is to define what asbestos is and how it is identified, and to provide background information as to how and why this association has arisen.

A. ASBESTOS BACKGROUND

A.1. What is asbestos?

Asbestos is a term that designates six naturally occurring minerals belonging to the serpentine and amphibole groups. Due to their specific morphology, i.e. long, thin, flexible fibres that are easily separable when crushed or processed, asbestos minerals can be woven, are resistant to heat and chemical attack and have good electrical

insulating properties. Each of these six asbestos minerals has a non-asbestos counterpart which shares the same chemical composition. They differ only:

- in the manner of crystal growth (the asbestos variety result from crystals that grow faster in one direction, i.e. asbestiform, whereas the non-asbestos variety, which are far more common, are the product of similar crystal growth rates in more than one dimension, i.e. non-asbestiform)
- and in their respective properties.

Asbestos and non asbestos classification

Group	Chemical Composition	Morphology	
		Asbestiform	Non-asbestiform
		Classification	
		Asbestos Variety	Non asbestos variety
Serpentine	$Mg_3 (Si_2O_5)(OH)_4$	Chrysotile*	antigorite
Amphibole	$Na_2 Fe_3^{2+} Fe_2^{3+} (Si_8O_{22}) (OH,F)_2$	crocidolite	riebeckite
	$(Mg,Fe)_7 (Si_8O_{22}) (OH,F)_2$	amosite	grunerite
	$(Mg,Fe^{2+})_7 (Si_8O_{22}) (OH, F)_2$	anthophyllite asbestos	anthophyllite
	$Ca_2 Mg_5 (Si_8 O_{22}) (OH,F)_2$	tremolite asbestos	tremolite
	$Ca_2 (Mg, Fe^{2+})_5 (Si_8O_{22}) (OH, F)_2$	actinolite asbestos	actinolite

* Chrysotile is the only asbestos mineral to have a tubular morphology. All the amphibole asbestos minerals have a needle-like morphology.

Therefore, to be classified under the term “asbestos”, a mineral has to:

a) present the specific asbestiform morphology.
b) have one of the above chemical compositions (see table above)

Asbestos minerals are always asbestiform but asbestiform minerals are not necessarily asbestos.

A.2. How is asbestos identified?

A.2.1. By its morphology

According to the American Society for Testing Minerals’ (ASTM’s) definition, asbestiform minerals consist of mineral fibre populations (see appendix 1) having the following characteristics when viewed by microscopy:

1) particles greater than 5 µm in length and having aspect ratios ranging from 20:1 to 100:1 or higher (photo 1),
2) the ability to split down into very thin fibrils (photo 1):
3) two or more of the following attributes:
   a) parallel fibres occurring in bundles (photos 2 and 3),
   b) fibres displaying splayed ends (photos 2 and 3),
   c) matted masses of individual fibres (photo 4),
   d) fibres showing curvature (photo 5).

A.2.2. By its chemical composition

A mineral’s chemical composition is determined by an EDX spectrum. As shown in the charts below, all asbestos minerals share the same spectrum as their non-asbestos counterparts:

A.3. How can we distinguish between asbestiform minerals and non-asbestiform minerals?

Asbestiform and non asbestiform minerals break down differently.
Due to their one directional crystal growth, asbestiform minerals separate systematically along their privileged axis of growth, resulting in thin fibrils. When an asbestiform mineral is milled, the predominant particle shape will always be a fibril or a bundle of fibrils. No matter how finely they are ground, asbestiform particles will have the same aspect/appearance but will become thinner due to bundle break-up (photos 6 and 7 below).

When a non-asbestiform mineral is milled, no matter how coarse or fine, the majority of the particles break down irregularly or into their three dimensional cleavage fragments (photo 8 and 9 below). However a few elongated fragments, resembling fibres, may appear and be incorrectly identified as asbestiform fibres.

The grinding of a non-asbestiform mineral will never produce an asbestos fibre.

B. HOW THE METHODS OF ANALYSIS CAN ADD TO THE CONFUSION

The most widely used methods consist first in observation by TEM (Transmission Electron Microscope) or SEM (Scanning Electron Microscope).

Attached is a summary of the published microscopy test methods for analysing asbestos in air, bulk materials, dust, soil and water. These test methods are issued by ASTM, ISO, NIOSH, and EPA. The methods are PLM, PCM , and TEM. It would be technically accurate to site these methods as most widely used.

If a fibre is detected, it is identified either by:

- EDS (Energy Dispersive Spectrometry) chemical analysis and/or
- SAED (Selected Area Electron Diffraction), only in the case of TEM.

Unfortunately, none of these methods is sufficiently precise because:

- with EDS, certain minerals' chemical compositions are so similar that it is impossible to distinguish the spectra, e.g. between talc and anthophyllite (both asbestos and non-asbestos varieties of anthophyllite);

- with SAED, in order to identify the patterns accurately, they should be analysed quantitatively. However, this quantitative analysis is not a requirement in most of the methods, e.g. ASTM 6261, ISO 13794.

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Experienced microscopists from independent laboratories would state that in many instances it is not necessary to quantitatively measure spacings on the SAED pattern to get a positive identification [JWPier]. This is especially true for chrysotile. It also is not difficult to distinguish between talc and amphiboles by SAED, even if the pattern is not quantitatively measured.

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Given that the above methods only take the aspect ratio and chemical compositions into account but not the other morphological criteria specific to asbestos, i.e. the ability to split down into very thin fibrils, parallel fibres occurring in bundles, fibres displaying splayed ends, matted masses of individual fibres, fibres with curvature, it is practically impossible to distinguish between, for

example, a fibrous particle of talc and anthophyllite asbestos particles (whose chemical composition is very similar to that of talc).

Our own evidence indicates that milling can affect bundles, frayed ends, matted masses, and/or curvature. In some talc deposits (e.g., Broughton, Quebec), virtually all of the fibrils that were identified as chrysotile were short, had no frayed ends, were un-curved, and did not appear in the milled talc product as matted masses. Independent analyses by R. J. Lee and HSL confirmed that the fibrils were naturally occurring chrysotile and not antigorite fragments (SAED confirmation).

C. TALC & ASBESTOS

C.1. What is talc?

Talc is a hydrated magnesium silicate with the following chemical composition:
$Mg_3\ Si_4\ O_{10}\ (OH)_2$

The crystal growth of talc elementary crystals is two dimensional. Talc particles are platy:

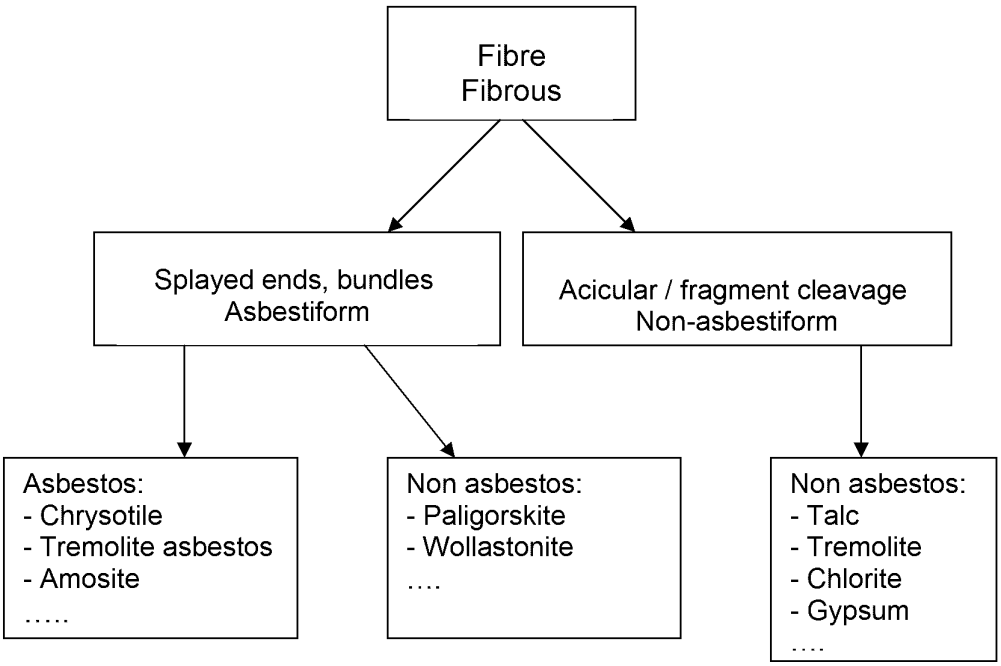
C.2. Does 'asbestiform or fibrous talc' exist?

People often confuse the terms "asbestiform" and "fibrous". It is not the same thing:

Fibrous means having an elongated form with an aspect ratio ranging from 3:1 to 5:1.

By definition (ASTM), asbestiform fibres refer to particles greater than 5 µm in length, with aspect ratios ranging from 20:1 to 100:1 or higher, with the ability to split down into very thin fibrils and with two or more of the following attributes:

- parallel fibres occurring in bundles,
- fibres displaying splayed ends,
- matted masses of individual fibres,
- fibres showing curvature.



Talc can therefore occur in a fibrous habit but asbestiform talc does not exist, it is a misnomer.

The term 'asbestiform talc' has also been applied to talc 'containing asbestos'. This is a misuse of the term since 'asbestiform' can only ever be used to describe a mineral's morphology. The correct term for a mixture of talc and asbestos is simply 'talc containing asbestos'.

C.3. Why the talc – asbestos connection?

In the early 1970s, a series of epidemiological studies on populations working in "talc" mines in the state of New York, US, concluded that there was an increase in the incidence of lung cancer. One of these deposits featured a rare combination of talc and three potential asbestos minerals: tremolite, anthophyllite, and serpentine. Despite the fact that the end product contained only about 25% talc, it was commonly referred to as 'New York Talc' or 'tremolitic talc'. In 1976, the CTFA (Cosmetic Toiletry and Fragrance Association) reacted to this issue by introducing a protocol to detect amphibole asbestos in talc.

Historically, the primary cause of the talc-asbestos association was due to the publication of studies that purportedly found asbestos in cosmetic talcs and baby powders. Because these studies generated growing public concern, they received widespread media coverage (New York Times, Washington Post, Wall Street Journal, etc.) The media attention prompted regulatory authorities (e.g., FDA, OSHA, MSHA) to look into the growing health and safety concerns with talc products. With prompting from the FDA, the CTFA developed the J4-1 test procedure for assuring the safety of consumer talc products. Relevant papers that contributed to this talc/asbestos association include:

Cralley LJ, Key MM, Groth DH, Lainhart WS, and Ligo RM. 1968. Fibrous and mineral content of cosmetic talcum products. *Am Ind Hyg Assoc J* 29(4):350-54.

Blejer HP and Arlon R. 1973. Talc: A possible occupational and environmental carcinogen. *J Occup Med* 15(2):92-97.

Rohl AN. 1974. Asbestos in talc. *Environ Health Perspect* 9:129-32

Rohl AN, Langer AM, Selikoff IJ, Tordini A, Klimentidis R, Bowes DR, and Skinner DL. 1976. Consumer talcums and powders: Mineral and chemical characterization. *J Toxicol Environ Health* 2(2), 255-84.

Parmentier CJ and Gill CJ. 1978. Practical aspects of talc and asbestos. In *National Bureau of Standards Special Publication 506. Proceedings of the Workshop on Asbestos: Definitions and Measurement Methods, NBS, Gaithersburg, MD, July 180-20, 1977*, pp. 403-11.

Blount AM and Vassiliou AH. 1983. Identification of chlorite and serpentine in cosmetic or pharmaceutical talc. *Environ Health Perspect* 51:379-85.

Paoletti L, Caiazza S, Donelli G, and Pocchiari F. 1984. Evaluation by electron microscopy techniques of asbestos contamination in industrial, cosmetic, and pharmaceutical talcs. *Regul Toxicol Pharmacol* 4(3):222-35.

Blount AM. 1991. Amphibole content of cosmetic and pharmaceutical talcs. *Environ Health Perspect* 94-225-30.

The company that owned the NY mine continued to vehemently defend their product and demonstrated that the tremolite and anthophyllite were not asbestiform. A public hearing organised by OSHA (Occupational Safety and Health Administration) was conducted between 1990 and 1992. The outcome was the amendment of the asbestos standards by the removal of non-asbestiform anthophyllite, tremolite and actinolite from their scope.

A number of other epidemiological studies have been conducted since 1992 with contradictory results. To this day, the issue remains controversial.

Virtually all references to talc and asbestos can be traced back to the New York State mines. This, combined with the confusion surrounding asbestos has led to unjustified bad press for the talc industry in general.

Coincidental with the publication of the studies reporting asbestos in cosmetic talc, epidemiological studies linking cosmetic talc and ovarian cancer began to appear. As this was another issue that generated widespread public concern, it too received extensive media coverage. These two 'very public' issues formed the foundation in the public's mind that "most talcs contained asbestos"; that "talc was asbestos-like"; and that "talc was a carcinogen." These beliefs and perceptions quickly carried over into the workplace and regulatory agencies – resulting in demands for "asbestos-free" talc and regulatory classifications of "asbestiform talc and non-asbestiform talc." In the late 1970's and early 1980's, TLV's in the workplace were officially established by OSHA and ACGIH for "talc containing asbestos" and "talc not containing asbestos". The IARC report on talc in 1985 issued findings for both categories of talcs. As more and more epidemiology studies were published (and publicized) linking talc and ovarian cancer, the talc/asbestos/carcinogen issue was refreshed each time in the public's mind. To this day, mis-perceptions and unfounded claims about talc continue to appear in newspapers, magazines, medical journals, electronic media, the Internet, etc., - most all of which can be

traced back to the asbestos-in-cosmetic talc controversy and the on-going talc/ovarian cancer association – both of which were issues of interest worldwide.

Some of these earlier papers which helped fuel the health and safety concerns of talc include:

Henderson WJ, Joslin CA, Turnbull AC, and Griffiths K. 1971. Talc and carcinoma of the ovary and cervix. *J Obstet Gynecol Br Commonw* 78:226-72.

Anonymous. 1977. Cosmetic talc powder [editorial]. *Lancet* :1348-49.

Henderson WJ, Hamilton TC, and Griffiths K. 1979. Talc in normal and malignant ovarian tissue [letter]. *Lancet* 1(8114):499.

Longo DL and Young RC. 1979. Cosmetic talc and ovarian cancer. *Lancet* ii:349.

Cramer DW, Welch WR, Scully RE, and Wojciechowski CA. 1982. Ovarian cancer and talc: A case-control study. *Cancer* 50:372-376.

Hartge P, Hoover R, Lesher LP, and McGowan L. 1983. Talc and ovarian cancer [letter]. *JAMA* 250:1844

Wehner AP, Hall AS, Weller RE, Lepel EA, and Schirmer RE. 1985. Do particles translocate from the vagina to the oviducts and beyond? *Fd Chem Toxicol* 23:367-72.

Wehner AP, Weller RE, and Lepel EA. 1986. On talc translocation from the vagina to the oviducts and beyond. *Fd Chem Toxicol* 24:329-38

Natow AJ. 1986. Talc: Need we beware? *Cutis* 37(5):328-29.

D. LUZENAC'S APPROACH & TESTING PROTOCOL

The health and safety of customers and employees is Luzenac's prime concern and the company takes its responsibility in these areas very seriously. To this end, rigorous and regular asbestos detection protocol based on best available practices has been part of Luzenac's testing for decades.

D.1. Control methods used by Luzenac

Luzenac Group has been using the CTFA J4/1 method, introduced by the American cosmetic industry, since 1978 to detect amphibole asbestos. It is based on X-ray diffraction technology and optical microscopy. It is accurate to 0.5%.

In line with increasingly stringent legislation and evolving technology, Luzenac has been investigating a more precise and accurate testing method based on electron microscopy (either Transmission Electron Microscopy or Scanning Electron Microscopy).

Because of the widespread public perception that "talc contained asbestos," J&J solicited McCrone Laboratories to formally develop a more sensitive test method (than J4-1) for detecting asbestos in talc. This TEM procedure became the standard J&J test method for assuring the quality of J&J Baby powder in the 1980's. The method was published in 1990.

Kremer T, Millette J. 1990. A Standard TEM Procedure for Identification of Asbestiform Minerals in Talc. *Microscope* 1990, Vol 38 No 4, 457-68.

Additionally, as asbestos litigation became pervasive in the late '70's early 1980's, both industrial as well as cosmetic talc customers began demanding "asbestos-free" certifications beyond the detection capability of the J4-1 method. As Cyprus Industrial Minerals and Pfizer (#1 and #2 talc producers at that time) both had transmission electron microscopes, TEM became the de-facto method for providing "asbestos-free" talc certifications. To our knowledge, the Kremer/Millette test procedure remains the only 'published' electron microscopy methodology specific for testing for the presence (or certifying the absence) of asbestos in talc.

In summary, many in the talc industry have been using a combination of x-ray diffraction (for bulk screening) and TEM (for product certification) for over 25 years.

D.2. Epidemiological studies

Luzenac mills 1,500,000 tonnes of talc a year in its operations worldwide. In addition to the analytical testing conducted on our ore bodies and our products, the health of mill workers has been closely monitored for over 50 years through independent epidemiological studies (see appendix 2). Studies performed in Luzenac's French, Italian and Austrian operations concluded that neither excess of lung cancer nor excess of any other type of cancer had been observed; pleural or peritoneal mesotheliomas known to be related to asbestos mineral exposure were not found in these workers' cohorts.

D.3. Carcinogenicity of talc in general

Talc has not been listed as a known or suspected human carcinogen by:

- the International Agency for Research on Cancer (IARC),
- the National Toxicity Program (NTP),
- the Occupational Health and Safety Administration (OSHA),
- the American Congress of Governmental Industrial Hygienists (ACGIH)
- the European Community DGXI Working Group