

A SECOND LOOK AT SUBSTITUTES
FOR ASBESTOS

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CENTLEMEN:

I first want tell you how deeply honored I am to have been invited to address such a distinguished audience. I realize that many people present in this hall have been involved in the asbestos industry for a long time. These people have, over the years, witnessed the constant rise of this industry, which was related to the simple basic fact that no single material, naturally-occurring or man-made, could replace asbestos in its multiplicity of applications.

These people have also witnessed recently a dramatic change in the situation, a change which was important both by the magnitude and the speed at which it was occurring. Today, all analyses of this phenomenon point to two main causes for this particular situation: first, the recent worldwide economic crisis, which led to a depressed activity in the building industry, with its resulting drop in demand for asbestos-based construction materials; and second, public perception of the health hazards associated with inappropriate or uncontrolled uses of asbestos. This latter cause has brought over the years a frenzy of debates and discussions, and eventually gave rise to various government actions in many countries, going from strict control regulations to outright banning.

Very simply stated, the basis for those who advocate banning is threefold:

- 1.- there is no safe threshold;
- 2.- there are no safe uses;
- 3.- there are substitutes.

Today, I would like to look at the last of these affirmations: the existence of substitutes. But before I do so, let me tell you quickly that I personally do not agree with the first two points, and state unequivocally that indeed there is a threshold exposure level for asbestos below which no adverse effect can be detected, and that this is based on recent experimental and epidemiological data. On the second point, let me also quickly state that, precisely because there is a threshold, there are some perfectly safe uses, and again we have data to support that point as well.

That leaves us with the third point, which is the subject of this presentation, and happens to be, as some of my scientist friends and colleagues have labelled it, «one of my pet obsessions», i.e., the relative merits of asbestos versus substitutes. I am not talking here of costs and technical feasibility. I am talking about one substance, for which there is a threshold, which can be used with an acceptable degree of safety, which can be controlled by appropriate engineering and work practices, and replacing it with a number of substitutes which are not controlled, and which we have only begun to submit to biological scrutiny.

Two years ago, I was attending a meeting in New York, hosted by Dr. Irving Selikoff. Many scientists, mostly from Dr. Selikoff's group, came in succession to present the results of their most recent findings, on many aspects of the biological action of respirable dusts in general, and on the various mechanisms of action of asbestos in particular.

At one point, after one presentation of new data showing asbestos to interfere with the immunological defense mechanisms of the body, I rose and asked a simple question to the speaker: «where is the indication in your data that the results you observe are specific for asbestos? In other words, do your data show that asbestos, and asbestos only, produces these results? Did you try other particulates such as quartz, silica, coal dust, man-made or other naturally-occurring silicates?».

Dr. Seilkoff was quick to rise and answer the question, by saying that «... yes indeed, we have no proof that the phenomenon is specific, and I agree that these other dusts should be investigated», ... and quickly closed the discussion!

You will understand that by my question, I was merely trying to underline that for years the focus had been so much on asbestos, that the tendency had been to assume that other dusts are not important. Indeed, in some circles, there was a very real presumption that substitutes are safe or safer.

That such may not be the case was evident last October, at a meeting in the Black Forest in Germany, when many scientists reported that some data, on the mechanism of action of dusts to explain the mode of action of particles, were also obtained with other dusts.

Thus, Dr. Voisin of Institut Pasteur in Lille (France) indicated that coal mine dust, like asbestos, can induce the phenomenon of «superoxides generation» in the cells. This phenomenon would be responsible for an increased risk of producing genetic damages in the nucleus of cells, which could result in cancerogenesis. Dr. Voisin recognized that many other particles such as carborundum, fumed silica, and even fungi and bacteria display the same potential, thus demonstrating that this particular response of the cells is not specific for asbestos.

Another mode of action attributed to asbestos is related to its ability to adsorb and carry true carcinogenic substances, such as benzo-a-pyrene, an organic chemical found in tobacco smoke and in the exhaust fumes of internal combustion engines. During the Black Forest Symposium, it was disclosed that, again, this phenomenon is not specific for asbestos, but is also displayed by other respirable dusts such as attapulgite, alumina, titanium dioxide. Let us now review some of the known biological effects of many substances which are now used for substitution for asbestos.

S L I D E S

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I could go on and on, reviewing the many adverse reactions in the cells which are caused by asbestos and many other respirable dusts. The point I am trying to make is that from what we already know, it stands to reason that all respirable dusts should be regulated.

In January 1985, a very timely review on the subject by A.A. Hodgson was published under the title «Alternatives to Asbestos and Asbestos Products». I would like to quote from Sir William Simpson's preface of this publication.

Sir William says:

«Football managers dream of having substitutes on the bench of the same calibre as their first team stars. It seldom happens. This is also true of alternative materials for asbestos in manufacturing and performance terms.».

Sir Williams goes on to say:

«... it is not merely a matter of finding materials that are technically competent to fill the shoes of asbestos; these other materials must be safe in use not only for workers who handle and process the substitute materials but also safe for the public who may be living with them or come in contact with them from time to time.».

On the particular question regarding the relative safety of substitutes, Sir William recalls that when the Advisory Committee on Asbestos published its Reports in 1979, there was a paucity of information about the safety of alternatives to asbestos. Section 4 of Volume 2 summarised the technical knowledge available 5 years ago, but there were no hard facts about these substitutes in terms of their danger to health.

The only helpful report was by a Working Party reporting to the Advisory Committee under the auspices of the Health and Safety Commission.

This Report dealt with the safety of man made Mineral Fibres (MMMF) and concluded «although no human cancer risk has been proven we cannot ignore the implications of animal studies and we consider it would be prudent to regard these fibres with suspicion».

That the authors of the Working Party were right in their 1979 report in warning us that «we should not ignore the implications of animal studies» was demonstrated in 1984, by the report of doctors Olsen and Jensen, of the Danish Cancer Registry, who published their results in the Scandinavian Journal of Work, Environment and Health (10: 17-24, 1984).

In their study on the cancer incidence among employees in one mineral wool production plant in Denmark, the authors observed that among workers with 20 or more years from first employment in the plant, a significant excess of cancer of the lungs, bladder, and skin was found (observed versus expected cases: 9 vs 4.3, 4 vs 1.6 and 5 vs 2.4, respectively).

The authors concluded that the results of their study «... support the hypothesis of a relationship between occupation in the mineral wool production industry and cancer of the lung».

This is one illustration of what I meant in the title of this presentation, pointing to the need for A SECOND LOOK AT SUBSTITUTES FOR ASBESTOS. There is now, I beleive, serious admonition from biological experimentation. In other words, science tells us now, on the basis of animal studies, what can be expected later on, if all respirable particles are not submitted to the same control measures that are now in effect for asbestos. I respectfully submit that government regulating agencies would be well advised to take notice.

FIBROUS SUBSTITUTES FOR ASBESTOS

NATURALLY-OCCURRING MINERALS	APPLICATIONS	KNOWN BIOLOGICAL EFFECTS
Attapulgite (Mg, Al silicate)	• Friction materials • Thickener in caulks, grouts and sealants • Drilling muds • Carrier for pesticides • Etc.	- Lung fibrosis (1) - Mesothelioma (2) - Cytotoxic to pulmonary macrophages (3) - Adsorbs and carries polyaromatic hydrocarbons (4)
Wollastonite (Ca silicate)	• Filler for plastics • Composite papers • Flooring felts • Insulation • Friction materials • Ceramics • Etc.	- Lung fibrosis, - Pleural thickening, Chronic bronchitis (5,6) - Morphologic and functional changes in lung macrophages (7)

- 1- Bignon, J. et al. (1980). In Biological Effects of Mineral Fibres Vol. 1: 163-181, Ed. J.C. Wagner, IARC Pub. No. 30.
- 2- Pott, F. et al. (1976). Ann. Anat. Pathol. 21: 237-246.
- 3- AIRD: Unpublished data.
- 4- Harvey, G. et al. (1984) Brit. J. Ind. Med. 41: 396-400.
- 5- Huuskonen, M.S. et al. (1983). Environ. Res. 30: 291-304.
- 6- Shasby, D.M. et al. (1979) in Dusts and Disease, Ed. R. Lemmen and J. Dement, Pathol. Publ.: 251-256
- 7- Warheit, D.B. et al. (1984). Scanning Elect. Mic. 2: 919-926.

FIBROUS SUBSTITUTES FOR ASBESTOS

MAN-MADE MINERALS	APPLICATIONS	KNOWN BIOLOGICAL EFFECTS
Ca SILICATES (1) (2)	• Friction materials	- Membranolytic (1)
Al SILICATES (3)	• Insulation	- Cytotoxic to pulmonary macrophages (2)
Ca-Al SILICATES (3)	• Gaskets	- Fibrogenic and cancerogenic in experimental animals (3)
	• Flooring and roofing felts	- Increased lung cancer in mineral wool production workers (4)
	• Etc.	
Also various compositions, such as:		
- Ca-Al-Mg SILICATES		
- Al-Br SILICATES		
<u>Referred to as:</u>		
«CERAMIC FIBERS»		
«SLAG WOOL»		
«PROCESSED MINERAL FIBERS»		
«KAOWOOL»		
«FIBROUS CERAMIC Al SILICATES GLASS»		
«MINERAL WOOL»		
«ROCK WOOL»		

1- and 2- AIRO, Unpublished data.

3- Davis, J.M.G. et al. (1983) in Biological Effects of Man-made Mineral Fibres, WHO/IARC, EURO Reports and Studies 81: 124.

4- Olsen, J.H. and Jensen, O.H. (1984). Scand. J. Work Environ. Health 10: 17-24.

FIBROUS SUBSTITUTES FOR ASBESTOS

GLASS FIBERS

APPLICATIONS: Numerous

KNOWN BIOLOGICAL EFFECTS:

- Produces mesothelioma in experimental animals (1).
- Glass fibers of a respirable size can have an effect on the (human) lung similar to that of asbestos (2).
- Effects in glass-fiber dusted animals parallel those observed on asbestos-dusted animals (3).
- Studies in fibrous glass production workers are consistent with a growing number of animal studies which demonstrate a carcinogenic response to glass fibers less than 1 μ in diameter (4)

REFERENCES

- 1- Pott, F. et al. (1974) Environ. Health Perspect 9: 313-315.
- 2- Chiappino, G. et al. (1981) Med. del Lavoro 72: 96-101.
- 3- Miller, K. (1980) in Biological Effects of Mineral Fibers (J.C. Wagner Ed.) Vol. 1: 459-465, IARC Sc. Pub. No. 30.
- 4- Bayliss, D.L. et al. (1976). U.S. Dept. of Commerce, NTIS, No. PB-257 784.

REFERENCES FROM FIGURE 1
FIBROUS SUBSTITUTES FOR ASBESTOS
(NATURALLY-OCCURRING MINERALS)

- 1.- Bignon J. et al. (1980). In Biological Effects of Mineral Fibres, Vol. 1: 163-181, Ed. J.C. Wagner, IARC Pub. No. 30

a) In this paper the authors mention that attapulgite fibers are within the «respirable size» range. These fibers have been found in the lung washing fluid of a 41 year-old patient with lung fibrosis, who had been exposed to attapulgite dusts for 3 years. The authors state that:

«... this mineral can induce a pulmonary fibrosis identical to asbestosis.» (p. 173).

b) The authors also mention that:

«The cytotoxic effects observed in vitro with attapulgite fibres raise the possibility of a carcinogenic effect in vivo...» (p. 178).

REFERENCES FROM FIGURE 1
FIBROUS SUBSTITUTES FOR ASBESTOS
(NATURALLY-OCCURRING MINERALS)

- 2.- Pott, F. et al. (1976). Ann. Anat. Pathol. 21: 237-246

In this paper, the authors indicate that following intra- peritoneal injection of palygorskite (3 X 25 mg doses), 76% of injected animals develop tumours (24 animals with mesothelioma, and 2 with sarcoma), in 34 animals injected. Palygorskite is synonymous to attapulgate.

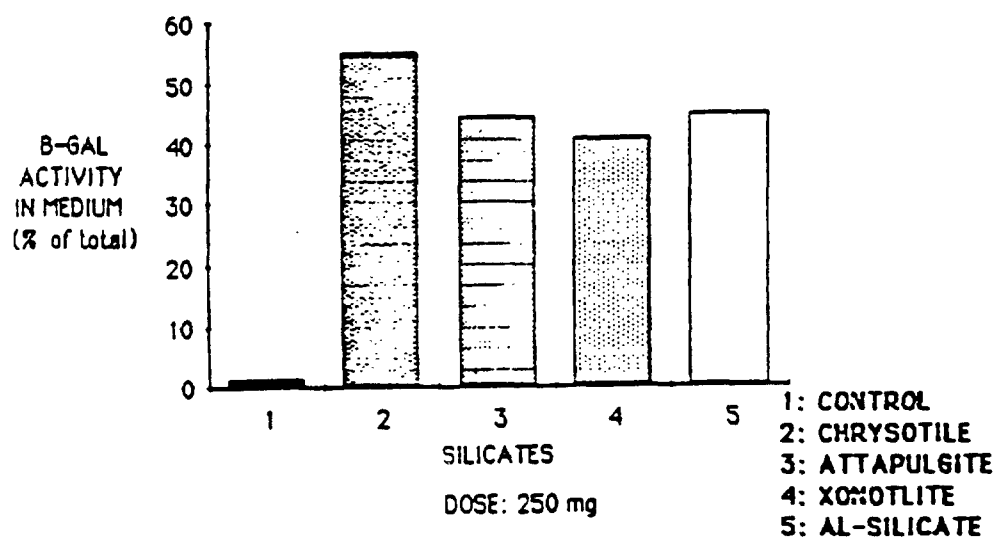
REFERENCES FROM FIGURE 1
FIBROUS SUBSTITUTES FOR ASBESTOS
(NATURALLY-OCCURRING MINERALS)

3.- AIRD: Unpublished data

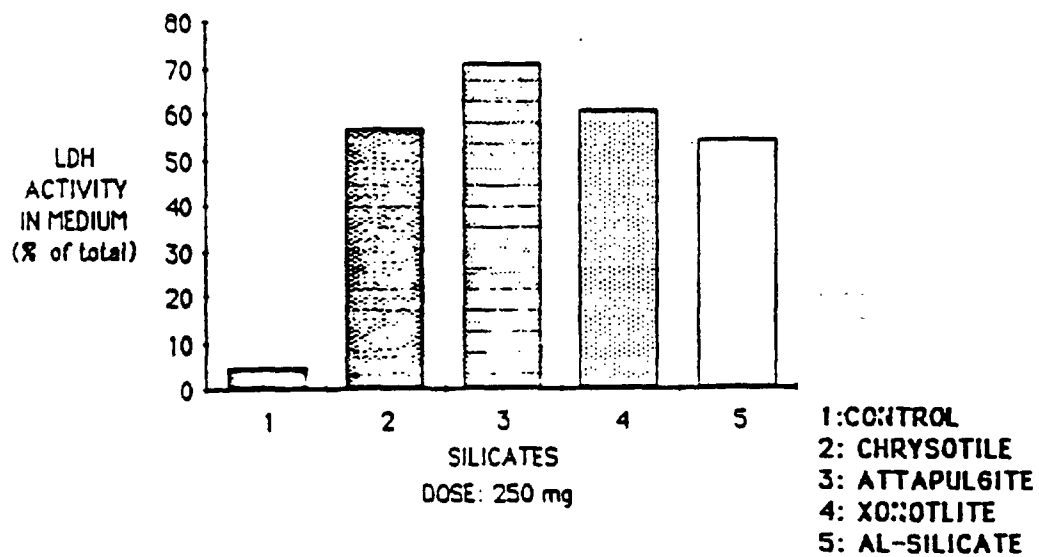
These data will be published as a paper in a volume of the Texas A & M University monograph series, to be released in early 1986.

The accompanying three figures point to the cytotoxic effect of attapulgitite on rat pulmonary macrophages, in comparison with the effects of three other fibrous silicates. The cytotoxic release of LDH and β -GAL enzymes, with the concomittant decrease in ATP levels is significant at the two doses used in these in vitro experiments.

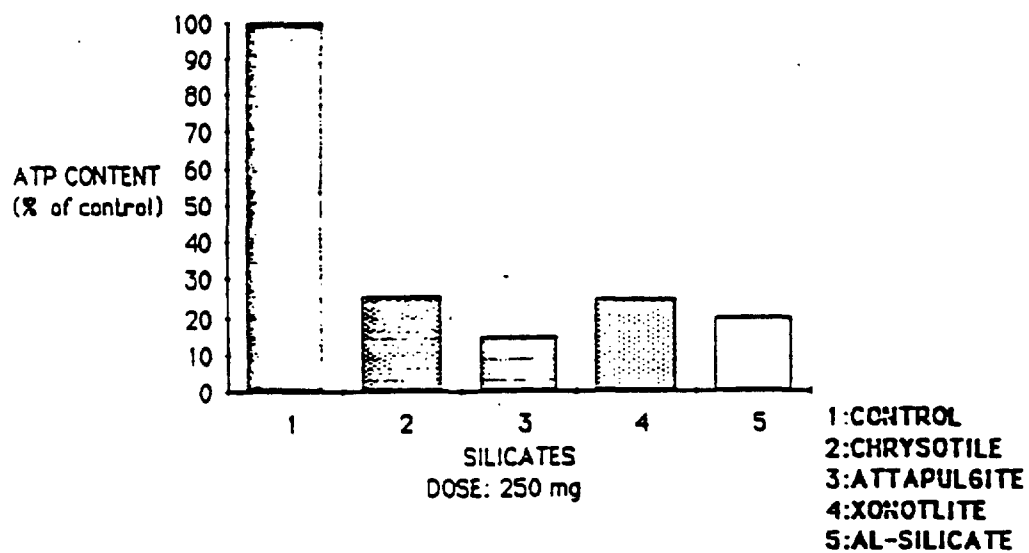
FRESH RAT PULMONARY MACROPHAGES RESPONSE



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REFERENCES FROM FIGURE 1
FIBROUS SUBSTITUTES FOR ASBESTOS
(NATURALLY-OCCURRING MINERALS)

4.- Harvey, G. et al. (1984). Brit. J. Ind. Med. 41:
396-400

- a) The authors indicate that attapulgite fibers from U.S.A. are very hemolytic, indicating a membranolytic potential (Table 2, p. 398), at least equal to that of Canadian chrysotile.

- b) Furthermore, the attapulgite fibers can bind true environmental carcinogenic hydrocarbons such as benzo-a-pyrene, nitrosonornicotine.

REFERENCES FROM FIGURE 1
FIBROUS SUBSTITUTES FOR ASBESTOS
(NATURALLY-OCCURRING MINERALS)

5.- Huuskonen, M.S. et al. (1983). Environ. Res. 30:
291-304

- a) The authors indicate that wollastonite fibers are rather similar in form, length, and diameter to amphibole fibers (p. 301).

- b) They indicate that in a study of wollastonite miners, there was increased prevalence of chronic bronchitis in nonsmokers, for which no explanation would be found other than exposure to dust (p. 301). Also reported in the cohort studied was slight lung fibrosis and pleural thickening among thirteen of forty-three workers studied.

REFERENCES FROM FIGURE 1
FIBROUS SUBSTITUTES FOR ASBESTOS
(NATURALLY-OCCURRING MINERALS)

- 6.- Shasby, D.M. et al. (1979). In Dusts and Disease, Ed.
R. Lemen and J. Demen, Pathol. Publ.: 251-256

In U.S.A. mine and mill workers of wollastonite, these authors found an increased prevalence of chronic bronchitis.

REFERENCES FROM FIGURE 1
FIBROUS SUBSTITUTES FOR ASBESTOS
(NATURALLY-OCCURRING MINERALS)

- 7.- Warheit, D.B. et al. (1984). Scanning Elect. Mic.
2: 292-926

In this paper, the authors present the results obtained following IN VITRO exposure of rat pulmonary macrophages wollastonite and crocidolite.

The indicate that «The results of these studies suggest that crocidolite and wollastonite exposures in vitro have effects on pulmonary macrophages which may simulate events occurring in the lung following dust exposures.»
(p. 919).

REFERENCES FROM FIGURE 2
FIBROUS SUBSTITUTES FOR ASBESTOS
(MAN-MADE MINERALS)

1 and 2: AIRD, Unpublished data

These data will be published as a paper in a volume of the Texas A & M University monographs series, to be released in early 1986.

The data will indicate that both calcium silicates (xonotlite) and aluminum silicates are cytotoxic to pulmonary macrophages. See the 3 figures mentioned in relation to References 3 of Figure 1.

REFERENCES FROM FIGURE 2
FIBROUS SUBSTITUTES FOR ASBESTOS
(MAN-MADE MINERALS)

- 3.- Davis, J.M.G. et al. (1983). In Biological Effects of
Man-made Mineral Fibres, WHO/IARC, EURO Reports and
Studies 81: 124

From a study of the pathogenic effects of fibrous aluminum silicate fibers on rats, the authors conclude that:

«From the results of this study it is apparent that the
sample of ceramic fibre dust used was both fibrogenic
and carcinogenic to rats.» (p. 124).

REFERENCES FROM FIGURE 2
FIBROUS SUBSTITUTES FOR ASBESTOS
(MAN-MADE MINERALS)

- 4.- Olsen, J.H. and Jensen, O.M. (1984). Scan. J. Work
Environ. Health 10: 17-24

In this publication, the authors studied the cancer incidence among employees in one mineral wool production plant in Denmark.

From the results of this study, the authors conclude:

«This study thus supports the working hypothesis of an association between lung cancer and mineral wool production when the latency period for this type of cancer is taken into consideration.» (p.17).

REFERENCES FROM FIGURE 3
FIBROUS SUBSTITUTES FOR ASBESTOS
(GLASS FIBERS)

- 1.- Pott, F. et al. (1974). Environ. Health Perspect.
9: 313-315

In this paper, the authors describe studies in which fibrous dusts (chrysotile, glass fibers, etc.) and other granular dusts were injected intraperitoneally into rats. Among their findings their results indicate that:

glass fibers (1 < 5 μ) produced a 57% tumour rate in experimental animals (Table 3, p. 314).

REFERENCES FROM FIGURE 3
FIBROUS SUBSTITUTES FOR ASBESTOS
(GLASS FIBERS)

- 2.- Chiappino, G. et al. (1981). Med. del Lavoro 72: 96-101

In this study of glass fibers workers, the authors found that after prolonged exposure to glass fibers, the subjects show signs of chronic bronchial irritation, haemorrhagic alveolitis and interstitial lung disease. The authors conclude:

«These observations support the theory that glass fibres of a respirable size can have an effect on the lung similar to that of asbestos fibres.» (p. 96).

REFERENCES FROM FIGURE 3
FIBROUS SUBSTITUTES FOR ASBESTOS
(GLASS FIBERS)

- 3.- Miller, K. (1980). In Biological Effects of Mineral Fibers (J.C. Wagner Ed.) Vol. 1: 459-465, IARC Sc. Publ. No. 30

In an inhalation study of animals exposed to airborne glass and crocidolite fibers, the authors monitored the response of the alveolar macrophages for signs of functional alterations. The authors indicate that:

«... inhalation of glass fibres, similarly to crocidolite asbestos, has a profound effect on the alveolar macrophage, which could be accompanied by altered immunological parameters.» (p. 464).

The authors state that:

«... the present observations concerning the morphology and function of alveolar macrophages obtained from glass-fibre-dusted rats parallel those made in earlier studies on asbestos-dusted animals» (p. 463).

REFERENCES FROM FIGURE 3
FIBROUS SUBSTITUTES FOR ASBESTOS
(GLASS FIBERS)

- 4.- Bayliss, D.L. et al. (1976). U.S. Dept. of Commerce,
NTIS, No. PB 257 784

In a case control study of workers occupationally exposed to small diameter glass fibers, the authors found borderline statistical significance between cases of respiratory disease, including cancer, and exposure.

«The authors consider the study to be consistent with results of a growing number of animal studies which demonstrate a carcinogenic response to glass fibers less than 1 μ m in diameter.» (p. 2).