Asbestos Fibre Types and Health Risks

Are Perceptions Related to FACTS?

This document is a rapid overview of the recent scientific studies that support a controlled approach for the use of chrysotile and puts in perspective the pitfalls of over regulation.

This review will therefore concentrate on the more recent scientific publications which, have formed the basis of a wide international scientific consensus.

From the FACTS presented in SCIENTIFIC publications in the recent years, it can be concluded that :

When asbestos fibres, or any natural and man-made fibrous respirable materials are inhaled, most fibres are expelled, but some can become lodged in the lungs and remain there throughout life. Fibres can accumulate and cause scarring and inflammation. Severe scarring and inflammation can affect breathing and increase the risk of lung cancer. Fibre dimensions (length and diameter) and selective retention times (biopersistence) must be considered in assessing health hazard and risk. Adverse effects are associated with fibres that are retained in the lung rather than with those that are cleared. Chrysotile is cleared rapidly from the lung, whereas amphiboles (tremolite, crocidolite and amosite) are characterized by extremely long biopersistence.

Evidence from morbidity, mortality and lung burden studies supports the concept of a much lower pathogenic potential for chrysotile compared to amphiboles. These differences should be considered when setting workplace threshold limit values (TLV). Moreover, recent updates of epidemiological studies are consistent with a practical threshold level of exposure below which no adverse effects are detectable.

The health risks associated with chrysotile exposure concern the workplace; risks for the general population, if they exist, are "below detection limits". With normal use and maintenance, fibre emission from modern, high-density chrysotile composites such as friction and chrysotile cement materials is minimal and does not constitute a measurable risk to the general population nor to the environment.

Risks are associated with inhalation, not ingestion. Thus, chrysotile cement pipe materials are safe, as epidemiological studies have failed to show demonstrable risks.

Smoking or cigarette smoke, in combination with exposure to asbestos, greatly increases the likelihood of lung cancer.

Perceptions Are Not Based On Science

The scientific community has put its expertise at work to determine circumstances in which fibre inhalation would result into professional diseases and thus, since the publication of the first studies demonstrating a relation between massive exposure to asbestos fibres and workers health-related problems.

It is agreed that, after tobacco, asbestos is one of the most studied product. Even if there is no concensus regarding the fibre exposure level that can cause a pulmonary fibrosis, there is a general agreement on certain realities that were demonstrated many times in the toxicologcal and epidemiological manner.

It is true that the early scientific reports were alarming. It is important to note that, at this moment of History, the working conditions for asbestos handlers were unacceptable. As the improvement in both the fibre extraction processes and the products manufacturing took many years to be established – and with the fact that diseases associated to high dust exposure could take up to 40 years to develop – human perceptions were then associated with a natural resource that continues to cause deaths (latency period), even if appropriate measures are now in place.

While several countries have adopted regulations based on sound science, some influential nations have let perception or commercial interests guide their approach on the use of asbestos. In these countries, the dramatic numbers of asbestos-related occupational diseases, as well as the growing number of factories converting to other fibres or substitutes and a strong litigation lobby have led some regulatory agencies, mainly in Europe, to adopt a restrictive approach regarding asbestos. In the area of occupational health, regulatory agencies in all countries have the responsibility to set workplace exposure limits, which will reduce the risk to workers to the lowest possible level.

However, some countries, while in the process of formulating so-called "revised" recommended asbestos standards, are still using scientific reviews that are far out of date. This is particularly unfortunate, as much new evidence has accumulated over the last few years, with the resulting frequent publications, not only of scientific papers, but also of editorials and commentaries inspired by the need to revisit the issue of risks related to asbestos.

By banning a product instead of regulating its use,
agencies are sending an inappropriate message
that can lead to dramatic reverse effects.

First, it implicitely sends the information that unregulated, or lightly regulated products, can be used without any caution.

Second, it prepares the ground for overreacting actions, such as the systematic removal where risk is nonexistent. The case of the shameless wasting of the financial resources in the United Kingdom over the removal of chrysotile-cement products is eloquent.

Bipersistence: A Key Factor For Fibre Pathogenicity

Numerous studies made over several decades relate to the importance of fibre dimensions (length and diameter) as prerequisites for biological potency, since these two parameters are related to respirability. However, new evidence published over the last 10 years has come from investigations using modern techniques, in particular from mineral analyses performed on lung tissue, also known as "lung burden" studies. As a result, an additional parameter of fibrous materials is now universally recognized as of paramount importance for assessing the pathological potential of inhaled particles: **durability**.

- Durability is this characteristic that varies widely amongst different respirable particles;
- Durability is likely related to the different chemical structures and crystalline habits of mineral particles;
- Durability will determine the extent of a key biological phenomenon: **biopersistence**.

It can be described as a time period for inhaled particles to persist in the lungs before they are eventually dissolved or otherwise cleared.

Biopersistence studies have been carried out on a number of different respirable particles. It has become clear that there are vast differences amongst various respirable fibrous materials presently used by industry, ranging from very short persistence (low durability) to practically indefinite persistence (very high durability).

It is now generally agreed that adverse effects are associated with fibres retained in the lung for long periods rather than with those that are cleared rapidly.

Regarding asbestos fibres, it was confirmed repeatedly that chrysotile displays low biopersistence, as opposed to the amphibole asbestos fibre types displaying exceedingly long biopersistence. In addition, various types of glass fibres also have different solubility and biopersistence characteristics according to their respective manufacturing processes and chemical compositions. A similar observation was reported for refractory ceramic fibres (RCF) and a series of man-made mineral fibres (MMMF), from glass fibres to RCFs and natural fibres for in vivo durability.

Recent animal experimentations by Bernstein (2003 to 2006), performed according to the most stringent protocols recognized by the European Union, show that soon after chrysotile fibres are inhaled, they are quickly cleared from the lungs. On the contrary, amphiboles, which resist the acidic environment of the lungs, are not cleared as rapidly. The amphiboles fibres remain in the lung for periods up to a year or more. These animal experimentations thus bring robust support to the many epidemiogical observations published in the past. They also support the more recent benchmark publication by Hodgson and Darnton (2000), showing that amphiboles are orders of magnitude more potent than chrysotile.

Thus it has become abundantly clear that biopersistence must now be taken into account when assessing risk associated with the use of respirable materials. Risk assessment and management of respirable fibrous materials must take into account not only the dimensions, but also the durability and biopersistence characteristics of all airborne materials used in industry.

This should apply not only to the different asbestos fibre types, but also to all fibrous materials, whether natural or man-made.

"Biopersistence of inhaled fibrous materials is a critical factor in determining carcinogenic potency". **Fraunhaufer Institute (1995).**

"...adverse effects are associated rather with the fibres that are retained (amphiboles), than with the ones being cleared (largely chrysotile)". **Albin M, Pooley FD, Strömberg U, Attewel R, Mitha R, Johansson L, Welinder H (1994) Occup Environ Med 51: 205-211.**

"...the importance of selective retention of fibres has been discussed in a recent paper. We are convinced that those diseases associated with exposure to mineral fibres are due to fibres retained in the lungs". **Wagner JC and Pooley FD (1986) Thorax 41: 161-166.**

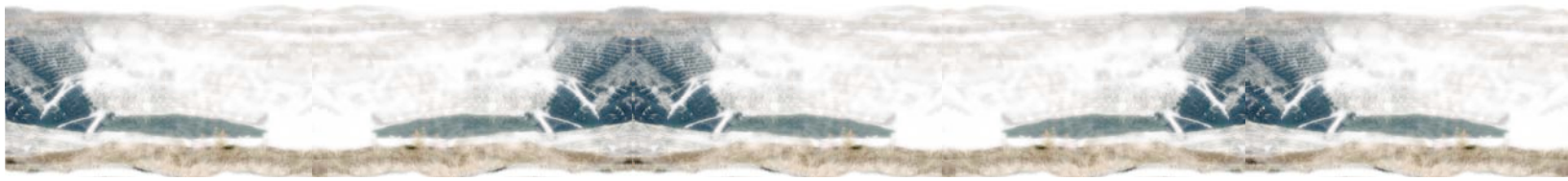
The Difference Between Asbestos Fibre Types

There are no less than 25 reports, from human studies, published in the last 25 years, pointing to the definite differences in biological effects and potencies of chrysotile and amphibole asbestos varieties.

From the 1977 study by Weiss to the most recent investigation by Yarborough (2006), studies have consistently demontrated an undetectable risk for mesothelioma in factories when chrysotile only is used.

One of the most important study in term of cohort dimension was done by Liddell, McDonald & McDonald in 1997, and have shown no evidence of increased cancer risk from chrysotile exposure at presently regulated occupational exposure levels (~1 f/ml, 8-hour time-weighted average), as recommended by the Group of Experts convened by the WHO in Oxford (1989).

More recently, the multi-centre case-control study in Europe by Carel R et al (2006) has shown that occupational exposure to asbestos does not appear to contribute to the lung cancer burden in men in Central and Eastern Europe while in contrast, the lung cancer risk in the UK is increased following exposure to asbestos. The authors suggest that differences in fibre types and circumstances of exposure may explain their results.



« Although epidemiological studies have confirmed amphibole asbestos fibers as a cause of mesothelioma, the link with chrysotile remains unsettled. An extensive review of the epidemiological cohort studies was undertaken to evaluate the extent of the evidence related to free chrysotile fibers, with particular attention to confounding by other fiber types, job exposure concentrations, and consistency of findings. The review of 71 asbestos cohorts exposed to free asbestos fibers does not support the hypothesis that chrysotile, uncontaminated by amphibolic substances, causes mesothelioma.» **Yarborough C M (2006) Chrysotile as a Cause of Mesothelioma : An assessment Based on Epidemiology. Ctitical Reviews in Toxicology 36 : 165-187**

« Currently, about 125 million people in the world are exposed to asbestos at the workplace. According to global estimates at least 90,000 people die each year from asbestos-related lung cancer. In 20 studies of over 100,000 asbestos workers, the standardized mortality rate ranged from 1.04 for chrysotile workers to 4.97 for amosite workers, with a combined relative risk of 2.00. It is difficult to determine the exposures involved because few of the studies reported measurements, and because it is a problem to convert historical asbestos measurements in millions of dust particles per cubic foot to gravimetric units. Nevertheless, little excess lung cancer is expected from low exposure levels. » **Concha-Barrientos M, et al. (2004) "Comparative Quantification of Health Risks: Global and Regional Burden of Disease Attributable to Selected Major Risk Factors". in: Ezzati M, Lopez AD, Rodgers A, Murray CJL, eds. Geneva: World Health Organization, chapter 21, pp.1651–1801.**

"Most asbestos workers who develop mesothelioma are exposed to amphibole asbestos. Few mesotheliomas are found in workers exposed to chrysotile[...] The tremolite exposure is considered to play a major role in the development of the mesotheliomas in these cases" **Kleinerman, J. (1988). The pathology of asbestos related lung disease. Proceedings, The Fleischner Society, Eighteenth Annual Symposium on Chest Disease, Montréal, Canada, 16-18 May, pp. 33-46.**

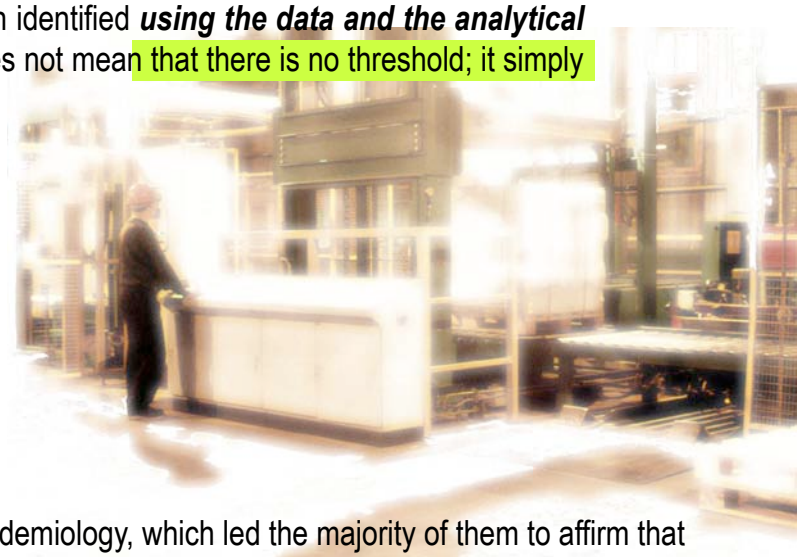
"We believe therefore that chrysotile is the least harmful form of asbestos in every respect and that more emphasis should be laid on the different biological effects of amphibole and serpentine asbestos fibre" **Wagner, J.C., Newhouse, M.L., Corrin, B., Rossiter, C.E.and Griffiths, D.M. (1988). Correlation between fibre content of the lung and disease in East London asbestos factory workers. British Journal of Industrial Medicine 45(5):305-308.**

Is There a Practical Threshold Level of Exposure to Chrysotile Asbestos?

A 1996 draft report from a WHO Task Group for Chrysotile Asbestos concludes that *"exposure to chrysotile asbestos poses increased risks for asbestosis, lung cancer and mesothelioma in a dose dependent manner. No threshold has been identified for carcinogenic risks"*.

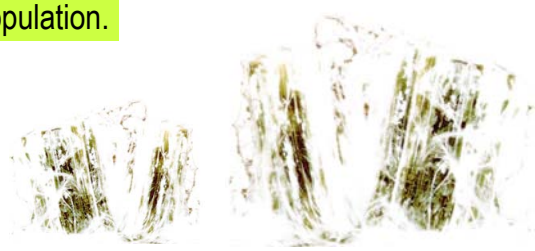
This statement makes sense to those who consider "epidemiology" as the only instrument for assessing risks and coming to a conclusion regarding the existence or absence of thresholds for toxic substances. The epidemiological approach is not the most appropriate tool to establish the existence or the absence of thresholds when very low levels of exposure are considered. It is for this reason that it is often said that no threshold has been "identified" for carcinogenic risks.

More precisely, it means that no threshold has been identified ***using the data and the analytical methodology available to epidemiologists.*** It does not mean that there is no threshold; it simply means that if there is one, it cannot be identified.



It is the careful nature of the scientists, intrinsic with the epidemiology, which led the majority of them to affirm that no threshold has been identified for carcinogenic risks for chrysotile. Nevertheless, that does not mean, as the supporters of the ban asbestos lobby would have it, that this threshold does not exist. It is practically an impossible goal to determine (quantify) a threshold with absolute certainty from the epidemiological approach, as data from several hundreds of thousands of people would be needed, and several complex confounding factors (ethno-socio-economic) would have to be considered in order to satisfy the requirements of scientifically credible statistical analysis.

Nevertheless, a “practical” threshold is likely to exist with the safe use of chrysotile at low level of exposure. Indeed, published evidence from a fairly large number of human studies in various settings and in different countries show that at low (~1 f/ml) occupational or environmental exposure levels to chrysotile, there is no statistically significant increase of incidence of asbestos-related diseases for workers or the general population.



The publication by Paustenbach et al in 2004 is a « state-of-the-art » review of the risk associated with the use of asbestos in the manufacture of friction materials and their use in the general automotive service industries. This review, covering studies and observations published over several decades, demonstrate that in general, exposures have been minimal and did not show any demonstrable risk when chrystile was used. The relatively few instances of increased health risks were always associated with the use of amphiboles. **Paustenbach DJ, Finley BL, Lu ET, Brorby GP, Sheehan PJ (2004) Environmental and occupational health hazard associated with the presence of asbestos in brake linings and pads (1900 to present) : A « state-of-the-art » review. Journal of Toxicology and Environmental Health, Part B, 7: 33–110**

“The final results of research undertaken by the WA Advisory Committee on Hazardous Substances indicate negligible risk to health from asbestos cement products. The Committee concludes therefore that it is not necessary on health grounds to require the use of coating agents or other similar containment systems on asbestos cement product”. **Western Australia (WA) Advisory Committee on Hazardous Substances (1990), Working Party on Asbestos Cement Products, Department of Occupational Health, Safety and Welfare of Western Australia.**

"The ingestion of chrysotile or of a mixture of chrysotile/crocidolite (75%-25%) at various doses, and even at high doses, did not adversely affect the health of rats and there was no evidence of any increase in tumours of the alime doses ntary tract or of any general increase in tumour frequency". **Truhaut, R. and Chouroulinkov, I. (1989). Effect of long-term ingestion of asbestos fibres in rats.In Non-Occupational Exposure to Mineral Fibres, Eds. J. Bignon, J. Peto and R. Saracci. WHO/IARC Scientific Publications No. 90, Lyon:127-133.**

“It would thus seem highly unlikely that the asbestos-cement pipe distribution system makes any biologically significant contribution to the asbestos content of water passing through it [....] “It is highly improbable that asbestos release from asbestos-cement pipes is relevant to the development of cancer”. **MacRae, K.D. (1988). Asbestos in drinking water and cancer. Journal of the Royal College of Physicians of London 22(1):7-10.**

"These observations should provide reassurance that exposure to chrysotile asbestos from urban air or in public buildings will not produce detectable disease". **Churg, A. (1986). Lung asbestos content in long-term residents of a chrysotile mining town.American Review of Respiratory Disease, 134(1):125-127.**

"The experience at this factory over a 40-year period showed that chrysotile asbestos was processed with no detectable excess mortality". **Berry, G. and Newhouse, M.L. (1983). Mortality of workers manufacturing friction materials using asbestos. British Journal of Industrial Medicine 40(1):1-7.**

"A comparison of the asbestos fibre concentrations in those areas with and without A/C roofing... lead to the conclusion that there is no statistically significant connection between the use of asbestos cement materials and the asbestos fibre concentrations found in the various measurement areas". **W. Felbermayer and M.B. Ussar (1980) Research Report: "Airborne Asbestos Fibres Eroded from Asbestos Cement sheets". Institut für Umweltschutz und Emissionsfragen, Leoben, Austria.**

The Quebec Miners Cohort

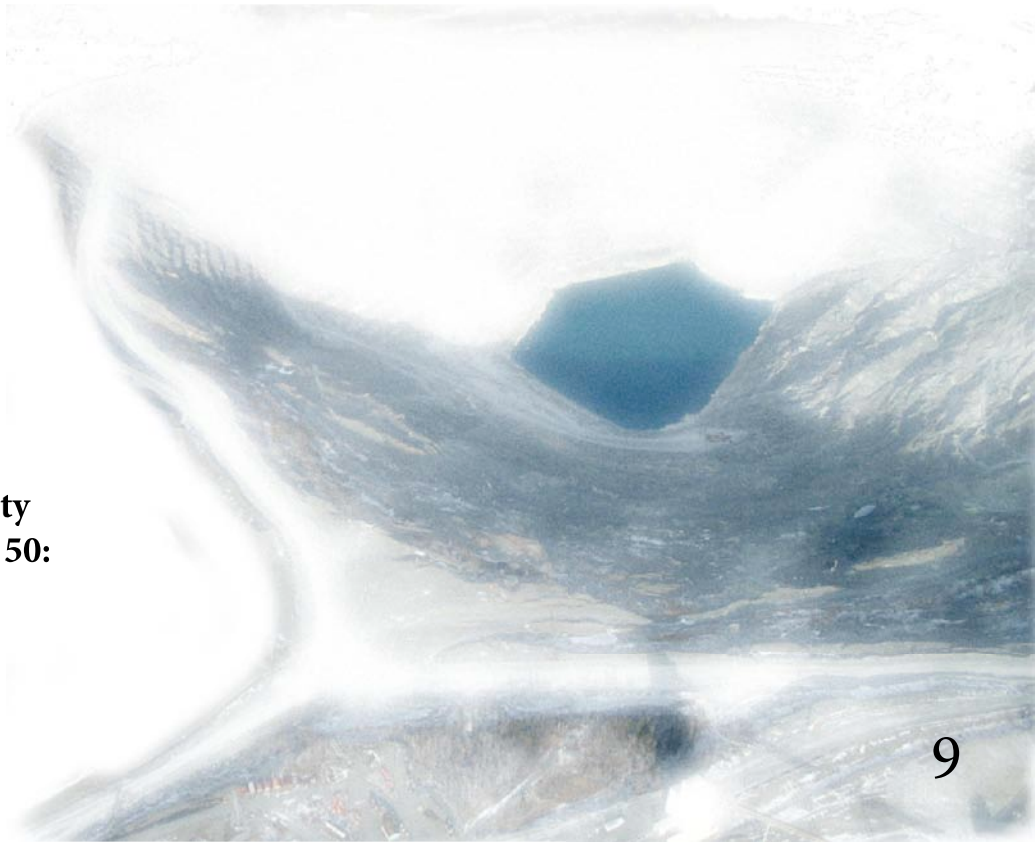
The study is undoubtedly the largest cohort of asbestos workers ever studied and followed for the longest period is that of the miners and millers of the chrysotile mines in Québec.

The cohort, which was established in 1966, comprises some 11,000 workers born between 1891 and 1920 and has been followed ever since. Optimal use was made of all available dust measurements to evaluate the exposures for each cohort member in terms of duration, intensity and timing.

First published in 1993, the authors updated their study in 1997, this time with 9780 men traced back to 1992. Results from exposures below 900 fibres/ml x years - or, say, 45 fibres/ml for 20 years - lead the authors to conclude:

"Thus it is concluded from the point of view of mortality that exposure in this industry to less than 300 mpcf.years has been essentially innocuous".

McDonald, JC, Liddell, DK, Dufresne, A. and McDonald, AD (1993) The 1891-1920 birth cohort of Quebec chrysotile miners and millers: mortality 1976-88, Brit. J. Ind. Med. 50: 1073-1081. Liddell FDK, McDonald JC and McDonald A. Ann. Occup. Hyg. 41:13-35 (1997).



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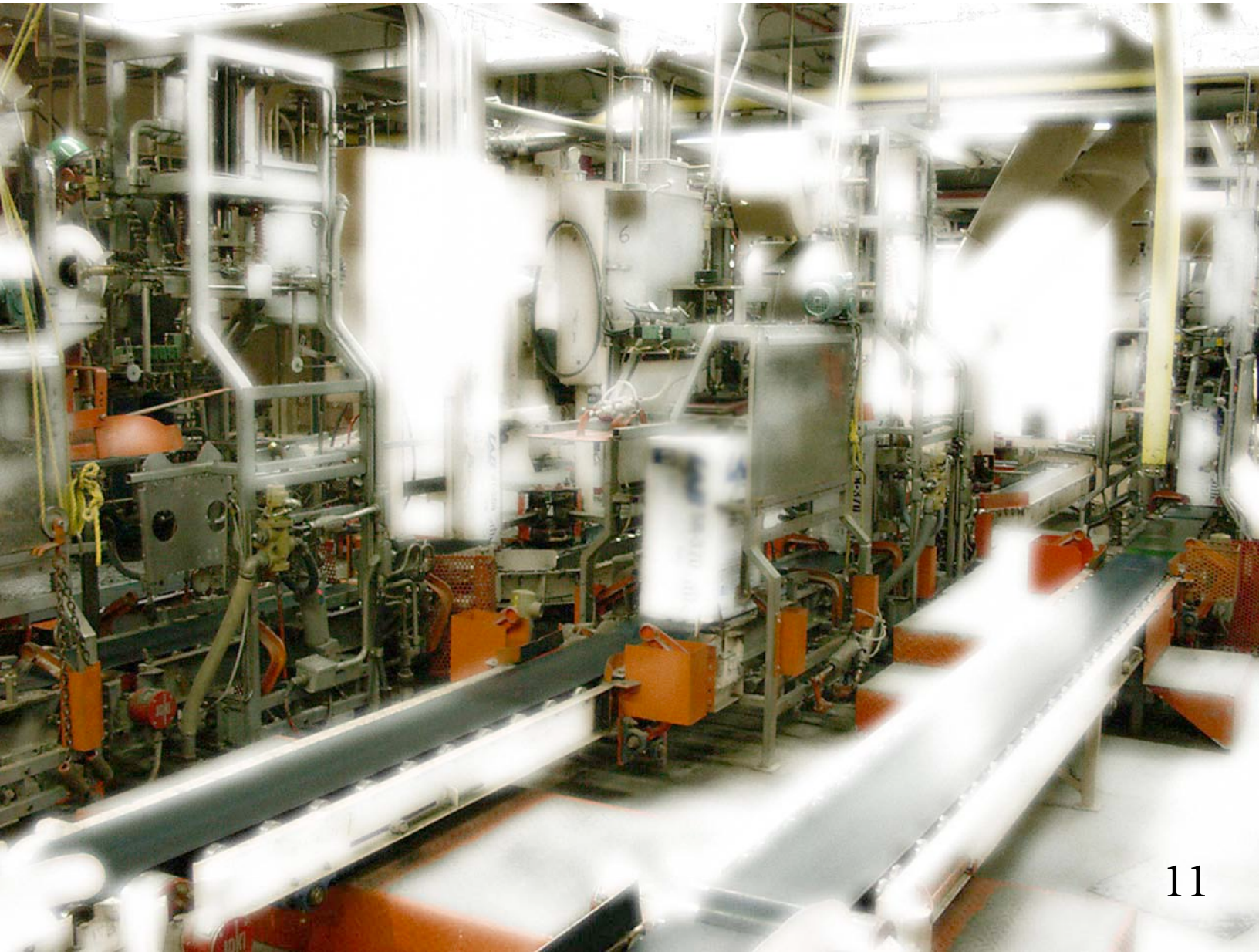

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Albin A, Pooley FD, Strömberg U, Attewell R, Mitha R and Welinder H (1994). Retention patterns of asbestos fibres in lung tissue among asbestos cement workers. A study showing different kinetics for amphibole and chrysotile fibres in human lung tissue. *Amphibole fibre concentrations increase with duration of exposure, whereas chrysotile concentrations do not. The authors indicate that their study supports a former finding of a possible adaptive clearance of chrysotile, and conclude that their findings "support the hypothesis that adverse effects are associated rather with the fibres that are retained (amphiboles), than with the ones being cleared (largely chrysotile).*"

Gibbs, A.R., Jones, J.S.P., Pooley, F.D., Griffiths, D.M. and Wagner, J.C. (1989). Non-occupational malignant mesotheliomas. In Non-Occupational Exposure to Mineral Fibres, Eds. J. Bignon, J. Peto and R. Saracci. WHO/IARC Scientific Publications No. 90, Lyon:219-228. *The mineral content of the lungs from 84 cases of malignant pleural mesothelioma was estimated by electron microscopy and energy-dispersive X-ray analysis. These cases were chosen because the history of asbestos exposure was absent, indirect or ill-defined. The chrysotile counts in the lungs from these mesothelioma cases were similar to those in controls. These findings confirm those of previous studies indicating that amphiboles are more important than chrysotile in the causation of malignant mesothelioma.*

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Berry, G. and Newhouse, M.L. (1983). Mortality of workers manufacturing friction materials using asbestos. British Journal of Industrial Medicine 40(1):1-7. *A study of 13,400 workers (friction materials) showing no mesothelioma when chrysotile only was used, but 10 mesotheliomas when crocidolite was also used.*

Thomas, H.F., Benjamin, I.T., Elwood, P.C. and Sweetnam, P.M. (1982). Further follow-up study of workers from an asbestos cement factory. British Journal of Industrial Medicine 39(3):273-276. *A study of 1,970 a/c workers, showing showing no case of mesothelioma over a 40-year period when chrysotile only was used, but 2 mesotheliomas when crocidolite was used during a 2-year period.*

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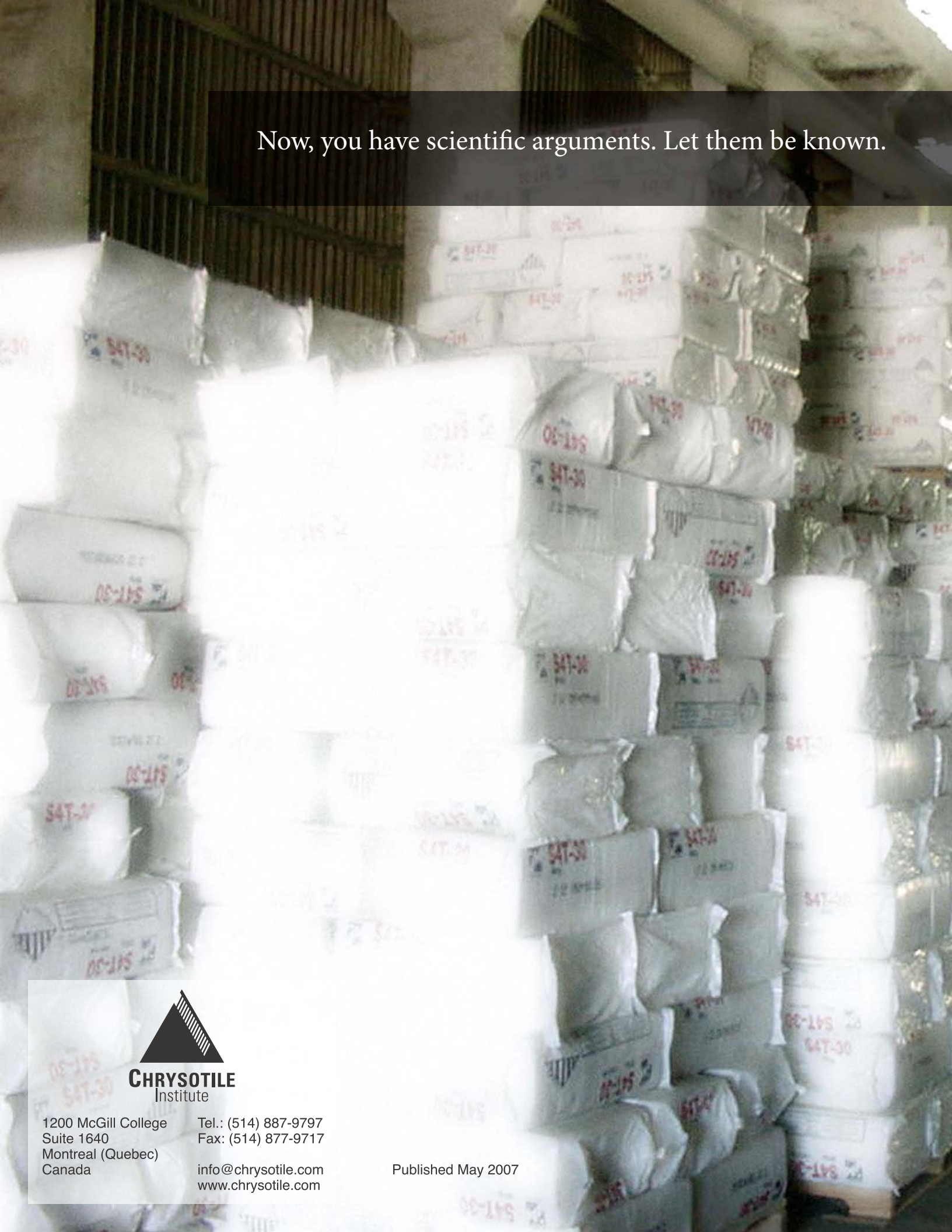

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Published May 2007