CORRESPONDENCE

On talc, tremolite, and tergiversation

Ter-gi-ver-sate: 2: to use subterfuges[1]

Sir,—Reger and Morgan (1990;47: 505–7) read the publications selectively in their attempt to get "non-asbestiform" tremolite off the hook. Three vital questions need to be answered if some fibrous tremolite is to be declared "safe" in the working and general environments. Firstly, can "non-asbestiform" fibres, by mineralogical definition, be unambiguously identified to the satisfaction of experts and regulators? Secondly, if they can be identified, are they present to the exclusion of "asbestiform" fibres in the same mix? Thirdly, if both of the previous conditions can be satisfied, do they inform as to the biological effects of long, thin, durable fibres that do not meet the crystallographic growth characteristics for asbestiform nature required by some experts? The answer to all three questions—without tergiversation—is no.

"Non-asbestiform" tremolite has a variable content of high aspect ratio (> 3:1 for regulatory purposes, but often > 10:1), long (> 5 μm, and many > 10 μm), and thin (< 3 μm, and many less than 0·25 μm) "fibres". The lack of mineralogical consensus as to what exactly the term means is such that the American Thoracic Society's statement on the health effects of tremolite observes that:

> "It became apparent both from our review of the literature and from submissions made to this Committee by experienced mineralogists, that the distinction between cleavage fragments and asbestiform fibres, although theoretically clear, is in practice extremely murky. Some mineralogists believe that these two types of particles are always distinct, whereas others believe they shade off one into the other . . . these same submissions were at odds with one another in identifying particular samples used in various experiments (including the play sand samples analysed by members of the Committee). . . ."[2]

The US Occupational Safety and Health Administration (OSHA) has observed that the primary proponent for use of a "mineralogically correct" definition of asbestos was a company mining and producing tremolite talc.[3] The OSHA also notes that ". . . many (biological) studies did not use carefully crafted definitions such as those currently submitted by the commentors (sic) from affected industries." The major flaw in the substitution of mineralogical definitions for microscopical characteristics is a reliance of the first on gross morphology. For regulatory and health assessment purposes, it is microscopical morphology that counts: there is no evidence that potentially affected cells can distinguish between "asbestiform" and "non-asbestiform" fibres having equivalent dimensions.

The lack of agreement as to what is and what is not "asbestiform" tremolite would be less critical if those who advocate such a definition could show that a clear line exists between the two forms when they present "fibrous" morphology. Unfortunately, this is not the case. Pooley has noted that the differences in structure between massive, acicular, and fibrous morphology are not "sharply defined" but rather represent points on a continuum.[4] So called cleavage fragments may, in a strict morphological sense, be fibrous in their appearance in microscopical fields, and there is no convincing evidence that these "fibres" are of no public health concern. The probability that clearly amorphous, non-fibrous massive particles are *individually* of less concern is irrelevant for regulatory purposes. Regulatory fibres (those greater than 5 μm in length and having aspect ratio > 3:1) are present in both asbestiform and non-asbestiform habit.

Even if there were agreement on a definition of non-asbestiform fibres, and even if it were possible consistently to observe real world samples for regulation in which one form or the other, but not both, were present, the most important question would remain unanswered. That is, do non-asbestiform fibres lack biological effects? Reger and Morgan refer to a recent action by the US Consumer Product Safety Commission (CPSC) refusing to ban tremolite-containing limestone products, specifically, play sand containing tremolite fibres. The decision by CPSC, based on a narrow interpretation of law, was split two to one, with two further commissioners' slots vacant. Abraham, Churg, and Sébastien have independently showed that ". . . long, thin, high aspect ratio tremolite fibers (respirable) are unequivocally present" in some play sand samples.[5]

Reger and Morgan correctly cite inconclusive epidemiological studies of lung cancer among talc miners, but omit convincing evidence that tremolite-actinolite (a mixture of mineralogical types) causes lung cancer, mesothelioma, and interstitial fibrosis in vermiculite miners.[6] Especially misleading is the limitation of the discussion of tremolite and talc health effects to cancer: the most important dose related health effect of "non-asbestiform" tremolite—and talc—is pulmonary fibrosis. This has been known for talc itself since the nineteenth century, and was established in the United Kingdom by Merewether in 1933.[7] Merewether noted 11 cases of rubber tyre workers with *x* ray film evidence of diffuse interstitial fibrosis, attributing the cases to their exposure to a fine granular talc dust. Thirteen further rubber tyre workers were added to the list in the subsequent year.

In discussing animal studies, studies flawed by improper sample preparation/characterisation and unacceptable animal survival figures are discussed as if they were valid, whereas the important work by Stanton *et al*[8] is misinterpreted. Tremolite, which was most carcinogenic in Stanton's paper, did not fit the usually cited dimensional range (diameter < 0·25 μm, length > 8 μm) but was composed largely of thicker and shorter fibres. Conversely, six of the seven talc preparations injected contained no fibres in the Stanton range *at all*. The exact make up, sources, and preparation methods for these samples are unknown. Reference to important recent work by Addison and Davis[9] and Davis *et al*[10] neglects to point out that one tremolite characterised before the experiment as fibrous (spicules) but not asbestiform ultimately produced mesothelioma in 70% of animals.

It is certainly true that more work is needed in the investigation of any role for mineralogical characteristics in the production of health effects by tremolite "fibres". Until there is actual evidence that "non-asbestiform" fibres are easily defined, clearly separated from tremolite asbestos in real world work environments, and

not productive of lung fibrosis or other health effects, it seems folly to declare them exempt from regulation.

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1 *Webster's New Collegiate Dictionary.* Springfield, Mass: G and C Merriam, 1977.
2 American Thoracic Society. Official statement. Health effects of tremolite. *Am Rev Respir Dis* 1990;**142**:1453–8.
3 United States Department of Labor, Occupational Safety and Health Commission. *Occupational exposure to asbestos, tremolite, anthophyllite and actinolite. Federal Register* 1990; 55:(No 29):4938–54. (Docket No H-033-d; 29 CFR parts 1910 and 1926.)
4 Pooley FD. Asbestos Mineralogy. In: Antman K, Aisner JE, eds. *Asbestos-related malignancy.* Orlando, Fla: Grune and Stratton, 1987:3–30.
5 Weill H, Abraham JL, Balmes JR, *et al. Draft report of the ATS Committee on the health effects of tremolite.* Exhibit 474, docket H-033-d, Department of Labor, Occupational Safety and Health Commission, exhibit list for 54 FR 30704 and 55 FR 4938, 1990.
6 McDonald JC, McDonald AD, Armstrong B, Sébastien P. Cohort study of mortality of vermiculite miners exposed to tremolite. *Br J Ind Med* 1986;**43**:436–44.
7 *Annual report of the chief inspector of factories and workshops for England and Wales.* London: HMSO, 1933: 63 and 1934: 65.
8 Stanton MF, Layard M, Tegeris A, *et al.* Relation of particle dimension to carcinogenicity in amphibole asbestoses and other fibrous minerals. *J Natl Cancer Inst* 1981;**67**:965–75.
9 Addison J, Davis JMG. A comparison of the carcinogenicity of six tremolites using the intraperitoneal injection assay in rats. *Proceedings of the VIIth International Pneumoconiosis Conference.* Pittsburgh: ILO, 1988.
10 Davis JMG, Addison J, McIntosh C, Miller B, Niven K. Variations in the carcinogenicity of tremolite dust samples of differing morphology. *Collegium Ramazzini conference on the third wave of asbestos disease.* New York: June, 1990.

Authors' reply

Case informs us that we "read the publications selectively"; we do not, but we try to base our opinions on well designed and carried out studies rather than on whim. Case poses three questions and then, in a series of ex cathedra pronouncements, answers them all. The first asks whether "non-asbestiform fibres can unambiguously be identified to the satisfaction of experts and regulators." We are informed that such fibres can be identified with certainty by most competent mineralogists and geologists of which there was only one on the American Thoracic Society (ATS) Committee.[1] His major interest has been measuring asbestos in the air. Your correspondent also gratuitously informs us that Abraham, Churg, and Sebastien have independently showed that "long thin high aspect ratio tremolite fibres are unequivocally present in some play sands." Abraham and Churg, although competent pathologists, have no geological expertise and most of Sebastien's research has not been in this area. Case then quotes Pooley as stating that "differences in structure between massive acicular and fibrous morphology are not sharply defined, but rather represent points on a continuum" thereby implying that non-asbestiform fibres cannot be identified with certainty. He omits to mention that in the same publication Pooley wrote that "the particles produced from non-fibrous forms of these minerals, ie tremolite, actinolite, and anthophyllite, are often referred to as cleavage fragments and are quite distinct from a similar sized group of asbestos particles."[2] Selective or defective reading? Pooley and other expert mineralogists have subsequently voiced the same opinion elsewhere[3] as has Schenk *et al.*[4]

Case goes on to state that for regulatory and health assessment purposes it is microscopical morphology that counts as potentially affected cells cannot distinguish between asbestiform and non-asbestiform fibres. We would suggest that this is not so and clear cut animal evidence exists to disprove this statement. Indeed, Stanton, in his animal experiments with various talcs was unable to induce tumours.[5] Case states that six of the seven samples of talc injected contained no fibres in the Stanton range at all. He then goes on to say that the exact make up, sources, and preparation methods for these samples is unknown. He is wrong on several counts. Stanton *et al* in their paper state that each fibre used was from a separate and diverse source and selected to include extreme ranges of dimension.[5] Moreover, the identity of each talc was made available to Ann Wylie, Professor of Geology, University of Maryland, and, furthermore, she was given access to all of Stanton's mineral samples. The sources of the two tremolite asbestos samples were, however, unknown.[5] As to whether affected cells can distinguish between asbestiform and non-asbestiform tremolite, although we are not experimental pathologists, we would also call the attention of Case to the studies of Endo-Capron *et al* who suggest otherwise.[6]

We are aware that talc is fibrogenic and can lead to pneumoconiosis, but the fact remains that talc is much less fibrogenic than is any type of asbestos[7] and, moreover, is non-carcinogenic. Case refers to studies of vermiculite, but omits to mention that the vermiculite in question was contaminated with asbestiform tremolite; a fact of which both of us were well aware since one of us was a coauthor of a paper relating to this topic[8] and which was referred to in the ATS statement.[1] Moreover, to compare present day exposures to talc with those that occurred in Merewether's day when threshold limit values (TLVs) did not exist, and when dust counts in those exposed to talc were around 100–150 million p/cu ft suggests either startling naivete or lubricious tendentiousness. According to Case the most important question that remains unanswered is "do non-asbestiform fibres lack biological effects?" Presumably, the question applies to non-asbestiform tremolite and other cleavage products, although this is not obvious from his letter. Clearly, such fibres have biological effects and indeed may produce fibrosis of the lung when inhaled as contaminants of talc and in concentrations way above the present TLV. The relevant question, however, is are they carcinogenic? In this regard talc has long been used as a means of inducing pleurodesis. In 210 subjects in whom direct application of talc and another phyllosilicate to the pleura was effectsd to prevent recurrent pneumothorax there was no increased incidence of either lung cancer or mesothelioma.[9] Thus the overwhelming evidence is that non-asbestiform cleavage products contained in talc are non-carcinogenic and they should not be treated as if they are. We are also told in passing that the decision of CPSC was based on a narrow interpretation of the law. Are we to assume that broad and sweeping generalisations are preferable, especially when applied to specific circumstances and to specific hazards?

Next we note with interest that the second reference to Addison's and Davis's studies relates to a meeting that recently took place in New York.[10] In referring to this work, Case writes "that the one tremolite characterised