



A review of carcinogenicity studies of asbestos and non-asbestos tremolite and other amphiboles

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Abstract

Experimental animal studies comparing asbestos and non-asbestos varieties of tremolite indicate tremolite asbestos is markedly more carcinogenic. By direct analogy, the differences in carcinogenicity between tremolite asbestos and non-asbestos prismatic tremolite should be the same for the other types of amphibole that also crystallize in the asbestos and non-asbestos habits. The earliest of the experimental animal studies, done more than 25 years ago, have design limitations by modern standards including the use of injection or surgical implantation as the route of administration rather than the more relevant route of inhalation. However, the differences in the carcinogenicity of amphibole asbestos and non-amphibole asbestos are sufficiently large to be clearly discernable even with the study limitations. Together with later studies on these and related minerals, there is strong evidence of a much lower hazard associated with the shorter, thicker fibers of the non-asbestos amphiboles, than is found for the asbestos analogues of the same mineral. It is possible that the non-asbestos amphiboles are no more hazardous than other silicate minerals widely considered nuisance dusts.

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1. Introduction

We will define some basic asbestos terminology to clarify the terms used. The glossary in ‘The Health Effects of Mineral Dusts’ produced by The Mineralogical Society of America (Guthrie and Mossman, 1993) has the following definition: “Asbestos is a term applied to asbestiform varieties of serpentine and amphibole, particularly chrysotile, ‘crocidolite’, ‘amosite’, asbestiform tremolite, asbestiform actinolite, and asbestiform anthophyllite. The asbestos minerals possess asbestiform characteristics”. The Mineral Society’s glossary goes on to define asbestiform as: ‘an adjective describing inorganic materials that possess the form and appearance of asbestos. When applied to a mineral, the term ‘fibrous’ is applied when it ‘gives the appearance of being composed of fibers, whether the mineral

actually contains separable fibers or not’ (Veblen and Wylie, 1993). Asbestiform is a subset of fibrous, where asbestiform implies relatively small fiber thickness and large fiber length, flexibility, easy separability and a parallel arrangement of the fibers in native (unprocessed) samples. Often, asbestos fibers occur in bundles, i.e. they are often polyfilamentous. From the definition it is clear that not all fibers or fibrous minerals are asbestiform and not all fibrous minerals called asbestiform are asbestos.

A convention has developed that a fiber is any particle with an aspect ratio equal to or greater than 3:1. This stems from the fiber definition in the early UK and US fiber counting methods (Asbestosis Research Council, 1969; Asbestos Textile Institute, 1971; Langer et al., 1991), it could just as easily have been 5:1 or 10:1. In using these methods, the microscopist had to make a decision to count or not count a particle depending on whether the shape and size met certain size criteria. The decision was more easily and consistently made for particles with aspect ratios just

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