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The Life Cycle of Asbestos: Understanding the Distinctions between Commercial and Naturally-Occurring Asbestos

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Asbestos is a commercial and regulatory term applied to six fibrous (asbestiform) minerals: the serpentine mineral chrysotile, and the fibrous varieties of five amphibole minerals, tremolite, actinolite riebeckite, cummingtonite-grunerite, and anthophyllite. Although initial recognition of the negative effects of asbestos inhalation came from heavy occupational exposures, years of research has clearly demonstrated that lower levels of secondary, non-occupational exposure can produce similar negative health outcomes. In recent decades research also has shown that exposure to fibrous amphiboles outside the regulatory definition (e.g. winchite at Libby, Montana) and fibrous zeolite minerals (e.g. erionite in Cappadocia, Turkey) represents a health risk equal to or greater than exposure to regulated asbestos minerals.

Here we present a model for the Life Cycle of Asbestos that seeks to understand asbestos from petrogenesis of primary asbestos and asbestos-like minerals (defined as fibrous minerals with known or suspected toxicity), through all stages of the extraction (industrial) and/or liberation (natural) of asbestos minerals. The goal of the life cycle model is better understanding of the occurrence of asbestos and asbestos-like minerals in both occupational and non-occupational settings, and to aid in the recognition of pathways to human exposures. Four major components are used in the model. (1) Primary Asbestos Minerals refers to all bedrock sources of asbestos and asbestos-like minerals, generally formed via hydrothermal activity in a variety of protolith rock types. (2) Naturally-Modified Asbestos Minerals refers to asbestos and asbestos-like minerals that have been liberated from primary outcrops by weathering and erosion, soil formation processes, and sediment transport (wind or water). (3) Commercially-Modified Asbestos (CMA) refers to the industrial extraction of ore-grade asbestos minerals, processing, separation, and grading of asbestos minerals, and the manufacturing of asbestos products (tiles, auto-brakes, insulation, fire retardants cement binders, etc.). (4) Anthropogentically-Disturbed Asbestos emphasizes human interactions with both commercially-modified asbestos and naturally-modified asbestos minerals and draws attention to the various pathways for human exposure.

Naturally-Occurring Asbestos (NOA) refers to both primary-asbestos minerals in outcrop and naturally-modified asbestos released by natural weathering. The distinction between NOA and CMA is important when considering the asbestos fiber populations (size and morphology), in assessing toxicity (related in part to morphology), in understanding potential differences in human exposure pathways, in developing appropriate monitoring strategies and risk assessment models, and in improving diagnostic protocols (e.g. patient histories). We will use a several case studies to illustrate the utility of the asbestos life cycle in understanding asbestos hazards and human exposure risk.