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The Geology of Asbestos in the United States and Its Practical Applications

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ABSTRACT

Recently, naturally occurring asbestos (NOA) has drawn the attention of numerous health and regulatory agencies and citizen groups. NOA can be released airborne by (1) the disturbance of asbestos-bearing bedrocks through human activities or natural weathering, and (2) the mining and milling of some mineral deposits in which asbestos occurs as an accessory mineral(s). Because asbestos forms in specific rock types and geologic conditions, this information can be used to focus on areas with the potential to contain asbestos, rather than devoting effort to areas with minimal NOA potential. All asbestos minerals contain magnesium, silica, and water as essential constituents, and some also contain major iron and/or calcium. Predictably, the geologic environments that host asbestos are enriched in these components. Most asbestos deposits form by metasomatic replacement of magnesium-rich rocks. Asbestos-forming environments typically display shear or evidence for a significant influx of silica-rich hydrothermal fluids. Asbestos-forming processes can be driven by regional metamorphism, contact metamorphism, or magmatic hydrothermal systems. Thus, asbestos deposits of all sizes and styles are typically hosted by magnesium-rich rocks (often also iron-rich) that were altered by a metamorphic or magmatic process. Rock types known to host asbestos include serpentinites, altered ultramafic and some mafic rocks, dolomitic marbles and metamorphosed dolostones, metamorphosed iron formations, and alkalic intrusions and carbonatites. Other rock types appear unlikely to contain asbestos. These geologic insights can be used by the mining industry, regulators, land managers, and others to focus attention on the critical locales most likely to contain asbestos.

ASBESTOS

"Asbestos" is not a mineralogical term, but rather a commercial and industrial term used to describe a group of specific silicate minerals that form bundles of long, very thin mineral fibers. When crushed or handled, asbestos bundles readily disaggregate and release microscopic mineral fibers. Asbestos fibers are typically less than a micrometer in diameter and range from several micrometers to hundreds of micrometers in length. The many different ways that asbestos and related terms have been described are summarized in Lowers and Meeker (2002).

The history of asbestos discovery and usage extends back at least 5,000 years (see Ross and Nolan, 2003). Commercial-grade asbestos is composed of long, thin, durable mineral fibers and fiber bundles that exhibit high tensile strength, flexibility, and resistance to heat, chemicals, and electricity (Ross, 1981; Zoltai, 1981; Cossette, 1984; Ross et al., 1984; and Skinner et al., 1988). These properties, especially its exceptional insulation and fire-resistance abilities, have made asbestos widely used in a number of products and industrial applications in the past and present (Virta and Mann, 1994; Ross and Virta, 2001).

Asbestos is most commonly defined as the asbestiform variety of several specific, naturally occurring, hydrated silicate minerals. Asbestos typically includes chrysotile, the asbestiform member of the serpentine group, and several members of the amphibole mineral group, including, but not limited to, the asbestiform varieties of (1) riebeckite (commercially called crocidolite), (2) cummingtonite-grunerite (commercially called amosite), (3) anthophyllite (anthophyllite asbestos), (4) actinolite (actinolite asbestos), and (5) tremolite (tremolite asbestos) (Table 1). Several other amphiboles are known to occur in the fibrous habit (Skinner et al., 1988), and some in the asbestiform habit, such as winchite, richterite (Meeker et al., 2003), and fluoro-edenite (Gianfagna and Oberti, 2001; Gianfagna et al., 2003), which have been linked to respiratory disease clusters. However, these more rigorous academic definitions for amphiboles (Table 2) have generally not been applied in regulatory language.

Historically, chrysotile has accounted for more than 90 percent of the world's asbestos production, and it presently accounts for more than 99 percent of