

## **Morphological characterizations of amphibole and amphibole-asbestos from Libby, Montana U.S.A. by polarized light microscopy**

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### **ABSTRACT**

Three amphibole samples collected from the former vermiculite mine located near Libby, Montana were characterized with a polarizing light microscope both in standard grain mounts and with the aid of a spindle stage. Two other samples were included in the study for comparison: the NIST tremolite-asbestos standard and a non-asbestos tremolite. For the grain mounts, the sizes and morphology of approximately 1,000 particles were determined. Based on the regulatory classification of asbestos (i.e. an aspect ratio of 3 or higher), 95% of the Libby amphibole, 92% of the NIST tremolite, and 48% of the non-asbestos tremolite were asbestos. Based on morphology, 36% of the Libby amphibole, 19% of the NIST tremolite, and 0% of the non-asbestos tremolite were asbestos. Extinction angles were also measured for the samples and used to help determine whether a sample rests on its (110) or (100) surface; extinction angles also aid in differentiating fibers and fragments.

Fifty single particles of the Libby amphibole, 25 of the NIST tremolite, and 10 of the non-asbestos tremolite were mounted on glass fibers and examined with the aid of a spindle stage. Each single particle was measured; in this case, unlike with the grain mounts, thickness could be determined. Also, extinction angles could be measured on any (hk0) plane because the particles were adjusted so their c-axes were parallel to the rotation axis of the spindle stage. In grain mount, many of the NIST tremolite particles appeared as fragments, but upon rotation they appeared as fibers. Extinction angles were also determined for different (hk0) planes. These observations show the non-asbestos samples mainly rested on their (110) surfaces, although the smaller of these were flattened on (100); the small fragments in the NIST tremolite and Libby amphibole were predominantly flattened on (100). Statistical analysis of the single-particle data yielded correlation between width and thickness. The single particle data showed no correlation between length and aspect ratio but a strong correlation between width and aspect ratio; the opposite, more common trend was observed in the grain mounts.