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Characterizing the source of potentially asbestos-bearing commercial vermiculite insulation using in situ IR spectroscopy

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Abstract

Commercially produced vermiculite insulation from Libby, Montana, contains trace levels of asbestiform amphibole, which is known to cause asbestos-related diseases. When vermiculite insulation is found in a building, evaluation for its potential asbestos content traditionally involves collecting a sample from an attic or wall and submitting it for time-consuming analyses at an off-site laboratory. The goal of this study was to determine if in situ near-infrared reflectance measurements could be used to reliably identify the source of vermiculite ore and therefore its potential to contain asbestos. Spectra of 52 expanded ore samples, including attic insulation, commercial packing materials, and horticultural products from Libby, Montana; Louisa, Virginia; Enoree, South Carolina; Palabora, South Africa; and Jiangsu, China, were measured with a portable spectrometer. The mine sources for these vermiculite ores were identified based on collection location, when known, and on differences in elemental composition as measured by electron probe microanalysis. Reflectance spectra of the insulation samples show vibrational overtone and combination absorptions that vary in wavelength position and relative intensity depending on elemental composition and proportions of their constituent micas (i.e., vermiculite ore usually consists of a mixture of hydrobiotite and vermiculite mineral flakes). Band depth ratios of the 1.38/2.32, 1.40/1.42, and 2.24/2.38 μm absorptions allow determination of a vermiculite insulation's source and detection of its potential to contain amphibole, talc, and/or serpentine impurities. Spectroscopy cannot distinguish asbestiform vs. non-asbestiform amphiboles. However, if the spectrally determined mica composition and mineralogy of an insulation sample is consistent with ore from Libby, then it is likely that some portion of the sodic-calcic amphibole it contains is asbestiform, given that all of the nearly two dozen Libby vermiculite insulation samples examined with scanning electron microscopy in this study contain amphiboles. One sample of expanded vermiculite ore from multiple sources was recognized as a limitation of the spectral method, therefore an additional test (i.e., 2.24 μm absorption position vs. 2.24/2.38 μm band depth ratio) was incorporated into the spectral method to eliminate misclassification caused by such mixtures. With portable field spectrometers, the methodology developed can be used to determine vermiculite insulation's source and estimate its potential amphibole content, thereby providing low-cost analysis with onsite reporting to property owners.

Keywords: Vermiculite insulation, expanded vermiculite ore, vermiculite, reflectance spectroscopy, elongate amphiboles, Libby, provenance, VSPEC method, electron probe microanalysis; Minerals in the Human Body