C26 Development of a Scanning Electron Microscopy Screening Method for World Trade Center Dust

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After attending this presentation, attendees will be knowledgeable about the procedures and methods used to develop a scanning electron microscopy signature screening method for World Trade Center (WTC) dust.

This presentation will impact the forensic science community by providing a detailed description of an environmental forensic challenge, the methodology used to address the problem, and the results of an inter-laboratory study designed to test a new analytical method.

Dust from the September 11, 2001, collapse of the WTC penetrated indoor areas of lower Manhattan. Apartments, offices, and public buildings were contaminated with the debris. In 2005, in response to continuing public health concerns about dust inhalation, including the "World Trade Center Cough," the U.S. Environmental Protection Agency and the U.S. Geological Survey (USGS) were tasked with developing a screening method to detect low-levels of WTC dust in the presence of indoor dusts from other sources.

The development of a WTC dust signature was complicated by the dilution of the dust by urban background dust accumulated over the period of four years. The composition of the analyzed dust was highly variable because of contributions from a number of sources unrelated to the WTC collapse on September 11, such as building damage, construction debris, and other common urban dust sources. In addition, variations in the composition of the WTC dust over the affected area due to exposure to moisture, distance from the WTC site, and elevation were evaluated.

Analysis performed by USGS by scanning electron microscopy with energy dispersive spectrometry (SEM/EDS) determined that the major components of the less-than-150-micrometer fraction of the WTC dust were gypsum/anhydrite, phases compatible with crushed concrete, and man-made vitreous fibers (MMVF), including a calcium-aluminum-silicon glass, soda-lime glass, rock wool, and slag wool. These components were also present in urban dusts not impacted from the event, but in different ratios than dusts from the WTC. Slag wool, specifically, was found to be present in WTC dust at much higher concentrations (20-25 % by area) than in urban background dusts (10^{-3} to 10^{-5} wt. %). Additionally, the slag wool identified in the WTC dust was distinguishable from rock wool found in most urban dusts by iron content. The definitions used for slag wool and rock wool were those used by the Thermal Insulation Manufacturer's Association.

A SEM/EDS point counting method was developed to determine the amount of slag wool (fibers/milligram) in collected dusts. The method described a procedure that included splitting, ashing, and sieving the collected dust. From each split, a suspension of the dust in alcohol was prepared and an aliquot was placed on a SEM substrate. Sources of measurement uncertainty were evaluated and the major source of variability was found to be directly related to the small number of slag wool fibers present on the sample stub. Suitable reference materials containing known amounts of characterized WTC dust must be used to obtain accurate results.

A subsequent inter-laboratory evaluation of the method was implemented by eight laboratories analyzing a number of dust samples consisting of background dust and background dust spiked with material affected by the WTC collapse. The inter-laboratory study results illustrated that the method was able to distinguish WTC affected dust at the 5% level by weight from 22 out of 25 background dust samples.

Scanning Electron Microscopy, World Trade Center Dust, Method Development