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Multi-laboratory testing of a screening method for world trade center (WTC) collapse dust

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ABSTRACT

The September 11, 2001 attack on the World Trade Center (WTC) covered a large area of downtown New York City with dust and debris. This paper describes the testing of an analytical method designed to evaluate whether sampled dust contains dust that may have originated from the collapse of the WTC. Using dust samples collected from locations affected and not affected (referred to as 'background' locations) by the collapse, a scanning electron microscopy (SEM) analysis method was developed to screen for three materials that are believed to be present in large quantities in WTC dusts: slag wool, concrete, and gypsum. An inter-laboratory evaluation of the method was implemented by having eight laboratories analyze a number of 'blind' dust samples, consisting of confirmed background dust and confirmed background dust spiked with varying amounts of dust affected by the WTC collapse. The levels of gypsum and concrete in the spiked samples were indistinguishable from the levels in the background samples. Measurements of slag wool in dust demonstrated potential for distinguishing between spiked and background samples in spite of considerable within and between laboratory variability. Slag wool measurements appear to be sufficiently sensitive to distinguish dust spiked with 5% WTC-affected dust from 22 out of 25 background dust samples. Additional development work and inter-laboratory testing of the slag wool component will be necessary to improve the precision and accuracy of the method and reduce inter- and intra-laboratory variability from levels observed in the inter-laboratory evaluation.

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1. Introduction

The September 11, 2001 attack on the World Trade Center (WTC) covered a large portion of downtown NY City with dust and debris. Characterization of the resulting dust showed it to contain construction materials, glass fibers and soot from the accompanying fires (Lioy et al., 2002). Exposure to this dust and debris during and after the WTC collapse has been associated with a significant decline in lung function of rescue and recovery workers (Banauch et al., 2005a, 2005b, 2006). Public concern over the continued exposure of workers and residents to this dust prompted the development of a method to distinguish between dust containing significant levels of residual WTC dust from typical urban dust. The development and multi-laboratory testing of this method are described here.

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In a study of air and settled dust in apartments in Lower Manhattan, the Agency for Toxic Substances and Disease Registry (ATSDR) and the New York City Department of Health and Mental Hygiene found significantly more man-made vitreous fibers (MMVF) and gypsum in dust samples collected from Lower Manhattan apartments compared to samples collected from apartments in areas above 59th Street (New York City Department of Health and Mental Hygiene (NYC-DOHMH) and Agency for Toxic Substances and Disease Registry (ATSDR), 2002). In a study of the composition of settled dust in the Deutsche Bank building at 130 Liberty Street, directly adjacent to the WTC site, R.J. Lee Group, Inc. (2004) measured numerous hazardous contaminants, including mineral wool (rock or slag wool types of MMVF) and gypsum, at levels much higher than in office buildings outside of the NY area, unaffected by the WTC collapse and presumed to represent 'background' conditions. Studies conducted by the USGS found that the WTC dust samples collected both indoors and outdoors shortly after 9/11 are dominated by gypsum, calcium-rich phases consistent with those found in concrete (PCC), and MMVF (Meeker et al., 2005). MMVF was found predominantly in the form of a glass fiber containing Mg, Al, Si, Ca, Na and less than 1.5% iron by weight (Lowers et al., 2005a). This glass fiber is identified as slag wool, based on definitions by the Thermal Insulation Manufacturer's Association (TIMA) (1991). Slag wool, a material used in fireproofing, was absent from many background samples obtained from locations not affected by the WTC collapse (Lowers et al., 2005a; New York City Department of Health and Mental Hygiene (NYCDOHMH) and Agency for Toxic Substances and Disease Registry (ATSDR), 2002; R.J. Lee Group, Inc., 2004; U.S. EPA, 2005).

Based on these findings, it was hypothesized that dust originating from the WTC building collapse would contain substantial quantities of slag wool, gypsum, and PCC. As these substances are contained in common building materials, they would be expected to be present in typical urban dust, but not at the high levels found in WTC collapse-affected dust.

2. Method development

A standard protocol for sample preparation and analysis for gypsum, PCC and slag wool needed to be developed. The analysis method developed was based on scanning electron microscopy (SEM) (U.S. EPA, 2005). Over 100 bulk dust samples collected from September 2004 to April 2005 were used in the method development process. Most samples were collected using a Nilfisk GS-80 High Efficiency Particulate Air (HEPA) vacuum cleaner (U.S. EPA, 2005). Others were collected from residential and commercial vacuum cleaner bags (U.S. EPA, 2005). Twenty-one samples known to have been affected by the collapse were collected in two buildings that were part of the Deutsche Bank complex located at 130 Liberty Street and 4 Albany Street, adjacent to the WTC complex. Both buildings were uninhabited and slated for demolition. Fifty samples were collected from locations well beyond the areas affected by the collapse, based on modeling, monitoring, and photo analysis, and are considered to be background dust (U.S. EPA, 2004). Forty-six samples were collected from locations that were possibly affected, but were farther from the WTC site than the samples taken from locations known to have been affected. None of these 46 samples were used in the multi-laboratory screening study, but several were evaluated during both the method development phase and post-study. In addition, one "source" sample was obtained from the USGS. This sample was a composite of dust predominantly from outdoor locations in the vicinity of the WTC. These dust samples were collected within days of the collapse in September of 2001 (Clark et al., 2001).

Analyses of a portion of the samples prepared using the developed protocol showed a difference in slag wool levels between samples collected in affected areas and those from background areas. Eighteen of the 21 samples from affected areas contained slag wool at concentrations of greater than 100,000 slag wool fibers per gram of dust, with a range of 69,000 to 13,400,000, while all of the samples from background areas had concentrations less than 100,000 fibers/g, ranging from no slag wool detected to 92,800 fibers/g of dust (U.S. EPA, 2005).

3. Method evaluation

Based on the previous work by USGS (Meeker et al., 2005), two government agencies and six commercial laboratories collaborated to refine a comprehensive screening method to distinguish WTC-affected dust from background dust, using slag wool, gypsum, and PCC as markers for WTC dust (U.S. EPA, 2005). Once a method was finalized, each laboratory received the final method (protocol), along with dust samples consisting of both confirmed background samples and confirmed background dust spiked with varying amounts of WTC-affected dust. The laboratories were given six weeks to analyze the dust samples; weekly conference calls were held to confirm progress and to discuss and resolve issues that arose during the study.

The two spiking dusts were the USGS composite sample of predominantly outdoor dust collected in September of 2001 described previously, and dust from inside the now demolished Deutsche Bank building at 4 Albany Street collected in September of 2004. The 4 Albany Street building was one block south of the WTC complex. The laboratories were not provided with the identities of the samples, but were provided a particle atlas for WTC dust to aid in particle identification (Lowers et al., 2005b). Laboratories then followed the method to prepare samples and perform the analyses for slag wool, gypsum, and PCC (U.S. EPA, 2005).

3.1. *Dust preparation*

Dust samples were ashed by heating samples in a furnace at 480 °C to burn off organics (U.S. EPA, 2005). The background samples for this study were ashed by U.S. EPA East Emergency Response Team (ERT). The spiked samples for this study were ashed, spiked and homogenized by the USGS Microbeam and Standards Laboratories (U.S. EPA, 2005). To prepare the spiked samples, dust confirmed as not affected (background) was split six ways. The splits were spiked at levels of 1, 5, or 10% total ashed mass with either of the two different WTC-affected