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Microanalysis and materials characterization of dusts generated by the World Trade Center collapse

Abstract

Two days after the September 11th attack on the World Trade Center (WTC), the U.S. Geological Survey was asked by the U.S. Environmental Protection Agency and the U.S. Public Health Service to conduct a remote sensing and mineralogical characterization study of lower Manhattan around the WTC. This study, conducted in cooperation with NASA and the Jet Propulsion Laboratory was requested to rapidly provide emergency response teams with information on the concentrations and distribution of asbestos and other materials in the dusts deposited around lower Manhattan. Preliminary results were released to emergency response teams on September 18th and September 27th, 2001. This presentation will focus on the results of the materials characterization portion of the study. The full report was released to the public on November 27th, 2001.

Thirty-six sweep samples of dusts deposited in lower Manhattan by the September 11, 2001, collapse of the World Trade Center towers were analyzed by scanning electron microscopy (SEM), energy dispersive and wavelength dispersive spectroscopy (EDS, WDS), and x-ray diffraction (XRD) at the USGS analytical Laboratories in Denver. The dust samples were collected from various surfaces (mostly outdoor) on September 17th -18th, 2001. Two of the samples were collected indoors and had not been exposed to rain prior to collection. XRD analyses indicate that most of the samples contain varying amounts of crystalline quartz, gypsum, calcite, anhydrite and amorphous material. Other phases identified by XRD in small amounts include: muscovite, feldspar, magnesiohornblende, lizardite, dolomite, bassanite, illite, portlandite, larnite, polymorphs of calcium silicates, possible chrysotile, and others. All of these phases can be components of the building dry wall material, concrete, and insulation.

SEM, EDS and WDS analyses were performed on unprocessed dust samples, primarily to look for the presence of asbestos and phases containing heavy, or potentially toxic metals. Predominant components of the dusts, as seen by SEM, include glass fibers (which are x-ray amorphous, and occur in levels as high as 40 by volume), concrete phases, and gypsum. Amphibole asbestos was not detected in any of the dust samples. However, trace amounts (generally < 1wt.% by XRD) of chrysotile asbestos have been identified in most of the samples. A large variety of other materials are present at trace levels including, vermiculite, particles enriched in Fe, Zn, Pb, Sr, Bi, Cu and other metals, and unidentified organic materials compatible with wood, paper, etc. The chemical composition of the majority of glass fibers (and glass spheres) in all samples is consistent with slag wool (Nomenclature Committee of TIMA Inc., 1991), however glass fibers with other compositions are present. SEM and EDS analysis of material coating a steel beam from the WTC debris indicates that chrysotile asbestos is present at levels possibly as high as 20% by volume. This material also contains abundant glass fibers.

Chemical leach tests were performed on dust samples collected from outdoor and indoor locations. The results indicate that the dusts can be chemically reactive should they come into contact with rain or wash water, or moisture in the eyes, mouth, and respiratory system. Any water or moisture that comes into contact with the dusts initially becomes alkaline to caustic, due to dissolution of calcium hydroxide from the concrete particles. As stated in the initial USGS report to emergency response workers, the materials identified by this study in the WTC dust and debris indicate that cleanup of dusts should be done with appropriate respiratory protection and dust control measures.

Biography

Greg Meeker is a research scientist and manager of the Electron Microbeam Laboratory at the U.S. Geological Survey in Denver, Colorado. Greg's research involves the application of microanalytical techniques to the fields of geochemistry, mineralogy, volcanology, and environmental geology. Prior to joining the USGS in 1989, he

worked for Charles Evans & Associates in Redwood City, California as a Senior Research Analyst. Greg began his career at the California Institute of Technology in the Department of Earth and Planetary Sciences where he studied meteorites and lunar materials with the SEM, electron microprobe, and ion microprobe.
Greg is currently Past President of the Microbeam Analysis Society and he has been a member of MAS since 1984. In 1995 he served as Local Arrangements Chair for Microbeam Analysis -95 in Breckenridge, Colorado and in 1996 he was elected for a three-year term as a Director of MAS. In 1998 Greg was the MAS Charles E. Fiori Tour Speaker.

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The Electron Microprobe and X-Ray Microanalysis-An Overview

Abstract
The electron probe microanalyzer (EPMA) is a sophisticated instrument routinely used for both the observation of and the chemical characterization (elemental identification and quantification) of solid samples. An electron microprobe has all the capabilities of a typical scanning electron microscope (SEM), plus the ability to nondestructively examine small analytical volumes, and to obtain compositional information with an analytical precision and accuracy at the +/- 1-2% level. Accurate quantitative analyses may be obtained with lateral spatial resolutions of 1 micron and nominal limits of detection of around 10 to 100 parts per million.

This talk will present a brief introduction to the technique; illustrate the instrumentation employed, and compare and contrast the two primary detector systems (Energy Dispersive Spectrometry (EDS) and Wavelength Dispersive Spectrometry (WDS)). The principles and practice of x-ray microanalysis (WDS) will be illustrated through various organic and inorganic examples.

Biography
Dan Kremser is a product and applications specialist at Advanced MicroBeam, Inc., in Vienna, Ohio. He received his B.A. in Geology at the University of Connecticut and his Ph.D. in Earth and Planetary Sciences at Washington University, St Louis, MO in 1982. He remained at Washington University for nineteen years, serving as manager of both the electron microprobe and x-ray diffraction laboratories, and was an associate in the department's ICP-MS Element facility. He joined Advanced MicroBeam in 2001. He has focused on solving analytical problems associated with the electron microprobe and X-Ray diffractometer on a wide variety of materials and minerals as well as laser ablation ICP-MS mineral studies. Dan also participates (since 2000) in the annual Lehigh Microscopy School operating the JEOL 733 for lab exercises.

Dan has been a MAS member since the mid-1980s and has been active in several local affiliate societies. Initially, he was involved with the MIKMAS (Missouri-Illinois-Kansas MAS) group, serving as secretary from 1995 to 1999. He was the first president (1999-2001) of the merged MIKMAS and Central States MSA group designated the Central States Microscopy and MicroAnalysis Society (CSMMS). He is currently a trustee (2003-2006) in the Microscopy Society of Northeastern Ohio (MSNO).