A180 Application of Cathodoluminescence (CL) Microscopy and Spectroscopy to Forensic Sediment Analysis

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After attending this presentation, attendees will understand the principles of cathodoluminescence (CL) microscopy and spectroscopy applied to forensic sediment analysis, as well as sample preparation, mineral component identification, digital image processing, and elemental analysis.

This presentation will impact the forensic science community by illustrating the key steps in practical application of the method and its integration into techniques currently used in forensic sediment analysis.

This presentation describes and demonstrates the application of cathodoluminescence (CL) microscopy and spectroscopy to the characterization of mineral components of sediment. Forensic geologic samples are often comprised of varying concentrations of both light and heavy minerals, as well as foraminifera, diatoms, and organic particles, making them amenable to identification by a variety of methods. Quartz, carbonates, and feldspars are the most abundant minerals on the Earth's crust and, as such, are usually encountered as constituents of sediment samples. Because these minerals are ubiquitous, they may be found in even very small amounts of trace geologic materials, such as smears and dust. Application of CL microscopy and spectroscopy is suitable to differentiate among common minerals and classes of minerals, such as feldspars, carbonates, zircons, and quartz, all of which exhibit characteristic CL colors when bombarded with an electron beam. The CL emission is related to the presence of trace element activators, such as Cr^{3+}, Mn^{2+}, Mn^{4+}, Fe^{3+}, and rare earth elements ($REE^{2+/3+}$), such as hafnium, dysprosium, and europium, as well as due to lattice defects within the crystal.

Within the mineral types, CL microscopy and spectroscopy will provide information that can discriminate among different sources of each mineral. The additional discrimination among sources of quartz, for example, would provide a useful tool for the forensic comparison of these geologic materials. Further, CL microscopy and spectroscopy, combined with traditional forensic geologic methods, may offer information for source determination by providing information about the conditions under which the mineral was formed.

At the 2009 AAFS Annual Meeting, study results including suitable sample preparation for processing with multiple techniques and particle elemental analysis, using automated SEM-EDS, and micro-XRF were presented. The focus of this study was to develop an optimized analytical scheme for processing small sample sizes with these microanalytical methods. Considerations of sample size and sequence of analyses necessary for sample manipulation, integrity and beam damage, as well as automation of processing for high sample throughput, was presented. This presentation will expand on these prior results, including refinement of the sample preparation process, comparison of CL and SEM-EDS particle identification results for hundreds of particles from different size fractions of several sources of sediment. Additionally, the application of automated digital image processing of CL images will be presented and evaluated in the context of its utility to process the large numbers of particles for necessary for source characterization.

Cathodoluminescence, Sediment, Microscopy

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