D51 Characterization of Soil Composition Using a Wavelength Dispersive Spectrometer X-Ray Mapping Method

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The goal of this presentation is to describe an electron microprobe method using stage mapping, which is being developed to help quantify soil characterization. Example soils that highlight the issues involved with developing the methodology of this approach for soil characterization will be discussed.

This presentation will impact the forensic science community by helping provide additional statistically defensible compositional parameters for the comparison of soils.

An electron microprobe method using stage mapping, which is being developed to help quantify soil characterization will be described. Example soils will be discussed that highlight the issues involved with developing the methodology of this approach for soil characterization.

Adoption of this, or similar methods, once developed for the characterization of soils will help provide additional statistically defensible compositional parameters for the comparison of soils.

Comparison of soil types can be subjective and dependent of the experience and biases of the forensic microscopist or investigator. Descriptions of soil often include aspects such as color, size fractions, general type – sand, silt, clay, amount of organic matter, and mineral composition. Most of these aspects rely on the experience of the examiner for adequate description. Therefore data from different examiners, especially data provided by examiners from different localities or organization, are often not directly comparable. Efforts to develop a standard method for semi-automatic compositional characterization of soils using stage mapping methods in an electron microprobe with wavelength dispersive spectrometers (WDS) are on- going. This approach is developing in tandem with an approach utilizing an automated scanning electron microscope with energy dispersive X-ray spectrometer (EDS).

Both the WDS and EDS approaches utilize a sieving process to portion out grains based on size, thus capturing statistics for the size of the soil particles. One size range at a time is characterized by composition. Additionally, morphology information can also be obtained. However, at this time research is focused on completing development of the algorithm for uniquely identifying the mineralogical composition of the grains. A sampling of one size fraction is prepared as a polished grain mount for analysis in the electron microprobe. The WDS approach utilizes element ratios and creates element ratio maps on a pixel by pixel basis created from elemental maps captured by the WDS system. The ratio of elements contained within different crystal structural sites of the soil minerals is unique to each mineral group. Therefore the abundance of the mineral types can then be determined from the element ratio maps. Each map can consist of millions of pixels, each representing a compositional analysis. The abundance of each mineral type for one size fraction can then be combined with the data acquired for the other

size fractions of a soil sample to provide a mineralogical histogram for the soil sample as a whole. In other words a quantitative description of the soil sample is produced containing statistical information pertaining to the size and to the mineralogical composition.

The latest progress in our efforts to refine this method will be presented. Ultimately, adoption and use of this method would improve quantitative comparison of soil samples from different localities. This would reduce subjectivity involved with soil comparisons and potentially increase the forensic usefulness of soil comparisons.

Quantitative, Soil Comparison, X-Ray Mapping

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