D14 Location of Graves Through Soil Spectroscopy: Differentiating the Reflectance of Grave Soils From Common Fertilization Treatments

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After attending this presentation, attendees will have learned that common fertilization practices of soils minimally affect the spectral signatures of soils and that the spectral signatures of grave soils differ from non-grave soils and fertilized soils. This differentiation in the spectral signature of grave soils, soils treated with manure, bone meal, or compost indicate that it is possible to use the spectroscopy of soils to identify locations of clandestine graves through aerial or satellite imagery with minimal confusion from common soil treatments.

This presentation will impact the forensic science community by increasing knowledge on how common fertilization practices affect the spectral signature of soil. A better knowledge about this matter indicates that it is possible with high confidence to determine the location of graves using hyperspectral data from aerial or potentially satellite imagery. Confusion between spectral signatures of treated soil (non grave soils mixed with manure, bone meal, or compost) and graves is minimal.

This research is part of ongoing multidisciplinary studies at the burial site of an African animal zoo (Parc Safari), near Montreal, Quebec, Canada. This site is an ideal ground to conduct research on the effects of cadaver decomposition on the soil properties. The site contains several graves with multiple animals that had been buried 6 to 50 years ago. For this particular aspect of the research a total of three different burial sites were examined: an African elephant buried six years ago, a comingled mass grave of unknown age containing the remains of several animals such as a zebra and a ram, and an unexcavated grave containing a large ungulate (similar to a buffalo) and potentially other remains and a reference area (non-grave site). Furthermore, treatments that are often found in association with fields (compost, manure, bone meal, blood meal) that may have effects on the reflectance properties of the soil similar to cadaveric decomposition were examined.

The objective was to determine if the reflectance of grave soils can be differentiated from soils that have been fertilized with manure, compost, bone meal, or blood meal. The manure used for this experiment was collected from the McGill University Farm and came from cattle that had been fed a mixed diet similar to what free range cattle would have. The organic bone meal and blood meal were purchased at a local gardening center and the two-year-old compost had been produced from grass cuttings. While spectroscopy of soils and soil properties is a well developed and studied field in the physical sciences, few studies have examined the effect of adding products such as manure or compost on soil reflectance. Virtually no studies have yet compared the reflectance of such treated soils to grave soils from the same site. It is important to be able to differentiate between the spectral signature of cadaveric decomposition in the soil and soil that has been fertilized or treated with additives such as compost and others in order to reduce the potential false positives when searching for clandestine graves from aerial or satellite imagery.

Soil samples were taken from the three aforementioned graves in addition to reference soil collected from an area of the cemetery containing no bodies. The reference soil was mixed in equal parts with each of the additives (manure, compost, bone meal, blood meal) and the reflectance from 400-1,000nm of each grave, pure treatment (e.g. pure bone meal), treatment mixed with reference soil and pure reference soil was measured with an Analytical Spectral Devices Handheld Spectrometer in a dark room under a high intensity halogen light source for illumination. Lighting and viewing geometries were kept constant for each measurement. The reflectance data was subsequently classified to allow for a quantitative assessment of spectral differences and also converted to spectral fingerprints to allow for a visual comparison.

The results indicate that not only does each of the treatments have very different spectral signatures from the reference soil, but when mixed with reference soil, the spectra are still from that of that of the reference soil. Furthermore, the spectral signatures of the treatments and the treated reference soil also differ markedly from the spectra of the three graves indicating that the likelihood for confusion between the spectra of graves and soils treated with common forms of fertilizations is minimal from hyperspectral data.

Spectroscopy, Clandestine Graves, Fertilization

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