B88 A Forensic Comparison of Sandy Soils Using Raman Spectroscopy, X-Ray Diffraction, and Synchrotron Powder Diffraction (PD)

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After attending this presentation, attendees will better understand an additional technique for the analysis of sandy soils, the ability to replicate that technique, and an understanding of the place of the technique in a forensic soil analysis approach.

This presentation will impact the forensic science community by raising the ability of practitioners to analyze sometimes-problematic sandy soils. This in turn may increase the profile of forensic soil analysis as a whole, leading to further developments and optimal use of a valuable evidence type. In addition, this presentation is a demonstration of opportunities for synchrotron research, an emerging field with funding available.

The examination and comparison of soil and related materials transferred in situations of contact is a powerful method for linking persons, vehicles, equipment, and locations. The evidential value of soil comparison derives from its widespread distribution, highly variable composition, relative ease of transfer, persistence, and resistance to degradation.[1] Ideally, sufficient soil is recovered to perform a range of tests allowing meaningful comparisons with samples from known locations. These tests include the comparison of the inorganic and/or organic fractions, with multiple techniques utilized.[2-4] Possible associations can be established in which the difference in characteristics lie within the expected limits of natural variation and measurement uncertainty.

Nonetheless, forensic soil comparisons employing bulk methods of analysis provide only limited discrimination where the soils have similar geological origin, or where insufficient sample is available to measure bulk properties reproducibly. Sandy soils present an additional challenge, with minimal organic material and heavy minerals resulting in limited material for comparisons, regardless of the bulk amounts present. One such area of forensic importance is the Swan Coastal Plain in Western Australia, covering much of the Perth metropolitan region and dominated by strongly leached sandy soils. While urbanization has resulted in an enrichment in the soil by organic and clay materials, areas of predominantly quartz sands remain.[5]

Primary and secondary minerals recovered from quartz grains within sandy soils allow additional scope for the differentiation of soils dominated by siliceous grains. A method for their recovery and analysis has been developed at ChemCentre and has been successful in analyzing trace mineral coatings on quartz sands from the Swan Coastal Plain in Perth, Western Australia. It is proposed that the approach is applicable to a broader range of sandy soils in general.

This study outlines efforts undertaken to characterize the primary and secondary minerals using Raman Spectroscopy, X-Ray Powder Diffraction (XRPD), and Synchrotron Powder Diffraction (PD). More than 40 samples of sites from within the Perth Metropolitan region have been examined, with the goal of further validating and expanding the technique previously undertaken using laboratory-based X-Ray Diffraction (XRD) on more than 350 samples. The chemometric analysis of PD beamline data obtained at the Australian Synchrotron from these samples exhibits differentiation and associations even within areas of minimal geological differences. Preliminary experiments attempting to analyze single sand grains using PD at the Australian Synchrotron were also undertaken.

This presentation will detail the approach, interpretation, and its place within a standard soil analysis framework. Examples of the use of the approach in casework will be provided. It is envisaged that the approach and associated database can be expanded and allow for the increased differentiation of highly leached, sandy soils from locations outside of Western Australia.

Portions of this research were undertaken on the powder diffraction beamline of the Australian Synchrotron, Victoria, Australia.

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Soils, Inorganic, Synchrotron

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