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The importance of geological and soil materials as trace evidence in solving criminal investigations in Australia

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Geological and soil materials are often powerful pieces of contact trace evidence to help in criminal investigations [1, 2]. The aim of forensic soil/geology analyses is to associate samples of geological and soil materials taken from questioned items, such as clothing, shoes, shovels or vehicles, with a known control location or the crime scene. Forensic geologists and soil scientists are now also using advanced techniques, which have the ability to acquire information from extremely small samples. When examining geological and soil evidence, there are a range of stages involving screening testing that help provide pieces of a puzzle and then more detailed tests that provide definitive answers [1]. With enough puzzle pieces a picture develops as indicated in a recent cold murder (33 years ago) investigation, which demonstrates how field observations (colour), X-ray diffraction (XRD) from laboratory and synchrotron X-ray sources and Scanning Electron Microscopy (SEM) have been critical in developing reliable soil/geology forensic information, from landscape to microscopic scales, to help in forensic investigations, which were used as evidence in the South Australian Supreme Court.

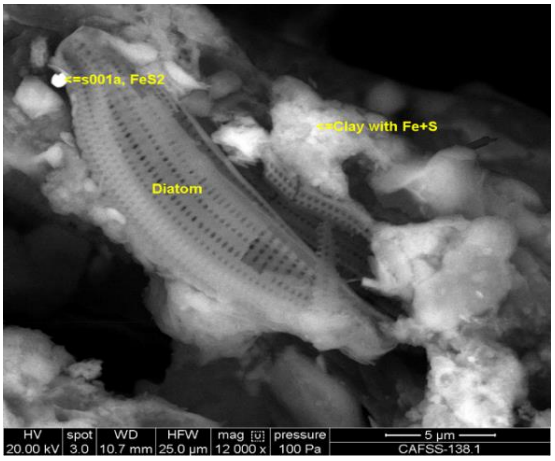

Figure 1: SEM (Electron Back Scatter Mode) of soil between fibres in the hem of the pyjama-top.

This forensic investigation highlights the critical importance of: (i) carefully cutting 3 questioned swatch samples (~20mm X 10mm) from the 9 year old victim's pyjama-top based on the intensity of brownish stain/soil deposits, especially in the hem, (ii) sampling a wide range of known control soils/sediments from the Onkaparinga estuary on the water edge and submerged under water (subaqueous soils), (iii) morphological observations with the naked eye and by SEM to identify pyrite (FeS_2), diatoms and clumps of clay (layer silicates) (Fig 1), (iv) chemical analyses (pH) to classify Acid Sulfate Soil features, (v) laboratory and synchrotron XRD to identify clay minerals and pyrite *in situ* on the pyjama-top, (vi) conducting laboratory transference shaking experiments with clean strips of pyjama-top fabric to verify that the mineral particles were dominantly on the surface of the pyjama fabric using SEM, whereas in the questioned pyjama-top swatches the particles were deeply impregnated in gaps between fibres of the fabric, which likely originated under water with force being applied on the pyjama top. To conclude, the swatches cut from the pyjama top with questioned soil samples on/in the fabric and known control subaqueous soil

samples with prominent acid sulfate soil material features (i.e. pyrite minerals) provides compelling evidence that they have virtually identical origins (i.e. a saline estuarine environment similar to the Onkaparinga estuary).

References:

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