B83 Assessing the Utility of Detrital Quartz Surface Textures and Feldspar Mineral Chemistry for Forensic and Intelligence Applications

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After attending this presentation, attendees will better understand the strengths and limitations of the light mineral fraction of soils as metrics for the characterization and discrimination of soil and dust samples.

This presentation will impact the forensic science community by demonstrating the techniques for the exploitation of quartz and feldspar as quantitative methods for the characterization of soil evidence, which may provide valuable prosecutorial evidence as well as lead identification for forensic investigations and intelligence purposes.

The mineral assemblages in soils are commonly utilized to make associations between people, objects, and locations. For forensic and provenance studies, the light mineral fraction (ρ<2.9g/cm3) of soils is not considered to be as discriminating as the heavy mineral fraction (ρ>2.9g/cm3); however, the light minerals typically account for 90%-99% of the fine-to-coarse (>50µm) mineral fraction and are, therefore, more likely to be present in sufficient quantity in the very small (<<1g) sample sizes commonly encountered in casework. The goal of this research was to investigate metrics to exploit potentially valuable information from the more abundant light mineral fraction of soils. To this end, 11 surface soil samples were collected from regions with distinct bedrock/surface geology, ecoregion, and physiography. This project investigated the two most common minerals in the light fraction of soils and sediments (quartz and feldspar). Interpretation of quartz surface textures using high-resolution Scanning Electron Microscopy (SEM) can be used to constrain environmental (littoral, subaqueous, eolian, among others) and petrogenetic (sedimentary, igneous, and metamorphic) origins.[1]

In addition, the major element composition of the detrital feldspar minerals was measured using quantitative SEM Silicon Drift Detector-Energy-Dispersive X-Ray Spectroscopy (SDD-EDS). The elemental composition of feldspar is highly variable and is closely related to the rock type from which it formed and thus may be used to infer the source rock type from which these minerals were derived.[2-5] Isolated grains were embedded in epoxy and subsequently ground and polished to expose the interior of the grains; quantitative analysis was performed using Desktop Spectrum Analyzer (DTSA-II), an open-source software package available from the National Institute of Standards and Technology (NIST).[6] Smithsonian Institution mineral and glass standards were used for calibration and as reference spectra for quantitative analysis.

Preliminary results show that the quartz surface textures (n=30-40 grains/sample) can be used to distinguish between several of the analyzed soil samples. In addition, the observed quartz surface textures correlate well with the geological and environmental settings from which the soils were collected. The elemental composition of isolated detrital feldspar grains (n=50-100 grains/sample) provided valuable information concerning the identity of the eroding local bedrock from which the soils were derived; however, several of the samples in this limited collection did not contain a sufficient number of feldspar grains for a meaningful, robust bedrock (source) assessment. The results from this research may provide new metrics and information for domestic criminal investigations and intelligence purposes.

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Reference(s):

1. Krinsley D.H., Doornkamp J.C., 1973. *Atlas of Quartz Sand Surface Textures*. Cambridge University Press, Cambridge.
2. Mizutani S. (1959). Clastic plagioclase in Permian graywacke from Mugi area, Gifu Prefecture, central Japan. *Journal of Earth Sciences*, Vol. 7, 108-136.
3. Pittman E.D. (1970). Plagioclase feldspar as an indicator of provenance of sedimentary rocks. *Journal of Sedimentary Petrology*, Vol. 40, No. 2, 591-598.
4. Trevena A.S., Nash W.P. (1981). An electron microprobe study of detrital feldspar. *Journal of Sedimentary Petrology*, Vol. 51, No. 1, 137-150.
5. Chakraborty S., Moecher D., Samson S., 2012. Provenance of the Lower Ocoee Supergroup, Eastern Great Smoky Mountains. *Geol. Soc. Am. Bull*. 124, 1278-1292. doi: 10.1130/B305778.1
6. Newbury D.E., Ritchie N.W.M., 2015. Performing elemental microanalysis with high accuracy and high precision by scanning electron microscopy/silicon drift detector energy-dispersive X-ray spectrometry (SEM/SDD-EDS). *J. Mater. Sci.*, 50, 493-518. DOI 10.1007/s10853-014-8685-2.

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