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Possibility of describing sand grain morphology by image analysis

Sugita, R.[1] and Kikkawa S. H.[1]

[1]National Research Institute of Police Science, 6-3-1 Kashiwanoha, Kashiwa Shi, Chiba 277-0882 Japan.
sugita@nrips.go.jp

Soil is often found related to a crime and examined to indicate relationship between a scene of crime, victim, suspect and tools used in the crime. Forensic soil examination utilizes various methods such as microscopy, X-ray diffraction, and elemental analysis. Microscopy is an essential and powerful method among all. Morphology of grains is an important factor for discrimination and provenance analysis in forensic geology [1]. Although it is important, description of morphology as a result of grain observation relies on an experienced examiner. Size of grains under the microscope is also described for forensic examination of soil. When the difference in size is observed among samples even the same size fractions are prepared, it will be one of the reasons to conclude that the samples cannot be derived from the same source. However, measuring size and morphology such as roundness, sphericity, and size of each grain is a time consuming task. One of the possible solutions is to introduce computer assisted image analysis. The purpose of this study is to propose utilizing image analysis to show multi-grain morphology in a sample for forensic soil examination.

Slide scanner (SS; SCAMERA MIDnano Scope 3, Newly Corporation, Japan) can acquire digital images of thin sections by transmitted light. A sheet of polarizing film as a polarizer was set under the thin section to obtain open nicol image, and another sheet as analyser was set on the crossed nicols image. Secondary electron or backscattered electron images of carbon coated thin sections were acquired by scanning electron microscope (SEM; JSM-6600LV, JEOL, Japan) by high vacuum mode. Images of SS was aligned by Photoshop 6 (Adobe Systems, USA), and all images were analysed by a free software Image [2]. Sand fractions of soil samples were examined by SS and SEM, and crushed minerals were also subjected to SEM examination.

Grain diameter was represented by length of “breadth”, which is defined as the largest axis perpendicular to the largest axis of a grain image, and feret diameter. Morphology of the outline in this study is represented by “sphericity”, which is MinR/MaxR where MinR is the radius of the inscribed circle centered at the center of mass and MaxR is the radius of the enclosing circle centered at the center of mass. It should be noted that the definitions of “sphericity” in this study, and sphericity widely used in geology are not the same. Images of the same thin section obtained by both SS and SEM provided similar results to each other. The result indicates that creating a binary image from SS images is utilizable. The result of analysis of sixteen sand samples by SS provided different features in their histograms. Size of grains is reduced by lapping and polishing when preparing thin sections, therefore utilizing such grain size distribution requires attention that the result is not directly comparative to other

grain size distribution results such as by Pye and Blott [3]. Other shape factors will be discussed in the presentation.

References:

[1] Bull PA and Morgan RM (2006) Science and Justice 46:107-124
[2] Rasband W (1997-2015), NIH, http:// imagej.nih.gov/ij/
[3] Pye K and Blott SJ (2004) FSI 144:19-27