B152 A Standard Development for Visual Color Determination and Comparison in Forensic Soil Examinations: The Organization of Scientific Area Committees (OSAC) Subcommittee on Geological Materials

Libby A. Stern, PhD, Federal Bureau of Investigation Laboratory - CFSRU, Quantico, VA 22135; Brad Lee, PhD, University of Kentucky, Lexington, KY 40546; Ethan Groves, BS, Microtrace, LLC, Elgin, IL 60123*

Learning Overview: The goal of this presentation is to describe the goals, justification, and purpose for the development of a standard for visual soil color determination as it applies to forensic soil examinations.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by explaining how the provision of standards for visual soil color determination and criteria for exclusion in forensic comparisons will provide the means for uniform processes to be employed by forensic laboratories as well as guidance in forensic soil examinations for professional geologists or soil scientists who may be asked to provide expertise to law enforcement.

Upon inception of the OSAC for Forensic Science, a geological materials subcommittee (OSAC-GEO, now a group within OSAC-Trace) has been developing documents to improve the analysis and interpretation of geological evidence as part of *criminal* investigations. This mission scope contrasts with *environmental* soil forensics, in which methods focus on detecting environmental contaminants or on the role of soil in civil engineering, for which distinct standards are needed. OSAC-GEO primarily focuses on analysis of geological materials as trace evidence that can be examined to provide information about how or where a putative criminal act occurred.

Among the initial documents produced by OSAC-GEO is one focused on visual soil color characterization and is currently in the process of pursuing approval as an American Society for Testing and Materials (ASTM) standard. Because visual examination of soil color is fast and non-destructive, it is typically characterized during the initial screening of forensic specimens; within the context of a soil comparison, color can be suitable for excluding a common source or directing further orthogonal analyses (e.g., microscopy and elemental analysis, among others). Because color is used as a screening metric, the criteria proposed for soil color comparisons are intended to minimize false exclusions and the "inclusion" windows are relatively coarse. Soil color may also be useful in soil examinations aimed at constraining the possible geographic source(s) of the soil to aid in investigative casework.

This document for forensic soil color determination is restricted to visual evaluation by reference to a soil color chart in the Munsell color system. While instrumental colorimetry can provide better precision, the proposed comparison criteria within the OSAC-GEO-developed document are specific to the discrete nature of pigmented chips in the soil color reference books widely used in the soil science community.

This document on soil color also describes circumstances in which color should not be used as a part of a forensic soil comparison, including: alteration or contamination of any of the samples being compared; non-representative soil exemplars; distinct treatments or size fractionation among the comparators; or when soils have different moisture contents.

The comparison criteria for forensic soil comparisons build upon the methods developed by the United States Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS) -National Cooperative Soil Survey for describing soil color contrast within a soil horizon. Specifically, boundaries between *faint* and *distinct* color contrast are expanded slightly in the case of low chroma soils. These color contrast thresholds are employed as the criteria to determine if two or more soils could share a common origin. If the soils exhibit colors with "faint" contrast, then they may have a common origin and further analytical characterization of the specimens is required. If the color contrast between two soils exceeds the exclusion criteria, then the analyst may conclude the soils originated from distinct sources.

Proposed color contrast criteria for inclusion in a forensic soil comparison are: (1) both soils are dark (values ≤ 3) with low color saturation (chroma ≤ 2); (2) both soils have low color saturation (chroma < 2), have the same values/lightness and have hue offsets of <7.5 hue units; or (3) the soil colors are offset by ≤ 1 chip in hue, value, and chroma in a standard Munsell Soil Color Book. Criteria 1 and 3 are derived directly from the boundary between faint and distinct color contrast defined by the NRCS-National Cooperative Soil Survey.

As color is a screening method, a color-based provisional inclusion must be followed by orthogonal higher discrimination examination methods; however, color may serve as a sufficient exclusionary difference in a soil comparison.

Soil Color, OSAC, SDO

*Presenting Author