Clarity of Shoe Impressions in Different Soil Types

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Abstract: Forensic science is a vastly expanding field as many different types of evidence and methods of analysis are being developed. One key type of evidence is impression evidence, and this experiment focused on shoe impressions made in soil. The research was based on how different types of soil at different moisture levels affects the clarity of shoe impressions. Shoe impressions were made in four various "types" of soil and three different impressions were made in each type. Molds were taken in plaster and then analyzed to see the clarity at which the shoe impressions could be made out. It was noted that none of the molds displayed individual characteristics and it was very different to observe even the basic tread of the shoe. The results show that the soil with the higher moisture levels made it overall easier to see and analyze the tread of the shoe and that soil that is more malleable, but not muddy, allows for shoe impressions to be more easily read.

Keywords*: soil, shoe, impressions, investigation*

As forensic science broadens into many forms of study and many different specialties of physical sciences, there are more subsets of forensic investigation coming about. One of the newer specialties coming around is forensic geoscience. There are many different aspects of forensic soil science, most of which involve using chemical compounds to enhance soil samples to link evidence to a crime scene. Recently, there have been inventions that analyze specific elements in soil to detect human remains in hard to reach places (Sanders 2010). However, impression evidence in said soil is becoming increasingly important as well. Recently, there has been a large push for impression evidence to be lifted at crime scenes, especially in things like soil or other aspects of the environment. It is normally done so through plaster, but other mediums are being used as well, and patents are being made using materials such as gypsum for these molds (Mel'nikov et al. 2010). These types of molds can then be analyzed by experts to compare the uniqueness of various shoe treads and seeing those individual characteristics in the molds lifted from the shoe impressions. This type of science is relatively new and there are many different challenges to doing so, as it has not been thoroughly researched and faces many admissibility challenges. There are multiple methods that can be used and are being utilized in different situations. Currently, methods are being tested and trained against one another to determine the best such method of comparing this type of evidence (Richetelli et al. 2017). More methods are

also being developed such as using techniques from facial recognition and applying them to these individual characteristics, and the accuracy of this type of evidence and the admissibility of the evidence can increase (Petraco et al. 2010). Techniques like this allow us to use numbers to prove how similar the two marks are, using the lowest possible chance that the marks are made in the same place with the same distance, shape, etc. There are many types of individual characteristics that can be identified, such as nicks, wear patterns, scratches, or even air bubbles in the sole of the footwear (Music and Bodziak 1988). These characteristics can be compared to shoes taken from the suspect and help lead detectives to matching the shoes impressions found at the crime scenes to a shoe from a suspect. The concept of individual characteristics is based on the principal that these characteristics are made knowing that the individual has freedom to move wherever but is confined to the rules and regulations of their specific life. Such that, every person could go wherever but they are confined but what they need to do for work, school, a family, and other responsibilities (Naryzhny 2016). Therefore, it can be implied that these marks and wear patterns on the sole are unique and individual to each shoe, as each person has a different daily ritual and goes different places. Because of this, forensic examiners can use these patterns to identify suspects and help link people to crime scenes.

Materials and Methods:

The experiment started by gathering four different soil types with different levels of moisture and consistency. The first soil type (Type A) was mostly large wood pieces and big chunks. The second soil type (Type B) was a damp potting soil, which we produced by adding water to the soil. It wasn't muddy, more so just squishy and held shapes very easily. The third soil type (Type C) was the same soil but without the added water. The fourth soil type (Type D) was a wet compacted sand, with the same consistency and moisture level as sand found at beaches on the shoreline. The soil samples were placed into paint trays so that the soil wasn't unnecessarily deep but deep enough to hold an impression without the soil revealing the bottom and edges of the tin. There were three samples of each soil type in their own individual trays such that there were twelve trays, three trays of each of the four soil types. The three trays were made to leave room for error in the molds. After the soil was placed, an impression was made by the same shoe in the same deepest part of the soil in the paint tray. Once the impression was made, Plaster of Paris was used. No fixative was used on the sand however, as it has been found that beach sand which is the type of sand used has the clearest molds when not sprayed with any fixative (Battiest et al. 2016). The plaster was poured on each impression and allowed forty-eight hours to dry. Once dried, the excess dirt was wiped off and the molds taken of the impressions were analyzed.

Results

The results of this experiment are qualitative in nature. As none of the molds were clear enough to make out individual characteristics of the shoes, the basic shapes of the shoes had to be observed and the characteristics compared against each other, observed in Table 1. Tread marks found on the shoe and in the mold can be seen in Figures 1 and 2.

Table 1:

Soil Type	Trial	Description
A	1	no distinguishable impression
A	2	no distinguishable impression
A	3	no distinguishable impression
B	1	shoe outline, no characteristics
B	2	outline, no distinguishable characteristics
B	3	outline, no distinguishable characteristics
C	1	no clear mark
C	2	some outline but no marks
C	3	only can see half the shoe
D	1	good shoe print, clear sole characteristics
D	2	print is clearly a shoe, not good sole marks
D	3	sole prints sort of clear

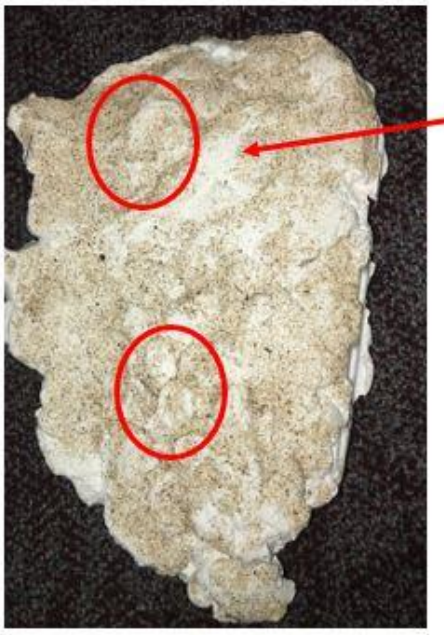

Figure 1: Mold of D1

Figure 2: Shoe used for impressions

Soil type D clearly had the clearest impressions as the molds were most similar to the shoe itself. Figure 1 shows the mold D1 while Figure 2 shows the original shoe. The areas circled along with the arrows are clear similarities between the shoe and the mold.

Discussion:

The results show a clear pattern between the various soil consistencies and moisture levels, as the finer soil as well as the damper soil allowed for a clearer impression to be made. This is shown as molds from soil type D showed much higher mold clarity than those from any other soil type, and that soil type B was the second-best soil impressions, however they were not nearly as clear as the ones left in soil type D. This implies that different soil types will affect the ability to lift impressions at various crime scenes and make it more difficult for the crime scene investigators as they try to collect evidence. The results are generally what is expected to occur as impressions are made easily in soft, malleable environments. Therefore, investigators should pay close attention to any shoe prints or other impressions left in the ground when investigating crimes left in softer soil. However, there were limitations for the study. For instance, the plaster was hardening very quickly and would come out in a blob and could have obstructed some of the clarity of various impressions. Another limitation is that most investigators use dental stone rather than Plaster of Paris and it may have affected how the impressions are lifted. A third factor to consider is that it was very humid during the time these molds were drying and as they were drying outside, the humidity may have affected how they dry as some molds fell apart when held for too long and never fully dried. This cause remains unknown, but it did affect the results as some of the molds were still wet when analyzed. A further study could be continued to see how different treads of shoe leave different clarities of impressions or how different humidity/temperature levels affect how the molds cure and dry. This would be good information to have as investigators continue to use molds to lift impressions found at crime scenes. Recent advances in technology have allowed for other ways to be invented that these impressions can be collected. One newer way is a scanner that can scan the impression and make a "three-dimensional documentation" of the impression (Buck et al. 2007). Another new technology is a foam that allows for impressions to be lifted from the snow, as these impressions are much more delicate than those made in soil (Petraco et al. 2016). More research needs to be done in this field to help analyze statistics on how these individual characteristics can be made, which has been started but it needs to continue as more types of shoes are made and more data is examined every day (Speir et al. 2016).

References:

Battiest, T., S. W. Clutter, and D. Mcgill. **2016**. A Comparison of Various Fixatives for Casting Footwear Impressions in Sand at Crime Scenes. Journal of Forensic Sciences. 61: 782–786.

Buck, U., N. Albertini, S. Naether, and M. J. Thali. **2007**. 3D documentation of footwear impressions and tyre tracks in snow with high resolution optical surface scanning. Forensic Science International. 171: 157–164.

Mel'nikov, I. N., D. V. Kairgaliev, and V. N. Khrustalev. **2010**. Gypsum composition for manufacturing molds in lead tracking in criminology.

Music, D. K., and W. J. Bodziak. **1988**. Evaluation of the Air Bubbles Present in Polyurethane Shoe Outsoles as Applicable in Footwear Impression Comparisons. Journal of Forensic Sciences. 33: 1185–97.

Naryzhny, Y. V.2016. An Integrated Approach For Obtaining Forensically Relevant Information From Shoe Traces When Investigating Crimes. Vestnik Tomskogo gosudarstvennogo universiteta. 192–196.

Petraco, N. D. K., C. Gambino, T. A. Kubic, D. Olivio, and N. Petraco. **2010**. Statistical Discrimination of Footwear: A Method for the Comparison of Accidentals on Shoe Outsoles Inspired by Facial Recognition Techniques. Journal of Forensic Sciences. 55: 34–41.

Petraco, N., H. Sherman, A. Dumitra, and M. Roberts. **2016**. Casting of 3-dimensional footwear prints in snow with foam blocks. Forensic Science International. 263: 147–151.

Richetelli, N., M. C. Lee, C. A. Lasky, M. E. Gump, and J. A. Speir. **2017**. Classification of footwear outsole patterns using Fourier transform and local interest points. Forensic Science International. 275: 102–109.

Sanders, L.2010. Molecules: Device detects whiffs of stiffs: Sniffer tube offers new way to find where bodies are buried. Science News. 178: 7–7.

Speir, J. A., N. Richetelli, M. Fagert, M. Hite, and W. J. Bodziak. **2016**. Quantifying randomly acquired characteristics on outsoles in terms of shape and position. Forensic Science International. 266: 399–411.