NOVATEUR PUBLICATIONS
JournalNX- A Multidisciplinary Peer Reviewed Journal
ISSN No: 2581 - 4230
VOLUME 7, ISSUE 8, Aug. -2021

STUDY OF METHODS INVOLVING COMPARISON OF SOIL SPECIMEN SAMPLES

Bhakti Pansare,
Bsc 3rd Forensic Science, YCIS satara

Smitesh Nalage
Assistant Professor, Department of Forensic Science, YCIS Satara

ABSTRACT:

Soil characterization methods including chemical analysis, mineralogy, spectroscopic and microscopic analysis are reviewed here. Soil differentiates in itself horizontally as well as vertically place to place by their different parent origin. These properties of soil are used for comparisons of specimens in forensic perspectives. Diverse characteristic of soil like colour, texture, granular size, density. crystalline structure etc. are supposed for analysis in these comparative study of soil specimens.

Keywords: Soil; Soil Morphology; Soil Evidences; soil comparison

I INTRODUCTION:

Soil is basic, valuable and individualistic evidence like a fingerprint. Soil is uppermost layer of earth's crust involving microorganisms and products of their death and decay. For pedologist soil is composition of sand, slit or clay, for farmers soil means the nutritional content to yield crops, for some people soil means the 'dirt' but for investigators soil is valuable and individualistic evidence because The structure and composition of soil may vary from place to place according to their origin and pedogenic history. naturally occurring soil is varying vertically as well as horizontally in itself layer. Hence, soil become linkage between suspect and crime scene. Transfer of soil is governed by locards exchange principle at crime scene. This analysis of soil addresses the legal questions to giving a path for systematic and perfect approach to solving mystry by law enforcement agencies.

In forensic science perspective different qualitative and quantitative studies are done to lead the investigation. Microscopic techniques by using different magnifications, indicative methods like elemental composition by SEM and TEM, mineral identification by light microscopy, color identification of sample, particle size distribution, density gradient technique measurement, EC, atomic absorption spectroscopy, X-ray diffraction techniques are various classic and conventional methods for soil analysis are used till now.

1.1 Classification and composition of soil:

Soil classified on the basis of physical and chemical properties in their horizon layers. "Soil taxonomy" uses colour, texture, structure and other properties of the surface two meter deep.

Factors affecting on soil:

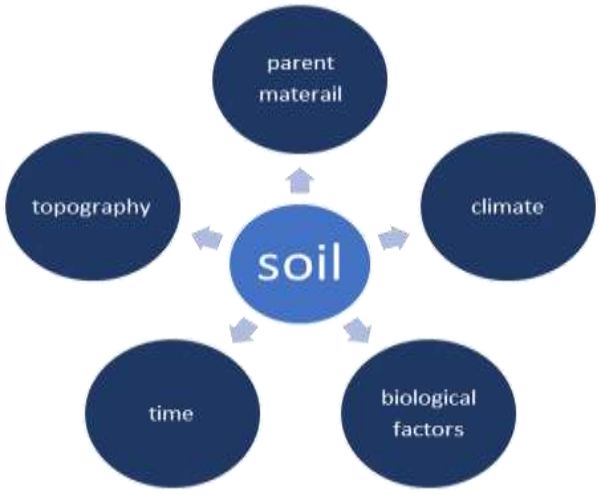

Fig 1: factors affecting on soil

Climate:

Climate affects the rate of weathering of parent rocks.it vary the inputs of heat and moisture. In the areas that experiences lot of rainfall, water percolating down through soil tends to leach nutrients and organic matter out of the upper layers, unless modified by other soil component like plant root.

Biota (flora, fauna and microorganisms):

Biota in conjugation with climate, modifies parent material to produce soil.

Eg. soil formed under trees are greatly different from soils formed under grass even though other soil forming factors are similar.

Soil as evidence:

Soil perfectly matches the aardahl's consideration of ideal trace evidence hence soil is preferred as "contact trace evidence".

1) It is highly individualistic
2) It can be quickly collected and separated
3) It has highly probability of transfer and retention
4) It is nearly invisible
5) It is able to have computerized database

Loacards exchange principle for soil:

Loacards exchange principle states that "when two surfaces come in physical contact there is mutual exchange of trace evidence between them". exchange of soil is common thing at crime scene.

Eg. Transfer of soil on shoes while person walking through that location.

MATERIAL AND METHODS:

1.1 Collection & transportation:

Collection, packaging and preservation in proper way is most important to avoid contamination of samples. Improper collection can lead to improper judgment. Soil analysis techniques are used for comparing the soil samples found at crime scene and on the suspect's evidential objects like shoes, clothes. this type of analysis required collection of both the questioned samples and controlled samples. questioned samples are collected from evidentiary objects like garments, wheels, shoes etc and control samples are intentionally collected from area of the crime scene. Munroe presents variety changing soil itself in horizontal and vertical direction, hence control samples should be collected by careful observation of colour, texture. due to some elevated temperatures and biological changes while transportation of soil or due to time interval the significant physicochemical properties in specimen may alter like In anaerobic conditions due to decomposition of organic matter nitrogen tends to loss. According to jackson's laboratory technique of soil sampling, long term transportation of soil requires cool temperature 5to 10 c/40 to 50 F to maintain significancy, small content of moisture should present in soil by partial drying.

1.2 Drying and sieving/grinding:

Drying for proper time interval is necessary to further comparative techniques and mineral identification of the specimen. It should be in appropriate temperature (21 to 27 C maintenance), to avoid microbial activities in soil but excessive drying may also cause the fixation of minerals like K (exceed 38 c). after drying,

1.3 Ph measurement:

Ph of soil determines the acidity or alkalinity of soil. Ph meter is general instrument to measure the hydrogen ion concentration in soil. pH is expressed by the equation,

$$pH = -log10(H+)$$

H+ ions show acidity of soil and OH- ions shows basicity of soil If the pH is less than 6 then it is said to be an acidic soil, the pH ranges from 6-8.5 it's a normal soil and greater than 8.5 then it is said to be alkaline soil. (Study done for

Analysis of Soil Samples for its Physico-Chemical Parameters from Kadi City(gujrat) by Chandak Nisha, Maiti Barnali Pathan Shabana, Desai Meena And Kamlesh Shah were collected Twenty surface soil (0-0.2m) samples from 5 different regions of Kadi of Gujarat state And found ph 7.4 to 7.9 that indicates alkalinity of that area.)

1.3 Colour comparison:

Soil colour is inherited from its parent materials. Colour of the soil vary from place to place according to their origin and mostly affected nearby areas. Munsell system for colour comparison contains mainly three parameters base colour, colour intensity and lightness. This system is based on mainly three attributes hue, value and chroma. Hue, it means a colour like red (R) yellow red (YR) green (G) green yellow (GY) and so on. Value Is lightness of colour and chroma is about how the weak or strong the colour.

Before drying, moistening and ashing Dudely carried out the colour comparison of soil samples by pretreatment like decomposition of organic matter and removal of iron oxide. because of covering of iron oxide actual shade of soil got hidden. Janseen et al produces colour comparison of clay fractions by removing earthy material in it. soil indicates white colour for presence of silica in the soil. gray colour of soil is indication of organic matter in soil. Soil shows red or brown colour when the iron oxides present in it.

1.4 Microscopic examination of soil:

Generally binocular microscopes are used for mineral identification. For rocks and stone material usually, petrographic microscopes are preferred. For magnification on biological material found in soil such as saliva, pollen etc. SEM and TEM are used.

Mineral identification of soil is done via light microscopy. Initially, various natural, artificial, mineral and non-mineral component in soil is compared by stereomicroscope at 10x to 40x magnification. Under the incident ray white background is used for dark specimen and black background used for light specimen. Modified version of standard compound biological microscope are petrographic microscopes. Density and refractive index can be analyzed by using polarized light, electrically heated stage in it. polarized microscope is helpful in analyzing the internal features. From the analysis of crystalline solid structure, class characteristics of crystal specimen are identified. standard compound is replacement of stereo and petrographic microscope.

In the comparison, Whenever the two soil samples appear closely for its colour by naked eyes, 40x magnification under the compound microscope can discriminate it by fine particles present in it like visible quartz crystals. Microscopy technique discriminate the soil samples also on the basis of small soil creatures.

1.5 Particle size distribution:

For discrimination of soil samples segregation by paricle size is important. That particle size can be observed by hand held lense or low power microscopes. Dry sieving and wet sieving are the methods that uses sieving diameters according to paricle size of grains. Wet sieving is effective in the case of clay, where for the clay dry sieving is erroneous. By marumo and sugita, dry sieving for coarse fraction and wet sieving for fine fractions are recommended. The distribution of soil mass due to particle size is considered to be a class characteristic of the soil sample. sieving will according to granular size diameter mesh. care should be take while sieving is, material used in sieving device should be free of elements; brass sieves should not be used if Cu and Zn are elements to determined (Benton jones 2001)

1.6 Comparison of densities:

Density is an intensive property. In the forensic soil analysis, discrimination of soil by density is done by density gradient technique. For the density comparison questioned sample mud is from the shoes then known sample must from the muddy field surface and not from digging. In this method, cylinder is filled with solution varying in densities are used. At the bottom solution of high density is preferred and at top low-density solution is filled. From bottom to top density tends to decreases. For discrimination in specimens, samples placed in the cylinders which filled with solution of different densities. soil particles get sink, suspended and make the band at the place where they match the density with density of solution. these bands discriminate the samples by densities. The profile of a questioned sample can be compared with the known sample to determine soil type.

The Study on Subsoil Profile by Density Gradient Tube Technique at Royal Malaysian Police College Campus in Forensic Perspective for Crime Investigation by T. Nataraja Moorthy and Wan Nur Syazwani Wan Mohamad Fuad, they collected the soil samples from corners of square distancing 100 m and by varying foot depth .in the gradient preparation of 50cm tube with 10mm diameter. At the bottom of tube bromoform (high density) solution is filled and at top brmobenzene (low density) solution is used. Parafilm used on burette to prevent evaporavtion .soil samples after proceeding by drying (sunlight &1000c) and sieving (60 micron mesh) added in density gradient column by removing parafilm and maintained the stability overnight. Then results for different bands according to densities were recoreded. Questioned samples are then compared to solve the mystry .

1.7 X ray diffraction method:

Soil contains primary minerals that provides the parent material, provenance, weathering rates etc, while secondary minerals formed crystallographic characteristics that determines physical and chemical properties. According to

Murray, “Quantitative XRD could possibly revolutionize forensic soil examination”. Xray diffraction technique provides detailed information of crystalline structure. This technique carried out on single crystal or powder. X rays of electromagnetic spectrum scatters by arranged crystals.

V singh and h r agrawal studied the XRD analysis of soil ,5 sample out of 24 are Randomly chosen samples to analysis due to same soil types.

Results of the XRD pattern of untreated sample show the high intensity and broad peaks of silica in the form of α quartz. after applying the required XRD setup conditions. Silica removal was confirmed by the much-reduced intensity peaks in the XRD pattern

RESULTS:

Methods resulting into comparing the soil specimens on the basis of soil texture, colour, and particle size grains. The varying nature of soil itself in density, particle size or variation in soil due to weathering and climatic changes makes the soil very unique. Soil formation from weathering of underlying rocks, have the same general chemistry as those original rocks. Soil inherits many properties from the parent material from which it forms, mineral composition, the colour, particle size and chemical elements etc.

1) Peninsular soil reflects the parent rock very much
2) Soil derived from lava rocks have black colour

3) Sandy soil derived from sandstone
4) Soils of northern plains and transported and deposited from Himalayan and peninsular blocks, so they have little relation to rock material in-situ

In this way Different techniques of soil evidence analysis are resulting into linking pattern, region, climate with respect to their texture, topography, parent material, biological factors etc. to the suspect from crime scene.

The method of collection and transportation of both the questioned samples and controlled samples by maintaining proper temperature 5to 10 c/40 to 50 F and transportation technique avoids the contamination of specimen samples. Drying at 21 to 27 C temperature avoids the microbial actions in the case of specimen storage for longer time. So the specimen would never get contaminated in any way by microbial actions.

One of the major factors from soil's alkanity could determinate is its ph. Most accurate method of dermining pH of soil is by pH meter. In this study, five different regions of Kadi of Gujarat state and found ph 7.4 to 7.9 that indicates alkalinity of that area is reviewed. Like this pH of the soil states alkanity of that area.

Soil analysis on the basis of its colour shows the colour differentiation with mineral composition in it, for example soil indicates white colour for presence of silica in the soil. gray colour of soil is indication of organic matter in soil. Soil shows red or brown colour when the iron oxides present in it.

Observation of soil specimens under microscope with different magnifications shows the crystalline structure of particles. Microscopic observation of soil deals with different soil creatures, biological components etc present in it. X Ray diffraction techniques results into confirmation of crystalline structure of particular soil specimen.

Soil varying vertically as well as horizontally according to its depth. In this kind of discrimination density is very varying factor with depth. Density gradient technique results into specify the densities of the soil specimens even in the same region and depth wise manner. These scientific techniques involving in soil samples analysis are effectively worked to solve different criminal cases.

DISCUSSION:

In the forensic science perspective, Morphology of the soil is an important and unique thing like fingerprint for investigators. Various classic methods of analysis of soil are studied till decompression of soil specimens on crime scene to the laboratory technique all the simple and expensive methods are useful. But one can solve the questioned mystry of soil specimens in laboratories throughout these simple and effective techniques also. From the Sherlock homes series to today soil performing main role of individuality. the recent case study done at malaysia polce; as a forensic practitioner in India had solved a mysterious crime with soil as physical evidence. That is, a person was murdered in one place (primary crime scene) and subsequently moved the dead body into a different place to about 1km and subsequently buried in a river bank (secondary crime scene). The body was exhumed in the presence of author and the author could collect soil adhering at the back of the dead, not related to the subsoil where the body was now found buried. The soil sample seized from the back of the dead body was compared with the suspected soil collected from the primary crime scene and fixed the original crime scene and thus solved the mystry.

CONCLUSION:

In this work, classical and effective methods of soil analysis in forensic science perspective is studied. The originity of soil from parent materials gives the soil some individual characteristics. Some enough and suitable methods without any huge instrumentation can

possible for soil analysis and for addressing the legal questions. All the need is only of proper collection and preservation methods and to avoid contamination.ph meter can compare soil on the basis of alkanity and acidity. Density gradient is most important for comparing soil specimens on the basis of densities, this is much effective because soil at every depth shows different density band in column. Only XRD is not enough for mineral identification, atomic absorption spectroscopy in conjugation with XRD is effective to mineral identification.

REFERENCES:

1) Murray RC. The Geologist as Private Eye. Natural History Magazine 1975 February
2) Thornton JI, Crim D, McLaren AD. Enzymatic Characterization of Soil Evidence. Journal of Forensic Sciences 1975; 20(4): 674-692.
3) Thornton JI, Crim D, McLaren AD. Enzymatic Characterization of Soil Evidence. Journal of Forensic Sciences 1975; 20(4): 674-692.
4) P. Bullock, C.P.Murphy (1976),Sage journals ,vol 8,issue 6, pages 348-354 ,The microscopic examination of the structure of sub-surface horizons of soils,doi.org 10.1177
5) R.J.Dudley (1979) Sage Journals,Vol19,Issue 1,Pages 39-48,The Use Of Density Gradient Columns In Forensic Comparison Of Soil ,Doi.Org./10.1177/002580247901900107
6) K Chaperlin, P.S. Howarth (1983) Forensic Science International, Vol23, Issue 2-3, Pages 161-177, Soil Comparison by Density Gradient Method – A Review And Evaluation
7) Murray RC. Soil in Trace Evidence Analysis. Proceedings of the International Symposium on the Forensic Aspects of Trace Evidence 1991: 75-78.
8) Petraco, N antoci,PR (1993), vol 38, issue 2, A technique for comparing soil colours in forensic laboratory , ISSN:0022-1198,DOI: 10.1520/JFS13425J
9) McAlister JJ, Smith BJ. A Rapid Preparation Technique for X-Ray Diffraction Analysis of Clay Minerals in Weathered Rock Materials. Microchemical Journal 1995; 52: 53-61.
10) Ugolini, F. C. Corti, G. Agnelli, A. Piccardi, F. ,(1996), Soil Science,August 1996, Volume 161 (8), p 521–542 , ISSN: 0038-075X, MINERALOGICAL, PHYSICAL, AND CHEMICAL PROPERTIES OF ROCK FRAGMENTS IN SOIL, 00010694-199608000-00007
11) Junger EP. Assessing the Unique Characteristics of Close-Proximity Soil Samples: Just How Useful Is Soil Evidence. Journal of Forensic Sciences 1996; 41(1): 27-34
12) Marumo Y, Sugita R. Validity of Color Examination for Forensic Soil Identification. Forensic Science International 1996; 83: 201-210.
13) Ishiwatari A. An Easy Identification Chart for Major Rock-Forming Minerals by Polarizing Microscope. Journal of Geological Society of Japan 1999; 105(2); 156-158.
14) Omelyanyuk GG, Alekseev AA, Somova NG. The Possibility of Application of the Multisubstrate Testing Method in Soil Criminalistic Investigation. Proceedings of the International Association of Forensic Science 1999; 15th: P12.
15) Petraco, N Forensic consultant to the New York City Police Department, Forensic Investigation Division, New York, NYKubic, T Full-time instructor and Ph.D. candidate in forensic science, John Jay College, City University of New York, New York, NY (july 2000) ASTM Intrnationals volume 45, issue 4, A Density Gradient Technique for Use in Forensic Soil Analysis. Journal of Forensic Sciences ISSN:0022-1198, DOI: 10.1520/JFS14786J
16) 13th INTERPOL Forensic Science Symposium, Lyon, France, October 16-19 2001 FORENSIC EXAMINATION OF SOIL EVIDENCE

17) Marumo Y, Sugita R. Screening of Soil Evidence by a Combination of Simple Techniques: Validity of Particle Size Distribution. Forensic Science International 2001; In press.
18) Yoshiteru Marumo,2003 Volume 7 Issue 2 Pages 95-111, J stage Japanese journal of science and technology for identification, forensic examination of soil evidence, doi.org/10.3408
19) Nicholas Petraco , Thomas A. Kubic , Nicholas D.K. Petraco , Forensic Science International 178 (2008) e23–e27, case studies in forensic soil examination,doi 10.1016
20) Virendra Singh, Harshil Agrawal (2012), Radiation Physics And Chemistry , 81(12) 1796-1803 DOI:10.1016
21) Professor T Nataraja Moorthy (2012) Journal For Bloomers Research,Study On Subsoil Profile By Density Gradient Tube Technique At Royal Malaysian Police College Campus In Forensic Perspective For Crime Investigation ,Vol5,No1
22) Rob w fitzpark (2013) soil forensic analysis In Wiley Encyclopedia of Forensic Science. DOI 10.1002
23) Lorna A.davson, Robert w. mayes, (2015), science direct, Pages 457-486,introduction to environmental forensics (third edition), Criminal and Environmental Soil Forensics: Soil as Physical Evidence in Forensic Investigations, doi 10.1016
24) Sonikajha And Suneetha V. School Of Biosciences And Technology, Vellore Institute Of Technology, Vellore, Tamilnadu, Journal Of Chemical And Pharmaceutical Research, 2015, 7(3): 291-293, ISSN: 0975-7384 CODEN(USA) : JCPRC5
25) Stephan Uitdehaag ,M.S.Wim Wiarda ,B.A.S. Timme Donders, Ph.D ,Iren Kuiper ,Ph.D. (2017), Journal Of Forensic Science, Vol.62,No4 Doi: 10.1111/1556-4029.13313
26) Chandak Nisha, Maiti Bernali, Pathan Shabana, Desai Meena, Kamlesh Shah (2017), Newest International Referred Iournals, Analysis of Soil Samples for Its Physic Chemical Parameters From Kadi City, ISSN :2349 3372
27) Munish Kumar Mishra, Ashutosh Maurya, Lav Kesharwani,(2018), International Journal For Research In Applied Science & Engineering Technology (IJRASET),Vol6,Issue VI,Analysis Of Heavy Metal In Soil Through Atomic Absorption Spectroscopy For Forensic Consideration, ISSN: 2321-9653
28) Camila Flojgaard,Tobias Guldberg Froslev,Ane Kirstine Brunbjerg,Hans Henric Brunn,Jesper Moeslund,Anders Johannes Handsen,Rasmus Ejrnaes (2019),Plos One,Doi.Org/10.1371
29) 2020, Mayssa hachem, bhoopesh kumar Sharma,ahmad el nagger,ishani pilankar,nashrah anwar (2020), DOI: 10.1109
30) Dr. Christine Watson (SAC), Elizabeth Stockdale and Lois Philipps, Institute of Organic Training & Advice,result of organic research, technical leaflet 4
31) Praveen Sarojam, Ph.D. PerkinElmer Global Application Center Mumbai, India, Analysis of Micronutrients in Soil by Using AA 800 Atomic Absorption Spectrophotometer, perkin elmer.