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Analysis of Heavy Metal in Soil through Atomic Absorption Spectroscopy for Forensic Consideration

Ashutosh Maurya [1], Lav Kesharwani [2], Munish Kumar Mishra [3]
[1]*Student of M.Sc. Forensic Science, SHUATS, Allahabad, U.P.*
[2]*Assistant professor, Department of Forensic Science, SHUATS, Allahabad, U.P.*
[3]*Assistant professor, Department of Forensic Science, SHUATS, Allahabad, U.P.*
Sam Higginbottom University of Agriculture Technology and Science, Allahabad, U.P, INDIA-211007

Abstract: ***As we know that the soil is the most important component of earth ecosystem, which has four key functions: it is a means for the growth of plants, is a means of storage, supply and purification of water, is a modifier of the earth's atmosphere. Soils can be infected by the accumulation of heavy metals and metalloids through the emissions of industrial waste, elimination of high quality metal waste, application of soil fertilizers, sludge purification, pesticides, sewage irrigation, coal combustion residues, petrochemical spills and atmospheric storage. Even though heavy metals are naturally found in the soil, geological and anthropogenic activities increase the concentration of heavy metals in harmful quantities which is dangerous for both plants and animals. In forensic science heavy metal analysis of soil Heavy metal is providing a unique fingerprint of any soil. The goal of this study will to determine if there is a correlation between land use type and concentrations of heavy metals in soil and characterisation of soil.Atomic absorption spectrometry (AAS) is a technique which is helpful to measuring the quantities of trace elements present in soil samples.***

Key words: Soil, Heavy metal, Atomic Absorption Spectrometry (AAS),Investigation,forensic science

I. INTRODUCTION

Soil is the material that is found on the earth's surface and is made of organic and inorganic material. The typical soil consists of about 45% mineral, 5% organic matter, 20-30% water, and 20-30% air. It is a blend of natural issue, minerals, gases, fluids, and living beings that together help to the existence of many life forms that have evolved on our planet. The Earth's body of soil is the pedosphere, which has four vital functions: it is a medium for plant growth, it is a means of water storage, supply and purification, it is a modifier of Earth's atmosphere. it is a natural surroundings for living beings. It would be very wrong to think of the land as a simple collection of fine mineral particles. The soil also contains air, water, dead organic matter and various types of living organisms. The soil interfaces with the lithosphere, the hydrosphere, the atmosphere and the biosphere.Soil is a major component of the Earth's ecosystem.

Soils may become contaminated by the accumulation of heavy metals and metalloids through emission from the rapidly expanding industrial areas, mine tailings, disposal of high metal wastes, leaded gasoline and paints, land application of fertilizers, animal manures, sewage sludge, pesticides, wastewater irrigation, coal combustion residues, spillage of petrochemicals, and atmospheric deposition . Heavy metals constitute an ill-defined group of inorganic chemical hazards, and those most commonly found at contaminated sites are lead (Pb), chromium (Cr), zinc (Zn), cadmium (Cd), copper (Cu), iron (Fe) and nickel (Ni) .

Although heavy metals are naturally found in the soil, geological and anthropogenic activities increase the concentration of trace elements in quantities dangerous for plants and animals. Some heavy metals such as Cu, Fe, Ni and Zn are required in small quantities by organisms. However, extreme amounts of these elements can become harmful to organisms.

Atomic Absorption Spectrometry (AAS) is an instrument for estimating the ingestion of follow components introduce in soil tests by estimating the radiation consumed by the compound component of intrigue. This is finished by investigation the spectra created when the sample is energized by radiation. It depends on the Beer-Lambert law standard in which atomic absorption technique measure the vitality as photons of light that are consumed by the sample.

A detector measures the wavelengths of light transmitted by the sample, and compares them to the wavelengths which originally passed through the sample. A signal processor then integrates the changes in wavelength absorbed, which appear in the readout as peaks of energy absorption at discrete wavelengths.

A. Forensic Examination of Soil Evidence

In Forensic science soil analysis is the use of soil sciences and other disciplines to help in criminal investigation. Soils are like fingerprints because every type of soil that exists has unique properties that act as identification markers. The variety in soils from place to put makes soil profitable proof to demonstrate linkage between a suspect and a crime scene. Soil is a composite blend with an assortment of mineralogical, chemical, biological, and physical properties. Thinking about such multifaceted nature, an assortment of strategies have been produced for legal science purposes. Since minerals are a critical segment of soils, mineralogical examination is basic in criminological soil recognizable proof Yoshiteru Marumo(2002) . This way that the source of the soil sample can be identified. For example, clay embedded in the shoe of a criminal can be followed back to a particular dirt compose found along a lake where a murder casualty was found. The greater part of soil cases includes impressions or tire denotes that have been left in the soil.On the investigation of soil parts and of firmly related materials, for example, plant pieces, dust and spores, and diatoms, with prominence on the significance of screening tests comprising of a few basic procedures.

II. MATERIAL AND METHODS

Heavy metals are natural constituents of the Earth's surface, yet aimless human exercises have radically modified their geochemical cycles and biochemical adjust. Drawn out introduction to Heavy metals, for example, cadmium, copper, lead, nickel, and zinc can cause injurious wellbeing impacts in people. These metals are a reason for ecological contamination from sources, for example, leaded oil, mechanical effluents, wastages, and draining of metal particles not with standing regular starting point from earth outside layer. They exist in the street side silt because of weathering, interruption of tainting through the above said sources and ensuing affidavit along the street sides from the water streams. Any metal species might be viewed as a "contaminant" on the off chance that it happens where it is undesirable, or in a shape or fixation that causes an unfavorable human or natural impact.

A. Study Area

The experimental site covers the area around the different agricultural sites of Allahabad . This research will be carried out in agricultural area, river bank, institutional area, industrial sites, urban area in Allahabad, India.The sites where will be collected samples as following River bank – Ganga river,Yamuna river (Old Yamuna bridge), Arail ghat.

2. Institutional area - (SHUATS) Agronomy field, Soil Science research field, Horticulture field Urban area- Allapur, Bakshi bandh, Salori area - Madauka, Manna ka pura, Naini.

B. Material Required

Soil sample, Plastic bag, Shovel, 2 Mm sieve, Beakers, Electronic balance, Hot plate, Measuring cylinder, Funnel, 100 ml air tight bottle, Whatman filter paper No. 42, Distilled water, Double distilled water

C. Chemical Required

35% Hcl ,70% High Purity Hno_3

D. Instrument Required

Perkin Elmer Atomic Absorption Spectrophotometer AAnalyst 400.

E. Sample Collection

The sample was collected from the sample location using clean shovel. The soil sample was
collected at 15cm depth around the sample area; it was thoroughly mixed and transferred into clean and labeled polythene bag for onward analysis.The samples was mix, gently homogenized and sieved through 2-mm-mesh sieve. The samples were first air dried, then placed in electric oven at a temperature of 40 °C approximately for 30 minutes. The resulting fine powder will kept at room temperature for digestion.

F. Digestion of Soil Samples

1g of the oven dried sample was weighed using a top loading balance and placed in a 250 ml Beakers separately to which 15 ml of aquaregia (35% HCL and 70% high purity HNO_3, in 3:1 ratio) will be added. The mixture was then digest at 70°C till the solution became transparent . The resulting solution was filtered through whatman filter paper no. 42 and into a 50ml dilute to 50 ml volumetric flask and diluted to mark volume using deionised water and the sample solution was analyze for concentrations of Cu, Zn, Cd, Ni, Mn, Cr and Pb using an atomic absorption spectrophotometer (Perkin–Elmer AAnalyst 400).

G. Analysis of soil samples

AAS Aanalyst 400 model used in determining the content of heavy metals in the previously digested soil samples. The nitrous oxide, acetylene gas and compressor were fixed and compressor turned on and the liquid trap blown to rid of any liquid trapped. The Extractor and the AAS control were turned on. The slender tube and nebulizer piece were cleaned with purifying wire and opening of the burner cleaned with an arrangement card. The worksheet of the AAS programming on the joined PC was opened and the empty cathode light embedded in the light holder. The light was turned on, beam from cathode adjusted to hit target zone of the arrangement card for ideal light throughput, at that point the machine was touched off. The fine was set in a 10 ml graduated chamber containing deionized water and yearning rate estimated. The analytical blank was prepared, and a series of calibration solutions of known amounts of analyte element (standards) were made. The blank and standards were atomized in turn and their responses measured. A calibration graph was plotted for each of the solutions, after which the sample solutions were atomized and measured. The various metal concentrations from the sample solution were determined from the calibration, based on the absorbance obtained for the unknown sample.

III. RESULT AND DISCUSSION

SAMPLE No.	Cd	Zn	Mn	Pb	Cu	Ni	Cr
S_1	0.1	42.4	16.6	20	8.85	2.5	12
S_2	0.75	67.9	8.5	16.7	34.95	ND	41.55
S_3	0.45	43.4	17.65	12.55	7.6	ND	14.05
S_4	0.5	50.05	75	15.7	40.8	0.1	27.65
S_5	1.15	59.8	17.5	20.65	42.4	ND	31.75
S_6	0.35	66.05	50	14.55	24.6	ND	22.45
S_7	0.35	79.35	65.95	14.65	29.35	ND	23.25
S_8	0.45	58.85	45.25	16.9	28.25	ND	29.75
S_9	0.3	38.4	59.55	20.4	10.7	ND	16.3
S_{10}	0.35	54.85	52.5	15.8	24.15	ND	24.4
S_{11}	15.8	47.45	38.55	12.35	21.4	ND	8.85
S_{12}	1.5	53.15	44.4	12.5	17.2	ND	15.7

In this study result shows the variation in the soil samples of the river sites, institutional area, urban area and industrial area.

The results of the study revealed that Zn and Mn present in the soil sample are in higher concentrations.Cu, Cr and Pb are present in lower than that of Zn and Mn. Cd and Ni are present in trace amount and were in the following order of Zn > Mn > Cu > Cr > Pb > Cd > Ni . This is due to the fact that the study area is contaminated by the industrial effluents from the nearby industries and vehicular emissions.

The above contamination may be due anthropogenic activities like releasing of industrial wastage and sewage to the environment. The permissible limit of heavy metal in the soil (mg/kg) is Cd (6), Zn (600), Mn (20), Pb (500), Cu (270), Ni (75), Cr (50).In all the soil samples Zn present in higher concentration but it present in below the permissible limit but In samples S_7 to S_{12} Mn concentration is higher than the permissible limit (20 ppm).the higher concentration of Mn not only diminish soil quality, but also

can lead to human intake through the tropic food web and harm human being .All other heavy metals (Cu, Cr, Pb, Cd, Ni) present in soil samples below the permissible limit.

IV. SUMMARY

The present study entitled "Analysis of Heavy Metal In Soil Through Atomic Absorption Spectroscopy For Forensic Consideration" was successfully carried out at the Department of Forensic Science, Sam Higginbottom University of Agriculture, Technology & Sciences, Allahabad, with following objective : To analyse the types and concentration of heavy metal in soil sample through atomic absorption spectrophotometer. For the present study, 12 soil samples were examined for colour, p^H, and heavy metal analysis of soil samples.Soil samples was collected from 4 different areas, such as river sites, institutional area, urban area, industrial area. Each area having 3 locations.Soil samples were analysed by AAS which detect the concentration of heavy metals in given soil samples. There was 7 heavy metal present in the soil samples but Ni present in only sample (S_1 and S_4) ,it was absent in all soil samples. The concentration of heavy metals present in soil samples in order of Zn > Mn > Cu > Cr > Pb > Cd > Ni.

V. CONCLUSION

From this study it was concluded that the variation of soil at different sites of river, institutional regions,urban areas, and industrial areas can be very useful during the investigation of various types of crimes. This experiment proves that heavy metal analysis of soil samples are valuable evidence for forensic purpose.The growth of urbanized regions is occurring worldwide, and, as a result, research in the area of soil contamination by heavy metals has become increasingly important excessive amounts of these elements can become harmful to organisms. Significantly large concentrations of toxic metals not only diminish soil quality, but also can lead to human intake through the tropic food web. Heavy metal is providing a unique fingerprint of any soil. it gives unique soil profile from one region to another region which is helpful in forensic investigation.Soil can be very helpful in various type of crime like murder, poisoning cases, hit and run, burglary, poisoning cases etc.

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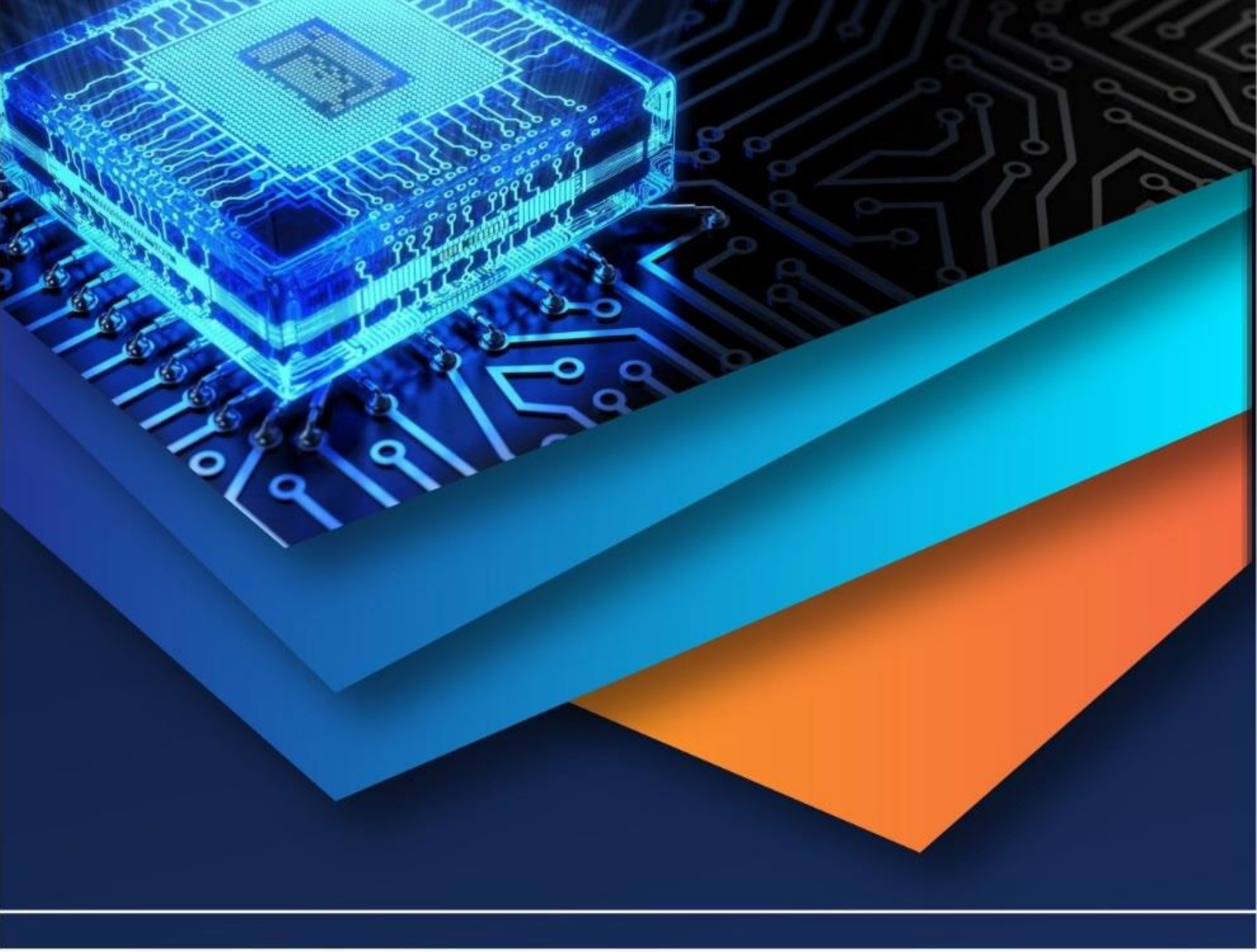

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