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Heavy Metal Contamination in Soil and Groundwater.

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Abstract: -- **Scattered literature is harnessed to critically review the possible sources,chemistry,potential biohazards And best available remedial strategies for a number of heavy metals(pb,cr,As,Zn,Cd, Cu, Hg and Ni Commonly found in contaminated soils.The principle advantages and disadvantages of immobilization ,soil washing and phytoremediation techniques which are frequently listed among the best demonstrated available technologies for cleaning of heavy metal contaminated sites are presented .Remediation of heavy metals contaminated soils is necessary to reduce the associated risks ,make the land resource available for agricultural production enhance food security.**

I. INTRODUCTION

Soils may become contaminated by the accumulation of heavy metals and metalloids through emissions from the rapidly expanding industrial areas ,mine tailings ,disposal of high metal wastes ,leaded gasoline and paints ,land application of fertilizers ,animal manures sludge pesticides wastewater irrigation ,coal combustion residues spillage of petrochemicals and atmospheric deposition .Heavy matals constitute a group of inorganic chemical hazards ,and those most commonly found at contaminated sites are Pb,Cr, As,Zn Cd,Cu, Hg,and Ni.Soils are the major sink for heavy metals released into the environment by aforementioned activities and unlike the organic contaminants which are oxidized to carbon (4) oxide by microbial action.The presence of toxic metals in soil can severly inhibit the biodegradation of organic contaminants .Heavy metal contamination of soil may pose risks and hazards to humans and the ecosystem through :direct ingestion or contact with contaminated soil,the food chain ,drinking of contaminated ground water ,reduction in food quality . The adequate protection and restoration of soil ecosystem contaminated by heavy metals require their characterization and remediation .Immobilization ,soil washing , and phytoremediation techniques are frequently listed among the best demonstrated available technologies for remediation of heavy metal-contaminated sites .Inspite of their cost effectiveness and environmental friendliness ,field application of these technologies have only been reported in developed countries.In most developing countries ,these are yet to become commercially available technologies possibly due to the inadequate awareness of their inherent advantages and principles of operation .In developing countries with great population density and scarce funds available for environmental restoration ,low cost and ecologically sustainable remedial options are required to restore contaminated lands.In this paper the principles ,advantages and disadvantages of immobilization ,soil washing and phytoremediation techniques as options for soil cleanup are also presented.

II. SOURCES OF HEAVY METALS IN CONTAMINATED SOILS

Heavy metals occur naturally in the soil environment from the pedogenetic processes of weathering of parent materials at levels that are regarded as trace (≤1000mg /kg)and rarely toxic .Due to the disturbance and acceleration of natures slowly occurring geochemical cycle of metals by man ,most soils of rural and urban environments may accumulate one or more the heavy metals cause risk to human health,plants animals,eco- System,or other media.The heavy metals essentially become contaminants in the soil environment because(1)their rates of generation via man made cycles are more rapid related to the natural ones, (2)they become transferred from mines to random environmental locations where higher potentials of direct exposure occur ,(3) the concentrations of the metals in discarded products are relatively high compared to those in the receiving environment and (4) the chemical form in which a metal is found in the receiving environmental system may render it more bioavailable .A simple mass balance of the heavy metals in the soil can be expressed as follows

$$M_{total} = (M^{P} \dagger M^{a} \dagger Mf \dagger M^{ag} \dagger M^{OW} \dagger M^{IP}) - (M^{cr} \dagger M^{l})$$

Where “M” is the heavy metal ,”P” is the parent material ,”a” is the atmospheric deposition ,”f”is sources ‘’ow’’ are the organic waste source “ip”are other inorganic pollutants “cr” is crop removal ,and “l” is the loses by leaching volatilization .

2.1 FERTILIZERS-Historically ,agriculture was the first major human influence on the soil .To grow and complete the lifecycle ,plants must acquire not only micronutrients .Some soils are deficient in the heavy metal like Co ,Cu, Fe,Mn ,Mo,Ni, and Zn that are essential for the growth and crops may be supplied with these as an addition to the soil or as a foliar spray.cereal crops grown on Cu deficient soils are occasionally treated with Cu as an addition to the soil ,and Mn may similarly be supplied to cereal and root crops .large quantities of fertilizers are regularly added to soils in intensive farming systems to provide adequate N,P and K for crop growth.The Compounds used to supply these elements contain trace amount of heavy metals(Cd and Pb) as impurities,which after continued fertilizer, Application may significantly increase their content in the soil.metals such as Cd and Pb, have no known physiological activity.Application of certain phosphatic fertilizers inadvertently adda Cd and other potentially toxic elements to the soil,including F,Hg and Pb.

2.2 PESTICIDES:Severalcommon pesticides used fairly extensively in agricultureand horticulture in the past contained substantial concentrations of metals .For instance in the recent past ,about 10% of the chemicals have approved for use as insecticides and fungicides were based on compounds which contain Cu,Hg,Mn,Pb or Zn.Examples of such pesticides like BORDEAUX (copper sulphate) and copper oxychloride.Lead arsenate was used in the fruit orchards for many years to control some parasitic insects .Arsenic containing compounds were also used extensively to control cattle ticks and to control pests in banana in some countries have been preserved with formulations of Cu,Cr and As which results soil concentrations of these elements greatly exceed background concentrations.such contamination has the potential to cause the problems compared with fertilizers,the use of such materials has been more localized ,being restricted to particular sites or crops.

2.3 BIOSOLIDS AND MANURES:The application of numerous biosolids like livestock manures,compost And municipal sewage to land inadvertently leads to the accumulation of heavy metals in the soil.Certain animal wastes such as poultry,cattle,and pig manures produced in agriculture and commonly applied to crops and pastures although most bmanures seen as valuable fertilizers.

2.4 WASTEWATER:The application of municipal and industrial wastewater accululates heavy metals.farmers generally are not bothered about environmental benefits or hazards and are primarily interested in maximizing their yields and profits.

2.5 METALS MINING AND MILLING PROCESSES AND INDUSTRIAL WASTES:

Materials that are generated by a variety of industries such as textile,tanning,petrochemicals from accidental oils spills or utilization of petroleum based products ,pesticides and pharmaceutical facilities and are highly variable in composition are responsible for accumulation of heavy metals in soils and groundwater.in addition many are potentially hazardous because of their contents of heavy metals or toxic organic compounds if ever applied to land are very low in plant nutrients or no soil conditioning properties.

2.6 AIR BORNE SOURCES:Airborne sources of metals include stack or duct emissions of air,gas or vapour streams ,and dust from storage areas or waste piles. Metals from airborne sources are generally released as particulates contained in the gas stream Some meatals are volatile during high temperature processing.These metals will cinvert to oxides and condense as fine particulates.for eg. Very high concentration of Cd,Pb and Zn has been found in plants and soils adjacent to smelting workers.Another major source of soil contamination is the aerial emissions of Pb from the combustion of petrol containing tetraethyl lead, this contributes substantially to the content of Pb in soils in urban areas.

III. REMEDIATION OF HEAVY METAL CONTAMINATED SOILS:

The overall objective of any soil remediation approach is to create a final solution that is protective of human health and the environment.For heavy metal contaminated soils, The physical and chemical form of the heavy metal contaminant in soil strongly influences the selection of appropriate remediation treatment approach. Several technologies exist for the remediation of metal contaminated soil.there are the three categories for the remediaton technologies.(1) gentle in situ remediation (2) in situ harsh soil restrictive measures and (3)in situ or ex situ harsh soil destructive metals .

3.1 IMMOBILIZATION TECHNIQUES :Ex situ and in situ immobilization techniques are practical approaches to remediation of metal contaminated soils.The ex situ technique is applied in areas where highly contaminated soils must be removed from its place of origin and its storage is connected with a high ecological risks in case of radio nuclides.The method's advantages are:(1)fast and easy applicability and(2)relatively low costs of investment and operation .The method,s disadvantages include (1) high invasivity to the environment ,(2)generation of a significant

amount of solid wastes (3)the byproduct must be stored on a special landfill site(4) In the case of changing of the physiochemical condition in the side product or its surrounding ,there is serious dangerof the release of additional contaminants to the environment (5)permanent control of the stored wastes is required . In the in situ technique the fixing agents amandments are applied on the unexcavated soil.The techniques advantage are (1)its low invasivity (2)simplicity and rapidity (3)relatively inexpensive and(4) small amounts of wastes are produced (5) high public acceptability (6) covers a broad spectrum of inorganic pollutants .The disadvantage of in situ immobilization are (1)its only a temporary solution (2) the activation of pollutants may occur when soil physicochemical properties change (3) the reclamation process is applied only to the surface layer of the soil and (6) permanent monitoring is necessary.

3.2 SOIL WASHING:Soil washing is essentially a volume reduction /waste minimization treatment process.During soil washing those soil particles which host the majority of the contamination are separated from bulk soil fractions .Contaminants are removed from the soil by aqueous chemicals and recovered from solution on a solid substrate .in all casae the separated contaminants then go to hazardous waste landfill .by removing the majority of the contamination from the soil the bulk fractions that remains can be recycled on the site being remediated as relatively inert backfill.used on another site or disposed of relatively cheaply as nonhazardous material. (a) Principles of soil washing :Soil washing is a volume reduction /waste minimization treatment technology based on physical or chemical processes.With physical soil washing ,differences between particle grain size,settling velocity,specific gravity,surface chemical behavior and rarely magnetic properties are used to separate those particles which host the majority of the contamination from the bulk .The equipment used is standard mineral processing equipment ,which is more generally used in the mining industry. With chemical soil washing ,soil particles are cleaned by selectively transferring the contaminants On the soil into solution .since heavy metals are sparingly soluble and occur predominantly in a sorbed state. (b)Chemical extractants for soil washing :Owing to the different nture of heavy metals ,extracting solutions that can optimally remove then must be carefully sought during soil washing.Several classes of chemicals used for soil washing include surfactants ,cosolvents cyclodextrin ,chelating agents and organic acids Natural low molecular weight organic acids including oxalic ,citric,formic,acetic,malic,succinic malonic maleic lactic and fumaric acids are the natural products .EDTA and citric acid appeared to offer greater potentials as chelating agents for remediating the permeable soil.tartaric acid was ,however recommended in events of moderate contamination.

3.3 PHYTOREMEDIATION:Phytoremediation ,also called green remediation ,botanoremediation ,agromediation,or vegetation remediation ,can be defined asan in situ remediation strategy that uses vegetation and associated microbiota,soil amendments and agronomic techniques to remove ,contain,or render environmental contaminants harmless .The idea of using metal accumulating plants to remove heavy metals and other compounds was first introduced in 1983,but the concept has actually been implemented for the past 300 yrs on wastewater discharges.plant may breakdown or degrade organic pollutants or remove and stabilize metal contaminants.The advantages of phytoremediation compared with classical remediation are that (1)it is more economically viable using the same tools and supplies as agriculture.(2) it is less disruptive to the environment and does not involve waiting for new plant communities to recolonize the site .

IV. CONCLUSION:

Background knowledge of the sources ,chemistry,and potential risks of toxic heavy metals in contaminated soils is necessary for the selection of appropriate remedial options.Remediation of soil contaminated by heavy metals is necessary in order to reduce the associated risks,make the land resource available for agricultural production ,enhance food security and scale down land tenure problems, Immobilization ,soil washing ,and phytoremediation are frequently listed among the best available technologies for cleaning up heavy metal contaminated soil but have been mostly demonstrated in developed countries .these technologies are recommended for field applicability and commercialization in the developing countries also where agriculture ,urbanization,and industrialization are leaving a legacy of environmental degradation.

REFERENCES

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