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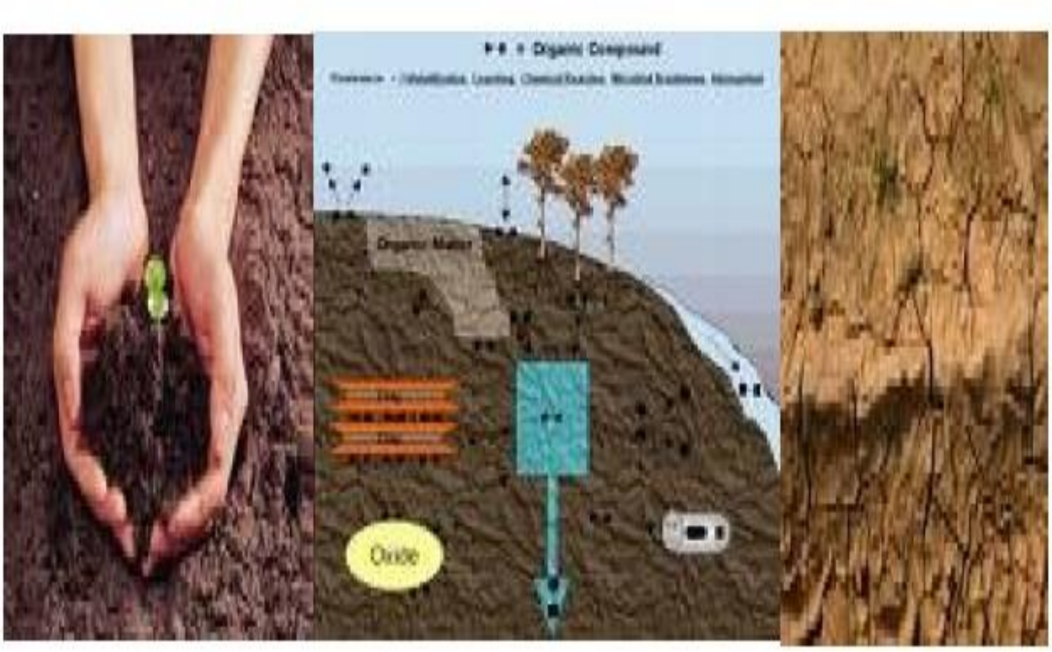
SOIL POLLUTION



MAJOR TYPES OF SOIL POLLUTANTS

For Post graduate Students 2020\2021

Faculty of Engineering

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1. Introduction

Soil Pollution defines as part of land degradation is caused by the presence of xenobiotic (human-made) chemicals or other alteration in the natural soil environment. It is typically caused by industrial activity, agricultural chemicals or improper disposal of waste.

Soil is the thin layer of organic and inorganic materials that covers the Earth's rocky surface. The organic portion, which is derived from the decayed remains of plants and animals, is concentrated in the dark uppermost topsoil. The inorganic portion made up of rock fragments, was formed over thousands of years by physical and chemical weathering of bedrock. Productive soils are necessary for agriculture to supply the world with sufficient food.

There are many different ways that soil can become polluted, such as:

- Seepage from a landfill
- Discharge of industrial waste into the soil
- Percolation of contaminated water into the soil
- Rupture of underground storage tanks
- Excess application of pesticides, herbicides or fertilizer
- Solid waste seepage

The most common chemicals involved in causing soil pollution are:

- Petroleum hydrocarbons
- Heavy metals
- Pesticides
- Solvents

2. Types of Soil Pollution

•<u>Agricultural Soil Pollution</u>

i) pollution of surface soil

ii) pollution of underground soil

•<u>Soil pollution by industrial effluents and solid wastes</u>

i) pollution of surface soil

ii) disturbances in soil profile

•<u>Pollution due to urban activities</u>

i) pollution of surface soil

ii) pollution of underground soil

- ### Heavy Metals and Their Salts

Natural concentrations of heavy metals in soils depend primarily on the type and chemistry of the parent materials from which the soils are derived. However, anthropogenic inputs may lead to concentrations highly exceeding those from natural sources. Average concentrations of some heavy metals in the Earth's crust, in some sediments and generally in soils, are shown in Table 6.1. From the table, we can conclude that lead, cadmium, tin, and mercury, are the most abundant metallic pollutants introduced into soil by anthropogenic activities. The mean concentration of cadmium in soils is six times its mean concentration in the crust. Concentrations of lead, mercury, and tin in soils attain double their mean values in the Earth's crust.

Table 6.1 Elemental composition of the Earth's crust and sediments. Note: Only iron and titanium are in percent, all other elements are in µg/g (modified after Salomons and Förstner 1984)

Element	Mean crust	Mean sediment	Average shale	Deep-sea clay	Shallow water sediments	River suspended sediments	Sandstone	Limestone	Soil
Iron	4.1%	4.1%	4.7%	6.5%	6.5%	4.8%	2.9%	1.7%	3.2%
Titanium	0.6%	0.4%	0.5%	0.5%	0.5%	0.6%	0.4%	0.03%	0.5%
Vanadium	160	105	130	120	145	170	20	45	108
Chromium	100(?)	72	90	90	60	100	35	11	84
Nickel	80(?)	52	68	250	35	90	9	7	34
Zinc	75	95	95	165	92	350	30	20	60
Copper	50	33	45	250	56	100	30	5.1	26
Cobalt	20	14	19	74	13	20	0.3	0.1	12
Lead	14	19	20	80	22	150	10	5.7	29
Tin	2.2	4.6	6.0	1.5	2	–	0.5	0.5	5.8
Cadmium	0.11	0.17	0.22	0.42	–	1	0.05	0.03	0.6
Mercury	0.05	0.19	0.18	0.08	–	–	0.29	16	0.1

2.1. Some Types of Heavy Metals:

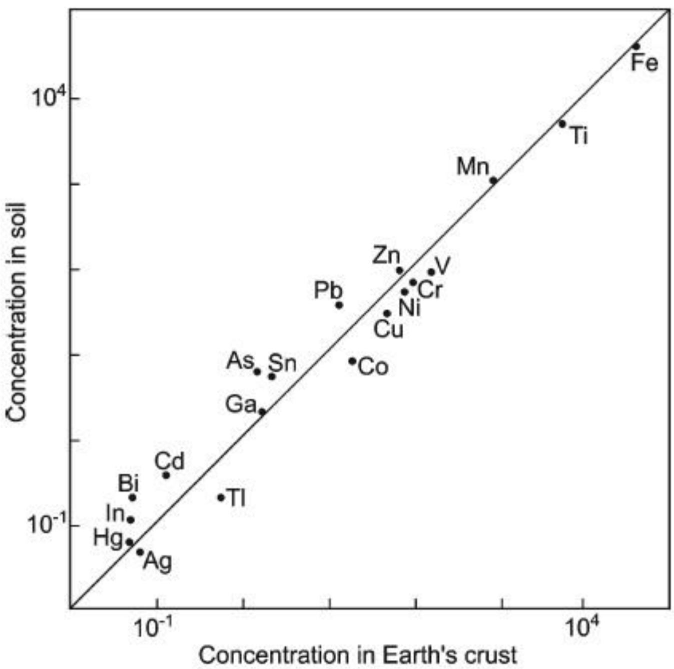
2.1.1. <u>Lead</u> is one of the oldest metallic pollutants introduced by man into the environment. Water drainage pipes made of lead and carrying the insignia of some Roman emperors are still in use, despite the fact that they introduce lead as a dangerous pollutant into the soil when they become porous. The use of lead to make water pipes is no longer allowed due to their dangerous effect on the environment and the harm they cause for humans.

2.1.2.<u>Cadmium</u> – a heavy metal, which is mainly used in the production of nickel/cadmium batteries or that of pigments and stabilisers for PVC; in metallurgical and electronic industries, it is one of the most frequently registered metallic pollutants. It passes into the environment through emissions in the metallurgical industries or application of phosphate fertilisers in agriculture. Detergents and petroleum products may also contribute to its circulation as an environmental pollutant.

2.1.3. <u>Tin</u>, a soft, pliable, silvery-white metal, which is used for can coating and as solder for joining pipes or electric circuits is, as said before, one of the most abundant metallic pollutants introduced by man into soils. For a long time it was also used for the production of tinfoil, which has been replaced by the aluminium ones. It has also many applications in the industry such as ceramics and electronic industries, yet it is mainly used for plating steel containers used to transport food and beverage. Tin enters the environment as a pollutant in different forms, the most dangerous of which is the organic one (methylated tin), used in various industrial processes such as the production of paints, plastics and pesticides.

Relations between metal concentration in soils and their parent material were investigated by Bowen (1979) and later discussed by Martin and Coughtrey (1982). Figure 6.1 shows that iron, titanium, manganese, zinc, gallium, silver, and mercury show a close relationship between parent material and soil concentrations, while thallium، cobalt, copper, nickel, chromium and vanadium are somewhat depleted in soils relative to parent rock, while indium, bismuth, cadmium, tin, and arsenic seem to beenriched in soil relative to the original material. Most studies dealing with vertical distribution in soil profiles report a tendency for several metals to be concentrated in the upper layers or horizons of many soils of open land and woodland. This was reported by Burton and John (1927), who studied the vertical distribution of lead, cadmium، copper, and nickel in some soils in Wales, as well as by Wilkins (1978), who reported higher concentrations of lead in surface soil layers of 500 sites in the United Kingdom.

Fig. 6.1 Relationship of recorded concentrations of various metals in soils with average concentrations in the Earth's crust (Martin and Coughtrey 1982, p. 155)



The interaction of metals with the solid state does not occur isolated from the liquid phase, for the pH, together with other properties of soil water, will control solution، adsorption on the solid surfaces and feasibility of chemical reactions within the system. In concrete terms the interaction of heavy metals with the solid state will be within the framework of any of the following processes:

Adsorption. Adsorption in the soil system depends principally on the physicochemical parameters, especially pH and the metal adsorbent. So we find that clay mineral will in general adsorb less amounts of metals than oxides and organic material. Dissolved organic matter can increase metal solubility and activate reactive mineral surfaces, thus enhancing adsorption.

Diffusion into soil material. Metal ions are capable of diffusing into the soil in rates that will depend upon their ionic diameters as well as the prevailing pH of the medium. Increases in pH, however, may lead to the formation of hydroxocomplexes that could cause an increase of the ionic diameters, thus decreasing the rate of diffusion and hence immobilising the heavy metals aspiring to diffusion.

3. Causes of Soil Pollution

Soil pollution is caused by the presence of man-made chemicals or other alteration in the natural soil environment. This type of contamination typically arises from the rupture of underground storage links, application of pesticides, percolation of contaminated surface water to subsurface strata, oil and fuel dumping, leaching of wastes from landfills or direct discharge of industrial wastes to the soil. The most common chemicals involved are petroleum hydrocarbons, solvents, pesticides, lead and other heavy metals. This occurrence of this phenomenon is correlated with the degree of industrialization and intensities of chemical usage.

4. Dumping of solid wastes

In general, solid waste includes garbage, domestic refuse and discarded solid materials such as those from commercial, industrial and agricultural operations. They contain increasing amounts of paper, cardboards, plastics, glass, old construction material, packaging material and toxic or otherwise hazardous substances. Since a significant amount of urban solid waste tends to be paper and food waste, the majority is recyclable or biodegradable in landfills. Similarly, most agricultural waste is recycled and mining waste is left on site.

The portion of solid waste that is hazardous such as oils, battery metals, heavy metals from smelting industries and organic solvents are the ones we have to pay particular attention to. These can in the long run, get deposited to the soils of the surrounding area and pollute them by altering their chemical and biological properties. They also contaminate drinking water aquifer sources. More than %٩٠ of hazardous waste is produced by chemical, petroleum and metal-related industries and small businesses such as dry cleaners and gas stations contribute as well.

5. Pollution of Underground Soil

Underground soil in cities is likely to be polluted by

•Chemicals released by industrial wastes and industrial wastes

•Decomposed and partially decomposed materials of sanitary wastes

Many dangerous chemicals like cadmium, chromium, lead, arsenic, selenium products are likely to be deposited in underground soil. Similarly underground soil polluted by sanitary wastes generate many harmful chemicals.These can damage the normal activities and ecological balance in the underground soil

Causes in brief:

•Polluted water discharged from factories

•Runoff from pollutants (paint, chemicals, rotting organic material) leaching out of landfill

•Oil and petroleum leaks from vehicles washed off the road by the rain into the surrounding habitat

•Chemical fertilizer runoff from farms and crops

•Acid rain (fumes from factories mixing with rain)

•Sewage discharged into rivers instead of being treated properly

•Over application of pesticides and fertilizers

•Purposeful injection into groundwater as a disposal method

•Interconnections between aquifers during drilling (poor technique(

•Septic tank seepage

•Lagoon seepage

•Sanitary/hazardous landfill seepage

•Cemeteries

•Scrap yards (waste oil and chemical drainage)

• Leaks from sanitary sewers

6. Effects of Soil Pollution

Agricultural

•Reduced soil fertility

•Reduced nitrogen fixation

•Increased erodibility

•Larger loss of soil and nutrients

•Deposition of silt in tanks and reservoirs

•Reduced crop yield

•Imbalance in soil fauna and flora

Industrial

•Dangerous chemicals entering underground water

•Ecological imbalance

•Release of pollutant gases

•Release of radioactive rays causing health problems

•Increased salinity

• Reduced vegetation

Urban

•Clogging of drains

•Inundation of areas

•Public health problems

•Pollution of drinking water sources

•Foul smell and release of gases

• Waste management problems

7.Control of soil pollution

Reducing chemical fertilizer and pesticide use

Applying bio-fertilizers and manures can reduce chemical fertilizer and pesticide use. Biological methods of pest control can also reduce the use of pesticides and thereby minimize soil pollution.

Reusing of materials

Materials such as glass containers, plastic bags, paper, cloth etc. can be reused at domestic levels rather than being disposed, reducing solid waste pollution.

Recycling and recovery of materials

This is a reasonable solution for reducing soil pollution. Materials such as paper, some kinds of plastics and glass can and are being recycled. This decreases the volume of refuse and helps in the conservation of natural resources. For example, recovery of one tonne of paper can save 17 trees.

Solid waste treatment

Proper methods should be adopted for management of solid waste disposal. Industrial wastes can be treated physically, chemically and biologically until they are less hazardous. Acidic and alkaline wastes should be first neutralized; the insoluble material if biodegradable should be allowed to degrade under controlled conditions before being disposed.