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# Influence and Effects of Industries on Geochemical Behaviour of Heavy Metals in Soil

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Abstract: Metals are considered as important toxic pollutants and there is extensive literature concerning their accumulation in ecosystems. Metals are continuously released into the biosphere by natural processes like volcanoes, weathering of rocks and also by various anthropogenic activities, such as mining, combustion of fuels, industrial and urban sewage and agricultural practices. On a global scale there is now abundant evidence that anthropogenic activities has polluted the surrounding environment with heavy metals from the poles to the tropics and from the mountains to the depths of the oceans. Once metals are introduced and contaminate the environment, they will remain. Metals do not degrade like carbon-based (organic) molecules. The only exceptions are mercury and selenium, which can be transformed and volatilized by microorganisms. However, in general it is very difficult to eliminate metals from the environment. Traditional treatments for metal contamination in soils are expensive and cost prohibitive when large areas of soil are contaminated. In this present studies on metal pollution in industrial area of Mysore city has been taken. Also, metal speciation, bioaccumulation in biota, as well as abiotic and biotic factors affecting their bioavailability, and ecological effects of heavy metal pollution will be studied. The geochemical behaviour of heavy metals were analysed through speciation studies. Studies show that the metals mobility is less in the heavy metals mobility is little low in the Exchangeable metal fraction and Carbonate bound metal fractions. But in the Fe- Mn oxide metal fraction and Organic and sulfide metal fractions mobility of the metals is comparatively little higher than the other fraction. The final residual metal fraction has the total remaining metal content in the sample In this study period, the industrial surrounding area soil has lost their natural fertility with the addition of some heavy metals by physico-chemical analysis.

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### INTRODUCTION

Metals are considered very important and highly toxic pollutants in the various environmental departments. Inputs of metals to the environment as a result of anthropogenic activities is difficult to measure due to the very large natural inputs from the erosion or rocks, wind-blowing dusts, volcanic activity and forest fires. Ecotoxicologists and environmental scientists use the term "heavy metals" to refer to metals that have caused environmental problems. The metals which have been studied extensively the last decades are: Cd, Hg, Zn, Cu, Ni, Cr, Pb, Co, V, Ti, Fe, Mn, Ag and Sn (Tin). Some metals that have received more attention are Hg, Cd, and Pb, because of their highly toxic properties and their effects on the environment and the living organisms. The inputs of metals to the environment from anthropogenic activities is complicated to distinguish as there are very large natural inputs from the erosion, wind-blown dust, volcanic activity and forest fires. Atmospheric and river inputs, dredging spoil, direct discharges, industrial dumping and sewage sludge are some of the important contributors to metal pollution, which lead to the release of metals to the marine environment. Some metals enter the sea from the atmosphere, e.g. natural inputs of metals, such as Aluminium (Al) in wind-blowing dust of rocks and shale's, and mercury (Hg) from volcanic activity. Lead (Pb) inputs in the atmosphere from industrial and vehicular exhaust are much greater than natural inputs. Some metals are deposited by gas exchange at the sea surface, by fallout of particles (dry deposition) or are scavenged from the air column by precipitation (rain) which is called wet deposition. Rivers make a major contribution of metals in the marine environment. The nature of metals depends on ore-bearing deposits in the catchment area and the discharge of human waste and discharges when the river passes through urban areas. Dredging of shipping channels produces large quantities of metal pollution. Much smaller quantities of metals are added to the sea by direct discharges of industrial and other waste and the dumping of sewage sludge<sup>1,2</sup>. Many metals are essential to living organisms but some of them are highly toxic or become toxic at high concentrations. Fe (haemoglobin), Cu (respiratory pigments), Zn (enzymes), Co (Vitamin B12), Mo and Mn (enzyme). Light metals Sodium (Na), Potassium (K) and Calcium (Ca) which play important biological roles. Transition metals Fe, Cu, Co and Mn which are essential but may be toxic at high concentrations. Metals such as Hg, Pb, Sn, Ni, Se, Cr and As which are generally not required for metabolic activity and are toxic to living organisms at quite low concentrations<sup>3,4</sup> Metal pollution, biogeochemistry, fate, occurrence and eco toxicological effects in living organisms are covered by numerous publications<sup>5,6</sup>. A series of books on metals covering a broad spectrum of subjects and environmental pollution were published in recent years<sup>7-11</sup>.

### **BIOACCUMULATION**

The extent of bioaccumulation of metals is dependent on the total amount, the bioavailability of each metal in the environmental medium and the route of uptake, storage and excretion mechanisms. The requirements of different organisms for essential metals vary substantially but optimal concentration ranges are narrow and frequently under careful homeostatic control. Excess metal concentration in an organism must be actively excreted, compartmentalized in cells or tissues, or metabolically immobilized. Some metal escape all these actions causing toxic and other adverse effects<sup>12,13</sup>. Metal in the aquatic environment are bio accumulated by organisms either passively from water or by facilitated uptake. Essential metals are maintained by binding to organic molecules at a variety of biochemical sites where they function mainly as catalysts to induce or enhance enzymatic activity. Essential metals at high concentrations can have sub-lethal toxicity effects to some organisms or lethal consequences to others. Also, metals at deficient concentrations can have again adverse health effects. Thus essential metals can have a double "toxic" threshold<sup>14</sup>. Living organisms exposed environmentally to high metal concentrations follow various mechanisms to counter potential toxicity. They reduce intake, enhance excretion and/or sequestration of the metals within tissues to render them non toxic. Metals can be sequestered through storage by metal binding proteins, such as metallothioneins, in cellular vesicles and granules. Some storage mechanisms can be related in some organisms of providing essential metals for future needs<sup>15</sup>.

Additionally, metal pollution is considered hazardous to biological systems because of their oxidative and carcinogenic potential. In the past metals were considered to bind on the nucleic acids, by reacting in sites of the cellular DNA and cause mutations, adducts or complexes. Also, metal cations were found to affect DNA replication, but at very high concentrations *in vitro*. In recent years. Strand scission, depurination, crosses linking and base modifications are the major lesions formed after exposure of experimental animals to carcinogenic metals. Scientists observed that carcinogenic metals caused damage in nuclear chromatin similar to oxygen free radicals and other free radical species. Recent studies found that metals can act as carcinogens through oxidative mechanisms, generating free radicals and reactive oxygen species (ROS), which attack and damage DNA and important enzymatic proteins. The toxicology and carcinogenicity of many heavy metals is another important environmental concern of the scientific community<sup>16</sup>.

### **METAL POLLUTION**

There are numerous publications and reports on metal pollution in marine, freshwater and terrestrial ecosystems in the last decades. Reports on metal pollution and effects on marine ecosystems have been published by United Nations Environment Programme (UNEP), GESAMP (Group of Experts on Scientific Aspects of Marine Environmental Pollution, Advisory body, established in 1969, consists of 25-30 international experts on marine pollution and emerging issues, is sponsored by UN, IMO, FAO, UNESCO-IOC, WMO, IAEA, UNIDO) and environmental specialists <sup>17, 18</sup>, The oceans provide a vital sink for many heavy metals and their compounds. There is a growing concern that the natural cycling rates of many metals are being disturbed by anthropogenic activities, especially the release from industrial, domestic and urban effluents of increasing amounts of Pb, Zn, Cd, Hg and Cu (Schindler PW)<sup>19</sup> Mercury is a typical example of metal pollution from natural and anthropogenic activities. It is estimated that up to 150.000 tonnes of Hg are released as a result of degassing from the Earth's crust and 8.000-10.000 tonnes from industrial and urban activities<sup>20</sup>. Lead (Pb) is another typical example of anthropogenic metal pollution. Beginning with very low levels at about 2.700 years ago, Pb concentration increased during the industrial age and has risen rapidly since Pb was added to gasoline fuel of vehicles. Pb levels in Greenland ice have risen 200-fold from the natural level. Atmospheric metal pollution is responsible from most of the dissolved Cd, Cu, Fe, Zn, Ni and As in the oceans <sup>17</sup>. Heavy metal pollution of freshwater ecosystems has been shown to be extensive<sup>21</sup>. High levels of heavy metals have been found in sediment and biota of ponds and lakes, rivers and wetlands <sup>22,23</sup>. Acid rain resulting from dissolved hydrogen sulphide, sulphur dioxide and oxides of nitrogen has contributed to alterations of soil and freshwater acidity. As a consequence there is an increase in the bioavailability of many heavy metals to freshwater biota<sup>24</sup>. The terrestrial environment is also an environmental department into which heavy metals are released. The metal content of soils may be strongly influenced by their 5 origins. Soils derived from shales are often rich in Cd, whereas soils derived from serpentine rocks contain elevated concentrations of Co, Ni and Cr. Environmental pollution by heavy metals in the terrestrial environment include mining, ore smelting, combustion of fossil fuels and certain pesticides containing As and Cu (Pennelas J,et.al.)<sup>25</sup>.

## SPECIATION OF HEAVY METALS IN SOIL SAMPLE

**Speciation analysis** is the analytical activity of identifying and/or measuring the quantities of one or more individual chemical species in a sample. The *chemical species* are specific forms of an element defined as to isotopic composition, electronic or oxidation state, and/or complex or molecular structure. The *speciation* of an element is the distribution of an element amongst defined chemical species in a system. In case that it is not possible to determine the concentration of the different individual chemical species that sum up the total concentration of an element in a given matrix, that means it is impossible to determine the speciation, it is a useful practice to do fractionation instead. Fractionation is the process of classification of an analyte or a group of analysts from a certain sample according to physical (e.g. size, solubility) or chemical (e.g. bonding, reactivity) properties.

Speciation analysis provides the necessary information to describe the effects of active species which is not available from the results of total trace element determinations. It is therefore predictable, that the concepts based on total trace element determination, such as

- Trace element determination
- Toxicity of elements
- Essentiality of elements
- Metals as environmental pollutants and workplace hazards
- Trace metals in human health and nutrition

will be replaced gradually by the more meaningful concepts using the information of speciation, that means

- Trace element speciation
- Toxicity of element species
- Essentiality of element species
- Element species as environmental pollutants and workplace hazards
- Trace element species in human health and nutrition

The additional information is very useful to direct actions enhancing the quality of products, improving production processes, reducing health risks associated with toxic species, leading to improved understanding of life and better control for the environment.

The chemical composition of soil influences to a great extent the speciation of heavy metals. In river water large proportion of metals is bound to organic and inorganic particulate matter. Other factors which influence speciation are: pH, hardness, and organic matter<sup>26, 27</sup>. Large amounts of dissolved organic complexes and particulate matter with heavy metals are transported great distances to end up in the sediments of the estuaries. Some metals, such as Cd, can be released from their organic complexes by increasing Cl (chlorine) concentrations, which form chloride complexes <sup>28</sup> Some metals are available for uptake into organisms from solution only as free ions, whereas others are transported over biological membranes as inorganic complexes. In experiments with Cu and Cd their toxicity and their bioavailability is correlated with the concentration of free metal concentration <sup>29,30</sup>, Inorganic Hg in the other hand is transported over lipid membranes principally as uncharged chloride complexes<sup>31</sup>. Sediments are more complex chemical environment than water and there are not reliable methods for assessing bioavailability of metals in such media<sup>32</sup> It has been shown that heavy metal in soils are associated with several distinct geochemical phases, such as clay minerals, organic matter, carbonates and sulphates.48 The types of reactions that are likely to control the partitioning of metals in soils are: adsorption and desorption, precipitation and solubilisation, surface complex formation, ion exchange and biological mobilization or immobilization<sup>33</sup>.

## MATERIALS AND METHODS

**Study area:** The study area Mysore is having more than 12 lakh populations and was capital of former state and  $11^{\circ}6^{1}$  latitude and  $77^{\circ}7^{1}$  longitude and general elevation is little more than 1800 feet above sea level. The climate of the city is moderated throughout the year with temperature during summer ranging from 30°C to 34°C. The rainy season is from June to October. The winter season starts from November to February. The source of water for domestic purpose is mainly from the Cauvery River and ground water.

Mysore is one of the growing cities of Karnataka and it is largely due to presence of industrial resources and a well developed communication network. Mysore has a rich and vibrant history and heritage and hence attracts a huge number of tourists. Also Mysore is now active centre for production and industrialisation. The city has been growing as a country parallel to Bangalore, with a large presume of software companies and the population is growing at a faster rate due to the influx of many industrial and commercial activities.

In recent year's industrialization has become main cause of city's growth. There is diversity in industrial landscape of Mysore with haphazard distribution. The industrial areas are distributed all over the city and its surroundings with lack of order and regulation in industrial location. A large number of small and medium scale industries exist in and around the Mysore city. Most of all medium scale industries like engineering, chemical, pharmaceutical, food, brewery, textile, steel and metal smelting etc.

Mysore city industrial area has been majorly divided in to three regions. Namely,

- 1. Metagalli industrial area.
- 2. Hebbal Industrial area.
- 3. Hootagalli Industrial area.

Metagalli Industrial area consisting of industries like tyre manufacturing, Aluminium industries, electric appliances manufacturing industry and metal industry. This industrial area is having medium and large scale industries.

In Hebbal industrial area, small scale industries and medium scale industries are more in number compared to large scale industries like electric appliances manufacturing industries, textile industry, metal product industries etc.

Hootagalli industrial area is smaller in its radius as compared to Metagalli and Hebbal industrial areas. Here the industries like textile, heavy earth movers manufacturing industry, chemical manufacturing industries and very few small scale industries are situated.

In the present study, sampling locations are included in all the 3 major industrial areas of Mysore city. The soil samples were collected during Pre-Monsoon season of 2012. The samples were collected in polythene covers and immediately brought to the laboratory for analysis. The samples were analysed using standard methods to determine the physico-chemical properties of the soil and finally we digested the soil sample to quantify the total metal concentration by using di-acid mixture. The digested soil sample was analysed for determination of total heavy metals concentration by using AAS.

### **EXPERIMENTAL WORK**

**Determination of pH and Electrical conductivity**: Place two teaspoonfuls of each soil in a beaker. Add the same amount of distilled water, stir with glass rod and leave to stand for 10 minutes. Stir again and immerse the pH meter into the water/soil suspension. Clean pH meter with distilled water before immersing in other sample

**Determination of Lime content**: 1g soil was taken and its dried to remove the moisture content on hot plate. Add 25ml of 0.1N HCl. Keep aside for 30min. Then titrate the content against NaOH in the burette.

**Determination of Organic carbon and Organic matter:** 1g of soil taken in to conical flask which contains 0.1N K2Cr2O7. Keep aside for 30min to get oxidation. Add 10ml of con.H2SO4. titrate this solution against 0.5N FAS.

**Determination of Sodium and Potassium**: Take 5g soil sample in a conical flask. To extract the calcium and magnesium add 100ml of 1N ammonium acetate and agitate the solution frequently at regular intervals for 1hr. Filter the solution and inject for flame photometer.

**Determination of Calcium and Magnesium**: Take 5g soil sample in a conical flask. To extract the calcium and magnesium add 100ml of 1N ammonium acetate and agitate the solution frequently at regular intervals for 1hr. Filter the solution and titrate against

**Determination of Total Heavy Metals**: 1g of soil sample was taken in to the test tube and mixed well with the concentrated  $H_2SO_4$ , Perchloric acid and Nitric acid. Heat the test tube content till the solution become whitish color. If white color appears it indicates that the soil sample is digested completely. Cool the solution to room temperature and filter using whatman filter paper. Make up the filtered solution to 100ml using distil water and take the readings after injecting the solution to AAS.

### RESULTS

|           | pН   | EC      | Lime content | OC    | ОМ     | Na    | К     | Ca      | Mg      |
|-----------|------|---------|--------------|-------|--------|-------|-------|---------|---------|
|           |      | (µs/cm) | (mg/kg)      | (%)   | (%)    | (ppm) | (ppm) | (mg/kg) | (mg/kg) |
| P1        | 6.86 | 81      | 2.96         | 0.38  | 0.655  | 5.6   | 7.2   | 142     | 68      |
| P2        | 7.1  | 81      | 1.38         | 0.09  | 0.155  | 4.6   | 11.6  | 138     | 56      |
| P3        | 6.71 | 79      | 1.96         | 0.096 | 0.1655 | 5.2   | 7.6   | 196     | 78      |
| P4        | 7.3  | 88      | 7.6          | 0.42  | 0.72   | 3.4   | 6.1   | 136     | 86      |
| P5        | 7.4  | 87      | 6.28         | 0.11  | 0.18   | 4.2   | 17    | 110     | 140     |
| <b>P6</b> | 6.9  | 82      | 3.1          | 0.29  | 0.45   | 4.1   | 12    | 194     | 172     |
| P7        | 7.2  | 84      | 3.42         | 0.3   | 0.5172 | 5     | 12.6  | 128     | 96      |
| <b>P8</b> | 7.34 | 84      | 5.4          | 0.21  | 0.362  | 5.2   | 13.1  | 146     | 78      |
| <b>P9</b> | 7.24 | 88      | 5.6          | 0.26  | 0.448  | 6.9   | 13.3  | 262     | 376     |
| P10       | 7.3  | 88      | 4.6          | 0.49  | 0.844  | 4.9   | 11.9  | 178     | 136     |

### Table 1: Physico-Chemical properties of the soil sample

#### Speciation of Heavy metals in soil sample:

| P1 (All fractions are expressed in mg/kg) |     |     |     |      |      |        |  |  |
|---|-----|-----|-----|------|------|--------|--|--|
|   | Ι   | Π   | III | IV   | V    | Total  |  |  |
| Fe  | 3.2 | 26  | 416 | 874  | 2467 | 3786.2 |  |  |
| Cu  | ND  | ND  | ND  | 3.3  | 17.7 | 21.0   |  |  |
| Cr  | ND  | ND  | 4.9 | 5.1  | 9.0  | 19.0   |  |  |
| Zn  | ND  | 8.8 | 71  | 6.2  | 17.0 | 103.0  |  |  |
| Ni  | ND  | ND  | 6.3 | 2.4  | 6.1  | 14.8   |  |  |
| P2  |     |     |     |      |      |        |  |  |
|   | Ι   | II  | III | IV   | V    | Total  |  |  |
| Fe  | 4.1 | 17  | 680 | 1060 | 2186 | 3947.1 |  |  |
| Cu  | ND  | ND  | 1.3 | 2.6  | 14.1 | 18.0   |  |  |
| Cr  | ND  | ND  | 1.7 | 3.3  | 3.6  | 8.6    |  |  |
| Zn  | 2.6 | 6.9 | 62  | 11.5 | 7.0  | 90     |  |  |
| Ni  | ND  | ND  | 4.9 | 3.7  | 11.6 | 20.2   |  |  |
| P3  |     |     |     |      |      |        |  |  |
|   | Ι   | II  | III | IV   | V    | Total  |  |  |

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| Fe                                    | 8.4                                    | 16              | 980   | 3400       | 1951      | 6355.4 |  |  |  |
|---------------------------------------|--|-----------------|-------|------------|-----------|--------|--|--|--|
| Cu                                    | ND                                     | ND              | 1.3   | 3.0        | 16.7      | 21.0   |  |  |  |
| Cr                                    | ND                                     | ND              | 3.6   | 4.7        | 6.7       | 15.0   |  |  |  |
| Zn                                    | ND                                     | 12              | 49    | 8.0        | 7.0       | 76.0   |  |  |  |
| Ni                                    | ND                                     | ND              | 6.1   | 2.9        | 6.0       | 15.0   |  |  |  |
| P4                                    |  |                 |       |            |           |        |  |  |  |
|                                       | Ι                                      | II              | III   | IV         | V         | Total  |  |  |  |
| Fe                                    | 2.6                                    | 16              | 678   | 1697       | 4216      | 6609.6 |  |  |  |
| Cu                                    | ND                                     | ND              | 1.0   | 3.8        | 15.2      | 20.0   |  |  |  |
| Cr                                    | ND                                     | ND              | 1.6   | 3.8        | 9.6       | 14.0   |  |  |  |
| Zn                                    | ND                                     | 9.0             | 56    | 14.0       | 11.0      | 90.0   |  |  |  |
| Ni                                    | ND                                     | 1.3             | 4.4   | 1.3        | 6.4       | 13.4   |  |  |  |
| P5                                    |  |                 |       |            |           |        |  |  |  |
|                                       | Ι                                      | II              | III   | IV         | V         | Total  |  |  |  |
| Fe                                    | 4.6                                    | 8.1             | 960   | 2919       | 3317      | 7208.7 |  |  |  |
| Cu                                    | ND                                     | ND              | ND    | 2.4        | 17.6      | 19.0   |  |  |  |
| Cr                                    | ND                                     | ND              | 4.9   | 8.9        | 9.2       | 21.0   |  |  |  |
| Zn                                    | ND                                     | 9.0             | 66    | 14.0       | 21        | 110.0  |  |  |  |
| Ni                                    | ND                                     | ND              | 43    | 2.4        | 12.5      | 19.2   |  |  |  |
| P6                                    | <u>NI IND 14.5 2.4 12.5 19.2</u><br>P6 |                 |       |            |           |        |  |  |  |
| 10                                    | I                                      | П               | III   | IV         | V         | Total  |  |  |  |
| Fe                                    | 3.6                                    | 94              | 419   | 1596       | 2896      | 4924   |  |  |  |
| Cu                                    | ND                                     | ND              | ND    | 1570       | 13.4      | 18.0   |  |  |  |
| Cu                                    | ND                                     | ND              | ND    | 4.0        | 83        | 13.0   |  |  |  |
| Zn                                    | 1.0                                    | ND<br>87        | ND 61 | 4.7        | 0.5       | 100.6  |  |  |  |
| ZII<br>Ni                             | 1.7<br>ND                              | 0.7             |       | 21         | 17        | 109.0  |  |  |  |
| D7                                    | ND                                     | 1.0             | 4.4   | 1./        | 9.5       | 17.2   |  |  |  |
| F/                                    | T                                      | п               | III   | IV/        | V         | Tatal  |  |  |  |
| Ea                                    |  |                 | 111   | 1V<br>2016 | V<br>2461 | 1 otal |  |  |  |
| Fe                                    | 3.2<br>ND                              | 10<br>ND        | 1/9   | 2010       | 2401      | 40/5.2 |  |  |  |
| Cu                                    | ND                                     | ND              | 1.0   | 3.0        | 10        | 20.0   |  |  |  |
| Cr                                    | ND                                     | ND              | 2.0   | 3.9        | 1.1       | 14.2   |  |  |  |
| Zn                                    | 1.6                                    | 14.1            | 49    | 32.3       | 3.6       | 100.6  |  |  |  |
| N1                                    |  | ND              | 3.4   | 2.6        | 7.2       | 13.2   |  |  |  |
| P8 (Al                                | fractions are ex                       | xpressed in mg/ | kg)   | T          | T         | T      |  |  |  |
|                                       | I                                      | II              |       | IV         | V         | Total  |  |  |  |
| Fe                                    | 5.1                                    | 19              | 267   | 1061       | 1632      | 2984.1 |  |  |  |
| Cu                                    | ND                                     | ND              | ND    | 5.0        | 16        | 21.0   |  |  |  |
| Cr                                    | ND                                     | ND              | 1.1   | 8.7        | 9.2       | 19.0   |  |  |  |
| Zn                                    | 1.1                                    | 6.9             | 41    | 43.6       | 4.4       | 97.0   |  |  |  |
| Ni                                    | ND                                     | ND              | 2.9   | 3.2        | 2.6       | 8.7    |  |  |  |
| P9                                    |  |                 |       |            |           |        |  |  |  |
|                                       | Ι                                      | II              | III   | IV         | V         | Total  |  |  |  |
| Fe                                    | 4.9                                    | 12.1            | 561   | 876        | 2697      | 4151   |  |  |  |
| Cu                                    | ND                                     | ND              | 1.2   | 2.1        | 17.0      | 20.3   |  |  |  |
| Cr                                    | ND                                     | ND              | 1.9   | 5.6        | 8.5       | 16.0   |  |  |  |
| Zn                                    | 7.9                                    | 14.3            | 58.6  | 41.2       | 4.0       | 126.6  |  |  |  |
| Ni                                    | ND                                     | ND              | 5.6   | 4.4        | 2.9       | 12.9   |  |  |  |
| · · · · · · · · · · · · · · · · · · · |  |                 |       |            |           |        |  |  |  |

## DISCUSSION

The physic-chemical property of soil sample has been shown in **Table 1.** Speciation of metals was carried out according to Tessier method. Table 2 show the results of total content of particular heavy metals in soil of industrial area located at Mysore and its distribution among particular fractions. The exchangeable fraction (F1) contains metal elements in the ionic form, which have a high mobility and can be drained by water. The fraction related to the carbonates (F2) is extractable and can be accumulated in the plants. The fraction related to the oxides of iron and manganese (F3) and that related to organic matter (F4) contain metals enclosed in the matrix. The fraction (F5) contains the inert metals. The results show that iron occurred mainly in residual fraction which is varied between 30.69% and 65.15% in different samples and also 17.22% to 53.49% of iron is bound to organic matter. It is bound in much smaller amounts in the form of oxides fraction which ranged from 3.82%–17.23% in different samples. Also only minor amounts of iron were detected in the exchangeable and bound to carbonate fractions. The analysis shows that zinc has been bound to hydrated oxides of iron and manganese fraction in the range of 42.2– 68.9% and also was bound to organic matter fraction in range of 6.01%–44.9%. The amount of zinc found in the residual fractions was varies from 3.1%- 19.09%. In exchangeable fraction the metal concentration was below the detection limit.

In the present study, nickel is found in the fraction bound to organic that is varies from 9.7%-36.78%, whereas 22.4%-65.1% in residual fraction. Bounded to oxide metal fraction for nickel is 22.4%-43.4% and 9.3%-9.7% in carbonate bound fraction. The level of nickel found in exchangeable metal fraction is once again lower than the detection limit. Toxicity of nickel is not important because of its low concentration in the mobile and bioavailable fractions.

The analysis for soil sample shows that, copper in the different soil samples have been found in organic matter fraction ranged from 10.3%-25.5% and varied in the range of 74.5%-92.6% in residual form. The level of copper in the exchangeable, carbonate fraction and fractions bound to hydrated oxides of iron and manganese and was lower than the detection limit. Copper is bound much more tightly by residual fraction than Ni and is much less likely to be displaced by the hydroxylamine hydrochloride reagent. Similar results are reported by McLaren and Clucas <sup>34</sup>. Copper in the soil is not present in the ionic forms which reduce its toxicity. The speciation analysis shows that chromium, in the soil sample is mainly found in the residual fraction in the range from 41.8%–68.5% and little lesser in the range of 26.8%–56.6% bound to the organic matter. Whereas in smaller amounts ranges from 5.7% - 25.7% in the fractions bound to hydrated iron and manganese oxides fractions. Thus, the bioavailability of chromium in the soil sample is considered insignificant.

In exchangeable fraction, except iron and Zinc, the concentration of all metals in this fraction is lower than the detection limit. The amounts of metals released in the carbonate fraction represent a low proportion of the total metal concentration. Copper, chromium and zinc are below the detection range and iron has low concentrations in this fraction. This fraction is susceptible to acid rain <sup>35</sup>. In the fractions bound to hydrated iron and manganese oxides, the amounts of nickel, iron and zinc associated are relatively high. These amounts of metals would be released under reducing conditions. The metal levels in fraction associated with organic matter are relatively high and they represent a large fraction of the total metal concentrations. These amounts of metals are released in soil under strong oxidizing conditions and consequently this fraction constitutes an important source of potentially available trace metals. It can be observed that the greatest part of the metals studies, especially iron was associated with the residual fraction. This fraction, named 'inert phase', corresponds to the part of the metals which cannot be mobilised.



Fig.1: Graphical representation of physico-chemical characters of soil sample.



#### CONCLUSION

In nature the environment is going to pollute day by day in so many ways. Weather it will be natural or human made. If the pollution caused by the nature, the effect is very low and it does not persist for a long time. But when pollution matter comes to the human made the persistence capacity is more and it would cause very dangerous effects on the environment. Here in this research work, the soil character was determined and we identified some toxic heavy metals. The soil has very low concentration of organic carbon and organic matter content. The heavy metals mobility is little low in the Exchangeable metal fraction and Carbonate bound metal fractions. But in the Fe- Mn oxide metal fraction and Organic and sulfide metal fractions mobility of the metals is comparatively little higher than the other fraction. The final residual metal fraction has the total remaining metal content in the sample. If the mobility of the metals is higher in initial two steps of speciation the toxicity will be more in nature. In addition to that the heavy metals are at risky levels in the study area. The heavy metals are nearer to maximum levels in the soil. After reaching the maximum level of contamination, it would percolate in to ground water and it result in bioaccumulation in the natural cycle. From the different processes going in industries releases toxic chemicals, waste water, dumping of untreated solid waste to the surrounding environment leads to release of heavy metals, acids etc. When pollutants get contaminate with soil, it will lose their fertility and plant growing capacity in it. All these above said pollution problems are arises from the increased industrial activities/process and more number of industrial sectors is opening day by day. For the future years the proper environmental management aspect should be taken care in the industrial areas by industries itself by making proper treatment/disposal of waste materials.

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