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SPATIAL AND TEMPORAL EVALUATION OF DIFFERENT ESSENTIAL AND NON-ESSENTIAL METALS IN ABANDONED GOLD TAILINGS AT KOLAR GOLD FIELDS

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Abstract- The purpose of this study is to assess presence of different heavy and non-heavy metals in an abandoned gold mining site in Kolar Gold Fields, Karnataka.

The region is called the Kolar schist belt of south India, well-known for its gold deposits which have been mined technically for over two centuries. Distribution of elements in the form of histogram diagrams were prepared to understand the levels of contamination in soil using thermo scientific make ICP-OES (Inductively Coupled Plasma-Optical Emission Spectroscopy) with Iteva software. Four sampling sites (dumpings) were selected based on its presence near by residential areas and analyzed between january-june 2014.Analysis of soil samples collected from four mine dumps in the study area indicates high levels of As, Cd, Fe, Ni, Cu, Pb, Cr, far above the above the threshold values in soil except Mn. The results of this study would facilitate in identifying the extent of groundwater pollution and prognosis of entry of pollutants into biotic components.

Key words- Metals, gold ore tailings, ICP-OES, soil, pollution, Kolar Gold Fields.

I. INTRODUCTION

With global changes resulting in new challenges in environmental protection and conservation there is a need for baseline data to evaluate the potential impacts of pollutants to ecosystems. Activity such as metal mining, release large amount of tailing and waste containing heavy metals which pose severe threat to water sources, agricultural soils and food crops[1]. Thus the demand for a country's economic, agricultural and industrial development needs a monitoring program for a safe and pure environment. Kolar Gold Fields (KGF), Karnataka, India has a heritage of 2000 years where the tradition of gold mining started as early as the first millennium BC. During all these years of exploitation, tailings from the underground mines were dumped on the surface without any proper treatment. Around 40 million tonnes of sand, which make upto 15 mine dumps spread out along an 8km distance in the mine area[2]. The impoundments were disposed-off in slurry form. The spent ore is mainly composed of quartz with lesser amounts of calcite, feldspar, chlorite, mica, amphiboles and pyrite[3]. The mine stopped production in 2001 with mine waste left untreated. The dumps are left exposed to the environment without any revegetation, between the months of april or may when the weather is dry and windy, these particles are carried eastward to the residential areas of KGF over a distance of 3km. With the onset of monsoon, rainwater carries these particles further down on to the tank beds[4].

Soils contaminated by heavy metals from agricultural activities have raised serious concern in recent decades regarding potential risk to human health through the direct intake , food chain, and in turn on ecological systems[5,6].Essential heavy metals (copper (Cu), and manganese (Mn) as well as nonessential metals (cadmium (Cd), chromium (Cr), manganese (Mn), lead (Pb), [7] arsenic (As), iron (Fe), nickel (Ni) are considered highly toxic for human and aquatic life[7].Recent research reveals that adverse effects on health due to lead and cadmium exposure may occur in the form of kidney damage, bone effects and fractures, and neurotoxic effects in children[8]

II. GEOLOGY

The KGF is situated at latitude 12^{O} 57' N and longitude 76^{O} 16' E to south of bangarpet taluk, Karnataka. It is located 100km east of Bangalore and about 300km west of Chennai. The region is characterized annual rainfall of 740mm. The day temperature over most part of the year is around 27-35^{o} C[3].

III. METHODOLGY

The sampling was done between January to June 2014. Four sampling sites (gold ore tailings). One sample was collected from each site per month, so four samples were analysed every month.

Sample sites- Location A,B,C,D were selected based on their distance from residential places Oorgaum, Tenants, Champion reefs, Balghat lane were named as location A, B, C, D and their distances from residential places were 50, 100, 200, 300 metres respectively. Analysis was done comparing four seasons in 2014.
Season 1- January, February, March
Season 2- April, May, June

Total of 12 samples were analysed each season and 24 samples were analysed between January to June 2014.

IV. MATERIALS AND METHODS

Sampling was done from the site during the two seasons in order to find the presence of individual elements. Soil samples were collected from the outer surface,i.e. 10-20 cm in depth in self locking polythene bags after removing surface contamination. Sample preparation procedure for spectrochemical determination of total recoverable elements were carried as per U.S ENVIRONMENTAL PROTECTION AGENCY (2012). High purity reagents were used whenever possible. All acids used for this method were of ultra purity grade, all chemicals for quantification were purchased from Rankem chemicals.

For the determination of total recoverable analytes in solid samples, sample was mixed thoroughly and a portion of it was transferred on tared weighing dish, sample was weighed and weight recorded. To achieve homogeneity, the dried sample was sieved using a 5-mesh propylene sieve and ground in a mortar and pestle.

To analyse the samples Thermo Scientific make ICP-OES (Inductively Coupled Plasma- Optical Emission Spectroscopy) was used with Iteva software.

V. RESULTS AND DISCUSSION

RESULTS FOR ARSENIC

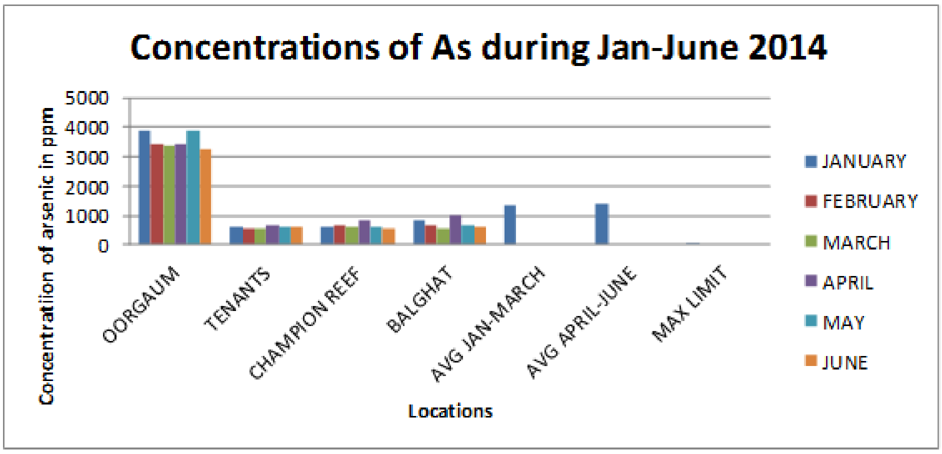

Fig-1 showing results for Arsenic at different locations.

RESULTS FOR CADMIUM

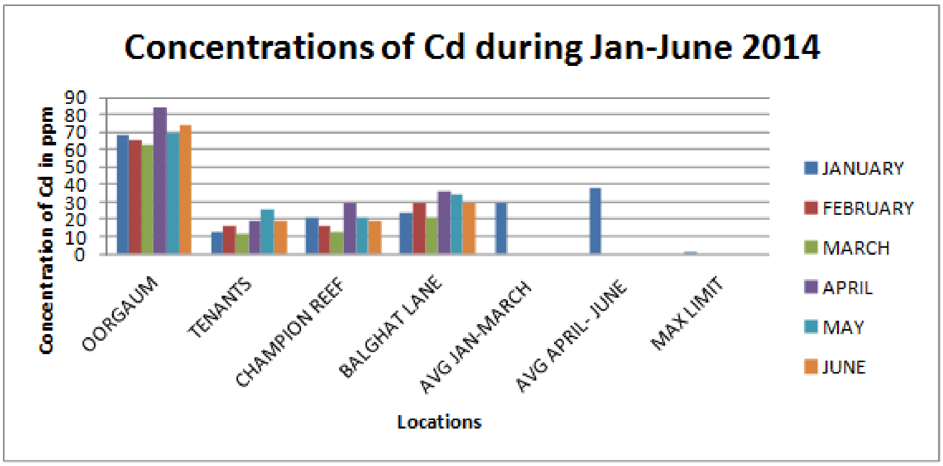

Fig-2 showing results for concentrations of cadmium

RESULTS FOR IRON

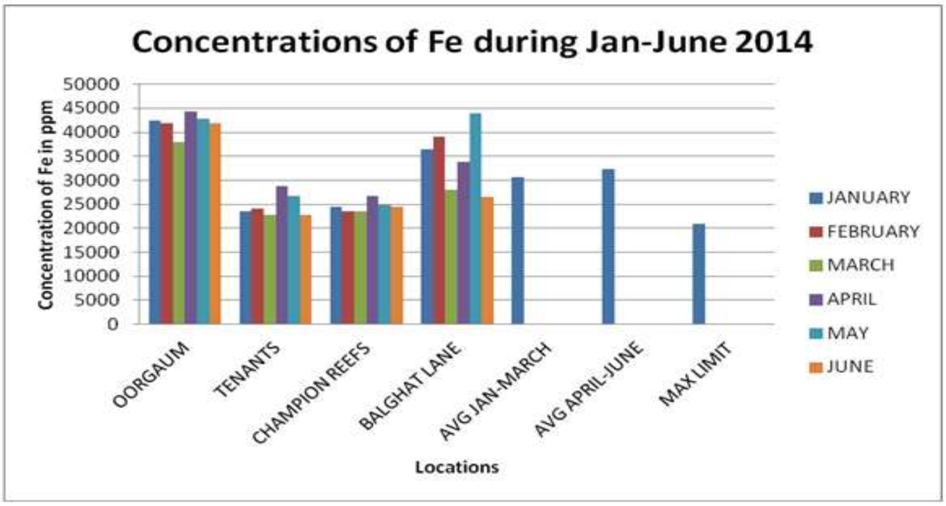

Fig-3 Concentrations of Fe during Jan-June 2014

RESULTS FOR NICKEL

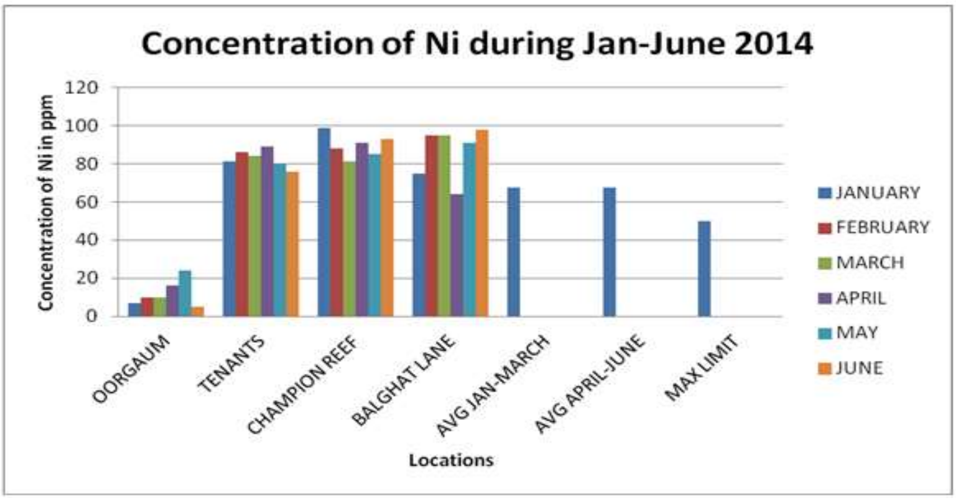

Fig -4 concentrations of Nickel in different locations

RESULTS FOR COPPER

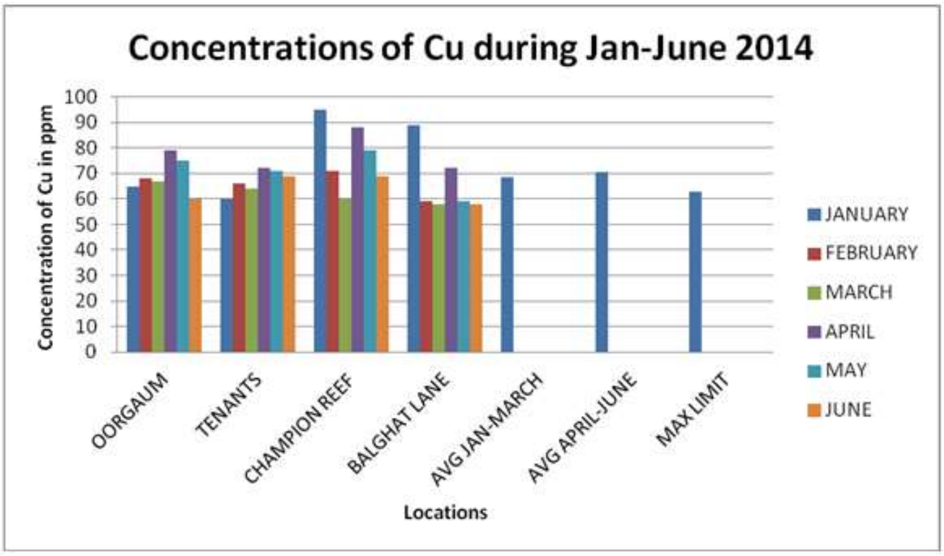

Fig -5 Concentrations of Copper in different locations

RESULTS FOR LEAD

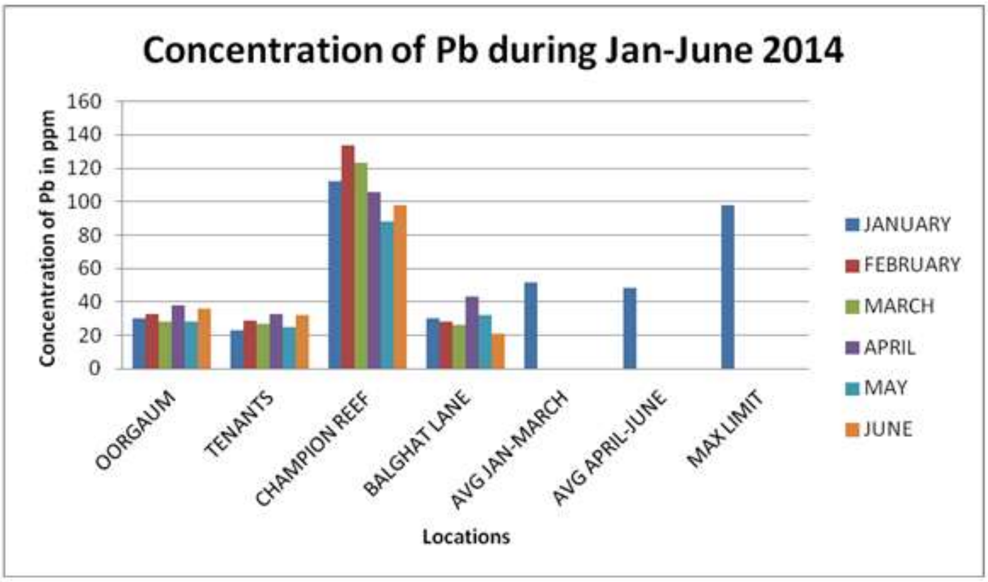

Fig-6 Concentrations of lead in different locations

RESULTS FOR CHROMIUM

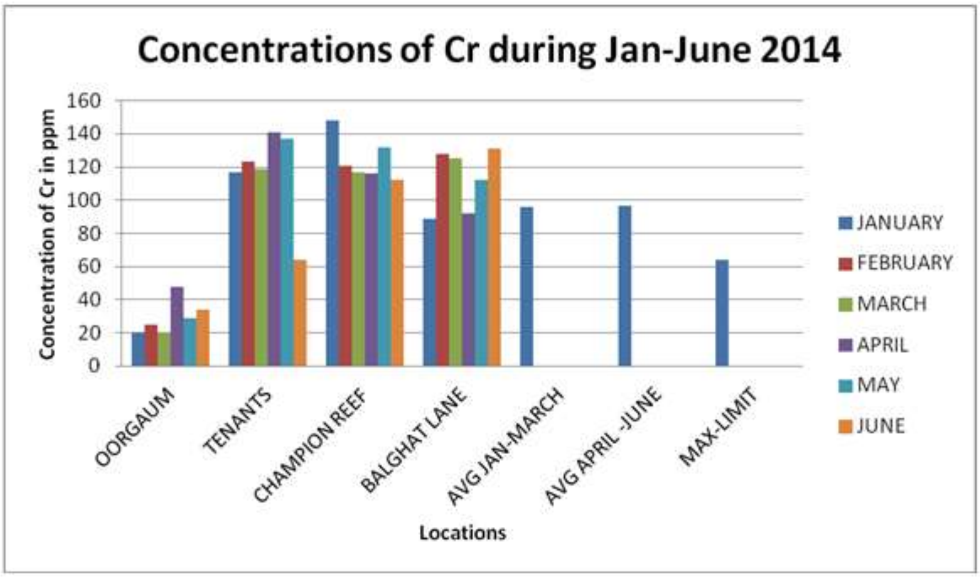

Fig-7 Concentrations of chromium in different locations

RESULTS FOR MANGANESE

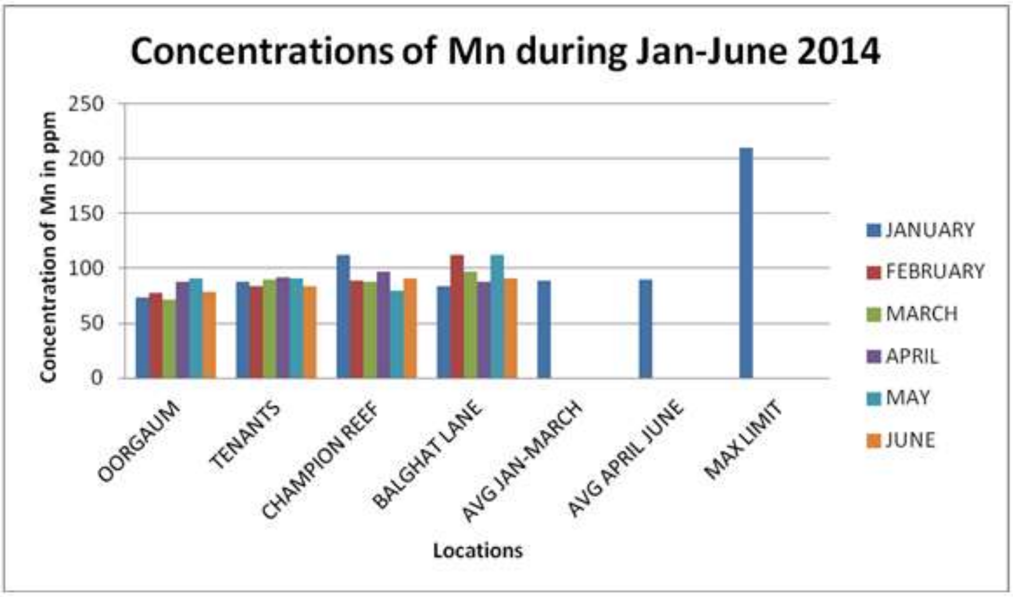

Fig-8 Concentrations of manganese in different locations

VI. DISCUSSION

Chemical analysis of soils collected from mine dumps in the study area indicated high levels of As, Cd, Fe, Cr, Cu, Pb, Mn represent the relevant statistical data of the elements between january to june 2014, far above the threshold values in soil except manganese.

In soil, the concentration of As in 4 dump sites ranged from 3900-550mg/Kg with an average of 1383mg/Kg against maximum permissible limits of 12mg/Kg[9].

The highest average concentration was seen in Oorgaum dump site and lowest average concentration of 604mg/Kg was seen at Champion reef dump site.

In soil, the concentration of Cd in 4 dump sites ranged from 84-11mg/Kg with an average of 31mg/Kg against maximum permissible limits of 1.5mg/Kg.The highest average concentration was seen in Oorgaum dump site at 70.5mg/Kg and lowest average concentration of 17mg/Kg was seen at Champion reef dump site.

In soil, the concentration of Fe in 4 dump sites ranged from 45647-22765mg/Kg with an average of 32649.6mg/Kg against maximum permissible limits of 21000mg/Kg.The highest average concentration 41860mg/Kg was seen in Oorgaum dump site and lowest average concentration of 26447mg/Kg was seen at Champion reef dump site.

In soil, the concentration of Ni in 4 dump sites ranged from 98-5mg/Kg against maximum permissible limits of 50 mg/Kg. The highest average concentration 89.5mg/Kg was seen in champion reef dump site and lowest average concentration of 12mg/Kg was seen at oorgaum dump site.

In soil, the concentration of Cu in 4 dump sites ranged from 89-58mg/Kg with an average of 69mg/Kg against maximum permissible limits of 63mg/Kg.The highest average concentration 77mg/Kg was seen in Champion reef dump site and lowest average concentration of 65.8mg/Kg was seen at Balghat dump site.

In soil, the concentration of Pb in 4 dump sites ranged from 134-21mg/Kg with an average of 87.6mg/Kg against maximum permissible limits of 98mg/Kg. The highest average concentration 110mg/Kg was seen in Champion reef dump site and lowest average concentration of 28.5mg/Kg was seen at Balghat dump site.

In soil, the concentration of Cr in 4 dump sites ranged from 148-20mg/Kg with an average of 96mg/Kg against maximum permissible limits of 64mg/Kg. The highest average concentration 121mg/Kg was seen in Champion reef dump site and lowest average concentration of 29mg/Kg was seen at Oorgaum dump site.

In soil, the concentration of Mn in 4 dump sites ranged from 112-71mg/Kg with an average of 89.6mg/Kg against maximum permissible limits of 210mg/Kg. The highest average concentration 97mg/Kg was seen in Balghat dump site and lowest average concentration of 80mg/Kg was seen at Oorgaum dump site

Because of the location of the residential areas amidst the dumps, there is a high probability that these high concentrations may cause health hazards.

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