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Determination of some Heavy metals in Sediment samples collected from Elabedia Traditional Gold Mining area – Sudan

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ABSTRACT

The present study was conducted to determine the concentration of heavy metals in some selected sediment samples from traditional gold mining area at Elabdeia Berber city Nile State Sudan. In addition, soil samples were collected from the site of the study to serves as control. The heavy metals were analyzed using X-Ray Fluoresce. The results were treated statistically by ANOVA analysis and multivariate analysis such as cluster. Based on obtained results, the average concentrations for Fe, Mn, Ni, Cr, Cu, Pb, and Zn were very high in the sediment. The concentrations of Fe, Mn, Cr, and Cu were very higher in the soil (control) than in sediment, but the concentration of Pb and Zn were higher in sediment and this attributed to industrial and extraction of gold mining. The results of this study were compared with previous literature.

Keywords: Gold mining, heavy metals, X-Ray Fluoresce, pollution.

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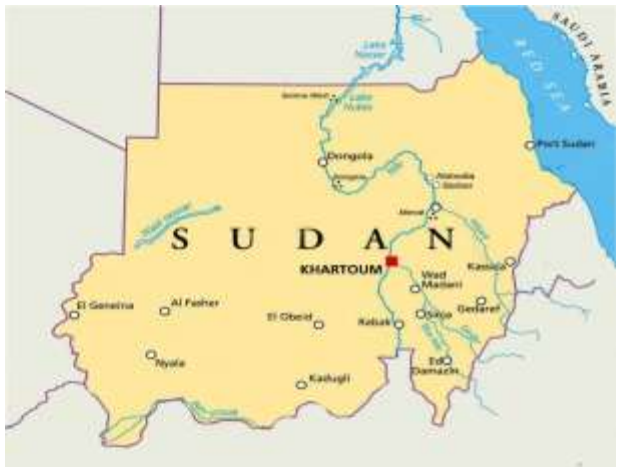
INTRODUCTION

Environmental pollution can be defined as an undesirable change in the physical, chemical and biological characteristics of the environment such changes are caused by substances that are introduced into the environment, by human activities {1}. Heavy metals are any metallic chemical element that has relatively high density (superior to 5 g/cm3); most of them are toxic or carcinogenic even at low concentrations, such as mercury, cadmium, arsenic and chromium *{1,2}*. The toxic elements enter the human body mostly through food and water and to a lesser extent through inhalation of polluted air, use of cosmetics, drugs, poor quality herbal formulations particularly {3}. Heavy metals get into the environment in different ways: with industrial, agricultural and household wastewaters, atmospheric deposits, or in the process of extraction of natural resources. The major part of heavy metal accumulates on the surface of soil and in the upper layers of bottom sediments of water basins. Heavy metals mix with the substances existing in such upper layers and change the characteristics. Soil reaction (pH) conditions a mobile form of amounts and organic substances in sediments acting like a buffer and storing these materials for a long time {4}. The extent and degree of heavy metal contamination around the mines vary depending on the capacity of mining activities and geochemical characteristics of the area {5}. Hazardous elements in the tails of mining and metallurgical operations are often dispersed, included in particulate material or in aqueous solution by wind and/or water after their disposal. Due to transport process, pollution could emerge because of primary contamination, formed by residues placed close to the contamination sources {2}. Hazardous elements in the tails of mining and metallurgical operations a e often dispersed, included in particulates material or in aqueous solution r by wind and \ or water after disposal due to transport process {6}. In recent years several studies have been made by number of researchers for determining heavy metals levels in contaminated sediment I kenaka et al.{7} studied the contamination of soil and sediment in Zambia ,their results indicated that heavy metal pollution in Zambia has strong regional differences. Investigation of. {8} evaluated the heavy metal concentrations (Cd, Cr, Cu, Pb and Zn) in surface sediments of Euhrates River Ireg. Abbas .{9}studied sediment samples from barks of River Nile around Khartoum state ,subjected to different human activates ,which suggested as emission sources for different trace elements, that lead to pollution. He used extraction procedure for the determination of trace element concentration. The aim of the present study was to evaluate the pollution level by some heavy metals in the work environment at Elabedia Traditional gold mining area -River Nile, state, Sudan

MATERIALS AND METHOD

Study Area

The site of the study is the traditional gold mining inside Elebedia which located in the River Nile State south Berber 15 Kilometers bounded by the Nile river from the west, AL sherik from the north, and the Red Sea State from the east scheme (1) the main profession of its inhabitants is agriculture, where is characterized by its fertile lands. Trade is considered of other professions in addition to the mining of gold. This site was surveyed during January 2017.



Samples Collection a pretreatment

Seven Sediment samples were collected from the site of the study scheme (2). Composite sediment samples were transported in labeled polyethylene bags, the polythene bags were rinsed with water of samples before the sediment samples were put into it. Sediment samples were air-dried in room temperature and the samples were repeatedly crushed with clean mortar and pestle through a 2-mm sieve to fineness and saved for analysis

Scheme (2) the area of study

Statistical analysis

The data obtained were subjected to descriptive and inferential Statistics. Descriptive statistics mainly mean and standard deviation was used to describe the concentrations of metals in sediment samples. Analysis of Variance (ANOVA) was used to test for significant differences in heavy metal content of the samples.

Multivariate Methods:

Multivariate methods are used to help in the interpretation of large multidimensional data arrays .it is needed to describe the relationships between the metals (variables) and samples (objects) in a rigorous and comprehensive way. Pattern recognition techniques are important classes of this multivariate method.

Heavy Elements Measurement:

The XRF system used in this study was X-MET5000 system (oxford instrument). Dry, clean and homogenous us soil or sediment sample was placed in to a plastic sample bag. This bag was placed on a background plate to minimize radiation scatter and to provide a constant background signal. The standards were prepared in a similar way. The concentrations of metals were measured directly by holed analyzer at right angles to the sample. The time of collection was 5 seconds. The X-MET model 5000(Fig2) is hand- held elemental analyzer intended for various different applications, include metal alloy analysis, soil and mining analysis, and electronic industry application. The XMET5000 series analyzers are based on energy dispersive X-Ray fluorescence technology and uses X-Ray tube as the source of excitation. The standard material is Rhodium. The analyzer contains a high resolution Penta. Pin diode detector with palter cooling the X-MET provides a method for chemical analysis or samples identification (sorting) directly from samples in various forms .The instrument is a fully portable analyzer with an integrated PDA(Personal Digital Assistant Computer) within X-MET analysis program the user may select analytical modes view spectra and save data .

Scheme (3) Shape of X -MT 5000

RESULTS AND DISCUSSION

The present study was designed to determine the concentration of heavy metals in the soil by using (XRF)technique from traditional gold mining in Elebidia Barber city, and control area were shown blew. The values of maximum, minimum, standard deviation and means were calculated, and Tukey significant difference was tested for means separation (P< 0.05). All statistical analyses were performed by using statistical package for social science software SPSS Statistics version 16.0.

Table 1: Summary of Statistical results for total elements Concentrations in ppm from sediment samples and soil (control) by XRF.

			Mean	Std. Deviation	Minimum	Maximum
No.	Types samples	Element				
1	Soil	Fe	866960.	20139.39616	827000.	890000.
	Sediment		6528.6	2004.75625	2800.00	8600.00
2	Soil	Mn	17578.	4752.83541	10500.00	23900.00
	Sediment		160.00	74.61010	100.00	300.00
3	Soil	Ni	1333.3	421.30749	900.00	2300.00
	Sediment		107.86	19.97022	90.00	150.00
4	Soil	Cr	900.00	632.45553	200.00	1900.00
	Sediment		311.43	119.36339	200.00	500.00
5	Soil	Cu	4427.8	2874.57726	1350.00	10100.00
	Sediment		382.14	142.47389	200.00	540.00
6	Soil	Pb	87.7778	59.95369	10.00	200.00
	Sediment		1114.3	1115.70392	100.00	2500.00
7	Soil	Zn	190.00	81.39410	100.00	310.00
	Sediment		212.86	85.38429	100.00	300.00

The analytical results for sediment site are summarized in tables (1). The differences between the arithmetic means and the medians in tables indicate that the results are positively skewed. High standard deviation (STD). The results showed that the concentrations for the all elements were very high in the sediment, mean concentrations of (Fe, Mn, Cr, Cu and Ni) are higher in soil than in sediment, but the concentrations of (Zn and pb) are lower in soil than in sediment, this may be due to anthropogenic source and gold mining extraction.

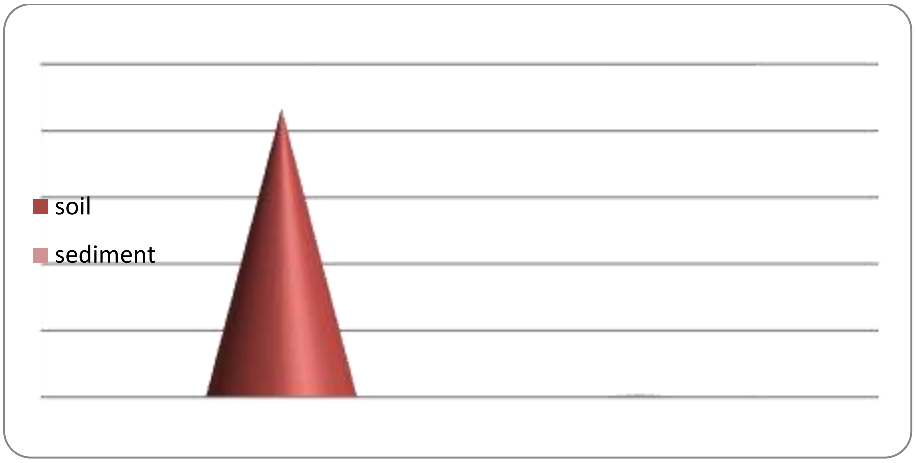


Figure 1: Mean concentration of Fe in soil and sediment samples.

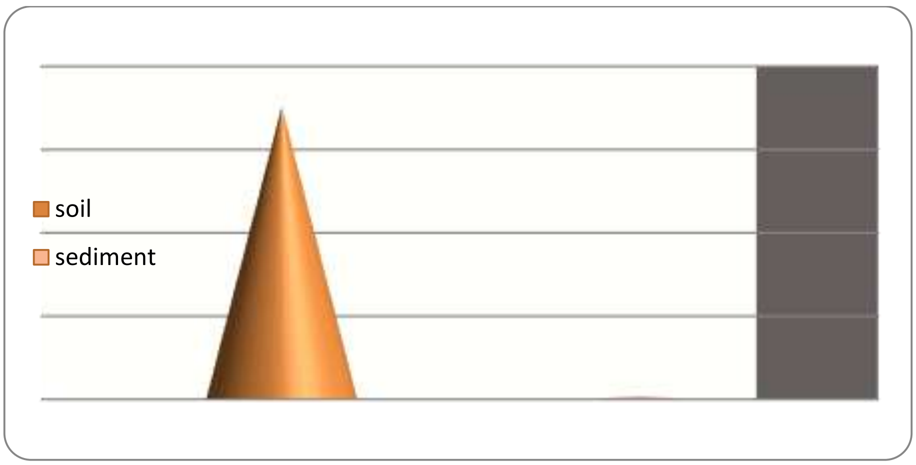


Figure 2: Mean concentration of Mn in soil and sediment samples.

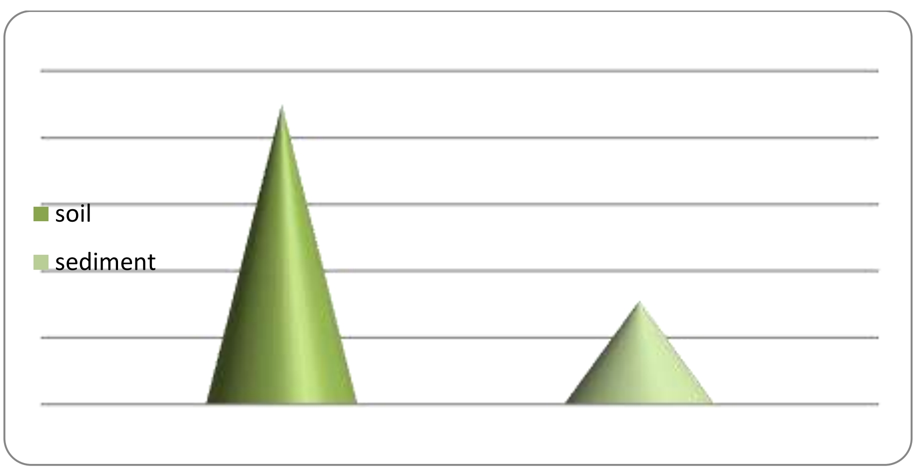


Figure 3: Mean concentration of Cr in soil and sediment samples.

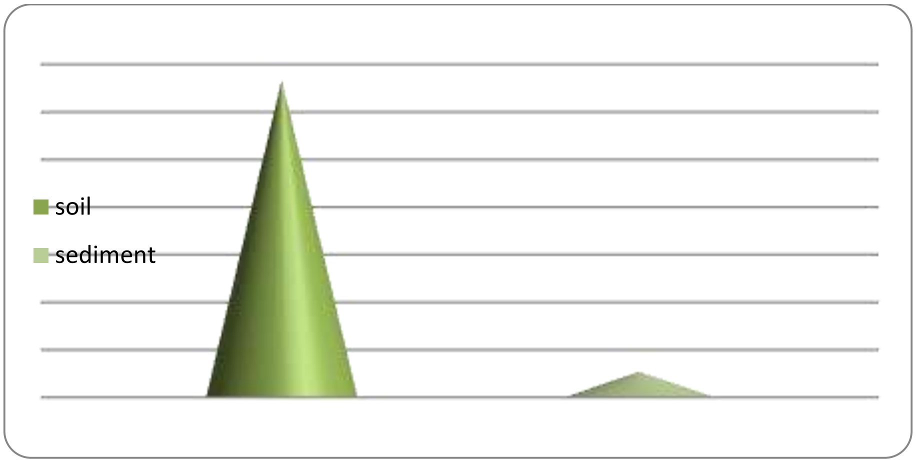


Figure 4: Mean concentration of Ni in soil and sediment samples.

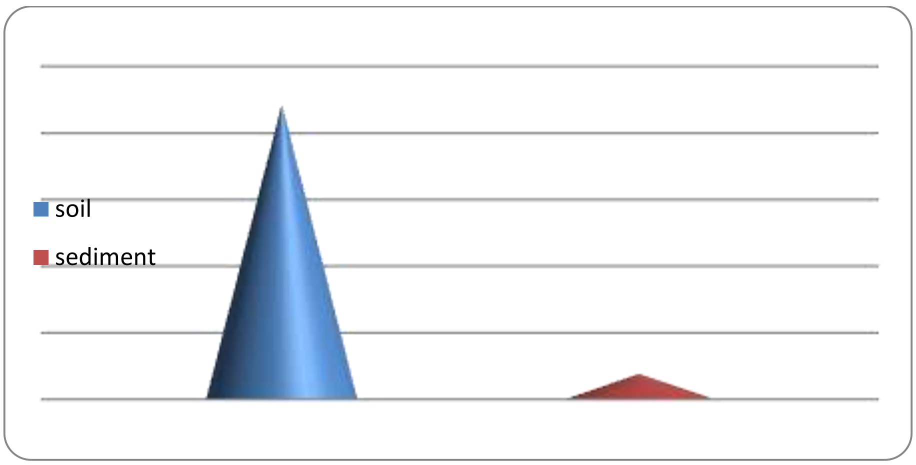


Figure 5: Mean concentration of Cu in soil and sediment samples.

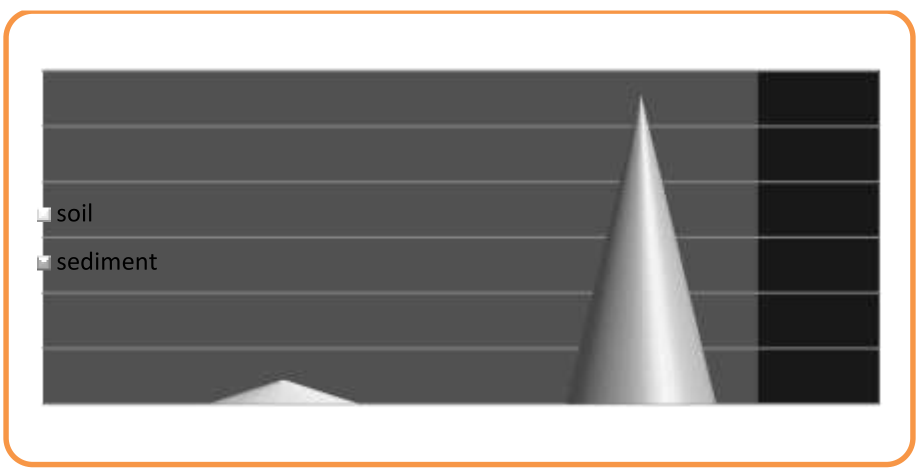


Figure 6: Mean concentration of Pb in soil and sediment samples.

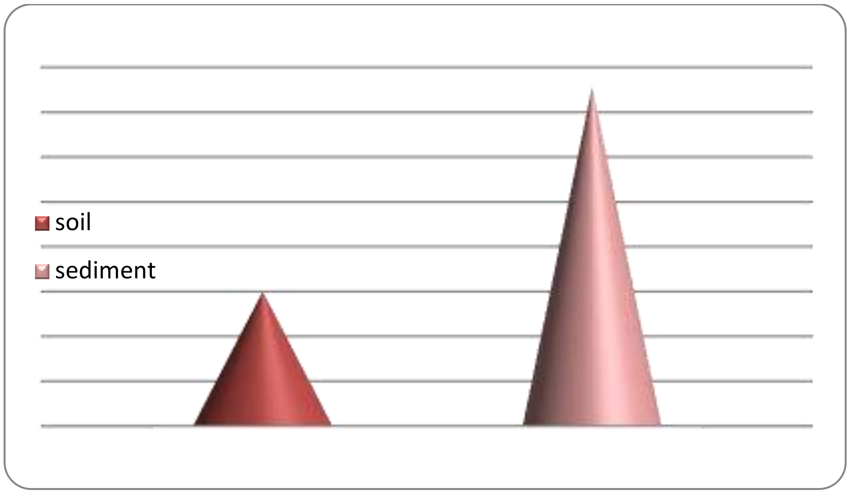


Figure 7: Mean concentration of Zn in soil and sediment samples.

ANOVA ONE WAY

Analysis of Variance (ANOVA) was used to test for significant differences in heavy metal content of the (soil and control samples). One-way ANOVA was used in all cases for mean metal level comparisons at 5% level of significance. From the data set of the composite, the mean value in soil, sediment and control samples and its standard Error have been calculated for each elemental concentration.

Table 2: Mean concentration (±SE.) of heavy metals in the soil and sediment samples (p p m).

No.	Elements	Soil	Sediment	P value
1	Fe	866960±(6713)	65286±(757.72)	0.000
2	Mn	17578±(1584.2)	1600.±(28.1997)	0.000
3	Ni	1333.3±(140. 43)	107.86±(7.54803)	0.000
4	Cr	900.0±(210.81)	311.43±(45.11512)	0.030
5	Cu	4427. 8±(958.19)	3 82.14±(53.85007)	0.002
6	Pb	87.778±(19.98456)	114.30±(421. 69)	0.015
7	Zn	190.00±(27.13137)	212. 86±(32.27223)	0.0414

Significant at; P value < 0.05

Analysis of Variance (ANOVA) was used to test for significant differences in heavy metal content of the (soil and sediment samples). One-way ANOVA was used in all cases for mean metal level comparisons at 5% level of significance. From the data set of the composite, the mean value in soil and sediment samples its standard Error have been calculated for each elemental concentration. The effects of major dominant activities on metallic contents in soil and sediment samples are indicated by one-way ANOVA for the obtained results table (2). ANOVA results showed that all the concentration elements were high significant. The order of occurrence of the metals in the sediment and soil samples in descending trend was as follows: Fe ≤ Mn ≤ Ni < Cu < Pb < Cr < Zn.

Cluster:

Cluster analysis was one of the multivariate analyses used in this study to identify the relatively homogeneous groups of heavy metals. Cluster was applied to the standardized bulk concentration data using Hierarchical cluster analysis dendogram of the sediment samples .In general ,this form cluster is regarded as very efficient ,although it tends to create small cluster fig. (8) The first cluster contained Cu, Cr, Pb and Fe. The second cluster contained Mn, Ni, Zn, Cr and Cu. Cluster three contained Pb, Fe, Cu and Cr .The long distance between the three cluster may suggest that the element of the second and three cluster are mainly natural and anthropogenic source.

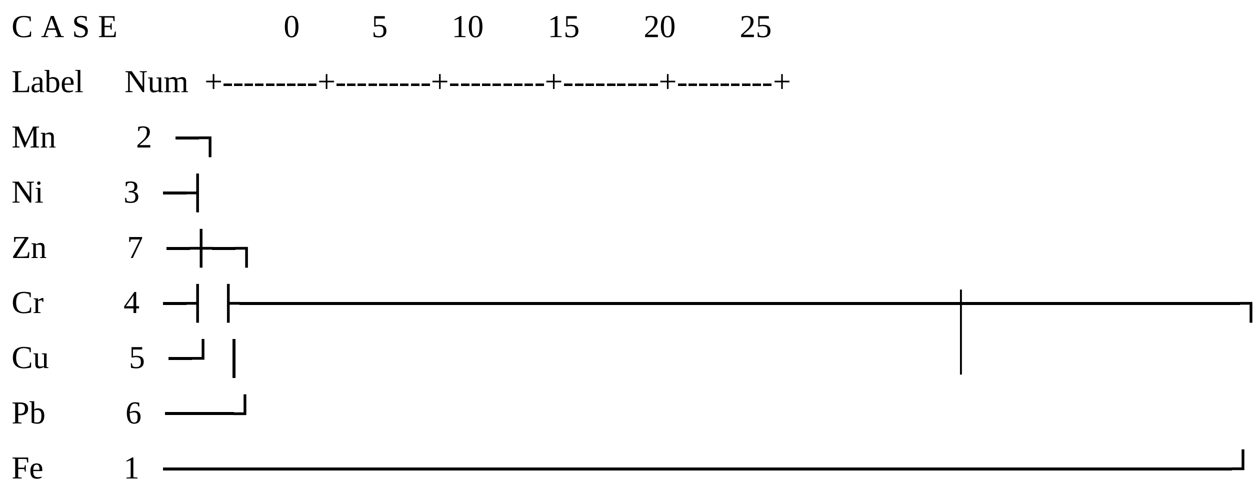


Figure 8: Cluster analysis of heavy metals concentration from sediment mining gold Dendrogram using Average Linkage (Between Groups)

Comparison of Result s of Sediment Analysis with Literature Data:

Table 3: Comparison of mean concentration of heavy metals in sediment in this work with literature data (p p m)

Elements	Cr	Ni	Cu	Zn	Pb	Mn	Fe
Zhang{9}	59.94	25.43	48. 00	139.44	60. 49	-	-
Salah{10}	58. 4	67.08	18.9	48. 00	22. 60	228.18	2249.47
Hu{11}	27	8	20	40	16	108	13000
Olubuni{12}	26.711	2.63	8.75	28.56	0.66	38.92	8144.0
our work	311. 43	107. 86	382.14	212.86	1114.3	160.00	6528.6

When the result of this study were compared with result reported by Zhang et al. {9} and Hu et al. {10} for the Sediment elemental content table {3} higher values concentration for all element in sediment of this study area were absorved, and this attributed to the extraction of heavy metal .In addition the results of this work were compared with results reported by Salah et al. {11} for the sediment elemental content in above table the concentration for the elements was very higher in the work of the study except the concentration of Mn element lower than values of Salah studies. This attributed to the anthropogenic source. In addition, the results of the present study compared with results of the analysis of soil samples from state Nigeria by Olubuni et al. {12} in above table high concentrations of the element Cr, Ni, Cu, Zn, Pb and Mn are observed in site, Iron concentration was much higher in the compared studies.

CONCLUSION:

The results of this study revealed compositions and distributions of heavy metal contaminants in sediment samples collected from traditional gold mining at El abedia barber city Sudan. Fe, Mn, Zn, Cu, Cr ,Ni and pb analyzed in this study by using X-MET5000, X-Ray fluorescence Analysis . The mean concentration of all element were high in the samples The statistical analysis of the results revealed three distinct source groups of elements according to the nature, Urban source from anthropogenic and other elements form natural and anthropogenic source . The results of this study were also compared with literature data.

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