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Heavy Metals Pollution Assessment in Soil of Al-Zubair Area, Southern Iraq

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ABSTRACT

Fourteen soil samples are collected from different stations in Al-Zubair City. The inductively coupled plasma mass spectrometry (ICP-MS) is applied for determination of (Pb, Zn, Ni, Cd, Co, Fe, Cu, Mn, Cr and as) to assess the level of pollution in soil. The grain size analysis indicates that soil of silty sand type with low content of clay. The acidity of the soil is acidic to slightly alkaline in most stations and have low to moderate content of total organic carbon (TOC) and salts (E.C). The mean concentration of heavy metals follows the order: Fe>Mn>Zn>Cr>Ni>Pb>Cu>As>Co>Cd. Based on Igeo and PI value, the results reveal high pollution level for both Cd and Zn especially in Kut Al-Markaz, Al-Faraha and Al-Thoahrat stations, whereas IPI indicates low to moderate levels. On the other hand, EF of heavy metals is in decreasing order: EFCo>EFCd>EFAs>EFPb>EFZn>EFNi>EFCu>EFCr>EFMn. Generally, the pollution of Al-Zubair soil is attributed to the anthropogenic sources like the industrial emission of Al-Shuaiba oil refinery, oil exploration processes, vehicle emissions in the center of city as well as the waste of petrochemical company nearby Al-Zubair City

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تقييم التلوث بالعناصر الثقيلة في تربة منطقة الزبير، جنوبي العراق

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الملخص

جمعت أربعة عشر عينة تربة من محطات مختلفة في مدينة الزبير، واستخدمت تقنية مطياف كتلة البلازما المقترنة بالحث (ICP-MS) لتحليل تراكيز العناصر الثقيلة (Pb, Zn, Ni, Cd, Co, Fe, Cu, Mn, Cr, As) فيها بهدف تحديد مستويات التلوث. أظهرت نتائج التحليل الحجمي لعينات التربة انها من نوع الرمل الغريني ذات المحتوى القليل جدا من الاطيان وهي من النوع الحامضي الى قليل القاعدية في معظم محطات الدراسة وذات محتوى قليل الى متوسط من الكاربون الكلي والاملاح. اتبع معدل تراكيز العناصر الثقيلة الترتيب التالي Fe>Mn>Zn>Cr>Ni>Pb>Cu>As>Co>Cd. واعتمادا على قيم معامل التراكم الجيوكيميائي (Igeo accumulation) ومؤشر التلوث (IP) تبين ان هناك مستويات عالية من التلوث بعنصر الكادميوم (Cd) والزنك (Zn) خصوصا في محطتي كوت المركز والفرهة والظويهرات، بينما أشار معامل التلوث التراكمي (IPI)ان التلوث بصورة عامة كان قليلاً الى متوسط، واتبعت العناصر الترتيب التالي من حيث معامل الاغناء : EFCo>EFCd>EFAs>EFPb>EFZn>EFNi>EFCu>EFCr>EFMn، وهذا ما يؤشر بصورة عامة ان مصادر التلوث الرئيسة في مدينة الزبير بهذه العناصر هي المصادر الصناعية المتمثلة بانبعاثات مصفى الشعيبة النفطي وعمليات التنقيب عن النفط في محيط مدينة الزبير وعوادم السيارات بخاصة في مركز المدينة إضافة الى بعض نفايات شركة البتروكيمياويات قرب المدينة .

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Introduction

With increasing of the industry, there has been a significant increase in industrial waste released into the environment, mostly into the soil, water and air causing heavy metals to accumulate, especially in urban areas. Uncontrolled heavy metal leakage into the land and rivers is a significant environmental problem. They are hazardous and cannot be broken down into non-toxic forms causing a global health issue. The principal causes of pollution in urban environments are population expansion, industrial activity, and cars in large cities. Some indications of environmental urban pollution include top soils, roadside and roadway dusts (Yeung et al., 2003; Sezgin et al., 2004). The accumulation of heavy metals in ecosystems is a global issue. This is because of their hazardous nature, widespread origins, and cumulative effects. Large quantities of heavy and trace metals left to accumulate in soil and water can be toxic to the land, flora and fauna of the sea, disrupting sensitive ecological equilibrium and contaminating food supplies, which could have negative consequences for human health (Hardaway et al., 2004). Metals like copper, nickel, zinc, and manganese are required for soil and plant and have beneficial effects even at low quantities, whereas lead, mercury, and cadmium are non-essential and hazardous even at extremely low concentrations making them possible cofactors in cancer.

Heavy metals found at elevated levels of soil are easily absorbed by humans through inhalation of dust-contaminated air or skin contact (Benhaddya and Hadjel, 2014). High levels of toxic metals have devastating effects on human and animal health including stunted development and growth, damaged organs, blood-forming systems, the cardiovascular, renal, and reproductive systems, harm the neurological system, and even death. In addition, exposure to these metals is associated with deficits in or lowered attention, aberrant behavior (Christoforidis and Stamatis, 2009). Anthropogenic sources of such metal could be found, such as the combustion of gasoline, diesel, and coal, as well as industrial operations (Loredo et al., 2003; Manasreh, 2010), together with the natural geochemical processes, such as weathering, can all contribute to the presence of heavy metals in soil. The study aims to assesst soil pollution of Al-Zubair area after using different pollution indices.

Methodology

Study Area

It is located in Al- Zubair district, between latitudes (30° 20'-30° 24' N) and a longitude (47° 40’-47° 44’ E) at the southwestern part of Basrah Governorate, with an area about 1134 km²; it is surrounded by many oil and gas fields, Al-Shuaiba oil refinery, State Company for Petrochemical Industry and Fertilizer factory plants (Fig. 1) (Municipality of Zubair Directorate, 2015).

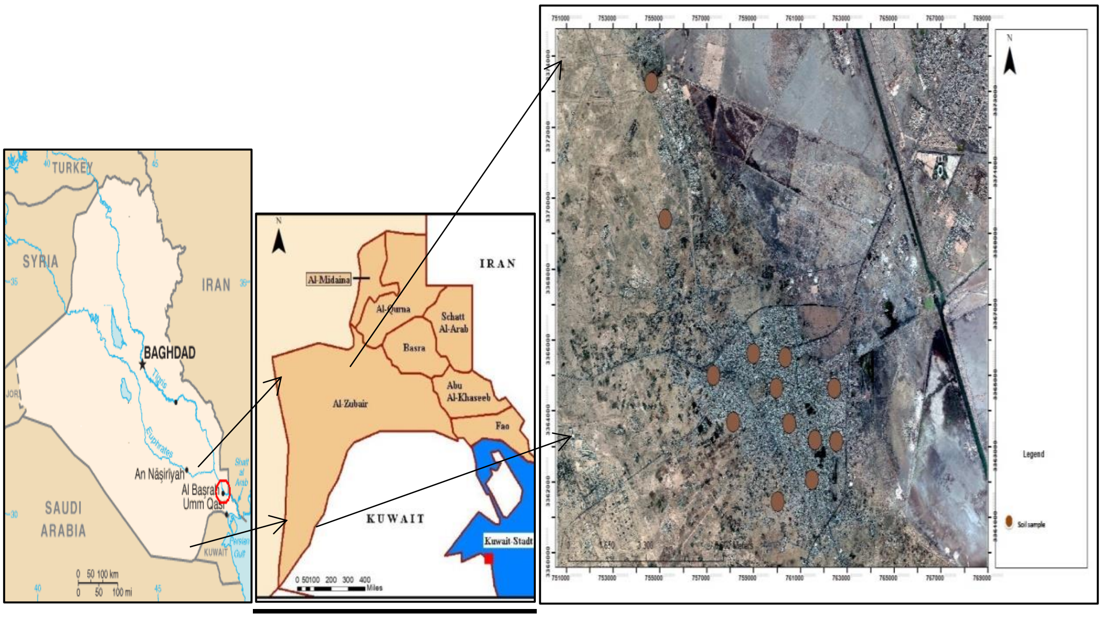

Fig. 1. Sample locations in studied area

Sampling and Sample Preparation

Soil samples (depth 0-20 cm) were taken from fourteen stations, namly (Al-Jumhuria Al-awlaa, Mahlat Al-Arab Al-awlaa, Kut Al-Markaz, Al-Drahmia, Al-Faraha and Al-Thoahrat, Al-Ameer, Mazraea (Kazem Al-Saraifi), Hay Al-Askary, Near Al-Al-Shuaiba Refinery, near Main Waste Area, Al-Hussain, Al-Shuaiba Houses, Al-Thobat and AL-Shuhdaa) (Fig. 1). The samples are cllected by hand shovel from the areas inside AL-Zubair City including green space, open space, traffic roadsides, industrial area and the area near solid waste.

Physiochemical Properties:

Measurements of physiochemical properties such as pH, EC, and TOC were conducted at Chemistry Department at Marine Science Center, University of Basrah. Ec and pH of soil were measured according to Mclean method ((1982). The absolute amounts of total organic carbon (TOC) were measured using Walkey and Black's method (1934) at the Geology Department of the University of Basrah. Eleven soil samples were selected to sieve for determining the particle size distributions. The Pipette method (Folk, 1974) is used to calculate the silt and clay content in soil, heavy metals were measured using an Agilent 7700 ICP-MS technique. Panalytical PW3830 X-ray diffraction analysis is also used to identify the clay and non-clay minerals in soil of at the laboratories of Iran University.

Pollution Assessment

1. Pollution Index (PI) and Integrated pollution index (IPI):

Both PI and IPI are broad indicators for pollution (Faiz et al., 2009). The PI is determined using the equation: PI =Cn/Bn ……. (1)

where Cn is the concentration of the analyzed element, and Bn shows the geochemical background.

For the first equation, both Cn and Bn were defined according to (Kabata-Pendias, 2011) (Table 1).

Table 1: The classification of indices (Faiz et al., 2009).

Indices	Category	Description
(PI)	**PI ≤ 1**	**Low pollution**
	1 <PI ≤ 3	Medium pollution
	PI> 3	High pollution
(IPI)	IPI ≤ 1	Low level of pollution
	1 <IPI ≤2	Medium level of pollution
	>2IPI ≤ 5	High level of pollution
	IPI> 5	Extreme high level of pollution
	Ef < 1	No enrichment
	1≤EF<2	Deficiency to minimal enrichment
	2≤EF<5	Moderate enrichment
	5≤EF<20	Significant enrichment
	20≤EF <40	Very high enrichment
	≤ 40	Extremely high enrichment
(I_{geo})	$I_{geo} \leq 0$	Practically unpolluted
	$0 < I_{geo} \leq 1$	Unpolluted to moderately polluted
	$1< I_{geo} \leq 2$	Moderately polluted
	$2 < I_{geo} \leq 3$	Moderately to heavily polluted
	$3 < I_{geo} \leq 4$	Heavily polluted
	$4 < I_{geo} \leq 5$	Heavily to extremely polluted
	5 <	Igeo Extremely polluted

2. Geo-accumulation index:

The geoaccumulation index (Igeo) is a good method to evaluate the pollution developed by Muller (1969) following equation.

Igeo = Log2 (Cn/1.5 Bn) ………. (2)

Where Cn is the measured concentration of the investigated metal in the soil and Bn is the metal's geochemical background concentration or reference value as determined by Kabata-Pendias (2011). Factor 1.5 is used because natural variation and human activity can both affect the baseline concentration of a given metal, requiring adjustment.

3. Enrichment Factor (EF):

Metal pollution and its effect on the environment can be gauged by looking at the enrichment ratio (EF). When comparing the levels of contamination in various environmental media, EF is a useful tool because of its universal formula (Benhaddya and Hadjel, 2013). In order to evaluate metal concentration, the EF, a normalization approach established by Simex and Helz (1981), is used. The ratio of metal concentration to another soil component is normalized (Rubio et al., 2000).

$$\boldsymbol{EF} = \frac{(\mathbf{CM/CFe})\mathbf{Sample}}{(\mathbf{CM/CFe})\ \mathbf{Earth\ ,s\ crust}} \ldots\ldots\ldots \ (3)$$

Where (CM/CFe) is the ratio of the amount element of concern (CM) to the amount of Fe (CFe) in the soil sample (ppm), and (CM/CFe) is the same ratio in an unpolluted reference sample (Kapata and Pandis, 2011). The classification of enrichment factor is applied according to Jiao et al. (2015).

Results and Discussion

1. Physiochemical properties and grain size analysis

The soil's acidity plays an important role to capture elements from the surface (Appel et al., 2002). Acidic conditions make many heavy metals more mobile allowing them to travel with the water through the sediments. In alkaline environment, heavy metals deposited as oxides, hydroxides, phosphates, and carbonates phases (Al-Khafaji and Jalal, 2020). The pH was high at AL-Shuhdaa station and the lowest value was at Hay Al-Askary station. Al-Shuaiba station had the lowest value of TOC (0.21%), while the industrial sector station around Al-Shuaiba Refinery had the highest value due to the oil spill near the refinery. Soil moisture content influenced the electrical conductivity (EC) of the soil. Soil particle size and texture are so closely correlated with EC (Crisso et al., 2005). The salinity (EC) level in Al-Shuaiba station is extremely high (52.8 ms/cm). Because the dissolved salt in water, urban areas tend to have higher salinity than rural regions, which may be a result of industrial activities like irrigation of land. Grain size analysis show that the soil is comprised of silty sand with low content of soil. The comparison between the results of the study area and the world soil background (Kabata-Pendias, 2011), and the world soil background (Rudnick et al., 2003) is shown in Tables (2,3).

2. Mineralogy

The X-ray diffraction patterns of bulk soil samples shows that quartz and calcite are the dominated non-clay minerals (Fig. 2a). The most common clay mineral is mixed layer montmorillonite-chlorite followed by illite, palygorskite, kaolinite, and chlorite (Fig. 2b). Clay minerals (hydrous aluminosilicates) can be found as colloidal form in almost types of soil, sediments, rocks. Clay is able to absorb cations and anions through ion exchange or adsorption, so clay minerals serve as a natural scavenger of contaminants in the environment (Yuan et al., 2013). All tests show that clay dosage is correlated positively with the adsorption rate (Liu et al., 2010). It is clear from the majority of researches that even a very low concentration of clay minerals can remove significant amounts of heavy metals from contaminated media.

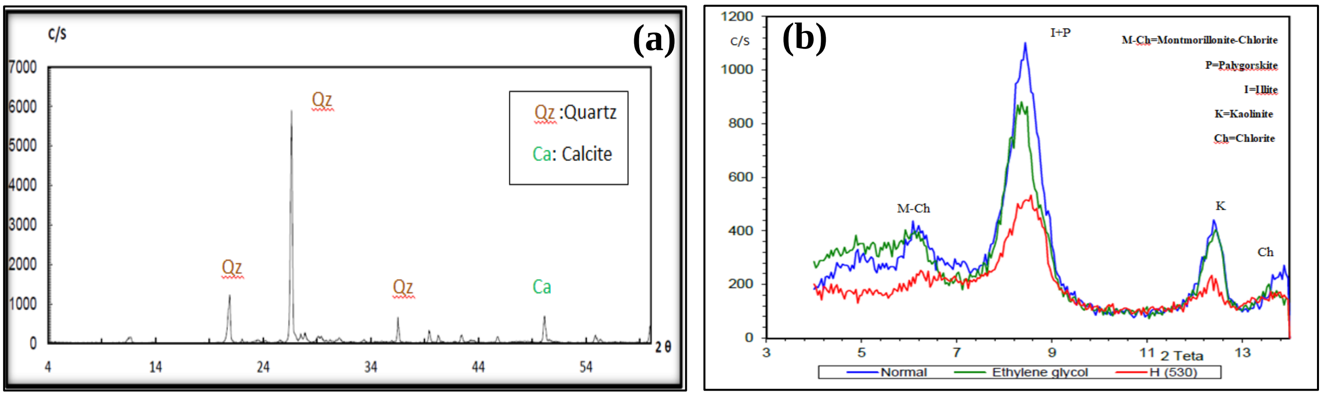

Fig. 2. XRD pattern of bulk soil samples near Al-Shuaiba Refinery for (a) non clay minerals and (b) clay minerals for Mazraea (Kazem Al-Saraifi) sample

3. Heavy metals

The mean levels of arsenic, cadmium, nickel, lead, and zinc are above a global geochemical background levels for soils (Kabata-Pendias, 2011) (Table 2). In general, the means of Cr, Co, Fe, Mn, and Cu are lower than normal value. Due to the increase of human activity, there is high concentrations of heavy metals in soil effected by industrial waste, vehicle emission, oil and gas exploration around Al-Zubair City. This indicates the discrete inputs from anthropogenic activities, which had a significant impact on soils, especially vehicles and industrial emissions, fossil, garages, metal workshops and waste dumps. The mean concentrations of Pb in soil of study are lower in comparison with the previous studies in Iraq and International Soil (Table 4). The mean of Zn is higher than its concentration reported in some International Soil, but have lower content in comparison to Jeddah City, Saudi Arabia, Hong Kong, and at Highway among Basra-Nasiriya and Samawa (Al-Khafaji and Al-Saleh, 2018), southern Iraq (Table 4). The mean of Co and Cr are lower than in previous studies. Generally, every region has a distinctive heavy metal signature depending on the industrial activity density, used technology, regional weather, and wind patterns.

Pollution Evaluation

1. Evaluation of Geo-accumulation index (Igeo)

According to Igeo values (Table 5), the pollution levels of Cd in all stations are higher than the other metals. Cd falls in unpolluted to moderately polluted' except in Kut Al-Markaz station (center of the city), which fall in moderately to heavily polluted. Other elements fall into the category of practically unpolluted. Zn is practically unpolluted, except in Al-Faraha and Al-Thoahrat stations. Generally, the Igeo of the heavy metals have the order: Cd >As>Ni>Pb>Zn>Fe>Cu>Cr>Mn>Co, suggesting that the main causes of pollution is human activities such as industrialization, urbanization, urban and industrial wastes, and car emissions.

Table 2: Physiochemical properties and heavy metals concentration (ppm) in study soils

Sampling stations	PH	EC (ms/cm)	TOC%	Pb	Zn	Ni	Fe	Mn	Cu	Co	Cd	Cr	As	Site description
Al-Jumhuria Al-awlaa	7.15	4.39	4.4	23	62	28	9352	153	17	0.2	0.2	35	5	Near houses
Mahlat Al-Arab Al-awlaa	8.04	9.65	5.04	26	59	13	6318	115	11	0.4	0.4	22	2	Open space
Kut Al-Markaz	7.26	1.58	6.54	27	152	41	14929	200	22	0.7	0.7	55	5	Near Houses
Al-Drahmia	7.95	7.83	5.58	17	43	15	7400	108	48	0.1	0.1	20	4	Park
Al-Faraha and Al-Thoahrat	7.86	3.34	3.43	22	453	22	7231	102	9	0.2	0.2	28	1	Near Houses
Al-Ameer	7.87	13.28	6.44	27	101	27	9484	297	44	0.3	0.3	34	3	Roadside
Mazraea(Khazim Al-Saraifi)	7.74	19.72	7.51	12	12	46	13340	242	11	0.3	0.3	99	4	Mazraea
Hay Al-Askary	6.46	9.25	8.79	14	24	13	8721	99	10	0.4	0.4	26	2	Roadside
Near Al-Al-Shuaiba Refinery	8.01	19.15	13	31	11	19	6167	226	8	0.4	0.2	21	2	Near Al-Shuaiba Refinry
Main Waste Area	8.14	3.52	5.47	10	13	29	8521	165	9	0.2	0.4	37	1	Near Waste Area
Al-Hussain	7.81	3.85	4.29	14	34	21	7732	119	12	0.3	0.5	33	1	Roadside
Al-Shuaiba Houses	8.41	52.8	0.21	15	27	16	5244	89	14	0.4	0.2	17	3	Shuaiba Houses
Al-Thobat	8.2	2.61	4.83	14	35	14	7635	90	16	0.2	0.3	26	2	Near school
AL-Shuhdaa	8.83	2.77	3.54	14	41	21	7465	116	14	0.1	0.3	30	3	Near houses
Min	6.46	1.58	0.21	10	11	13	5244	89	8	0.1	0.1	17	1	
Max	8.83	52.8	13	31	453	46	14929	297	48	0.7	0.7	99	5	
Mean	7.8	10.9	5.6	19	76.2	23.21	8538.5	151.5	17.5	0.3	0.32	34.5	2.71	
World soil background [a]	-	-	-	15	70	20	35000	900	55	10	0.1	100	1.8	
Upper crust content_ [b]	-	-	-	17	67	47	-	-	28	17.3	0.09	92	4.8	

a= Kabata-Pendias (2011), b= Rudnick et al. (2003)

Table 3: Grain size analysis of soils

No.	Sampling station	Sand %	Silt %	Clay %	Textural Class (Folk,1974)
1.	Al-Jumhuria Al-awlaa	91	5	4	Silty sand
2.	Mahlat Al-Arab Al-awlaa	79	10	11	Clayey Silty sand
3.	Kut Al-Markaz	78	12	10	Silty sand
4.	Al-Mualmin and Al-Baldia	94	4	2	Sand
5.	Al-Drahmia	95	3	2	Sand
6.	Al-Faraha and Al-Thoahrat	90	6	4	Silty sand
7.	Al-Ameer	74	14	12	Silty sand
8.	Mazraea (Kazhim Al-Saraifi)	77	18	5	Silty sand
9.	Hay Al-Askary	85	10	5	Silty sand
10.	Near Al-Shuaiba Refinery	61	25	14	Silty sand
11.	Main Waste Area	75	15	10	Silty sand

Table 4: Comparison the mean of heavy metals concentrations (ppm) in Al-Zubair soil with soil of Basrah and other local and world soil

Location	Pb	Zn	Ni	Fe	Mn	Co	Cd	Cu	Cr	As	References
International Soil	15	70	20	35000	900	10	0.1	55	100	1.8	Kabata-Pendias.2011
Basra city	41.5-97.4	-	70.9-152.1	4694-5130.0	-	54.3-64.9	-	36.4-49.5	-	-	Al-Hassan,2011
Australia (Sydney estuar)	194	187	13	-	-	6	0.4	-	19	-	Birch et al. (2011)
Iraq (Kirkuk)	9	-	52.5	-	-	-	13.3	-	71.2	-	Al-Dabbas et al. (2015b)
Poland (Gdańsk)	11	4.9	1.1	-	-	-	0.080	3	-	-	Jarzyńska and Falandysz (2012)
Basra city	31.4	71.96	131.4	24392.94	443	6.35	0.23	47.22	488.18	9.32	Al-Khafaji and Jalal, (2020)
China (Ju country (Eastern China)	28.40	65.81	29.36	-	-	13.26	0.13	-	68.28	-	Lv et al. (2015)
Highway between Basra-Nasiriya and Samawa	177.28-28.164	12612-89.338	266.59-67.664	38626.314-5723.752	-	89.68-4.494	9.39-6.21	189.64-34.984	535.69-84.454	14.316-2.982	Al-Khafaja and Al Saleh (2018)
Eskisehir, Turkey	64.93	31.50	161.53	19149.72	395.16	-	1.28	39.33	97.65	-	Malkoc et al. (2010)
Hong Kong	88.10	103.00	3.65	-	-	-	0.33	10.40	16.80	-	Lee CS et al. (2006)
Jeddah City, Saudi Arabia	52.60	91	33.10	-	-		-	-	57	-	Kadi (2009)
Al-Zubair city	19	76.2142	23.2142	8538.5	151.5	0.3	0.3214	17.5	34.5	2.7142	This study

Table 5: Pollution level of Al-Zubair soil

Elements	Range of Igeo	Mean of Igeo	Pollution level according to Igeo (Muller 1969)
Pb	-0.0324~0.4623	-0.32913	Practically unpolluted'
Ni	-1.2064~0.6166	-0.48486	Practically unpolluted'
Mn	-3.9230~-2.1844	-3.26707	Practically unpolluted'
Fe	0.0998~0.2843	-2.67681	Practically unpolluted'
Cu	-3.3663~-0.7813	-2.48264	Practically unpolluted'
Cr	0.1133~0.66	-2.28185	Practically unpolluted'
Co	-7.2288~-4.4214	-5.83152	Practically unpolluted'
Cd	-0.5849~2.2223	0.948547	Unpolluted to moderately polluted' except in Kut Al-Markaz fall in moderately to heavily polluted
As	-1.4329~0.8889	-0.19019	Practically unpolluted'
Zn	-3.2548~2.1091	-1.31056	Practically unpolluted' except in Al-Faraha and Al-Thoahrat fall in moderately to heavily polluted

2. Enrichment Factor (EF)

EF is employed to speculate on whether or not heavy metals have a lithogeny or anthropogenic origin because it is a handy measure of geochemical trends; (Sutherland 2000; Ye et al. 2011). The extreme values, as well as the mean of EF are shown in (Table 6) the maximum value of Pb was recorded Near Al-Shuaiba Refinery (11.729ppm) while the minimum at Mazraea(Khazim Al-Saraifi) station (2.098ppm), the significant enrichment of Pb in the most stations indicate anthropogenic sources (Table 6,Fig 3).Zn have moderate enrichment except in Al-Faraha and Al-Thoahrat station which have very high enrichment of Zn. Whereas Mn, Cu and Cr have minimal enrichment. The EF value of Co was very high Near Al-Al-Shuaiba Refinery and have extremely high enrichment in the most station. The enrichment factor of metals in study area have the order: EFCo>EFCd>EFAs>EFPb>EFZn>EFNi>EFCu>EFCr>EFMn in the most stations the Co, Zn, Cd, Pb and As have higher enrichment in comparison to natural soil, the classification of enrichment factor according to (Jiao et al.,2015) and have high EF confirming an important role of anthropogenic sources of pollution, such as the vehicle emissions incineration of waste, in addition to the pollutants of power stations, the emissions of Al-Shuaiba oil refinery and petrochemical company around Al-Zubair city.

Table 6: Enrichment factor values of heavy metals in the soil.

Station	Pb	Zn	Ni	Mn	Cu	Cr	Co	Cd
Al-Jumhuria Al-awlaa	5.738	3.314	5.239	0.636	1.156	1.309	41.176	7.485
Mahlat Al-Arab Al-awlaa	9.602	4.669	3.600	0.707	1.107	1.218	127.272	22.158
Kut Al-Markaz	4.219	5.090	4.806	0.520	0.937	1.289	111.363	16.411
Al-Drahmia	5.360	2.905	3.547	0.567	4.127	0.945	7.291	4.729
Al-Faraha and Al-Thoahrat	7.099	31.323	5.324	0.548	0.792	1.355	77.777	9.680
Al-Ameer	6.642	5.324	4.982	1.217	2.952	1.254	23.863	11.071
Mazraea(Khazim Al-Saraifi)	2.098	0.449	6.034	0.705	0.524	2.597	95.454	7.871
Hay Al-Askary	3.745	1.375	2.608	0.441	0.729	1.043	140	16.053
Near Al-Al-Shuaiba Refinery	11.729	0.891	5.391	1.425	0.825	1.191	175	11.350
Main Waste Area	2.738	0.762	5.955	0.753	0.672	1.519	77.777	16.43
Al-Hussain	4.224	2.198	4.752	0.598	0.987	1.493	87.5	22.633
Al-Shuaiba Houses	6.674	2.574	5.339	0.660	1.698	1.134	100	13.348
Al-Thobat	4.278	2.292	3.208	0.458	1.333	1.191	43.75	13.752
AL-Shuhdaa	4.375	2.746	4.922	0.604	1.193	1.406	25	14.065
Min	2.098	0.449	2.608	0.441	0.524	0.945	7.291	4.729
Max	11.729	31.323	6.034	1.425	4.127	2.597	175	22.633
Mean	5.609	4.708	4.693	0.703	1.360	1.353	80.944	13.360

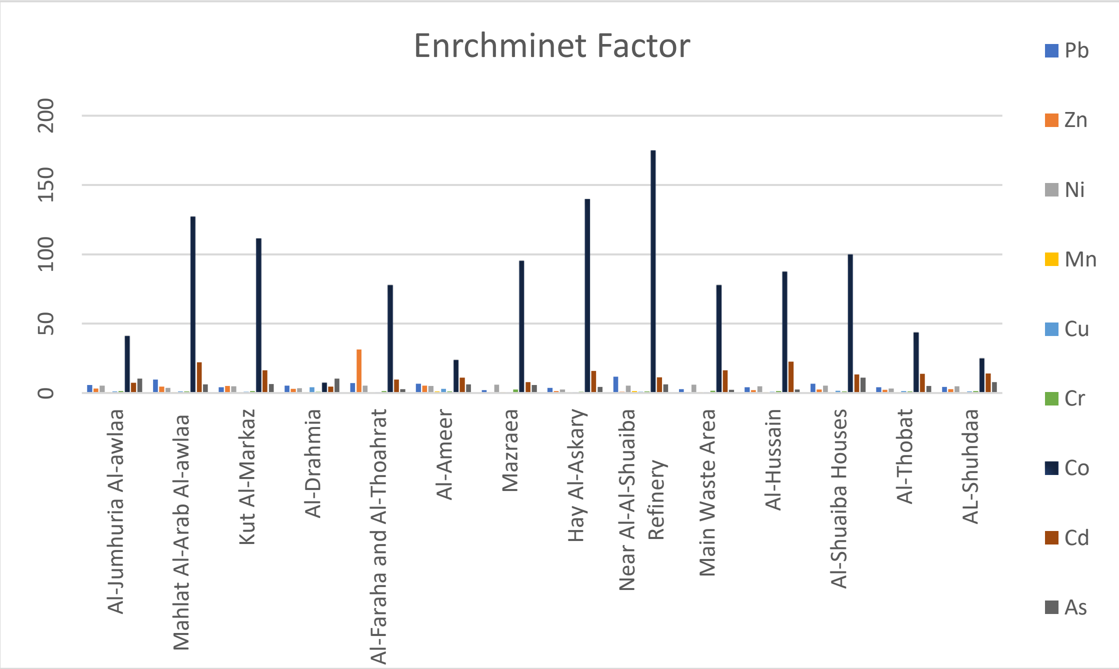

Fig.3 Enrichment factor histogram

3. Pollution Index and Integrated pollution index of heavy metals (PI, IPI)

The data of PI exhibited that Mn, Fe, Cu, Cr and Co have lower values of PI, while Pb, Ni, and **as** have medium pollution indices. Zn and Cd have highly pollution indices (Table 7) (Fig. 4). Therefore, the soils in these locations may have been extensively impacted by traffic and industrial sources. The results show that: Kut Al-Markaz**,** Al-Faraha and Al-Thoahrat stations have medium to high values of IPI (Table 7). Therefore, the soil in these locations may have been extensively impacted by increase of traffic gases released from nearby Al-Zubair oil fields in addition to the effect of Al-Shuaiba refinery.

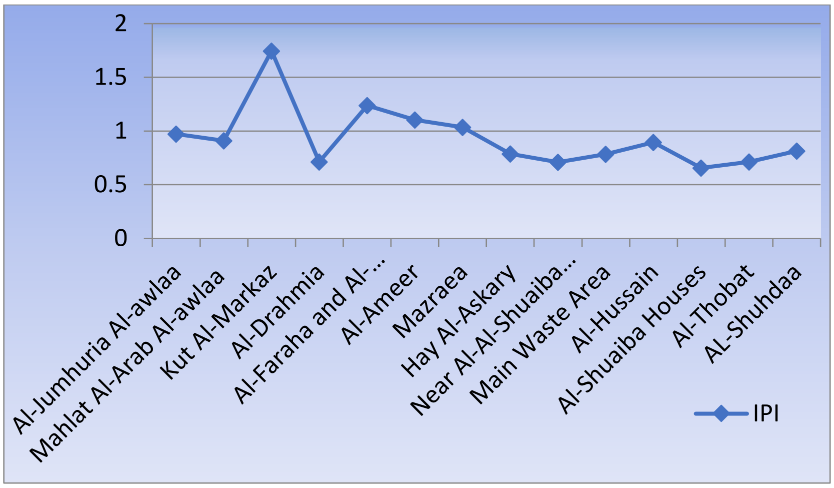

Fig.4. Integrated pollution index (IPI) of heavy metals in the soils

Table 7: Pollution index (PI) and integrated pollution index (IPI) of heavy metals in soils

Heavy metals / Sampling station	PI										IPI
	Pb	**Zn**	**Ni**	**Mn**	**Fe**	**Cu**	**Cr**	**Co**	**Cd**	**As**	
Al-Jumhuria Al-awlaa	1.533	0.885	1.4	0.17	0.267	0.309	0.35	0.02	2	2.777	0.971
Mahlat Al-Arab Al-awlaa	1.733	0.842	0.65	0.127	0.180	0.2	0.22	0.04	4	1.111	0.910
Kut Al-Markaz	1.8	2.171	2.05	0.222	0.426	0.4	0.55	0.07	7	2.777	1.746
Al-Drahmia	1.133	0.614	0.75	0.12	0.211	0.872	0.2	0.01	1	2.222	0.713
Al-Faraha and Al-Thoahrat	1.466	6.471	1.1	0.113	0.206	0.163	0.28	0.02	2	0.555	1.237
Al-Ameer	1.8	1.442	1.35	0.33	0.270	0.8	0.34	0.03	3	1.666	1.103
Mazraea (Khazim Al-Saraifi)	0.8	0.171	2.3	0.268	0.381	0.2	0.99	0.03	3	2.222	1.036
Hay Al-Askary	0.933	0.342	0.65	0.11	0.249	0.181	0.26	0.04	4	1.111	0.787
Near Al-Al-Shuaiba Refinery	2.066	0.157	0.95	0.251	0.176	0.145	0.21	0.04	2	1.111	0.710
Main Waste Area	0.666	0.185	1.45	0.183	0.243	0.163	0.37	0.02	4	0.555	0.783
Al-Hussain	0.933	0.485	1.05	0.132	0.220	0.218	0.33	0.03	5	0.555	0.895
Al-Shuaiba Houses	1	0.385	0.8	0.098	0.149	0.254	0.17	0.04	2	1.666	0.656
Al-Thobat	0.933	0.5	0.7	0.1	0.218	0.290	0.26	0.02	3	1.111	0.713
AL-Shuhdaa	0.933	0.585	1.05	0.128	0.213	0.254	0.3	0.01	3	1.666	0.814
Min	0.666	0.157	0.65	0.098	0.149	0.145	0.17	0.01	1	0.555	0.656
Max	2.066	6.471	2.3	0.33	0.426	0.872	0.99	0.07	7	2.777	1.746
Mean	1.266	1.088	1.160	0.168	0.243	0.318	0.345	0.03	3.21	1.507	0.934

Conclusions

The present study is carried out to assess the pollution levels of heavy metals in the soils of Al-Zubair City, southern Iraq. The study concludes that soil in most stations are of acidic to slightly alkaline with low to moderate content of TOC and salts. The mean concentrations of heavy metals are in the order of Fe>Mn>Zn>Cr>Ni>Pb>Cu>As>Co>Cd. Soil quality assessment using Igeo, EF, PI and IPI indices. Igeo indicates particularly polluted soils by Pb, Ni, Mn, Fe, Cu, Cr and as for the most stations, but unpolluted-moderately to heavily polluted soils by Cd and Zn are that in Kut Al-Markaz and Al-Farha station at the center of city. The EF range is from moderate to significant enrichment for most heavy metals and extremely enrichment for Co which vehicle emissions. Also, IPI results indicate the medium to low pollutions for most samples, so the main sources of pollution of soil in study area are the anthropogenic sources like oil refinery, petrochemical industry, vehicle emissions and fertilizer factory.

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