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A study on The Level of Environmental Pollution by Heavy Metals in The City of Sebha-Libya

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Abstract: The concentration of a number of heavy metals Lead, Cadmium, Zinc, Copper, Cobalt, Nickel and Iron was studied in the recent deposits of Sebha city. It was found that the concentration were below the pollution level and the concentration falls within the range of the natural concentrations of similar sediments in the different areas of the world. The concentration rates were as follows: Pb 10.06 ppm, Cd 0.09 ppm, Zn 1.88 ppm, Cu 0.79 ppm, Co 0.64 ppm, Ni 1.03 ppm and Fe 384.55 ppm. The results also indicated that the high concentrations of Pb, Zn, and Fe at the edge of the roads and the decrease with depth might be reflected the role of the different means of transportation represented by hydrocarbon's exhausts in the concentration of these elements.

1. Introduction

Environmental problems have worsened significantly in the past two decades, due to the random use of natural resources by man and the entry of countries into the area of heavy industries and intensive production. The heavy elements are included in the damage to the ecosystem environmental problem of its natural characteristics, as they are included in various industrial fields. The movement of these elements and their transfer to other areas, such as their transfer from the lithosphere to the hydrosphere or atmosphere, had a negative impact on people. The engines of various means of transportation and the hydrocarbon's exhausts are among the important sources that affect the environment, as they are the main source of toxic carbon monoxide and some elements with a toxic effect such as Lead and Cadmium,(1).

The aim of this study is to know the level of concentration of heavy elements represented by Lead, Calcium, Zinc, Copper, Cobalt, Nickel, and Iron in the recent sediments of Sebha city located southern Libya(Fig. 1), and the extent of the possibility of sediments contamination with these elements and their relationship to various means of transportation, organic materials and the type of sediments.

Figure 1: A map of Libya showing the location of the studied areas

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2. Samples preparation for test

In this study, 33 samples of fresh surface sediment were collected from the city of Sabah. The samples were taken from different depths 0-2 cm, 2-5 cm, and 5 – 10 cm, in addition to other mixed samples taken from 0-10 cm depth. Most of the samples were collected from two pathways on some of the main roads in the city, namely, Al mahdya pathway (in the middle of the area) and Al thanawya pathway (near the College of Science). They were collected at 5 m, 10 m, 20 m, 40 m, and 50 m distances from the edge of the road. They dried at laboratory temperature, then sieved them with a 2 mm sieve and separated the impurities from them.

The samples were treated with inorganic acids (HF, HCl, HNO_3), then analyzed by a Perkin-Elmer Model 283 AAS atomic absorption device, then the organic matter was estimated in three replicates by Page method (2),

The simple correlation between the concentrations of different elements and organic matter was studied.

3. The Results

3.1 - Geology of the area

The study was carried out within the city of Sebha on the sediments covered by the Misak Formation, specifically the Jurassic Germa member (3). The rocks of this formation consist mainly of a succession of sandy, silty and clayey rocks. Recent sediments formed partly by the erosion of rocks and the other part of them was moving by the sediments during the process of urban expansion and it covers most of the sides of the main and secondary roads in Sebha region.

3.2 - Geochemistry

3.2.1- Lead (Pb)

The concentration of lead in the city of Sabha ranged between 0.93ppm - 153.3ppm, with an average 10.06 ppm (Table -1). The highest value was in the Al thanawya area and the lowest value was in Al-jadeed area. At Al mahdya pathway the average concentration rate was 5.05 ppm; however, at Al thanawya pathway was 7.29 ppm (the concentration in sample17 of 153.3 ppm was excluded)..

3.2.2- Cadmium (Cd)

Cadmium concentration ranged between 0.01-0.29 ppm at a rate of 0.09 ppm, the highest value was in the sample 27 at Al hajarah area, and the lowest was in the Al mahdya pathway and Al thanawya areas (samples 6 & 29). At Al mahdya pathway, the rate of concentration was 0.05 ppm, whereas the concentration rate was 0.1ppm at Al thanawya pathway.

3.2.3- Zinc (Zn)

The concentrations of zinc in Sebha city ranged between 0.73-7.65 ppm, with an average of 1.88 ppm, and the highest value of zinc was in the sample No. 20 in Soukra area and, the lowest value was in Al mahdya pathway (sample 5). The average concentration was 1.42 ppm at Al mahdya pathway and 1.68 ppm at Al thanawya pathway.

3.2.4- Copper (Cu)

Copper concentrations in the city of Sebha ranged between 0.34-3.17 ppm, with an average of 0.79 ppm. The highest value was in the city of Soukra (sample 20) and the lowest value with sample 27 at Al hajarah area, 10 meters from the public road. The average concentration was 0.57 ppm at Al mahdya pathway and 0.61 ppm in Al thanawya pathway.

3.2.5- Cobalt (Co)

Cobalt concentrations ranged between 0.06 -1.34 ppm with an average of 0.64 ppm, the highest value was at Al thanawya pathway 10 meters from the main road (mixed sample 18), and the lowest value was at Abdulkafee area, 10 meters from the public road (sample 30). The samples from Al mahdya pathway had an average concentration of 0.36 ppm and Al thanawya pathway had 0.71 ppm.

3.2.6- Nikel (Ni)

Nikel concentrations in the city of Sebha ranged between 0.1-2.26 ppm, with an average of 1.03 ppm, and the highest value was at Al thanawya pathway 20 meters from the public road (sample 16) .The lowest concentration in the sample 29 south of Al thanawya pathway. The average concentration at Al mahdya pathway was 0.85 ppm and Al thanawya pathway was 0.99 ppm.

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3.2.7- Iron (Fe)

Iron concentrations in the city ranged between 107.43 - 1257.3 ppm. with an average concentration of 384.55 ppm. The highest value was at Al thanawya path at a distance of 10 meters from the main road and at a depth of 10 cm (sample 15), whereas the lowest value was in the sample 29 at the Al thanawya pathway. The average concentration at Al Mahdya pathway was 271.24 ppm, and at the Al thanawya pathway was 424.70 ppm.

4. Discussion

The average concentrations of the studied elements in Sebha city were ; 10.06 ppm Lead, 0.09 ppm Cadmium , 1.88 ppm Zinc, 0.79 ppm Copper, 0.64 ppm Cobalt, 1.03 ppm Nickel and, 384.55 ppm Iron (Table 1). When comparing the concentrations of the studied areas with similar studies in different areas of the world as shown in Table 2, they indicated that there was no contamination by the studied elements in the city of Sebha.

The differences in the concentrations of all studied elements and the increase in concentrations at the edges of the roads of Pb, Zn, and Fe at 5m distance from the raod and 0-2 cm in depth (Fig.2, Fig.3 and Table-2) might be due to the following reasons:

1- The effect of different means of transportation.
2- The difference in the proportions of mineral and organic components.

Two pathways (Al mahdya and Al thanawya) were selected to show if there were differences in concentration of the studied elements with distance from the edge of the roads and with depth in Sebha city. For distance study the concentration of Pb , Zn , and Fe, were high at distance of 5 m compared to the concentration in other distances.(Figs.2 and.3).however, sample 17 is excluded at al thanawya pathway; 40 m distance and 0-2 cm in depth , which has 153.3 ppm Lead concentration. The study also showed random variations in concentrations in other distances and also in other elements.

For the depth study, the concentration of the studied elements (except Pb, Zn, and Fe decreased with depths at 5m distance) had random variations and show no specific trend in concentrations. However, Cd and Co show a slight decrease in concentration with depth also. With regard to the percentages of organic materials and their relationship with the concentration of the studied elements (Table-3). The study showed that with the exception of cadmium, the existence of a direct relationship ranging between weak and strong between the studied elements and organic materials.

Field and laboratory studies show that the sediment size and their mineral components are similar. The sediments are fine to medium in grain size and contain mainly quartz (light mineral), a small percentage of heavy and clay minerals. The similarity in size and the low content of mineral components might be reflected the low effects of the size and mineral components (heavy and clay minerals) on the variation in the concentration of the studied elements. Similar to the grain size and mineral components of the sediments, the organic materials which show a weak to strong positive relationship with the elements might play a certain role in the concentration of the studied elements, but are not the main reason for the differences in the concentration at the different distances from the edges of the roads or with depths. This was evident from the relationship between the concentrations of some elements and organic materials, where for example at Al thanawya pathway; the concentration of Lead at the distance of 5 m was 8.4 ppm (sample 10), and this concentration increased at the distance of 10 m 2.22 ppm (sample 13), while this percentage of organic materials at a distance of 5 m was equal to 0.36 % and decreased to 0.25 % at a distance of 10 m (Table 1). Also the concentrations of Cobalt in Al mahdya pathway at 0-2 cm, 5-10 cm decreased from 0.27 ppm (sample 4) to 0.17 ppm (sample 6) respectively. While the percentage of organic materials increased from 0.15 % to 0.25 % respectively.

The previous discussion indicated the low effects of grain size, mineral components and organic materials on the variation in concentration of the studied elements. Therefore, the relatively high concentration of Pb, Zn, and Fe elements at a distance of 5 m , and 0-2 cm in depth and their decrease with depth is most probably due to the influence of different means of transportation represented mainly by hydrocarbon's exhaust where surface sediments are more susceptible to contamination with elements than the deep sediments. Moreover, the hydrocarbon's exhaust might also play a certain role in the concentration of all of the other elements, but was not the only source. This is due to low effect of grain size, mineral composition and organic material as discussed previously. The random variations in concentration of these elements on other distances and depths and of other elements with distances and depths might be related to the effects of other sources in addition to the hydrocarbon, such as residential waste (including organic material). Moreover, fenders such as trees and walls might block the emitted elements by various vehicles and then concentrated them in some localities without others. Basi et al (4) reported a concentration of sediments with various elements by hydrocarbon's exhaust of various vehicle along the sides of the roads between Bengazi and Sirt cities-Libya. The studies of Fergussun (1), FAO (5), Varnvas et al (6), Kostial (7), Wedepohel et al (8) and Wedepohel et al (9) indicated that the various transportation fuels, fats, sheets, electrical materials for cars, organic materials and clay minerals are all or some of them are sources of Lead, Cadmium, Zinc, Nickel, Cobalt, Copper, and Iron.

For iron study, the high concentration in the studied area, which is arid to semi-arid in climate, might be related to the local differences in oxidation of iron in the studied sediments in addition to the hydrocarbon's exhausts, size of sediments, minerals components of the sediments and organic materials. Pettijohn (10) indicated that the oxidation of iron in arid desert area forms desert varnish that is a thin layer of one micrometer thick and contain iron and manganese oxide.

5. Conclusion

The study of the concentration in recent sediments by some heavy minerals in the city of Sebha showed that the sediments weren't polluted and with natural concentrations. Also, the study showed that the concentrations of Pb, Zn, and Fe elements is high at the edges of the roads at a distance of 5 m and a depth of 0-2 cm and decreased with depth. The high and the decrease in concentrations of these elements might be mainly due to the hydrocarbon's exhausts at Al mahdya, Al thanawya pathways and the other locations. This might be indicated the similar sources of concentration in different areas in Sebha city. The high concentration of iron and the variations in its concentration might be due to the local difference in the rate of iron oxidation in the studied sediments in addition to the other sources.

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Table -1: Concentrations of the studied elements (ppm) and the percentage of organic matter in the study area.

Sample No.	Location	Distance (m)	Depth (cm)	Elements (ppm)							Organic Materials (%)
				Pb	Cd	Zn	Cu	Co	Ni	Fe	
1	Al mahdya pathway	5	0-2	13.0	0.048	2.18	0.66	0.42	1.17	395.15	0.42
2	Al mahdya pathway	5	2-5	8.60	0.036	2.04	0.64	0.40	1.18	279.89	0.32
3	Al mahdya pathway	5	5-10	2.80	0.016	1.17	0.58	0.38	1.12	241.93	0.09
4	Al mahdya pathway	10	0-2	3.00	0.06	0.86	0.52	0.27	0.36	178.32	0.15
5	Al mahdya pathway	10	2-5	3.60	0.05	0.73	0.48	0.23	0.43	188.05	0.13
6	Al mahdya pathway	10	5-10	2.60	0.01	1.23	0.69	0.17	0.85	484.30	0.25
7	Al mahdya pathway	20	2	5.06	0.07	1.32	0.68	0.30	1.24	241.80	0.19
8	Al mahdya pathway	50	2	2.50	0.11	1.78	0.40	0.46	1.11	188.29	0.18
9	Al mahdya pathway	10	Mixed sample	4.30	0.084	1.66	0.44	0.60	0.20	243.46	0.18
10	Al thanawya pathway	5	0-2	8.40	0.15	2.24	0.72	0.88	1.20	648.20	0.36
11	Al thanawya pathway	5	2-5	1.70	0.09	1.40	0.85	0.56	1.12	376.00	0.20
12	Al thanawya pathway	5	5-10	2.06	0.07	1.66	0.75	0.52	1.17	368.00	0.17
13	Al thanawya pathway	10	0-2	22.0	0.13	1.58	0.58	0.69	0.77	277.70	0.25
14	Al thanawya pathway	10	2-5	6.10	0.12	2.02	0.56	0.68	0.40	483.80	0.25
15	Al thanawya pathway	10	5-10	1.46	0.11	1.28	0.56	0.63	1.92	1257.3	0.14
16	Al thanawya pathway	20	2	9.30	0.11	1.97	0.64	0.58	2.26	349.16	0.57
17	Al thanawya pathway (Car station)	40	2	153.3	0.07	1.50	0.60	0.74	0.61	322.80	0.45
18	Al thanawya pathway	10	Mixed sample	21.20	0.12	2.00	0.45	1.34	0.55	293.40	0.30
19	Qead	10	Mixed sample	6.46	0.17	3.10	1.52	0.60	0.61	367.60	0.47
20	Soukra (Cars Park)	-----	Mixed sample	11.20	0.11	7.65	3.17	0.91	1.79	781.00	1.01
21	Al Hajarah area (Near fuel station)	-----	Mixed sample	10.00	0.02	3.42	1.14	0.68	1.08	510.16	1.21
22	Al thanawya pathway	10	Mixed sample	4.9	0.15	1.57	0.50	0.76	0.77	187.90	0.56
23	Qurdha (the center)	10	Mixed sample	1.46	0.13	1.23	0.44	0.52	1.65	241.90	0.13
24	Qurdha (the edge)	10	Mixed sample	2.60	0.08	1.62	0.46	1.02	1.46	446.60	1.17
25	Al jaded area	10	Mixed sample	0.93	0.16	1.48	0.65	1.04	1.94	403.40	0.11
26	Al jaded area	10	2	1.53	0.05	0.83	0.36	0.56	0.67	135.70	0.13
27	l Hajarah area (the edge	10	Mixed sample	3.00	0.29	0.99	0.34	0.83	0.57	243.60	0.12
28	l Hajarah area (the edge	10	2	2.5	0.07	1.53	0.58	1.10	0.97	215.28	0.21
29	Al thanawya pathway	10	2	4.7	0.01	1.31	0.48	0.40	0.10	107.43	0.33
30	Abdulkafee area	10	Mixed sample	2.00	0.016	1.67	0.83	0.06	1.14	672.50	0.34
31	Abdulkafee area	10	Mixed sample	2.73	0.19	2.24	0.85	1.04	2.23	618.30	0.45
32	Abdulkafee area	----	Mixed sample	5.66	0.08	3.31	3.15	0.89	0.43	645.16	0.60
33	Brak raod -Sebha	5	Mixed sample	1.40	0.042	1.41	0.69	0.78	1.02	296.00	0.04
Average				10.06	0.09	1.88	0.79	0.64	1.03	384.55	0.34

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Table -2 : The range and rate comparison of the studied elements concentration

Item No.	Metals	Concentration range (ppm)	Concentration (Average)	Comparison
1	Lead (Pb)	0.93 – 153.3	10.06	FAO, (5) , uncontaminated sediment, concentration rate 19 ppm. Fergussun, (1), Unpolluted soils less than 100ppm.
2	Cadimum (Cd)	0.01 – 0.29	0.09	FAO (5) Unpolluted sediments in Africa, with concentration rates ranging between 0.2-2.5 ppm, and unpolluted sediments in Saudi Arabia, where average concentrations range between 2.5-9.5 ppm.
3	Zinc (Zn)	0.73 – 7.65	1.88	FAO, (5), Unpolluted sediments with concentration rate of 59. ppm, and unpolluted sediments in Saudi Arabia, where average concentrations range between 4 - 32 ppm.
4	Copper (Cu)	0.34 – 3.17	0.79	FAO (5), Fresh sediments 33 ppm and average concentrations in uncontaminated sediments in Saudi Arabia, Kuwait and Bahrain are: 5.4 - 16.6, 9.2 - 20, and 5.6 – 100ppm, respectively.
5	Cobalt (Co)	0.17 – 1.34	0.64	Vernvas et.al, In Greece (6), the concentrations ranged between 2.9-9 ppm, Abo Dhahi and Al-Younes (11) indicated that the concentrations in the soil ranged from 1-40 ppm.
6	Nikel (Ni)	0.1 – 2.26	1.03	Vernas et al, In Greece, (6), the concentrations ranged from 2.3-99 ppm , Abo Dhahi and Al-Younis (11), indicated that the toxic effect is more than 100ppm and the average concentration is 100ppm .
7	Iron (Fe)	107.43 – 1257.3	384.55	FAO (5), Unpolluted continental sediments and the average concentration is 14×10^3 Abo Dhahi and Al-Younis (11), referred to the average concentration in soils is 2000 ppm.

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Table -3 : The relationship between the concentration of organic materials with concentration of the studied elements.

Metals	Correlation Coefficient (r)	Significant values (t)	Relationship
Lead (Pb)	0.1	0.5	Weak positive relationship
Caldimum (Ca)	0.03	- 0.02	There is no relationship
Zinc (Zn)	0.65	4.8	Strong positive relationship
Copper (Cu)	0.49	3.12	Strong positive relationship
Cobalt (Co)	0.45	2.75	Strong positive relationship
Nikel (Ni)	0.04	0.22	Weak positive relationship
Iron (Fe)	0.26	1.54	Weak positive relationship

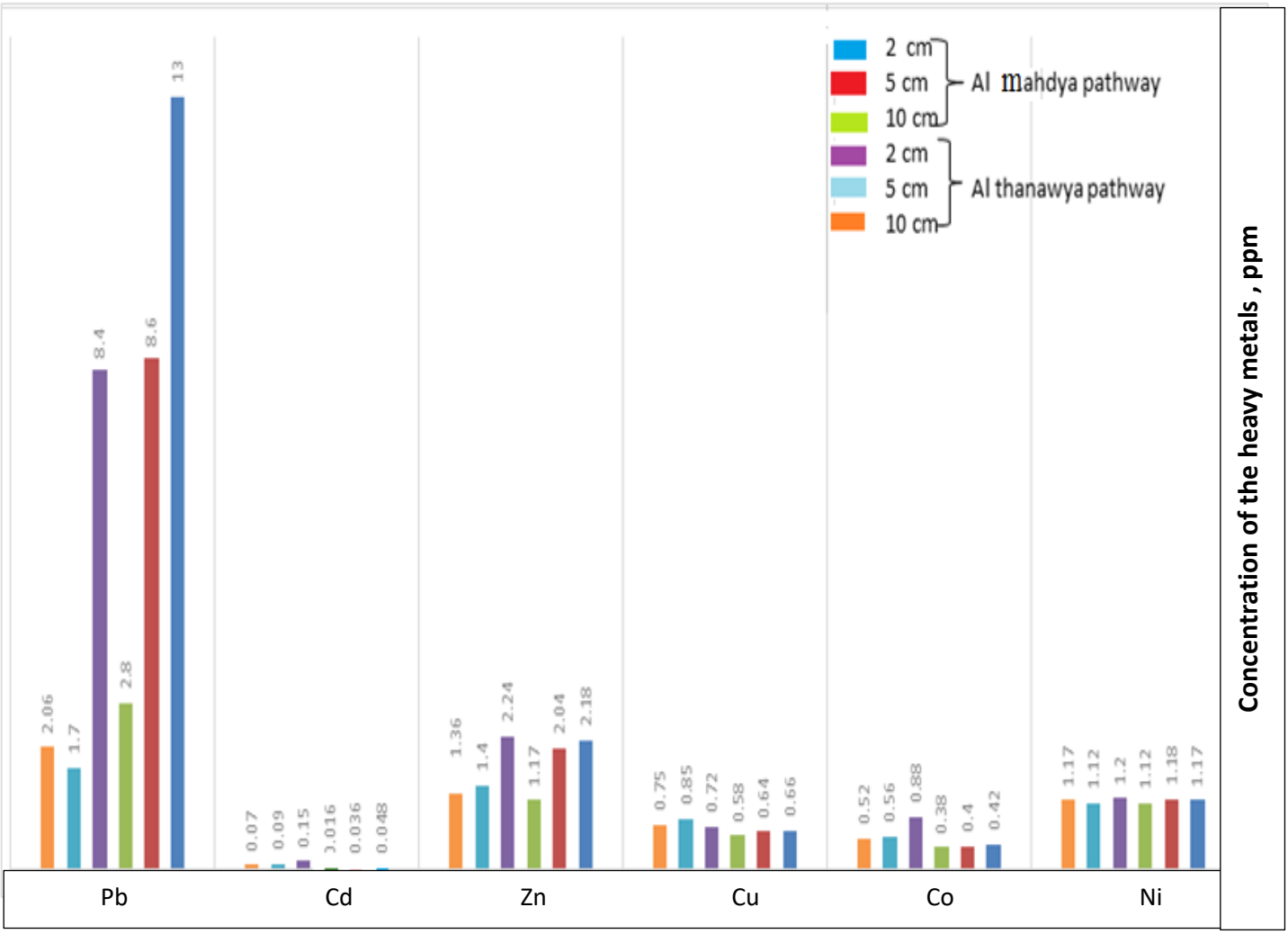

Figure 2: Concentration of the most of the heavy metals at different distances and different depths at Al mahdya and Al thanawya pathways

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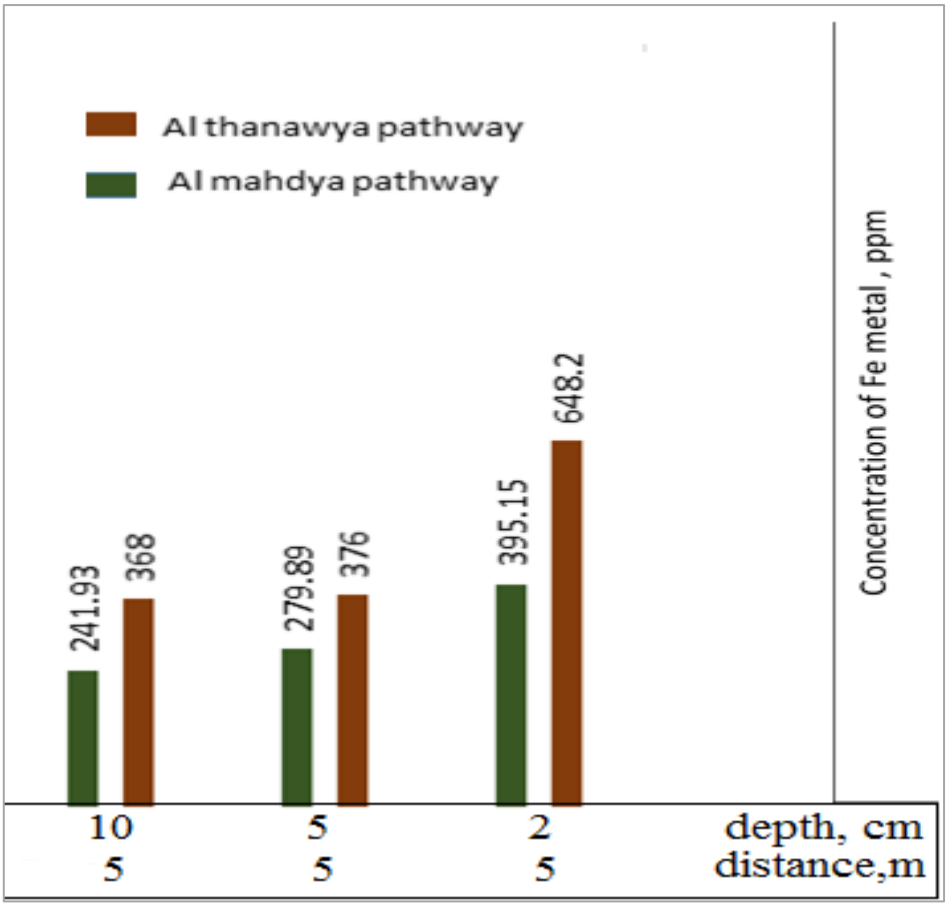

Figure 3: Concentration of Fe metal at different depths and 5 m distance from Al mahdya and Al thanawya pathways

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